# Investigating and Measuring Knowledge and Beliefs for Successful Weight Loss Maintenance

**Denisa Genes**

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

The University of Sheffield
Faculty of Science
Department of Psychology

June 2022

## Acknowledgements

I am deeply grateful to my supervisors Dr. Nicola Buckland and Prof. Fuschia Sirois for their guidance and support at every stage of my research.

I would like to express my sincere gratitude to Dr. Nicola Buckland for giving me the opportunity to conduct this research by believing in my abilities and helping me secure funding for conducting this PhD. This dissertation would not have been possible without the funding from my Teaching Fellow position in the Department of Psychology.

I would like to express my gratitude to all the people that volunteered their time to participate in my research studies. Finally, I would like to give thanks to my partner and family for their unwavering support and belief in me.

## Abstract

Obesity levels have increased in the past years and while there are effective interventions for weight loss, weight loss maintenance is more difficult to achieve. This thesis aimed to investigate whether knowledge and beliefs influence weight loss maintenance success. To this aim, a novel Weight Loss Maintenance Knowledge and Beliefs scale was developed and validated over a series of four studies. The necessity and importance of such a scale were explored focusing on theory, empirical evidence, and existing scales. A multi-dimensional scale was proposed consisting of two subscales: the Knowledge subscale which assesses knowledge about food choice and energy balance, and the Beliefs subscale that measures beliefs about hunger, calorie compensatory behaviours, and diet/obesity. In Study 1 the interpretation and understanding of the items was assessed in a sample from the general population ($n$ = 16) using the 'think aloud' method. In Study 2, the factor structure, construct and face validity of the scale were analysed in a sample of nutrition ($n$ = 106) and non-nutrition students ($n$ = 302). The convergent, discriminant and predictive validity of the scale were evaluated in Studies 3 and 4 in samples of individuals attempting to manage their weight ($n$ = 166), and weight loss maintainers and regainers ($n$ = 238). In Study 4, the influence of knowledge and beliefs on the impact of the COVID-19 lockdown on weight management practices was investigated in a sample of individuals attempting to manage their weight when the first COVID-19 lockdown started. Overall, the results provided evidence of the reliability and validity of the new Weight Loss Maintenance Knowledge and Beliefs scale in a range of different samples. Scores on the scale were related to better weight maintenance, engagement in weight management attempts and physical activity. Initial evidence of the influence of knowledge and beliefs on weight loss maintenance was demonstrated. Implications of the current research and uses for the novel scale are discussed and future research directions are proposed.

# Dissemination and Awards

## Journal Papers in preparation

**Genes, D.**, Sirois, F., and Buckland, N., “The impact of the first COVID-19 lockdown on weight management practices in UK adults: A self-regulation perspective,” (Chapter 6)

**Genes, D.**, Sirois, F., and Buckland, N., “Development and validation of a novel Weight loss maintenance knowledge and beliefs scale,” (Chapters 3, 4 & 5)

**Genes, D.**, Sirois, F., and Buckland, N., “The influence of knowledge and beliefs on weight management practices during the COVID-19 lockdown,” (Chapter 6)

## Awards

The Association for the Study of Obesity SciComm 101: Early Career Researcher Rising Star Award, September 2021

University of Sheffield Postgraduate Research Student Publication Scholarship, February – April 2022

Won a place at The European Association for the Study of Obesity Autumn School: ‘Hot Topics in Obesity’, Naples, Italy, September 2019

## Oral Presentations

**Genes, D.**, Sirois, F., and Buckland, N., “The impact of the first COVID-19 lockdown on weight management practices in UK adults: A self-regulation perspective”, The Association for the Study of Obesity SciComm, Online event, September 2021

**Genes, D.**, Sirois, F., and Buckland, N., “Validity testing of a new weight loss maintenance knowledge and beliefs scale”, University of Sheffield Psychology Postgraduate Research Conference, Sheffield, United Kingdom, July 2020

**Genes, D.**, Sirois, F., and Buckland, N., "Development and validation of a novel weight loss maintenance knowledge and beliefs scale" Food and Nutrition research Theme Meeting, Sheffield, United Kingdom, January 2020

**Genes, D.**, Sirois, F., and Buckland, N., "Exploring strategies for successful weight loss maintenance", University of Sheffield Psychology Postgraduate Research Conference, Sheffield, United Kingdom, May 2018

### Poster presentations

**Genes, D.**, Sirois, F., and Buckland, N., "Development and validation of a novel weight loss maintenance knowledge and beliefs scale" EASO Autumn School, Naples, Italy, September 2019

**Genes, D.**, Sirois, F., and Buckland, N., "Development and validation of a novel weight loss maintenance knowledge and beliefs scale", UK Congress on Obesity, Leeds, United Kingdom, September 2019

**Genes, D.**, Sirois, F., and Buckland, N., "A novel weight loss maintenance knowledge and beliefs scale", University of Sheffield Faculty of Science School Showcase, Sheffield, United Kingdom, March 2019

# Contents

# List of Tables

# List of Figures

# List of Appendices

# List of Abbreviations

AEBQ - The Adult Eating Behaviour Questionnaire

BMI – Body mass index

BREQ-3 - Behavioural Regulation in Exercise Questionnaire

BS - Beliefs subscale

CCB - Calory Compensatory Behaviours

CHBs – Compensatory health beliefs

COEQ - Control of Eating Questionnaire

CoNKS – Consumer Nutrition Knowledge Scale

DBS - Dieting Beliefs Scale

DWHQ - Dieting and Weight History Questionnaire

EI – Energy intake

FF – Food fussiness

GNKQ – General nutrition knowledge questionnaire

IFB - The Irrational Food Beliefs Scale

IMD - Index of Multiple Deprivation

ITT - Intention-to-treat analysis

KS - Knowledge subscale

LCS – low calorie sweeteners

MRP – Meal replacement products

NoHow – Navigation to a Healthy Weight

NWCR - National Weight Control Registry

OxFAB - Oxford Food and Activity Behaviors taxonomy

PA – Physical activity

PKB-7 - Practical Knowledge about Balanced Meals scale

PKM-11 - Practical Knowledge about Meal Calories scale

PSRS - The Perceived Self-regulatory success in dieting scale

R – reversed

REE – resting energy expenditure

SES – Socio-economic status

SDT – Self-determination theory

T1 – baseline

T2 – follow-up after 4 weeks

TD - temporarily stopped

TFEQ-R18 - The Three Factor Eating Questionnaire

VAS - visual analogue scales

VIF - variance inflation factor

WCSS - Weight control strategies scale

WHO – World Health Organisation

WL – Weight loss

WLM – Weight loss maintenance

WLMKB – Weight loss maintenance knowledge and beliefs

WMA - weight management attempts

WMNKQ – Weight Management Nutrition Knowledge Questionnaire

# Chapter 1: Introduction

Obesity levels have increased and pose a major health issue due to the associated risk of diseases (Blüher, 2019). Existing obesity treatments such as medication (Jones & Bloom, 2015), surgery (O'Brien et al., 2019), or behavioural interventions are successful in achieving weight loss (WL) (Hall & Kahan, 2018), but weight regain is common in most people after one year (Wing & Phelan, 2005). The current thesis aimed to investigate weight loss maintenance (WLM) focusing on identifying psychological and behavioural predictors of successful long-term weight management, as well as understanding what are the barriers in achieving WLM.

According to health behaviour theories (Ng et al., 2012; West & Michie, 2020) and WLM theories (Hill, Peters, & Wyatt, 2009; Martins, Dutton, Hunter, & Gower, 2020; Stice & Yokum, 2016), knowledge and beliefs about WLM related factors might be an important factor for WLM success. Whilst multiple interventions focus on improving knowledge and beliefs (Chung, Fong, & Law, 2021; Clifton, Condo, & Keogh, 2014; Vreeland et al., 2003), there currently are no validated measures to assess the accuracy of WLM knowledge and beliefs. Therefore, a new WLM knowledge and beliefs scale was developed and validated.

The current research explores whether knowledge and beliefs about WLM related factors influences WLM success. To this end, first a thorough literature review (Chapter 2) was conducted based on which a new scale was developed (Chapter 3). Secondly, the scale was tested for reliability and validity (Chapters 4 and 5). Finally, the scale was used in a study on the influence of the COVID-19 lockdown on weight management in a sample of individuals engaged in a weight management attempt at the beginning of the COVID-19 lockdown to assess the scale relation to weight management and engagement in weight management strategies (Chapter 6). This chapter will provide an overview of the research questions and how it was addressed in this thesis.

## 1.1. Obesity

Obesity has reached pandemic levels in the last 50 years (Blüher, 2019). This represents a major health challenge because obesity increases the risk of diseases such as: diabetes, fatty liver disease, hypertension, myocardial infarction, stroke, dementia, osteoarthritis, obstructive sleep apnoea, and several cancers (Blüher, 2019). Furthermore, there is a negative impact on emotional and mental well-being due to stigma and discrimination (Sikorski et al., 2011).

Obesity is defined by the World Health Organisation (WHO) as an excessive accumulation of fat that might affect health. Obesity is diagnosed at a body mass index (BMI) of $\geq 30$ kg/m$^2$ (MacMahon et al., 2009). Obesity levels have increased from 15% to 28% since 1993. In England, 29% of women and 27% of men are living with obesity and 31% of women and 41% of men are overweight (Baker, 2021). Treatments so far have not been successful in the long term (Hall & Kahan, 2018), in part due to complex and persistent hormonal and metabolic changes (Rosenbaum & Leibel, 2010) that fight against WL and promote weight regain (Greaves, Poltawski, Garside, & Briscoe, 2017).

There are various obesity interventions that are effective in achieving WL. These include various types of diets, lifestyle interventions, medication, and surgical procedures. Meta-analysis shows that the principal bariatric surgical procedures provide substantial and durable WL (O'Brien et al., 2019). Even though surgery seems to be the most effective intervention for long-term WL, cases of reoperation after surgery are still common and side effects and morbidity rates are high (Gribben, Ilonzo, Neifert, & Leitman, 2018; Wolfe, Kvach, & Eckel, 2016).

Another possible treatment for obesity is pharmacotherapy. Pharmacotherapy aims to target energy intake and energy expenditure related factors such as: appetite reduction, food reward system and increase resting energy expenditure (Jones & Bloom, 2015). There are multiple anti-obesity drugs that are currently available (e.g., Orlistat, Lorcaserin). Although effective for WL, these drugs have multiple side-effects (Jones & Bloom, 2015) and weight regain is very likely to happen after terminating use (Hainer & Hainerová, 2012).

## 1.2. Weight Loss Maintenance

Interventions targeting obesity have mainly focused on WL, but WLM proves to be a greater challenge (MacLean et al., 2015). Almost 80% of people that manage to lose weight gain it back in the first year (Wing & Phelan, 2005) and most will regain the weight or exceed it after 3-5 years (Avenell et al., 2004). Therefore, effective long-term treatments are necessary to tackle obesity.

WLM has been defined as intentionally losing at least 10% of the initial body weight and keeping it off for at least one year (Wing & Hill, 2001). Studies indicate that the key to success is long-term adherence to a controlled healthy diet and exercise (Grief & Miranda, 2010). WL and WLM are two different processes and require different strategies for success (Sciamanna et al., 2011). WLM is more difficult to achieve due to the necessity of long-term adherence to behaviour change as well as additional physiological challenges. The negative energy balance and decreased energy stores after WL induce changes in peripheral nutrient, hormonal (especially leptin and insulin), and other afferent neural signals, that lead to increased appetite (Cornier, Von Kaenel, Bessesen, & Tregellas, 2007; Rosenbaum, Sy, Pavlovich, Leibel, & Hirsch, 2008) and to diminish satiation (Das et al., 2007) and disproportionately decreased energy expenditure (MacLean et al., 2015; Rosenbaum &

Leibel, 2010). These processes create optimal circumstances for weight regain following successful WL.

Therefore, for successful long-term weight management, behaviour change and maintenance are necessary (Grief & Miranda, 2010). These changes are required in dietary behaviour and physical activity (Hartmann-Boyce et al., 2018), as well as setting goals and monitoring of progress towards reaching those goals (Spreckley, Seidell, & Halberstadt, 2021; Teixeira et al., 2015). However, adherence to behaviour change is challenging (Faries, 2016; Mauro, Taylor, Wharton, & Sharma, 2008). Several health behaviour theories have been developed to better explain behaviour and promote behaviour change. The main theories are presented below.

## 1.3. Health Behaviour Theories for Weight Management

According to the Self-determination theory (SDT) (Williams, Grow, Freedman, Ryan, & Deci, 1996), adherence to health behaviours and long-term success is influenced by individuals' feelings of autonomy and capability. Successful WLM depends on knowledge about what needs to be done (Eyles & Mhurchu, 2009; Truman & Elliott, 2019), and then engagement in the required behaviours (Spronk, Kullen, Burdon, & O'Connor, 2014). Engagement in certain behaviours depends on the belief that those behaviours will be useful to reach one's goals (Faries & Abreu, 2017; Pedersen et al., 2018).

Given the existent evidence of the importance of perceived and actual self-efficacy in behaviour change and maintenance (Carraça, Santos, Mata, & Teixeira, 2018; Jorge et al., 2020), knowledge and beliefs people have about WLM and its related factors are important predictors of future WLM success. Evidence to date has shown that knowledge and beliefs are weakly correlated with behaviour ($r < .30$) (Bessems, Linssen, Lomme, & Van Assema, 2020; Sason, Adelson, Herzman-Harari, & Peles, 2018; Swift, Glazebrook, Anness, &

Goddard, 2009; Wang & Coups, 2010). Researchers suggest that this is due to the characteristics of the existing available scales (Mötteli, Barbey, Keller, Bucher, & Siegrist, 2016). At the moment there are various scales that measure factors related to WLM such as: weight management nutrition knowledge (Mikhail et al., 2020), nutrition knowledge (Kliemann, Wardle, Johnson, & Croker, 2016), obesity beliefs (Swift et al., 2009) and diet belief (Osberg, Poland, Aguayo, & MacDougall, 2008) scales. But none of these are directly targeted at the belief in the effectiveness of each behaviour in WLM. Furthermore, there are currently no validated scales to measure knowledge and beliefs about WLM related factors.

There are multiple reasons why such a scale would be useful (Mikhail et al., 2020; Mötteli, Barbey, Keller, Bucher, & Siegrist, 2017). First, the scale could help investigate the relationship between knowledge and beliefs and weight management behaviour. Secondly, it will help identify individuals at greatest risk of weight regain. Thirdly, the scale can be used to evaluate the effectiveness of possible health education interventions. Finally, the scale can be used to control for differences in knowledge and beliefs to better measure the influence of other variables on WLM success.

The current research programme aimed to develop and validate a WLM knowledge and beliefs (WLMKB) scale as well as identify individual characteristics and strategies for successful WLM. The scale development followed the eight-step methodology for nutrition knowledge questionnaire development and validation recommended by Trakman et al. (Trakman, Forsyth, Hoye, & Belski, 2017). This guidance generally follows recommended psychometric testing procedures (Kline, 2000; Robinson, 2018). According to this methodology there are eight recommended steps when developing nutrition knowledge scales: i) definition of the concept; ii) generation of the item pool; iii) choice of the scoring system; iv) assessment of content validity; v) assessment of face validity; vi) item analysis;

vii) evaluation of the scale (factor structure, internal reliability); viii) assess temporal stability and confirm construct validity.

Figure 1.1 presents each step undertaken to develop and validate the WLMKB scale. Each of the steps will be presented in the chapters of this thesis. Chapter 2 of the thesis will present an overview of the existent knowledge on obesity, weight management, WLM and health behaviour theories. Chapter 3 will propose a new scale to measure knowledge and beliefs about WLM. Chapter 4 will present the second study conducted to assess the factor structure of the scale. Chapter 5 will present the third study conducted to validate the WLMKB scale. Chapter 6 will present a study conducted to identify the impact of WLMKB on weight management in a stressful time (COVID-19 first lockdown). Finally, Chapter 7 will discuss the overall results from this thesis in relation to theories and research, and present implications and conclusions of the findings in light of the strengths and limitations of the research conducted.

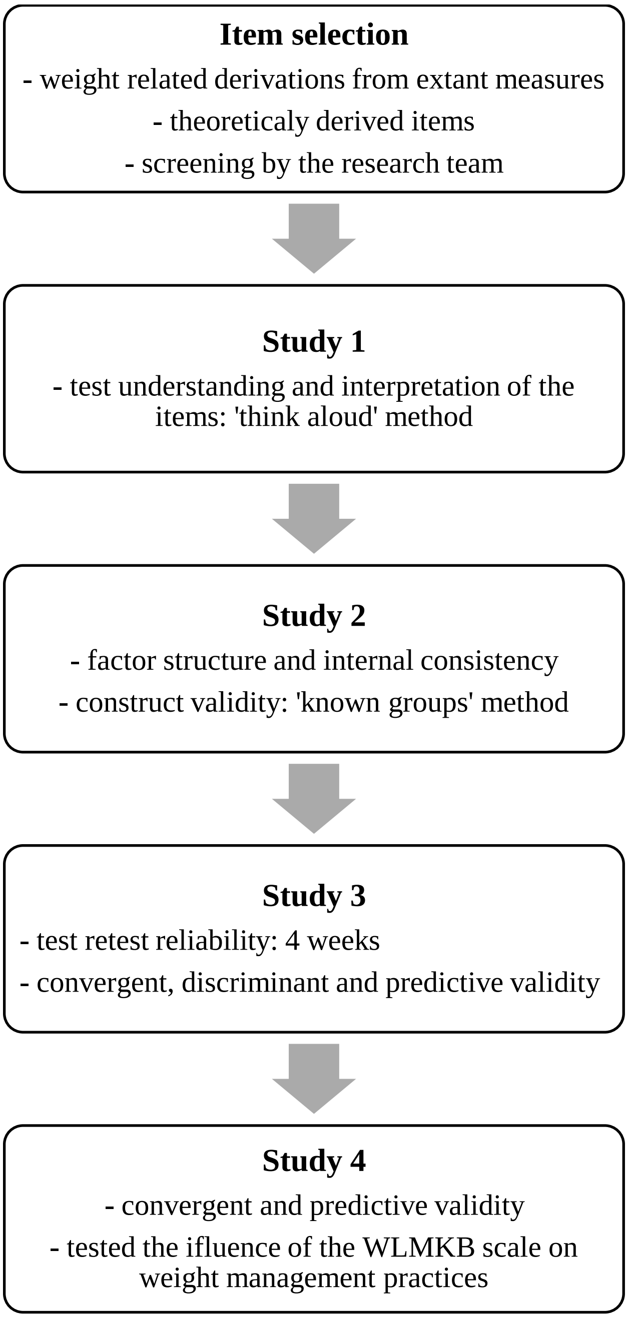



*Figure 1.1: Scale development and validation process flow chart*

# Chapter 2: Literature review

## 2.1. Importance of weight management

In England in 2019, 29% of women and 27% of men were living with obesity, and 31% of women and 41% of men were overweight (Baker, 2021). Overweight and obesity are terms used to refer to an excess of body fat and relate to increased weight-for-height. Obesity is caused by overconsumption relative to energy expenditure. However, the factors contributing to the development of obesity are numerous including genetic, environmental, physiologic, psychologic, social, and economic factors (Keith et al., 2006).

Given the rise in obesity prevalence, there is also an increase in weight management attempts, with 42% of the general population reporting trying to lose weight and 23% trying to maintain weight at some point in their life (Santos, Sniehotta, Marques, Carraça, & Teixeira, 2017). Weight management has health benefits, a WL of 5% of body weight can have a significant impact on health (Hainer, Toplak, & Mitrakou, 2008; Magkos et al., 2016). Comparatively, small weight gain in a short period can lead to permanent substantial weight gain over time (Schoeller, 2014).

While people are generally successful at losing weight, maintaining WL for a long period is harder to achieve, with most of the weight being gained back after one year. Only 20% of the people who lose weight maintain the WL for at least one year (Wing & Phelan, 2005).

WL and WLM are two distinct processes that require different strategies for success (Sciamanna et al., 2011). Extensive research has been conducted on WL generating a great number of WL programmes that suggest various ways in which an individual can lose weight (Hartmann-Boyce et al., 2021; Jolly et al., 2011; Turicchi et al., 2019). On the other hand, WLM is an under-researched area. From the limited available data, results indicate that the key to successful WLM is long-term adherence to a diet and exercise programme (Grief & Miranda, 2010). Adherence to a regimen is the biggest challenge for successful WLM. Other factors found to be associated with successful WLM are social support, accountability for one's decisions, a strong sense of autonomy, internal motivation, and self-efficacy (Elfhag & Rössner, 2005).

This chapter presents an overview of the knowledge to date regarding obesity epidemiology, treatment and theory of related factors and individual differences that impact success in weight management or susceptibility to weight gain.

### 2.1.1. Obesity

Obesity levels in the UK have increased in the last 30 years (Baker, 2021). Since 1993, the proportion of adults living with overweight or obesity in the UK has risen from 52.9% to 64.3% (NHS, 2019). Furthermore, the percentage is higher in more deprived areas, among people with disabilities and lower levels of education (Baker, 2021).

The most used method for obesity is Body Mass Index (BMI). BMI is measured by weight in kilograms divided by the square of height in meters. A BMI of 25 kg/m$^2$ to 29.9 kg/m$^2$ is an indicator that a person is overweight. A person with a BMI of 30 kg/m$^2$ or higher is considered to have obesity. BMI has been criticised as not being an accurate measure as it can be influenced by muscle mass (Prentice & Jebb, 2001). As a result, other additional measures were recommended to better identify overweight and obesity, such as waist measurement (Janssen, Katzmarzyk, & Ross, 2004). Although BMI is not a perfect measure, it has been shown to be a good proxy for body fat (Flegal et al., 2009).

Obesity is a confirmed risk factor for increased morbidity and mortality (James, 2008). Related health issues include cardiovascular disease, diabetes, and cancer. There are also other acute and chronic diseases that are related to obesity such as osteoarthritis, liver disease, kidney disease and sleep apnoea (Pi-Sunyer, 2009). Apart from the several physiological issues, there are also psychological health issues related to obesity. These include depression, low self-esteem and stigma (Schafer & Ferraro, 2011). Even though obesity and overweight were identified as major problems, a lot of individuals fail to acknowledge them. A Health Survey for England (2018) showed that out of the 61% of adults that were classified with either overweight or obesity, 45% perceived their weight as being too heavy. However, out of the individuals that were classified with overweight, 52% of men and 31% of women thought they were the right weight. The same was true for individuals living with obesity (68% men, 80% women). This could be an issue as these individuals are at higher risk of weight gain and developing other obesity related health issues (Lowe & Timko, 2004).

Possible explanations for what might have caused the increase in obesity levels include an increase in the availability of calorie-rich foods and a decrease in physical activity (Wright & Aronne, 2012). However, there is individual variability in response to the obesogenic environment, some individuals being more susceptible to the influence of external food cues than others depending on differences in eating behaviour traits (Llewellyn & Wardle, 2015; Sharma & Padwal, 2010; Townshend & Lake, 2017). Some of these traits are hedonic hunger and disinhibited eating. Hedonic hunger refers to the experience of frequent thoughts, feelings and urges about food in the absence of an energy deficit (Ely, Howard, & Lowe, 2015; Finlayson, King, & Blundell, 2007). The word hunger is commonly used to describe a physiological state that reflects the existence of energy deprivation (Lowe & Butryn, 2007). But given the changes in the food environment in the availability of palatable foods, it seems that eating behaviour is now more driven by hedonic factors rather than the need for calories (Espel-Huynh, Muratore, & Lowe, 2018). Disinhibited eating refers to the tendency to over-eat and eat opportunistically (Johnson, Pratt, & Wardle, 2012). Some examples include not being able to abstain from eating and over-eating in response to palatable foods. Disinhibition was positively associated with obesity and BMI (Bryant, King, & Blundell, 2008). Therefore, the programmes that target obesity should address both physiological and psychological aspects of obesity (Winik & Bonham, 2018). Weight management is necessary in the treatment and prevention of overweight and obesity. Presented below are principles and factors related to weight management.

### 2.1.2. Weight management

Weight management refers to the intentional control over behaviour to lose, gain or maintain weight (Winik & Bonham, 2018). Weight management is the result of the relationship between energy intake and energy expenditure (Soleymani, Daniel, & Garvey, 2016). A positive energy balance leads to weight gain, while a negative balance leads to weight loss. There are various factors that influence weight management success. Physiological factors are direct factors that have an impact on body weight such as: energy expenditure and energy intake. Changes in each of these will result in weight fluctuation (Chow & Hall, 2014; Stubbs et al., 2021). Psychological factors indirectly influence body weight through their impact on eating behaviour and physical activity.

#### 2.1.2.1. Physiological factors

Energy expenditure

Energy expenditure is the amount of calories that are burnt and is determined by body size, body composition, environment and behaviour. There are three components of daily energy expenditure: the thermic effect of food, physical activity and resting energy expenditure (Hall & Guo, 2017).

The thermic effect of food is the observed increase in metabolic rate following the ingestion of food. Therefore, it represents the energy cost of processing dietary macronutrients. Based on energy cost, protein causes the most energy expenditure, followed by carbohydrate and then fat (Westerterp-Plantenga et al., 2006).

Resting energy expenditure (REE) is the largest contributor to daily energy expenditure. It is defined as the energy expended while not performing any physical activity. Body mass and body composition are determinants of REE. A larger body mass and more fat-free mass will result in a higher REE. The amount of fat-free mass increases in obesity along with fat mass. People with obesity have a higher REE compared to lean people (Long, Nelson, Weinsier, & Schutz, 1992).

The third component of daily energy expenditure is physical activity. Physical activity can be further divided into two categories: volitional exercise and daily activities. The energy expended during physical activities is determined by duration and intensity and depends on body mass and body composition. The more a person weighs, the more energy they burn during physical activity. Therefore, people with obesity can have similar daily energy expenditure for physical activity as people without obesity, even if they are less active (Weinheimer, Sands, & Campbellnure, 2010).

Energy intake

Energy intake is defined as the total number of calories that a person ingests and is the most important factor that influences body weight. Energy intake has a direct effect on body weight as well as an indirect effect through changes in the components of daily energy expenditure (Westerterp, 2017). Energy intake includes three macronutrient groups: carbohydrates, protein and fat. Another smaller component is alcohol. The absorption of energy varies among individuals depending on type of food eaten and its preparation, and intestinal factors. Changes in macronutrient intake lead to alteration in body composition. Also it can lead to changes in body weight even when energy content is constant due to different fluid retention depending on macronutrients (Hall et al., 2012).

There are two distinct neuro-behavioural systems that regulate eating. The homeostatic system and the reward system. The homeostatic system works as a physiological-behavioural feedback loop that governs energy intake. According to this system people eat in response to the feeling of physiological hunger. Therefore, the main factors that influence energy intake are hunger, satiety and satiation. Some of the factors that were found to affect these are diet macronutrient composition (Buckland et al., 2018; Ebbeling, Swain, & Feldman, 2012; Hunot et al., 2016; Sharafi, Alamdari, Wilson, Leidy, & Glynn, 2018), medication (Wright & Aronne, 2012) and smoking (Rom, Reznick, Keidar, Karkabi, & Aizenbud, 2015).

Various types of medication have been associated with weight gain due to their influence on appetite. For example, psychotropic medication, diabetes treatment, steroid hormones, contraceptives, antihistamines, and protease inhibitors (Wright & Aronne, 2012). Some of the effects of drug-induced weight gain include increased risks of developing type II diabetes, hypertension, hyperlipidaemia, as well as poor medication compliance (Aronne & Segal, 2003). However, drugs do not directly cause weight gain, but make weight management more difficult by stimulating appetite, affecting metabolism or how the body stores and absorbs sugars and other nutrients (Saunders, Igel, Shukla, & Aronne, 2016). Therefore, medicine-related weight gain may be minimised by controlling food intake and physical activity.

Contrary to the homeostatic system, the reward system influences food intake through the sensory experience of food. The two dimensions of reward are liking and wanting

(Berridge, Robinson, & Aldridge, 2009). Liking is the hedonic part of reward and it is associated with the sensory pleasure given by eating palatable foods. Wanting is the dimension of reward that most challenges self-control. It manifests as motivation, desire, temptation and craving (Finlayson et al., 2007). Furthermore, research showed that the reward system was the primary driver of overeating (Lowe & Butryn, 2007). These results suggest that the reward system might have led to the increase in overweight and obesity in modern society.

Considering both homeostatic and hedonic systems, eating behaviour is not a simple response to physiological hunger and is greatly influenced by other psychological factors. To better understand the drivers of eating behaviour and the influence of energy intake on weight management, the concept of energy balance and the dynamic between energy intake and energy expenditure are presented below.

Balance between energy intake and energy expenditure is necessary for weight maintenance. Research suggests that this balance is not something that needs to be controlled on a short-term scale (Chow & Hall, 2014). Chow and Hall (2014) used mathematical models of human energy balance and body weight to investigate how short and long-term patterns of energy intake affect body weight. Results showed that despite large fluctuations in daily food intake, weight is stable if there is an energy balance over many months. These results suggest that the relationship between energy intake and expenditure is more complicated, each of the two influencing the other. For example, physical activity influences energy intake through appetite. Specifically, evidence showed that cardiovascular and intensive physical activity increase appetite (Blundell et al., 2020; King et al., 2009; Martins, Morgan, & Truby, 2008). Additionally, one study showed that in free-living conditions, daily energy requirements coming either from physical activity or resting metabolic rate influence daily energy intake (Hopkins et al., 2019). On the other hand, a reduction in energy intake leads to decreased energy expenditure due to changes in body composition and the thermic effect of food. Phenomenon also called adaptative thermogenesis or metabolic adaptation (Rosenbaum & Leibel, 2010; Westerterp, 2013). Furthermore, energy intake influences energy expenditure through the effect of diet macronutrient composition on body fat-free mass. Diets that differ in macronutrient composition influence the partitioning of energy storage towards body fat or protein. For example, dietary protein is known to positively influence fat-free mass and higher protein intake can lead to small increases in REE (Ebbeling et al., 2012). Research also showed that macronutrient composition can influence energy intake when the amount eaten is not controlled. As an example, increased dietary fat intake can lead to greater energy intake. However, regardless of the diet composition, no particular diet was found to be more efficient, most of them having the same trajectory, resulting in decrease in adherence over time (Chow & Hall, 2014; Freedhoff & Hall, 2016). Additionally, the energy density of foods influence energy intake by their effect on appetite and satiety. For example, lower density foods have higher volume per calorie ingested and can help reduce sensations of hunger and subsequent lower energy ingested (Buckland et al., 2019; Stinson et al., 2018). Also, there are several studies suggesting that for WL to occur an energy deficit must be established. Therefore, it does not matter if the diet is targeted toward reducing fat or carbohydrate, or increasing protein, if energy intake is not restricted, WL is not going to occur (Thom & Lean, 2017). These studies provide evidence supporting two separate views. On one side studies based on the "energy in/energy out" model suggest that obesity respects the first law of thermodynamics, that all calories that enter the body must be used as fuel or stored. Comparatively, there is evidence that some dietary approaches are more supportive for lower energy intake. For example, diets favouring low energy density foods were shown to promote satiety and helped reduce hedonic hunger (Rolls, Drewnowski, & Ledikwe, 2005). Further research is necessary to support either of the approaches, but it is widely recognised that different diet macronutrient composition influence weight management success.

#### 2.1.2.2. Psychological factors

As presented above, weight management is influenced by the dynamic between energy intake and energy expenditure. These two processes are influenced by external factors as well as each other. Furthermore, apart from the direct physiological factors that influence weight management, there are indirect psychological factors that influence behaviour and therefore weight management. Several key factors that play a role in WLM are presented below. These include habits, emotional eating, self-compassion, and restrained eating.

Habits

Habits are learned sequences of acts that were reinforced in the past by rewarding experiences and that are triggered by the environment to produce behaviour, largely outside of people's conscious awareness (Neal, Wood, Wu, & Kurlander, 2011). A significant part of daily eating behaviour consists of habits. Research shows that habits are important predictors of eating behaviour (van't Riet, Sijtsema, Dagevos, & de Bruijn, 2011). Also, people that have strong habits were shown to be less responsive to relevant information concerning alternative behavioural options (Betsch, Haberstroh, Glöckner, Haar, & Fiedler, 2001). All these factors create difficulties in the implementation of new healthy behaviours. New behaviours require deliberate intentions and conscious control (Verplanken & Aarts, 2011) and when cognitive resources are sparse it is easier to fall back to old habits (Neal et al., 2011). Habits were shown to be important factors in long-term adherence to health behaviours (Neal, Wood, & Drolet, 2013). Furthermore, successful WL maintainers report developing healthier habits (Phelan, Halfman, Pinto, & Foster, 2020).

Evidence of the importance of habits on weight management behaviour aligns with the Dual Process model (Sheeran, Gollwitzer, & Bargh, 2013). According to the Dual Process model of behaviour there are two types of cognitive processes. System 1 is comprised of the processes that are unconscious, rapid and automatic. System 2 is described by processes that are conscious, slow and deliberate (Hagger, 2016). In the context of behaviour change maintenance, the Dual Process model suggests that new health behaviours should become automatic to be easily maintained. One explanation is that when a behaviour is new or is executed infrequently, the execution of the behaviour is guided by deliberate intentions (reflexive processes, System 2), whereas when a behaviour has become habitual, intentions have little effect on behaviour (Orbell & Verplanken, 2010). In accordance with the Dual Process model, the importance of dietary habits have been largely researched (Rothman, Sheeran, & Wood, 2009; van't Riet et al., 2011). Furthermore, research showed that habit strength influences people's responsiveness to alternative behaviour options (Betsch, Haberstroh, Glockner, Haar, & Fiedler, 2001). Specifically, stronger habits were related to less responsiveness to new healthier alternatives. Relating to WLM, in a qualitative study long-term WL maintainers reported having formed habitual routines that allowed for more flexibility and stronger self-control (Pedersen et al., 2018). Therefore, future intervention in the context of WLM should aim to form new healthy habits that will cease to need conscious control and will be stronger in the face of temptation and influence of old bad habits.

Emotional eating

Differences in emotion regulation can help explain the discrepancy between initially successful WL and subsequent WLM (Sainsbury et al., 2017). According to emotional eating theory, some people eat in response to negative emotions such as stress and are more at risk of developing overweight and obesity (Canetti, Bachar, & Berry, 2002). The concept of emotion regulation refers to the efforts that people undertake to influence the experience and expression of their emotions (Gross, 1999). As an ability, emotion regulation is defined as the ability to recognise, understand, and accept emotions; control impulsive behaviours and instead act in line with long-term goals, even in the presence of negative emotions; and to flexibly apply emotion regulation strategies to modulate emotional responses to meet such goals (Gratz & Roemer, 2004). A poor ability to regulate emotions can lead to emotional eating, manifested by overeating in response to negative emotions and using food to suppress unpleasant aversive emotional experiences (Sainsbury et al., 2017).

Emotional regulation is linked to a range of psychiatric illnesses, such as anorexia nervosa, bulimia nervosa and binge eating (Gianini, White, & Masheb, 2013; Harrison, Sullivan, Tchanturia, & Treasure, 2010). This suggests that disordered eating behaviours may represent attempts at regulating emotions (Sainsbury et al., 2017). Tice and Bratslavsky (2000) argue that emotional regulation is a special case of self-regulation that can often undermine attempts at other kinds of self-control. The main reason being connected to attention, for example focusing on regulating moods and feeling states can lead to a failure of self-control in other areas such as dieting time-management and impulse control. Also, self-control involves denying impulses or hedonistic tendencies, which can lead to negative affect. People often report that they eat, drink, or smoke to feel good (Tice & Bratslavsky, 2000) and that refraining from these activities results in a negative state.

Most research in the weight management field has focused on the effect of the emotional experience on food intake but results are not always consistent (Macht, 2008; Sadler et al., 2021; Sainsbury et al., 2018; Stubbs et al., 2021). Evers et al. (2010) investigated the link between emotional regulation and emotional eating. They hypothesised that the different strategies that individuals employ to regulate the emotions are responsible for the changes in eating behaviour. Relative to reappraisal and spontaneous expression, suppression led to increased food intake, but only of the comfort foods. The results of the study show that suppressing emotions leads to an increased food intake.

Based on the three dimensions of emotions: valence, arousal and intensity, each of these dimensions have different effects on eating. High-arousal states were reported to inhibit food intake as compared to low-arousal states (Macht, 2008). There is little known about the effects of positive emotions on eating and about differences between negative emotions such as anger, sadness and fear in their effect on eating. It is suggested that anger is an important antecedent of binge eating. Disgust contributes to the maintenance of pathological eating patterns and may complicate attempts to normalize eating (Troop, Treasure, & Serpell, 2002). Therefore, evidence shows that emotions and emotion regulation are important factors that influence eating behaviour and weight management. Furthermore, emotion regulation has been researched in relation to WLM showing that individuals attempting to manage their weight might face additional negative emotions that can hinder their weight management attempts (Sainsbury et al., 2018; Stubbs et al., 2021).

### Self-compassion

Given that emotions have such strong impact on the self-regulation of health behaviours, studies have started focusing on also managing emotions in the context of health behaviour interventions. Terry and Leary (2011) argued that self-compassion may play a role in the self-regulation of health behaviour. Self-compassion is defined as taking a kind, compassionate, and accepting stance toward oneself during difficult times (Neff, 2003). Self-compassion is defined as being composed of three interrelated components: self-kindness, common humanity, and mindfulness. Self-kindness is defined as being kind and understanding towards oneself, in comparison to being harshly judgemental. Common humanity involves the realisation that everyone is imperfect, fails, makes mistakes, and faces challenges, as opposed to feeling isolated in times of suffering and considering that it is only “me” who has a difficult time. Mindfulness within the self-compassion framework entails being aware of one’s negative thoughts and emotions in a balanced way, without any exaggeration or ignorance (Neff, 2003).

Self-compassion plays a role in weight management by aiding with emotion regulation (Duarte et al., 2019; Rahimi-Ardabili, Reynolds, Vartanian, McLeod, & Zwar, 2018). For example, a diet transgression can result in feelings of shame, self-criticism and unrestrained eating (Polivy, Herman, & Deo, 2010). A self-compassionate person may view these transgressions less negatively and therefore, not become overly self-critical, or experience feelings of guilt and shame.

Rahimi-Ardabili et al. (2017), in a systematic review, investigated the effects of interventions that aim to increase self-compassion on obesity and weight related psychological conditions. The analysed studies suggest that self-compassion might have beneficial effects on a range of outcomes in healthy, normal weight or overweight people. These benefits can include WL (Mantzios & Wilson, 2015), improved nutrition behaviours (Braun, Osecheck, & Joyce, 2012), reduced dietary disinhibition (Adams & Leary, 2007) and reduced risk factors such as body dissatisfaction (Albertson, Neff, & Dill-Shackleford, 2015). Also, there is theoretical evidence that self-compassion might alleviate barriers to healthy weight management, specifically through emotional regulation such as decreasing self-critical thoughts, decreasing stress, and increasing acceptance (Adams & Leary, 2007).

Self-compassion is a relatively stable personality trait that can also be induced or fosters as a state (Leary, Tate, Adams, Allen, & Hancock, 2007; Neff & Germer, 2013), therefore, research into the connection of self-compassion and health behaviour maintenance can be helpful in the development of interventions for promoting long-term behaviour changes such as those needed for WLM. Interventions that are based on improving self-compassion depend on the levels of depression and perfectionism (Rahimi-Ardabili et al., 2018). Also, in order for self-compassion interventions to be effective there needs to be a negative response to a transgression from the goal (Terry & Leary, 2011). Therefore, the individual needs to have a conscious goal (WLM) and to self-monitor progress towards that goal (weighing). Whilst there is some evidence showing that higher self-compassion is associated with better WLM (Stubbs et al., 2011), healthier eating habits (Sirois, Kitner, & Hirsch, 2015), and adaptive responding to dietary lapses (Thøgersen-Ntoumani, Dodos, Stenling, & Ntoumanis, 2020), to date there is limited research on the effects of self-compassion on WLM, suggesting further research is necessary (Biber & Ellis, 2019; Rahimi-Ardabili et al., 2018).

### Restrained eating

Restrained eating is defined as an eating style that is under cognitive control and is described by a persistent pattern of eating-related behaviours and cognitions that aim to reduce or maintain body weight (Herman & Mack, 1975). Conscious control of eating behaviour can result in disinhibition and overeating when under limited cognitive capacity or when experiencing negative emotions (Cools, Schotte, & McNally, 1992). One explanation for these findings is that negative emotions undermine restrained eaters' ability to continue dieting because they become a primary concern and lead to eating "as if the diet boundary had been knocked down" (Keller & Hartmann, 2016; Stroebe, Van Koningsbruggen, Papies, & Aarts, 2017).

An alternative explanation is the "limited capacity hypothesis" (Boon, Stroebe, Schut, & Ijntema, 2002), which proposes that restrained eaters' food intake is increased, if their cognitive capacity to maintain restricted food intake is limited by distraction. Processing of emotional stimuli requires attention, and since cognitive capacity is limited, cognitive control over eating may be impaired. The overeating response was attributed to ironic processes, for example, the more people exert cognitive control, the higher their vulnerability to overeating will be (Boon et al., 2002).

Even though research tends to suggest that eating restraint can cause disinhibited eating in certain situations, this perspective has been criticised. A possible alternative explanation for the association between restrained eating and disinhibited eating can be attributed to the measuring tool used to assess restrained eating (Johnson et al., 2012). The Restraint Scale (Polivy, Herman, & Warsh, 1978) was the first tool developed to measure restrained eating, and it also includes subscales about disinhibited eating, weight history and weight fluctuation. When other scales have been used to measure restrained eating such as The Three Factor Food Questionnaire (Stunkard & Messick, 1985) or the Dutch Eating Behaviour Scale (Wardle, 1987) no correlation was found with disinhibited eating (Johnson et al., 2012). This suggests that restrained eating is not a cause of disinhibited eating. Rather, people with poor self-control have to become restrained to lose or maintain weight. These results suggest that the correlation between restrained eating and disinhibited eating is explained by the fact that the Restraint Scale is a measure of unsuccessful restrained eating rather than restrained eating per se. Furthermore, using other scales to measure restrained eating associates restrained eating with lower energy intakes (Polivy, Herman, & Mills, 2020; Stewart, Martin, Williamson, 2022).

For the purpose of clarity in the current thesis restrained eating/eaters was used to refer to the conscious effort to restrict food intake or the intent of controlling food intake (Lowe & Timko, 2004). Restrained eaters therefore include individuals that are dieting and restricting their food intake, as well as those that only want to do so. Furthermore, dietary restraint will be used as referring to the actual control of food intake.

Weight management requires some form of dietary restraint (Stewart et al., 2022; Thom & Lean, 2017). There are two types of dietary restraint: flexible restraint refers to a balanced approach to eating, whereas rigid restraint is described by a dichotomous, all or nothing approach to eating (Westenhoefer, Stunkard, & Pudel, 1999). The two approaches to dietary restraint have different effects on weight management with flexible restraint being linked to better WL outcomes (Westenhoefer et al., 2013) and rigid restraint being highly correlated with disinhibited eating (Westenhoefer, 1991).

Research on cognitive restraint and WLM is limited, however research to date suggests that dietary restraint is necessary for WLM (Johnson et al., 2012; Vogels, Diepvens, & Westerterp-Plantenga, 2005; Westerterp-Plantenga, Kempen, & Saris, 1998). Further research should be conducted to better understand how different types of dietary restraint affect WLM.

## 2.2. Weight loss maintenance

The above section covered the importance of weight management for tackling obesity and presented the physiological and psychological factors relating to weight management and WLM. This section will further present research evidence on WLM focusing on identifying limitations of the methods used and gaps in knowledge and understanding of WLM.

In research, WLM has been defined as intentionally losing at least 10% of the initial body weight and keeping it off for at least one year (Wing & Hill, 2001). This definition varies between studies, ranging from initial WL of 5% to 10% and maintenance period from 6 months to 2 years (Santos, Vieira, Silva, Sardinha, & Teixeira, 2017). Research shows that WLM is difficult to achieve and it imposes a greater challenge compared to WL (Mcguire, Wing, Klem, Seagle, & Hill, 1998; Stubbs et al., 2011). Sciamanna et al. (2011) argue that the reason for the difference in success rate between WL and WLM is due to weight maintenance interventions being based on the simple continuation of WL strategies in the long term even though different strategies are necessary for WLM. In their study, out of 36 practices, only 8 provided advice for both WL and WLM. Some of the behaviours that have been identified as facilitating WLM include high levels of physical activity, low calorie and fat intake, high dietary restraint, eating breakfast daily, self-monitoring of food intake, and regular self-weighing (Ramage, Farmer, Apps Eccles, & McCargar, 2014). WL maintainers also control their appetite, engage in more physical activity and remain more vigilant (Stubbs & Lavin, 2013). Existing evidence shows that response to lapses is an important factor differentiating between WL maintainers and regainers (Dohm, Beattie, Aibel, & Striegel-Moore, 2001).

### 2.2.1. Methods used in WLM research

One used approach to identify factors related to successful WLM is to study individuals that have successfully lost weight and maintained the weight loss. National Registries in the United States, Portugal, Germany, Finland and Greece (Feller et al., 2015; Santos et al., 2017; Wing & Phelan, 2005), are large databases of WL maintainers. The first registry was the National Weight Control Registry (NWCR) established in 1994 in the United States. These registries facilitate access to the population and follow their experience and success. A systematic review of weight control registries, with 52 articles from five registries (Paixão et al., 2020), identified the cognitive and behavioural weight management strategies related to WLM. Results showed that most WL maintainers relied on strategies such as: regular breakfast intake, increased consumption of vegetables and fibre rich foods, limiting intake of fatty and sugary foods, reducing fat in meals, having healthy foods available at home, and having a regular meal frequency. These results provide evidence on the importance of weight control registries in providing knowledge on WLM. Furthermore, these results show that WL maintainers rely on different strategies, and no single combination of behaviours works for all.

Although a frequently used approach, research using weight control registries has been criticised. Some of the issues are self-selection bias, self-reported data and weight regain after registering (Ikeda et al., 2005). All these issues suggest that registries might not be representative samples of the WL maintainers population. Furthermore, these limitations could lead to an overestimation of the success rate in WLM. Although, findings from these weight control registries might have limited applicability to the general population, these registries provided access to a hard-to-reach population and generated initial evidence of the characteristics of successful WL maintainers (Ikeda et al., 2005). A systematic review of weight control registries concluded that there is no single approach to WL and WLM and highlight the importance of flexibility and use of different combinations of cognitive and behavioural strategies (Paixão et al., 2020).

Another approach used to research WLM is to follow the participants of WL programmes after the programme has finished (Coughlin et al., 2016; Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011). For example, a study investigating the long-term effects of type of exercise combined with diet interventions, showed that including physical exercise in WL programmes had an effect on body composition and BMI after three years from the intervention (Rojo-Tirado et al., 2021). Findings from these types of studies provide insight into behavioural strategies that WL maintainers use. Therefore, information about the reasons why some participants chose to continue using certain strategies or not cannot be obtained using this type of approach. This is because the WL strategies used are guided by the assessed programme, and further information on the behaviours and strategies used after the intervention terminated are not collected.

Other methods used to study WLM include qualitative studies, systematic reviews, and meta-analysis. For instance, qualitative interviews were conducted to gain insight into factors such as: weight stigma (Greaves et al., 2017), WLM strategies (Carrard & Kruseman, 2016; Kruseman, Schmutz, & Carrard, 2017), and weight regain (Sainsbury et al., 2018). Reviews on WLM have looked at different aspects such as: intervention outcomes on WLM (Franz et al., 2007), strategies for WL compared to WLM (Sciamanna et al., 2011), behavioural and cognitive determinants of WLM (Varkevisser, van Stralen, Kroeze, Ket, & Steenhuis, 2018).

### 2.2.2. Predictors of WLM success

In a systematic review, Varkevisser et al. (2018) identified determinants of WLM. Each strategy was grouped as related to monitoring, energy expenditure or energy intake. Results showed that positive predictors of WLM were: self-monitoring eating and weight, increase in physical activity and reducing energy intake (portion control, cutting unhealthy foods) (Varkevisser et al., 2018). Some of the psychological factors that were found to predict WLM included self-efficacy for exercise and weight management. Low impulse control was found to be a negative predictor. As a conclusion Varkevisser et al. (2018) suggest that interventions should focus on changing behaviour to reduce energy intake and increase energy expenditure. Also, self-monitoring techniques should be promoted and self-efficacy for diet and exercise should be stimulated.

The role of self-weighing in weight management as a means of self-monitoring has been extensively discussed. Some arguments against daily weighing practices include feeling of discouragement with results (Brownell, 2004; Cooper & Fairburn, 2001) or engagement in unhealthy weight control practices (Heckerman, Brownell, & Westlake, 1978). Pacanowski et al. (2014) in a critical review of literature argue that daily self-weighing is effective in preventing age-related weight gain. There is also agreement that the frequency of self-weighing correlates with success in losing weight and sustaining the WL (Kinsey et al., 2021; Thomas, Bond, Phelan, Hill, & Wing, 2014). Additionally, vigilance was identified as an important factor in WLM (Stubbs & Lavin, 2013), with WL maintainers reporting they use more self-monitoring strategies (Hartmann-Boyce, Boylan, Jebb, & Aveyard, 2019) and better coping strategies when lapses occur (Dohm et al., 2001).

Behavioural theory states that weighing may serve as a mildly aversive stimulus and a reinforcer by helping patients notice deviations in their weight throughout the day (Pacanowski, Bertz, & Levitsky, 2014). But research shows that self-weighing without an intervention for WL does not produce a significant WL (Benn, Webb, Chang, & Harkin, 2016; Carrard & Kruseman, 2016; Daley, 2014; Fahey, Klesges, Kocak, Wayne Talcott, & Krukowski, 2018). Self-weighing is associated with WLM, the more frequently people weigh themselves the more successful they are at maintaining their weight after a year (Thomas et al., 2014). Data on the NWCR shows that 75% of WL maintainers reported that they weighed themselves at least one per week.

Daily self-weighing seems to have a positive effect on weight management (Pacanowski et al., 2014). Published data shows that people who frequently weigh themselves are more successful at losing weight and maintaining weight loss, with frequency of weighing being a possible indicator of the motivation to control weight. Although we must be vigilant of possible negative side effects of frequent self-weighing on restrained eaters and people who might be vulnerable to eating disorders (Benn et al., 2016; Carrard & Kruseman, 2016), the data, so far, does not present a cogent argument for daily self-weighing as a serious risk (Fahey et al., 2018; Houston, Van Dellen, & Cooper, 2019).

While interventions for WL are successful, WLM interventions have not rendered similar results (Ahlgren et al., 2016; Forman et al., 2007; Ross, Thomas, & Wing, 2016). The number of WLM interventions available is limited (Dombrowski, Knittle, Avenell, Araújo-Soares, & Sniehotta, 2014; Golay, 2015). Thus, most weight management programmes focus only on WL and do not provide specific strategies for WLM. Given existent research, future interventions for WLM should provide strategies specific for weight maintenance and focus on behaviours that influence energy intake and expenditure. Other factors that should be targeted include self-monitoring and self-efficacy.

## 2.3. WL versus WLM

Considering the above processes that take part in weight management, there are factors that can be controlled (energy intake, exercise energy expenditure) and factors that are outside of our conscious control (resting energy expenditure, thermic effect of food). Existing behavioural interventions focus on training individuals to control their behaviour to lower energy intake and increase energy expenditure (Mann et al., 2007; NICE, 2014; Nordmo, Danielsen, Nordmo, Sørebø, & Magnus, 2020).

Behaviour change interventions have been widely used and tested, and there is strong evidence on their effectiveness in achieving significant WL (Lawlor, Islam, et al., 2020; Weinheimer et al., 2010). WLM is however more difficult to achieve. Evidence and arguments on why this might be the case are discussed next.

### 2.3.1. Psychological barriers to WLM

WL and WLM are two different phases that require distinct strategies for success. Compared to WL, WLM is a greater challenge because of the necessity to adhere to health behaviours in the long term. Also, there are a multitude of other psychological and physiological barriers added in the WLM period compared to WL. Each of these will now be discussed.

One of the biggest challenges of WLM is the necessity of long-term adherence to a diet and exercise programme (Grief & Miranda, 2010). Most people regain weight after WL because they stop using strategies to control their energy intake and expenditure to manage their weight (Lowe & Timko, 2004). A possible explanation for the declining adherence is that the cost of adherence gradually exceeds the perceived benefits. The positive consequences of WL outweigh the effort needed to lose weight. In contrast, in the WLM phase the positive feedback is less compared to the effort required to keep adhering to the same regimen (MacLean et al., 2015).

Another psychological barrier of WLM is that a lot of times the necessity of control over eating and monitoring weight are perceived as a burden (Kruseman et al., 2017). In a qualitative study on WL maintainers and people with a lifetime stable normal weight, results showed that WL maintainers perceived strategies for WLM as a burden. Inaccurate beliefs about WLM could be a possible explanation for this. For example, WLMs might believe that they have to avoid certain foods that they like in order to maintain their weight "I cut out all soft drinks, ice-tea, I banned all that from my diet" (Kruseman et al., 2017). Also, another possible explanation is that WLMs tend to believe that other people can eat a lot without gaining weight "I'd like to be one of those persons who can eat everything and never gain one gram" (Kruseman et al., 2017). To date there is no evidence of the impact of inaccurate beliefs on WLM. However, results relating to WL (Osberg et al., 2008) and eating disorders (Osberg & Eggert, 2012) argue on the importance of these beliefs in weight management (Nolan & Jenkins, 2019).

### 2.3.2. Physiological barriers to WLM

As previously mentioned, weight maintenance is the direct result of energy balance between energy intake and energy expenditure. Several factors that influence energy balance have been identified. Compared to weight management, WLM presents additional barriers and factors that influence energy balance. These barriers are further presented.

Body weight is regulated through the peripheral hormonal signals released from the gastrointestinal tract, pancreas, and adipose tissue integrates, primarily in the hypothalamus (MacLean et al., 2015). These signals regulate food intake and energy expenditure (Schwartz, Woods, Porte, Seeley, & Baskin, 2000). There are a great number of identified peripheral modulators of appetite, these include: leptin, insulin, ghrelin, cholecystokinin, peptide YY, pancreatic polypeptide, and glucagon-like peptide 1 (Sumithran et al., 2011).

Compensatory physiological responses to WL result in a rapid, profound reduction in circulating levels of leptin and energy expenditure and an increase in appetite. Research shows that WL perturbs the hormones, peptides and nutrients that are involved in the regulation of body weight. After diet-induced weight loss, there are modifications in the postprandial release of amylin and pancreatic polypeptide. Furthermore, the changes in levels of leptin, ghrelin, peptide YY, gastric inhibitory polypeptide, pancreatic polypeptide, amylin, and cholecystokinin, as well as changes in appetite, persist for 12 months (Sumithran et al., 2011). Additionally, these hormonal changes are experienced by individuals as increased hunger (Martins, Dutton, et al., 2020).

The negative energy balance and decreased energy stores after WL induce changes in peripheral nutrient, hormonal (especially leptin and insulin), and other afferent neural signals, that lead to increased appetite by the response in neural circuitry providing feed-forward input to enhance rewarding value of food (Cornier, Von Kaenel, Bessesen, & Tregellas, 2007; Rosenbaum, Sy, Pavlovich, Leibel, & Hirsch, 2008) and to diminish satiation (Anton et al., 2009; Das et al., 2007) and disproportionately decreased energy expenditure (MacLean et al., 2011; Rosenbaum et al., 2010). These processes are creating optimal circumstance for weight regain following WL by increasing appetite and decreasing energy expenditure. These compensatory mechanisms that encourage weight regain need to be overcome in order to maintain WL.

### 2.3.3. WLM Theories

Several WLM theories have been developed that argue on the importance of the metabolic adaptation following WL in weight regain. For example, the Compensatory theory proposes that there are metabolic adaptations after WL that lead to weight regain (Fothergill et al., 2016; MacLean, Bergouignan, Cornier, & Jackman, 2011). According to the Compensatory theory, weight regain after WL is caused by adaptations in the organism that promote it (Doucet, McInis, & Mahmoodianfard, 2018; Martins, Dutton, et al., 2020; Sumithran et al., 2011). These adaptations include hormonal changes that lead to increase in appetite and decrease in satiety and metabolic adaptations that lead to decrease in energy intake (Müller, Enderle, & Bosy-Westphal, 2016; Rosenbaum & Leibel, 2010). This theory generated interest in identifying whether metabolic adaptation due to WL predicts relapse (Camps, Verhoef, & Westerterp, 2013; Fothergill et al., 2016; Johannsen et al., 2012; Weinsier, Nagy, Hunter, Darnell, & Hensrud, 2000).

However, the evidence on the subject is not consistent (Ostendorf et al., 2018). Recent evidence showed that there is no metabolic adaptation after two years from WL. Additionally, no association was observed between metabolic adaptation and weight regain. Further results show that metabolic adaptation is linked to energy balance, with increase metabolic adaptation when in energy deficit (Martins, Gower, Hill, & Hunter, 2020; Martins, Roekenes, Salamati, Gower, & Hunter, 2020).

Research examining the effect of WL on appetite showed that contrary to expectations, satiety levels increased after WL (Nymo et al., 2019). Due to these results, the authors proposed an alternative theory to the compensatory model called the Normalisation theory (Martins, Dutton, et al., 2020). According to the Normalisation theory, WL does not lead to metabolic adaptation but to normalisation towards a lower BMI. Therefore, as metabolic adaptation is not the driver of weight regain, other factors are responsible for weight regain after WL and these should be further investigated.

Another WLM theory is the Energy Gap theory (Hill et al., 2009), according to which weight gain after WL is caused by the difference between the energy required and the energy desired. This gap is accentuated due to the increase in appetite following WL and the lower energy required at the new lower BMI (Doucet et al., 2018; Ostendorf et al., 2019). Therefore, following this theory, WLM success is dependent on the persistent conscious effort to not overeat. Research testing this theory showed that WL maintainers achieve energy balance by engaging in higher levels of physical activity compared to controls to compensate for the higher energy intake (Creasy et al., 2021). These results bring evidence on the benefits of a high energy flux for WLM (Melby, Paris, Drew Sayer, Bell, & Hill, 2019). However, whether more exercise is better for preventing weight regain and promoting WLM is still under debate (Jakicic, 2021; Washburn et al., 2021).

The Dynamic Vulnerability Model of Obesity (Stice & Yokum, 2016) is an alternative model to the behavioural change models. While behavioural change models are based on the thesis that there is a homeostatic regulation of appetitive behaviour, the Vulnerability model focuses on the hedonically motivated behaviour model (Stice & Burger, 2019). This theory was developed on the basis of neurology research that shows similarities in the reward system relating to substance and that of food (Burger & Stice, 2011). According to this theory, individuals at risk for obesity experience hyper-reward responsivity from food intake that leads to overeating. Episodes of overeating then lead to a reduction in the receptors and signalling to food intake as well as hyper-responsivity to food cues. Therefore, weight gain is a dynamic process based on reward sensitivity that drives overeating in a feed-forward fashion (Burger & Stice, 2011).

Evidence based on the hedonic motivated behaviour model of obesity shows the importance of reward, habits and food cues on weight gain (Stice & Burger, 2019). Treatment implications would therefore suggest on targeting habits and food cues to lower the vulnerability dynamic process.

## 2.4. Health Behaviour Theories for Weight Management

Research interest in WLM has only risen in recent years. Although there are already studies applying health theories to WLM, most of them have only been applied in the more general domain of weight management or WL. This section will present some of the health behaviour theories that present models of health behaviour maintenance that are relevant in the context of WLM.

### 2.4.1. Self-Determination theory

SDT suggests that behaviour will occur and be maintained if it is autonomously motivated (Williams et al., 1996). In the context of WLM research, SDT suggests that it is important to distinguish between behaviours that are chosen and have an internal locus of control (autonomous), and behaviours that are driven by external pressures and have an external locus of causality (controlled) (Ng et al., 2012). For WL, the theory argues that lasting behaviour is the result of accepting the behaviour change as one's own. Therefore, it requires internalization of values and behaviours relevant to the proposed aim. In accordance with this theory, WLM success will be the result of behaviour change driven by personal internal motivation and internalised value over necessary behaviours for weight and health maintenance. Interventions in accordance to this theory aim to enhance individual's competence (Ng et al., 2012; Teixeira, Carraça, Markland, Silva, & Ryan, 2012).

Studies show that diet flexibility (Joki, Mäkelä, & Fogelholm, 2017) and autonomous motivation (Miquelon, Knäuper, & Vallerand, 2012) are key factors for WLM. Additionally, weight locus of control was a key factor for WLM success (Jorge et al., 2020). Weight locus of control being defined as the individuals' belief in their ability to affect or control their weight (Stotland & Ztiroff, 1990). It is therefore important to promote accurate information about the processes of WL and WLM. With proper knowledge about how diet and exercise work for WLM, people can choose the strategies that better fit their lifestyle, and strategies that they find sustainable in the long term. Increasing people's knowledge on nutrition and physical exercise can increase their feeling of competence. Also, the freedom to choose strategies for WLM can make individuals more autonomous and therefore increase the internalisation and autonomous motivation for WLM. Whilst there are interventions that promote and train participants on knowledge related to WL and WLM. Currently there are no validated measures to assess accuracy of knowledge related to WLM. Such a measure would help assess the effectiveness of these interventions and would also enable research on the influence of knowledge on weight locus of control.

### 2.4.2. The Health Belief Model

The focus of the Health Belief Model (Champion & Skinner, 2008; Janz & Becker, 1984) is on beliefs. This model argues that beliefs provide a link between socialization and behaviour. Beliefs are also modifiable and can differentiate between individuals from the same background. The model defines the relationship between health beliefs and behaviours based on Lewin's expectancy-value model (Lewin, 2004). According to this model engagement and adherence to a behaviour depends on the perceived value of the outcome, or the expectation that the desired outcome will be achieved (Champion & Skinner, 2008). Early research found that these health beliefs were corelated with health behaviour (Williams et al., 1996). Therefore, health beliefs and outcome expectancy could be useful in differentiating between those who do and do not undertake such behaviours.

The Health Belief Model focuses on two aspects of individual's representation of health and health behaviour: threat perception and behavioural evaluation. Threat perception was constructed as two key beliefs, perceived susceptibility to illness or health problems anticipated severity of the consequences of illness. Behavioural evaluation also consisted of two distinct sets of beliefs, those concerning the benefits or efficacy of a recommended health behaviour and those concerning the costs of, or barriers to, enacting the behaviour (Noar & Zimmerman, 2005).

The Health Belief Model emphasizes on the importance that health beliefs have on behaviour. Weight management success largely depends on people engaging in behaviours that will help balance energy intake and energy expenditure. A strong belief in the effectiveness of health behaviours will make people more likely to engage in them and therefore more successful in managing weight. It is therefore important to be aware of people's health belief about WLM related behaviours and their effectiveness. A good assessment of these might help predict behaviour and therefore success.

### 2.4.3. Compensatory Health Beliefs

WLM requires a change in eating behaviour and physical activity for a long period of time. Previous research showed that only a few individuals can successfully change their eating behaviour in the long run (Wing & Phelan, 2005). The Compensatory Health Belief Model (Knäuper, Rabiau, Cohen, & Patriciu, 2004) describes a number of strategies that adults use to maximize pleasure and minimize harm when dealing with temptations that may interfere with their health goals. Having a long-term goal for losing weight and then getting an offer to eat fast food, can produce a motivational conflict and cognitive dissonance (Festinger, 1962) for the individual. To alleviate the bad feeling and justify the behaviour, people activate Compensatory Health Beliefs (CHBs) (Rabiau, Knäuper, & Miquelon, 2006).

There are three strategies that individuals can use when faced with temptations. The first strategy is to resist the temptation. This behavioural strategy is effortful and requires self-control, high levels of self-efficacy, and intrinsic motivation (Rabiau et al., 2006). The second strategy is to change the perception of harm caused by the behaviour or re-evaluating outcome expectancies (Rabiau, Knäuper, & Miquelon, 2006). For example, changing beliefs that the behaviour is unhealthy, into thinking that there is no negative health risk such as weight gain. Using this strategy minimises the cognitive dissonance and results in doing the unhealthy behaviour, guilt-free. The third strategy is to activate CHBs. CHBs are beliefs that the negative consequences of an unhealthy behaviour can be compensated for with the assumed positive effects of a healthy behaviour. For example, believing that a behaviour that might compromise health goals, such as eating high calorie foods, can be engaged in if it is compensated by another healthy behaviour, such as exercising. The activation of CHBs can lower intentions to resist the desire for unhealthy food (Knäuper et al., 2004), which in turn can help to explain the occurrence of unhealthy eating (Kronick, Auerbach, Stich, & Knäuper, 2011) despite the intention to eat healthily.

Implementation intentions are strategies that consist of making a detailed plan for a future situation, such as, '*I will go to the gym at 7pm after work and use the treadmill for twenty minutes*' (Gollwitzer, 1999). The actual initiation of the planned behaviour depends on the level of self-efficacy. There is a bigger chance of the compensatory behaviour being carried out if the individuals have a high level of self-efficacy and think they can carry out the behaviour (Rabiau, 2007).

Tendencies to engage in CHBs have been associated with negative health outcomes (Rabiau, Knäuper, & Miquelon, 2006). There are two possible explanations for this association. Firstly, individuals could develop inaccurate or maladaptive CHBs. A maladaptive CHB is an incorrect belief that an unhealthy behaviour can be compensated for by the healthy outcome of a different behaviour. For example, the belief that the negative health outcome of fast-food consumption (i.e. additional calories) can be minimised by eating salad as the additional calories cannot be eliminated from consuming another food.

Secondly, the negative association between CHBs and health could be due to CHBs being developed in response to nutritional interventions for overweight and obesity. For example, a study showed that the increased awareness of portion sizes and the use of front-of-package logos resulted in compensation behaviours and was associated with increased food consumption (Poelman, Vermeer, Vyth, & Steenhuis, 2013). Research found that individuals with overweight or obesity, hold more CHBs than healthy weight individuals (Knäuper, Rabiau, Cohen & Patriciu, 2004). Furthermore, individuals that tended to use CHBs in one health domain were more likely to use CHBs in other health domains (e.g. substance use, stress, weight regulation). Research on CHBs for WL dieting showed that a more autonomous motivation to manage weight was associated with fewer CHBs (Miquelon, Knäuper & Vallerand, 2012). This could be due to the individuals' better ability to resist the temptations interfering with their self-set goals. Furthermore, CHBs may have different effects at different stages of the behaviour change process (Radtke, Kaklamanou, Scholz, Hornung, & Armitage, 2014).

However, the concept of compensation could be favourable for weight maintenance. Compensatory behaviours could be used in response to excessive energy intakes (Wammes, French & Brug, 2007). The ‘balance intervention’ is an example of intervention that promotes caloric compensation either through decreasing food intake or increasing physical activity in response to overeating to maintain energy balance. The balance intervention was associated with more positive attitudes, intentions and self-reported compensatory caloric restriction in response to overeating (Wammes, Breedveld, Kremers, & Brug, 2006).

According to Teixeira et al. (2010) a flexible dietary restraint was shown to be better for WLM than a rigid dietary restraint. Research shows that increased exercise self-efficacy leads to a more flexible dietary restraint. A possible explanation for this correlation can be an increase in CHBs. If the individuals feel they can carry out physical exercise, there is a greater chance they will believe that they can compensate for a less rigid calorie intake. Also, accurate or adaptive CHBs have an overall positive health outcome if the compensatory behaviour is performed (Rabiau et al., 2006).

In today’s food environment, overeating episodes are very likely to happen. When control over food intake is consciously controlled and resources are depleted the likelihood of consuming high calorie palatable foods rises (Hofmann, Rauch, & Gawronski, 2007). In this context, it is important for individuals to know how they can compensate for episodes of overconsumption. Strategies that can be used to compensate overconsumption could include subsequent increase in energy expenditure or a decrease in energy intake. Research shows that individuals report post-consumption compensation as a strategy for dealing with dietary splurges (Knäuper et al., 2004), and attempting to compensate with calorie restriction following splurges is one factor associated with lower weight and WL (Shimpo & Akamatsu, 2015). Therefore, research on WL and eating behaviour suggests that compensatory beliefs and more so behaviours are shown to be positively related to WLM (O'Brien, Kahn, Zenko, Fernandez, & Ariely, 2018). However, there is no evidence of this relationship to date, and further research is necessary.

The health behaviour theories presented here are but a selection of the most relevant theories for WLM. There are several other theories that aim to explain behaviour change and all these cover several factors relevant to initiation and long-term adherence to weight-related health behaviours. Some of these theories worth mentioning are the Theory of Planned Behaviour (Ajzen, 1991), The Transtheoretical model (Prochaska & DiClemente, 1983) and the COM-B model (West & Michie, 2020). Each of these theories have similar elements that argue on the importance of knowledge and beliefs for health behaviours. For example, all describe attitudinal beliefs about the behaviour and self-efficacy as important factors for behaviour change and maintenance (Noar & Zimmerman, 2005).

Health behaviour theories are important as they act as basis for future research. To date the research on health behaviour theories and WLM is limited. In particular, little is known about the effects of knowledge and beliefs on self-efficacy and WLM success.

Health behaviour theories and specifically WLM related theories were the basis for several interventions targeting long-term WL. Presented below are some of the existing interventions for WLM.

## 2.5. Interventions

WLM is the result of long-term adherence to a diet and exercise programme. Interventions usually are aimed at controlling calorie intake and increasing energy expenditure (Dombrowski et al., 2014). Given the multitude of difficulties encountered when trying to adhere to a programme, research suggests that interventions should aim to target physiological, psychological and environmental factors related to WLM.

The main physiological factors to be targeted are appetite and energy expenditure (Hall et al., 2012). An example of intervention to manage appetite is the Volumetrics approach (Rolls et al., 2005). This is an approach that promotes changing the energy density of the diet as a strategy for weight management. This approach helps lower energy intake without reducing the volume of food to help individuals feel less hungry or deprived (Rolls et al., 2005). Energy expenditure focused interventions can be aimed at changing body composition (Borg, Kukkonen-Harjula, Fogelholm, & Pasanen, 2002; Rojo-Tirado et al., 2021; Westerterp, 2017) or increase overall physical activity energy expenditure (van Baak, Hul, Astrup, & Saris, 2021).

Environment is a great contributor to the increase in obesity prevalence. High calorie foods are more available, and this can lead to overconsumption in relation to energy expenditure (Varkevisser et al., 2018). Primary interventions should target food environment directly with changes such as the reduction of availability and portion sizes of high-calorie foods, and enhancing the attractiveness of healthy foods (Wright & Aronne, 2012).

Secondary interventions can be targeted at people’s personal food environment (Fisher, Lattimore, & Malinowski, 2016; Fogel et al., 2018; Vartanian et al., 2017). The personal food environment can be defined as all the food-related situations that an individual encounters, creates, or seeks out in the course of their daily lives (Lowe, 2003). Various theories have emerged that argue on the importance of food related cues in the environment. One of the theories is the goal conflict model proposed by Stroebe, Mensink, Aarts, Schut and Kruglanski (2008) which states that restrained eaters hold two goals, an eating goal and a dieting goal. Also, several research studies support this assumption by assessing the impact of food cues in relation to eating behaviour (Buckland, Finlayson, Edge, & Hetherington, 2014; Chen et al., 2018; Stroebe et al., 2017). Interventions for WL and WLM should therefore aim to teach individuals to limit exposure to high-calorie foods and increase exposure to healthy nutrient rich foods and foods that increase satiety.

But even if an individual manages to create a healthy food environment at home, outside high calorie palatable foods are widely available. Considering that most dietary lapses are caused by falling into temptation (Cleobury & Tapper, 2014) interventions for WLM should aim to teach individuals strategies to face temptation. The mechanisms that influence temptation are: reward-driven attentional biases, temporal discounting, and the cold-hot empathy gap (Appelhans, French, Pagoto, & Sherwood, 2017). Due to the reward capacity food has, it can elicit attentional biases such as more rapid detection of food cues, susceptibility to distraction by food and difficulty in disengaging from food cues (Pool, Brosch, Delplanque, & Sander, 2016). Another process that has an influence on temptation is temporal discounting, in which people discount future rewards for immediate ones, and was related to body weight and overeating (Appelhans et al., 2012; Epstein et al., 2014). The cold-hot empathy gap refers to the process where individuals in a cold state underestimate the degree to which they will value a reward in a hot state. In the eating behaviour context, individuals in a satiated state underestimate the value food will have to them when they will be hungry (Fisher & Rangel, 2014).

Interventions for temptation management can focus either on resisting temptation when it is experienced, or on avoiding it. Appelhans et al. (2017) argue that temptation resistance strategies (e.g. inhibiting the urge to eat) rely more heavily on effortful inhibition compared to temptation preventing strategies (e.g. stimulus control). Also, some interventions focus on planning and scheduling eating behaviour as means to manage temptation (Gillison et al., 2015; Kiernan et al., 2013).

When not based on direct factors affecting weight management, interventions are developed based on health behaviour theories and most of them are targeting WL rather than WLM. Examples of such interventions are: interventions for WL targeting behavioural lifestyle change (Lv et al., 2017), brief interventions based on habit-formation theory (Beeken et al., 2017), transtheoretical model-based multiple behaviour interventions for weight management (Johnson et al., 2008), intervention based on Schachter's externality theory for overweight children (Boutelle et al., 2014), and interventions for health behaviour change based on SDT (Ryan, Patrick, Deci, & Williams, 2008).

As there are a great number of existent interventions that target weight management, several reviews were conducted to identify characteristics of effective interventions. Review results showed most effective weight management interventions to be characterised by: targeting multiple components, promoting calorie control and providing structured individualized nutritional counselling (Kirk, Penney, McHugh, & Sharma, 2012). Also, reviews were conducted to show intervention characteristics that are effective in improving factors related to WLM such as: self-efficacy (Prestwich et al., 2013), assisted support (Job, Fjeldsoe, Eakin, & Reeves, 2018).

Studies testing interventions on WLM showed an important relation with internalization, autonomy and intrinsic goals and motivation. Controlled clinical trial linked maintained WL to treatment autonomy support, and the internalization of treatment goals (Williams et al., 1996). A clinical intervention for obese children showed that a focus on the intrinsic goal of health rather than the extrinsic goal of attractiveness as reasons for change resulted not only in greater initial weight loss, but also better maintenance over a two-year period (Vansteenkiste, Braet, Bachman, & Deci, 2007). More recent research on WLM interventions tested an acceptance-based behavioural intervention for WLM targeting physical activity levels. Results showed medium to large effect, participants increasing physical activity by 69% compared to baseline (Butryn, Kerrigan, Arigo, Raggio, & Forman, 2018).

The delivery of health behaviour interventions has largely changed. Given that technology has become more accessible and now most people have access to it, interventions have started using technology to better access participants. In this context, the question arises of whether alternative methods of delivering interventions are as effective as in person interventions. Research shows that interventions using computers or phone messages have effective results compared to minimal interventions using pamphlets, but render smaller effects compared to in-person interventions (Wieland et al., 2012). But research using new technology are quite few and further studies have to be conducted for a conclusion to be reached.

One of the largest dietary interventions studies focusing on long-term WL and WLM is The Diet, Obesity and Genes Study (Diogenes). The DiOGenes is a programme aimed at identifying key factors related to overweight and obesity with the goal of generating new knowledge and advice to minimise risks (Saris, 2005). This project constituted of a dietary intervention on a large scale in multiple European countries, and provides evidence on the feasibility of dietary interventions in different cultures (Larsen et al., 2010). This project has generated large datasets and important evidence on factors related to WLM such as: fruit and vegetable intake (Buijsse et al., 2009); initial WL (Handjieva-Darlenska et al., 2010); physical activity (van Baak et al., 2021); diet type (Halkjær et al., 2010) and body composition (Turicchi et al., 2020).

Another large intervention programme focusing on WLM is the Navigation to a Healthy Weight (NoHow) trial (Scott et al., 2019). This trial aimed to test the efficacy of an evidence-based digital toolkit that targeted self-regulation, motivation, and emotional regulation. Results for this trial showed the benefits of several factors to WLM: consistent sleep onset (Larsen et al., 2020); attribution of weight regain to emotional reasons (Sainsbury et al., 2018)

Other such interventions looking at long-term weight management include the Look AHEAD Study (Delahanty et al., 2011), NULevel trial (Sniehotta et al., 2019), WLM randomised controlled trial (Svetkey et al., 2008) and the PREVIEW study (Huttunen-Lenz et al., 2019). Based on evidence from the current existent research a position statement was developed on the behavioural approaches to longer-term weight management (Stubbs et al., 2021). According to this statement, developing skills for self-managing eating behaviours leads to more effective WLM. However, the effects of the existing WLM interventions were modest.

## 2.6. Aims

Research on WLM is scarce and further studies are required to identify predictors and strategies for successful WLM. Following health behaviour and WLM theories, there are multiple factors that influence WLM success. However, all theories agree on the importance of individuals' ability to control behaviour. A case is made on the importance of knowledge and beliefs on weight management success. Consequently, most interventions include training on nutrition and some focus on changing beliefs (Mikhail et al., 2020; Wright, Mutsekwa, Hamilton, Campbell, & Kelly, 2021). However, there is limited evidence of the importance of these factors in WLM. The reason why this is the case is due to the lack of validated scales that can measure these factors.

The current research aims to investigate the role of knowledge and beliefs about WLM on weight management success and behaviour. To this end, a novel WLM Knowledge and Beliefs scale was developed and validated. The following chapters will first make a case for the importance of knowledge and beliefs for WLM. Secondly, existing scales will be presented and discussed. Thirdly, the development and validation process of a new measure of knowledge and beliefs about WLM will be presented. Finally, the relationship between knowledge and beliefs and WLM will be explored, and the impact and uses of the novel scale will be outlined.

# Chapter 3: Development of the WLMKB scale

The previous chapter presented the issues related to long-term weight management, and the barriers people encounter in their attempts to maintain WL. The current chapter presents the development of a new WLM knowledge and beliefs scale. This scale will help assess the role of knowledge and beliefs on WLM to better understand the difficulties individuals face and inform future interventions. Furthermore, the scale will help enable research in this area as to date there are no validated scales available to measure these factors.

## 3.1. Introduction

An increasing number of individuals are attempting to manage their weight (Santos, Sniehotta, Marques, Carraça, & Teixeira, 2017). WL programmes are available and there are different ways in which an individual can lose weight (Jolly et al., 2011). WLM on the other hand is harder to achieve and there are fewer programmes available that people can follow. A strict diet works for WL but is very difficult to adhere to in the long term, and therefore is not conducive for WLM (Joki et al., 2017). Trying to continue adhering to a strict diet or going back to old habits after WL are the main causes for failure to maintain weight (Greaves et al., 2017; Sairanen, Lappalainen, Lapveteläinen, Tolvanen, & Karhunen, 2014).

For successful behaviour change and maintenance, it is important to regulate behaviour through goal setting, developing specific behaviour change plans, monitoring towards the goal, and developing and implementing the skills necessary to reach the goal (Brantley et al., 2014). Other factors that impact initiation and maintenance of behaviour change are health knowledge, beliefs regarding self-efficacy and outcome expectancies, self-regulatory skills and barriers to change (Murawski et al., 2009).

WLM requires life-long control of food intake and sustained physical activity (Grief & Miranda, 2010). Given that knowledge and beliefs influence people's behaviour (Mitchell et al., 2021), the accuracy of these beliefs might be important factors in distinguishing between WL maintainers and weight regainers. However, currently there are no scales that measure if people have accurate knowledge of what WLM is and what type of behaviours it requires. Such a scale would be valuable to measure knowledge and beliefs that can predict successful long-term weight management.

This chapter presents the development of a scale to measure knowledge and beliefs about WLM related factors. The WLMKB scale will be useful to: (i) identify individuals that are at risk of weight regain; (ii) assess gaps in understanding of WLM to better target interventions and (iii) test the effectiveness of education-based interventions.

## 3.2. The Weight Loss Maintenance Knowledge and Beliefs Scale

### 3.2.1. Rationale for developing the scale

WLM proves to be harder to achieve than WL, with only 20% of individuals managing to maintain their weight in the long term (Wing & Phelan, 2005). Research on WLM is limited and WLM interventions are not proving to be very effective (Sniehotta et al., 2019). It is therefore important to identify the characteristics that differentiate between successful and unsuccessful WL maintainers. Given that knowledge and beliefs have a great impact on behaviour change and maintenance, assessing these in relation to WLM could inform which individuals are more at risk to regain weight after WL and therefore indicate who can be provided with additional support.

Knowledge and beliefs are valuable in a wide range of behaviours and domains. While there are multiple existing measures that assess knowledge and beliefs about weight management related factors (e.g., nutrition knowledge (Parmenter & Wardle, 1999), obesity beliefs (Swift, Glazebrook, Novak, & Anness, 2007), or strategies for and types of WL (Pinto, Fava, Raynor, Larose, & Wing, 2013; Witt, Katterman, & Lowe, 2013), each of these has shortcomings: (i) there is no one scale to measure all the factors and using a separate scale for each would lead to participant exhaustion; (ii) focus on nutrition in relation to health [General Nutrition Knowledge Scale (Kliemann et al., 2016), CoNKQ (Dickson-Spillmann, Siegrist, & Keller, 2011)] but not weight management; (iii) are too difficult (assess specialist nutrition knowledge) for use with the general public and (iv) assess general guidelines without testing the understanding of the underlying processes. Existing measures and their characteristics are presented below.

### 3.2.2. Existing Knowledge and Beliefs scales

Eating behaviour is influenced by various factors including nutrition knowledge (Baranowski, Cullen, & Baranowski, 1999). Higher levels of nutrition knowledge were associated with higher fruit and vegetable intake (Dickson-Spillmann et al., 2011), lower fat intake (Parmenter, Waller, & Wardle, 2000) and better adherence to a Mediterranean diet (Bonaccio et al., 2013), in a sample from the general population. However, nutrition knowledge was not associated with BMI (O’Brien & Davies, 2007). Nevertheless, increasing nutrition knowledge is still a major public health strategy (Flynn, 2015; O’Brien & Davies, 2007).

Additionally, beliefs about the effectiveness of strategies and causality of weight gain can influence weight management behaviour. For example, a study on the use of meal replacement products (MRP) (Hartmann, Keller, & Siegrist, 2016) showed that MRP may be used as a license to indulge in palatable food, based on beliefs that they can compensate for calorie overconsumption. However, MRP might help with restrained eating to reduce energy intake. Additionally, for individuals that regularly overeat, MRP might be used to compensate for overeating episodes and maintain dietary goals. These results suggest that inaccurate beliefs about MRP affect their use and therefore, effectiveness for weight management. This could also be the case for various other strategies or tools such as: physical activity, intermittent fasting, meal skipping and low-calorie meals.

Other examples of the influence beliefs have on behaviour are locus of control (Anastasiou, Fappa, Karfopoulou, Gkza, & Yannakoulia, 2015), and beliefs about causes of obesity (Stapleton, 2015). Research shows that obesity beliefs and beliefs about self-efficacy influence engagement in weight-related health behaviours (Carraça et al., 2018). For example, higher self-efficacy and internal locus of control were associated with higher engagement in weight-related health behaviours (Jorge et al., 2020). Additionally, BMI was predicted by beliefs about the prevention strategies and barriers to effective weight management and beliefs that weight gain can be prevented by access to health education and exercise were associated with less overweight (Dryer & Ware, 2014).

There are multiple scales available that aim to measure weight management related factors. Some of these scales include general nutrition scales, the energy content of meals, sports nutrition, irrational dieting beliefs and obesity beliefs. However, there are various limitations to these scales. Existing scales, their use and limitations are presented below.

**Weight Management Nutrition Knowledge Questionnaire for adults (WMNKQ)** (Mikhail et al., 2020)**.**

There are multiple interventions that target obesity that require participants to learn certain knowledge about nutrition, physical activity and cognitive behavioural principles (Jensen et al., 2014). However, they do not measure whether these principles are learned by the participants. The only outcomes of interest being the amount and duration of WL (Ajie & Chapman-Novakofski, 2014; Voils et al., 2017).

Furthermore, there are limited existent measures to assess knowledge about weight management. One of these measures is the Weight Management Nutrition Knowledge Questionnaire for adults (WMNKQ) (Mikhail et al., 2020). The scale consists of 43 items that assess nutrition knowledge about: energy density of food, portion size/serving size, alcohol, sugar-sweetened beverages, how food variety affects food intake and reliable nutritional information sources. The scale showed good internal consistency (Cronbach's alpha = 0.88), reliability (test-retest correlation), construct validity (known-groups comparison) and criterion validity (pre- to post-intervention improvement in knowledge scores).

The WMNKQ is a useful tool to assess nutrition knowledge relating to weight management. For example, results from a study on participants in a self-managed commercial programme showed that nutrition knowledge as measured by the WMNKQ was associated with WL at 18 months (Mitchell et al., 2021). This provides evidence on the importance of nutrition knowledge on WL on a self-managed commercial programme. Additionally, this is an example of how such a scale could be used to assess the effect of an intervention on nutrition knowledge. However, the scale has several limitations. First, the scale only focuses on eating behaviour. This is a limitation because weight management is influenced by multiple factors, including physical activity, hunger and monitoring (Hansen, Andersen, Astrup, Blundell, & Sjödin, 2019; Johns, Hartmann-Boyce, Jebb, & Aveyard, 2014). Secondly, the scale is focused on knowledge only, whereas knowing certain nutrition facts might not translate into practical knowledge of strategies or belief in the efficacy of the nutrition facts for weight management (Mötteli et al., 2016; West & Michie, 2020). Furthermore, the WMKNQ was developed to assess intervention effectiveness, further research is necessary to inform whether the scale is appropriate to use in samples of individuals attempting to manage their weight without professional support.

**General Nutrition Knowledge Questionnaire (GNKQ)** (Parmenter & Wardle, 1999)

The GNKQ is the most frequently used measure to assess general nutrition knowledge. The GNKQ is a questionnaire developed to assess nutrition knowledge to identify weaknesses in individuals' understanding of healthy eating. The original scale was developed in 1994 but has been more recently revised (Kliemann et al., 2016) to bring it in line with current nutrition advice. The revised scale consists of 88 items and showed good internal reliability ($\alpha$ = .70 - .86). The GNKQ scale was also tested for construct validity and convergent validity. Furthermore, the scale was shown to be sensitive to changes in knowledge following intervention (Kliemann et al., 2016). Scores on GNKQ were associated with demographic information such as gender, age, level of education and socio-economic status (Parmenter et al., 2000). Additionally, nutrition knowledge was positively associated with a healthy diet (Wardle, Parmenter, & Waller, 2000) but not with weight status (O'Brien & Davies, 2007). The GNKQ was also used to assess the effectiveness of information-based interventions (Chung et al., 2021), showing that nutrition knowledge can be improved using an app and lead to changes in eating behaviours such as increasing fruit and vegetable consumption and reduce sugar intake. Whilst most evidence links nutrition knowledge with better diets, a more recent study showed that higher nutrition knowledge may enhance concerns about body weight and shape and eating pathology (Schwartz, Hecht, & Haedt-Matt, 2021).

The GNKQ has been widely used in the field of eating behaviour and weight management (Alkhaldy et al., 2019; Chung et al., 2021; Teasdale et al., 2020), proving to be a useful tool. However, various studies argue there are also some shortcomings to using this scale. Firstly, some researchers argue that it is time consuming (Hartmann et al., 2016) and contains several items of questionable relevance for weight management (e.g. items on salt content and calcium content of foods) (Spronk, Kullen, Burdon, & O'Connor, 2014). Secondly, it does not cover all areas related to nutrition such as supplements, fluids or appetite (Trakman, Forsyth, Devlin, & Belski, 2016).

**Consumer Nutrition Knowledge Scale (CoNKS)** (Dickson-Spillmann et al., 2011)

The Consumer Nutrition Knowledge Scale is a consumer-oriented nutrition knowledge questionnaire that measures procedural and declarative nutrition knowledge. The scale was developed and tested on a Swiss sample and consists of 20 items based on recommendations from Swiss nutrition experts. The scale demonstrated good internal reliability ($\alpha = .73$) and criterion validity (Dickson-Spillmann et al., 2011). Research using the scale showed that nutrition knowledge was associated with a more favourable food consumption and better diet quality (Koch, Hoffmann, & Claupein, 2021). However, the associations were weak (*r's* < .2), and the authors concluded that increased nutrition knowledge alone seems unlikely to result in large improvements in dietary behaviours. This might be due, in part to the fact that nutrition knowledge about calorie content of macronutrients in foods and meals might be too technical to be implemented into eating behaviours (Spronk et al., 2014).

The CoNKS helped generate further evidence on the importance of nutrition knowledge on diet quality and food consumption. The scale has not been used in a weight management context, but results from a study in the general population of Germany showed that individuals with higher nutrition knowledge as measured with the CoNKS scale had a healthy weight and were more physically active (Koch et al., 2021). However, the CoNKS assesses nutrition knowledge in general and is not specific to weight management. The items of the scale are based on dietary guidelines and nutrition facts. This is a shortcoming when trying to assess knowledge related to dietary behaviour because there is evidence that such scales are too technical to be translated into a diet with adequate energy intake (Grunert et al., 2012). Furthermore, knowledge on calorie content of foods were not related to knowledge on dietary recommendations or source of nutrients (Koch et al., 2021).

**Practical Knowledge about Meal Calories scale (PKM-11)** (Mötteli et al., 2017)

PKM-11 is a scale that assesses knowledge about the energy content of meals. This scale is useful as it is more important to assess foods eaten together rather than individual food items. Additionally, lack of knowledge about energy content of meals could be a risk factor for higher energy intake (Brindal, Wilson, Mohr, & Wittert, 2012; Carels, Konrad, & Harper, 2007). The PKM-11 was validated on the general population in Switzerland. It is a brief unidimensional measure consisting of 11 items and is aimed to be used to identify gaps in knowledge about energy content in meals. The scale was developed using a Rasch model approach (Rasch, 1993) and demonstrated concurrent validity (correlated with nutrition knowledge, $r = .47$), content validity (dietitians achieved higher scores, $p < .001$), and retest reliability ($r = .73$). The PKM-11 is less widely used and to date has not been validated in a UK population.

**Practical Knowledge about Balanced Meals scale (PKB-7)** (Mötteli et al., 2016)

PKB-7 is a 7-item measure of basic nutrition knowledge that is based on the dietary guidelines in Switzerland. It is a tool to assess individuals' knowledge about dietary recommendations on balanced meals. The scale was developed using a Rasch model approach (Bond & Fox, 2007) and demonstrated concurrent validity by testing the association with the General Nutritional Knowledge Scale. The scales correlated to .49, indicating that the PKB-7 captures relevant nutrition knowledge. The scale showed acceptable test re-test reliability ($r$ = .68). However, the PKB-7 is assessing knowledge specifically on guidelines for balanced meals in Switzerland.

The PKM-11 and PKB-7 have been less widely used and are not yet validated in the UK population. To date, there is evidence that scores on the two scales are related to use of meal replacement products and compensatory beliefs (Hartmann et al., 2016). The scales have been used in relation to diet quality (Lavelle et al., 2020), test interventions (Asher et al., 2020), and validation studies (Rapson, Conlon, Beck, von Hurst, & Ali, 2020; Schreiber, Bucher, Collins, & Dohle, 2020). Additionally, the PKB-7 was positively associated with diet quality and negatively to BMI in a sample form the general population (Mötteli, Siegrist, & Keller, 2017).

**Physical activity related nutrition knowledge scales**

Physical activity is an important factor in weight management and specifically for WLM (Kinsey et al., 2021; Kleine, Mccormack, Drooger, & Meendering, 2019; Ostendorf et al., 2021). The previous section presented nutrition knowledge scales in relation to energy intake, this section will present nutrition knowledge scales in relation to physical activity. Research shows that nutrition knowledge programmes significantly improve athletic performance (Rodriguez, DiMarco, & Langley, 2009). One explanation is that food choice influences physical activity performance, and food choice may be driven by attitudes towards nutrition and nutrition knowledge (Birkenhead & Slater, 2015; Spronk et al., 2014). Research on the relation between nutrition knowledge and dietary intake could be affected by the quality of the measures used (Spronk et al., 2014).

Some of the issues identified in a review (Trakman et al., 2016) of nutrition knowledge measures were: (i) they do not measure all aspects related to nutrition; (ii) they are not properly validated and a lot of research used non validated scales; (iii) most research has been conducted on American college students; (iv) there are example of outdated items, which relevance and accuracy could be challenged.

An example of a more suitable sport nutrition scale is the General and Sports Nutrition Knowledge Questionnaire (Trakman, Forsyth, Hoye, & Belski, 2018): an abbreviated version of the Nutrition for Sport Knowledge Questionnaire (Trakman, Forsyth, Hoye, & Belski, 2017). Consists of 37 items measuring general nutrition knowledge and sports related nutrition knowledge. The scale showed good reliability (PerSepIndex = .80) and showed good construct validity and test re-test reliability. However, the scale is aimed at athletes and can be very difficult for the general population. While sports nutrition is related to weight management, the items are not specifically developed to assess knowledge relating to weight management or WLM.

**Belief scales**

Apart from knowledge and skills, beliefs have a great impact on behaviour. In regards to weight management, there is evidence that beliefs about self-efficacy (Teixeira et al., 2015), risk to health (Swift, Glazebrook, & Macdonald, 2006) or the causes of obesity (Wang & Coups, 2010) influence weight related behaviours. Furthermore, beliefs that obesity is inherited were associated with lower levels of physical activity and fruit and vegetable consumption. In addition, beliefs that obesity is caused by lifestyle choices were associated with greater levels of physical activity but not fruit and vegetable consumption (Wang & Coups, 2010).

Another means by which beliefs influence behaviours are compensatory beliefs and compensatory behaviours. Research in this area suggests that individuals have inaccurate expectations regarding compensatory behaviours after overeating episodes and these in turn can lead to weight gain (O’Brien et al., 2018). For example, individuals plan to undercompensate for overeating episodes, or they expect weight change to happen more quickly than is realistic.

There are various scales that measure beliefs regarding obesity or weight management, some of these are presented below.

**The Irrational Food Beliefs Scale (IFB)** (Osberg et al., 2008)

It is important to assess and modify individuals' erroneous ideas about food in order to improve weight maintenance. The IFB is a scale that measures inaccurate beliefs about food. The scale was developed based on clinical experience and assesses beliefs such as the following: (i) food can help manage negative emotions; (ii) food can substitute for other unfulfilled needs; (iii) that is impossible to live without certain foods; (iv) food choice is unrelated to health (Osberg et al., 2008). The scale consists of 41 items, showed good internal consistency ($\alpha = .89$), and demonstrated construct validity (was associated with eating disorder scales, $r = .67$) and predictive validity (predicted weight management, $r = -.30$).

Various studies have used the IFB scale and scores on the scale were related to factors such as sport behaviour (Ramezanzade & Arabnarmi, 2019), obesity (Fathabadi, Mona, Taghavi, Shalani, & Sadeghi, 2017) and binge eating (Nikčević, Marino, Caselli, & Spada, 2017). Further research also suggests that the detrimental effect of maladaptive health beliefs may be counterbalanced by providing individuals with accurate information (Karademas, Paschali, Hadjulis, & Papadimitriou, 2016).

Additionally, there are other proposed scales that measure concepts similar to the IFB such as the Calorie Catastrophizing Scale and Dietary Misinformation Questionnaire (Monaghan & Santor, 2017). The scales include items such as '*If I have even one cookie, I have ruined my diet completely'*. These scales helped gather evidence on the importance of dietary misinformation to unhealthy eating behaviour. For example, there was a link between dietary misinformation and eating pathology which was mediated by distorted cognitions about food (Monaghan, 2017).

**Dieting Beliefs Scale (DBS)** (Stotland & Ztiroff, 1990)

The DBS is an instrument that distinguishes more internal from more external locus of control. The 16-item scale showed acceptable internal consistency (α = .69), good test re-test reliability ($r$ = .81) and demonstrated construct validity score being negatively related to weight ($r$ = .30).

Weight locus of control was shown to be a key factor for long-term success in weight management (Jorge et al., 2020). Internal locus of control regarding weight refers to the belief that weight is under the individuals' control as compared to being the result of external factors. Internal locus of control regarding weight has been widely researched and has been identified as a key factor for long-term weight management success (Jorge et al., 2020).

As mentioned above, there are various scales that measure beliefs regarding weight management and obesity. These scales have helped bring evidence on the impact of beliefs on weight management. However, these measures are not developed specifically for measuring beliefs about WLM.

Given the difference in strategies and barriers experienced by people in the WL and WLM phases (MacLean et al., 2015), a better targeted scale specifically for WLM is necessary to differentiate between people at risk of weight regain. Measuring more factors related to WLM apart from nutrition knowledge will also help in better identifying factors that need to be targeted in the intervention. In this chapter a novel scale is proposed that will aim to measure knowledge and beliefs about WLM related factors.

The aim of this study was to develop a new WLM knowledge and beliefs (WLMKB) scale and test the understanding and interpretation of the items. The WLMKB scale will (i) include a wide range of WLM related factors (ii) test the understanding of the underlying mechanisms of weight management (iii) be based on self-regulation theory (iv) assess beliefs in the effectiveness of weight management strategies (v) be concise and accessible for the general population.

Reasons why the WLMKB is necessary:

1. One single comprehensive scale to measure all WLM related factors
2. Tool to assess effectiveness of education-based interventions
3. Identify gaps in knowledge and understanding
4. Assess accuracy of beliefs

## 3.3. Scale development

The WLMKB scale development followed the eight-step methodology for nutrition knowledge questionnaire development (Trakman et al., 2017). This methodology follows classic guidelines for psychometric scale development (Kline, 2015). Additionally, it also focuses on commonly used and accepted practices in nutrition knowledge scale development (e.g. item difficulty analysis, known group comparisons). In the first step, a literature search was conducted to define the concept of WLM and identify related factors (presented in Chapter 2:). The second step consisted in the development of an initial item pool (51 items). The items were developed based on current theory and research or were adapted from other existing scales. The initial item pool was developed to cover all the factors identified as important for WLM in the literature review. The items covered psychological (e.g. goal setting and monitoring, diet and obesity beliefs, self-efficacy) as well as physiological (e.g. hunger, physical activity, energy intake) factors that influence WLM. Additionally, existing research was consulted, and further items were developed to cover aspects of the experience of dealing with WLM, including feelings of burden and inability to control and manage one's weight (Kruseman et al., 2017). Finally, several additional items were developed based on other existing scales that assess WLM related factors such as nutrition knowledge, dieting beliefs and compensatory health beliefs (Table 3.1). Together with the research team, the initial items were reviewed to assess content validity, and scoring system and response format were then discussed and decided. Following this step, 11 items were removed, and a factor structure was proposed. The following step in the development process was to test the understanding and interpretation of the items (Chapter 3:). The overall process of scale development and validation was presented in Figure 1.1.

The sources and theory on which the items of the WLMKB scale were based on are presented below. The scale factor structure and information on the sources of each of the items are presented in Table 3.1.

### 3.3.1. Background theory (proposing a new WLM knowledge and beliefs scale)

Considering the various health behaviour theories and study results, factors such as beliefs, self-efficacy and nutrition knowledge are important for successful WLM. As presented, there are various measures that target aspects of WLM. Whilst each of these measures assess some of the factors related to WLM, they are not directly targeting the effectiveness of the items in the context of WLM.

The WLMKB scale was developed to measure knowledge and beliefs about WLM related factors. The items of the scale have been developed using the following methods: adapted from other existing measures, based on health behaviour theory, following the calorie in/ calorie out model or individuals experience with WLM. First, a literature review was conducted to define WLM focusing on differences between WL and WLM and the added barriers to WLM. Second, health behaviour theories and WLM theories were consulted to identify factors that influence and predict successful WLM. Finally, existing research and other scales that assess factors related to WLM were reviewed to identify the existing evidence. Each of these steps were used as basis for developing the initial item pool of 51 items of the WLMKB scale with the aim of covering all the direct and indirect factors that influence WLM. After further assessment from the research team and existing theory, a final item pool of 40 items was agreed upon for further testing. The theory on which the items are based on is presented below. Table 3.1 presents all the items arranged by factors with their origin.

## Energy in/Energy out model of obesity

The "energy in/energy out" model of obesity is based on the first law of thermodynamics, that energy can neither be created nor destroyed. Therefore, put simplistically, all calories entering the body must be oxidized as fuel or stored as adipose tissue. Weight gain results when energy intake exceeds energy expenditure, and energy balance and weight stability is achieved when these two factors are matched over time (Anderson, Foreyt, Sigman-Grant, & Allison, 2012; Thom & Lean, 2017).

Following the energy in/energy out model, successful WLM requires continued engagement in weight management strategies to achieve energy balance. There are various conscious and unconscious processes leading to energy balance. However, conscious control over the amount of calories ingested, the amount of calories expended or both can help reach an energy balance and manage weight. The WLMKB scale includes items that assess knowledge and beliefs about calorie balance and its components and how they relate to successful WLM. Additionally, items on nutrition knowledge and energy expenditure have been adapted from other existing measures.

## Self-regulation theory

Self-regulation of behaviour is necessary for WLM, specifically the ability to adhere, monitor and adapt weight management behaviours (Moilanen, 2007). Apart from being aware of what behaviours one should engage in to maintain weight, it is also important to be aware of strategies that help with long-term adherence to these behaviours. These strategies include goal setting and monitoring progress in relation to the goal. Therefore, following self-regulation theory (Vohs & Baumeister, 2004), items that assess weight monitoring, focusing on weighing frequency and beliefs about weight fluctuation will be included in the WLMKB scale. Monitoring weight, eating and exercise behaviour is an important aspect for WLM as it can help identify when lapses occur and inform when changes in behaviour are necessary for achieving energy balance (Butryn, Phelan, Hill, & Wing, 2007; Hartmann-Boyce et al., 2019).

## Compensatory Health Beliefs – caloric compensation

The Compensatory Health Belief Model (CHBs) (Knäuper et al., 2004) describes several strategies that adults use to maximize pleasure and minimize harm when dealing with temptations that may interfere with their health goals. CHBs are beliefs that the negative consequences of an unhealthy behaviour can be compensated for with the assumed positive effects of a healthy behaviour. For example, believing that a behaviour that might compromise health goals, such as eating high calorie foods, can be indulged in if it is compensated by another healthy behaviour, such as, going to the gym. CHBs are significant predictors of behaviour when included in interventions aimed at promoting healthy food consumption (Amrein, Rackow, Inauen, Radtke, & Scholz, 2017), and compensatory eating (West, Guelfi, Dimmock, & Jackson, 2018). CHBs were associated with increased food consumption in men with overweight (Sim, Lee, & Cheon, 2018), and high-calorie snack consumption in the general population (Amrein, Scholz, & Inauen, 2021; Radtke, Inauen, Rennie, Orbell, & Scholz, 2014).

However, while CHBs have a negative effect on health behaviours, compensatory health behaviours could be beneficial for weight management. Compensatory behaviour can be used in response to overeating or ‘overbalanced’ energy intakes (Wammes, French, & Brug, 2007). For example, the ‘balance intervention’ promotes caloric compensation by moderating food intake or increasing physical activity in response to overeating to maintain a neutral energy balance. The ‘balance’ approach accepts that occasions of overeating are likely to occur and focuses on making people aware of these occasions of overeating, and to motivate and enable them to compensate for them within a short span of time (Wammes et al., 2006). In one study diet related compensatory behaviours were related to an improved diet quality and an increase in physical activity over time in individuals from the general population (Sob, Siegrist, Hagmann, & Hartmann, 2021). Given the existing evidence, compensatory behaviours might promote WLM by means of caloric compensation. Therefore, the WLMKB will include items measuring knowledge and beliefs about the effectiveness of calorie compensatory behaviours.

Additionally, engaging in calorie compensatory behaviours is also beneficial as it allows for a more flexible approach to eating restraint. WLM usually requires a form of dietary restraint. Dietary restraint refers to the restriction of food intake with the aim of controlling body weight (Herman & Mack, 1975). Flexible restraint is described by a balanced approach to eating, such as eating less at a subsequent meal if too much food was eaten earlier (Westenhoefer et al., 1999). Flexible restraint has been linked with improved WL outcomes (James, Roe, Loken, & Rolls, 2018; Westenhoefer et al., 2013). While a strict diet might work for WL, it is not recommended for WLM, as it is not sustainable in the long term (Sairanen et al., 2014).

## Self-Determination Theory

SDT proposes that behaviour change will occur and persist if it is autonomously motivated (Williams et al., 1996). Autonomous motivation refers to behaviours driven by internal factors such as personal benefits, consistency with values or enjoyment (Ryan & Deci, 2000). Autonomous motivation implies an internal locus of causality for behaviour as opposed to an external one. For example, believing that weight change is the result of one's behaviour. When applied to WL, the SDT suggests that people will be motivated to lose weight if they believe that WL will decrease their likelihood of contracting a life-threatening illness. They also have an internal locus of control and expect that specific behaviours such as reduced calorie intake and exercise will yield significant WL (Elfhag & Rössner, 2005).

Given that autonomous motivation and locus of control have been positively associated with WL and WLM (Hartmann, Dohle, & Siegrist, 2015; Teixeira, Silva, Mata, Palmeira, & Markland, 2012) the WLMKB scale will include items regarding locus of control. These items will assess individual beliefs about control and expectations regarding weight gain and maintenance. For example, some items suggest an increased level of control over weight management (e.g. *To maintain weight the number of calories consumed must be equal to the number of calories expended*.) and others the lack of such a control (e.g. *Some overweight patients can live on 800-1200 kcal day without losing weight* (reversed)). It is hoped that this will help identify people that are more susceptible to weight gain.

## Weight loss maintenance barriers

Behaviour change and maintenance are necessary for successful weight management. Long-term adherence to weight management strategies is influenced by psychological (e.g. motivation, self-control) as well as physiological factors (Chapter 2:). There are additional physiological barriers to WLM compared to WL (MacLean et al., 2015). WL perturbs the hormones, peptides and nutrients that are involved in the regulation of body weight. After diet-induced WL, there are modifications in the postprandial release of amylin and pancreatic polypeptide as well as a reduction in circulating levels of leptin. All these hormonal changes lead to a decrease in energy expenditure and an increase in appetite which lead to weight gain in the long term (Stubbs & Lavin, 2013).

Increased levels of hunger are common after WL, and managing increased appetite is important for weight management (Hetherington et al., 2013). Accordingly, the WLMKB scale includes items about individuals' beliefs about hunger and the necessity to eat in response to it. For example: *Learning to deal with hunger is good for weight loss maintenance.; If you feel hungry it means that you should eat to stay healthy.* (reversed), address these important aspects of WLM.

Furthermore, long-term WLM strategies are experienced as a burden by WL maintainers (Kruseman et al., 2017). These feelings of burden were described by the participants as the hardship of maintaining weight, the anxiety of regaining weight or the loneliness and unfairness of their situation. These feelings could be increased by several factors. First, inaccurate beliefs about the strategies required for WLM. For example, beliefs that certain foods need to be completely avoided *"I cut out all soft drinks, ice-tea, I banned all that from my diet*" (Kruseman et al., 2017). Secondly, beliefs that challenges with weight are specific to themselves and not others. For example, participants believe that other people can eat a lot without gaining weight "*I'd like to be one of those persons who can eat everything and never gain one gram*" (Kruseman et al., 2017).

Taking in consideration these statements from people trying to maintain weight, the WLMKB scale includes items that assess the degree to which individuals agree to certain statements about diet restriction for weight maintenance (e.g. *To maintain a healthy weight people should cut fat out entirely from their diet* (reversed)). Also, items regarding beliefs about other people's health behaviours (e.g. *Some people can eat whatever they want and not gain weight* (reversed)).

### 3.3.2. Scale description

The final version of the WLMKB scale will be comprised of 40 items measuring the accuracy of knowledge and beliefs people have about several factors related to WLM such as: nutrition, overweight and obesity, monitoring weight, diet, calorie compensatory behaviours, physical activity and hunger.

The scale will have two subscales, one measures accuracy of knowledge and the other measures beliefs. For conciseness and ease of expression the term "accuracy of beliefs" will be used throughout this thesis to refer to the degree of agreement with WLM conducive beliefs. The knowledge subscale will include 20 items with a three-point response scale: true, false, don't know. The beliefs subscale will be comprised of 20 items with a 6-point Likert type response scale, 1 being strongly disagree and 6 strongly agree. A high score for this measure will signify that the person has accurate knowledge and beliefs about how certain factors and behaviours affect WLM. Table 3.1 presents the main components measured in the WLMKB scale and each item with its source or theoretical reasoning.

The next step after developing the items of the scale was to test the understanding and interpretation of the items in the general population. Therefore, the first study conducted used a 'think aloud' method to test the items of the scale. This study is presented below.

*Table 3.1:* Scale items with theoretical sources

| Factor | Item | Theory |
|---|---|---|
| Nutrition | 1. Starchy foods such as bread, potatoes and pasta are fattening. R<br>2. High sugar intake is a greater cause of obesity than a high fat intake. R | - Items from 'Improving the Nutrition and Care of the Overweight Patient Survey' (Hankey, Eley, Leslie, Hunter, & Lean, 2004).<br>- The scale contains questions that explore beliefs, attitudes and knowledge about the links between obesity, nutrition and health. Developed to document knowledge, attitudes, beliefs of health professionals.<br>- The participants had to respond to each item with: disagree, neutral or agree. |
| | 3. Eating bread always causes weight gain. R<br>4. To maintain a healthy weight people should cut fat out entirely from their diet. R<br>5. Eating fibre can reduce the chances of gaining weight. | - Items from the General Nutrition Knowledge Questionnaire – Revised (Kliemann et al., 2016).<br>- The scale consists of four independent sections, each assessing a different aspect of nutrition knowledge: Dietary recommendations; Food groups; Healthy Food choices and Diet, disease and weight management.<br>- For the current scale, only items related to weight management have been included.<br>- The response type for the items varies from section to section, the items on weight management have three options response scale with: agree, disagree, and not sure. |
| | 6. To maintain weight, the number of calories consumed must be equal to the number of calories expended.<br>7. Replacing a regular soda (330 ml) with a diet soda will save ~150 kcal.<br>8. Swapping sugar with artificial sweeteners can help with weight loss maintenance. | - Replacing the daily intake of sugar with low calorie sweeteners (LCS) can help with weight maintenance. It has been estimated that adults can prevent weight gain by reducing intake by 100 kcal/d (Hill, 2009).<br>- It is a common strategy to replace sugar with low-calorie sweeteners to facilitate weight control. This strategy enabling people to eat sweet foods, or beverages without the added calories from sugar. But in order for sweeteners to have an impact on weight management they have to be associated with a reduced energy diet (Bellisle & Drewnowski, 2007). Despite this evidence, there are claims that LCS undermine weight management. Three claims are that: (1) LCS disrupt the learned control of energy intake (sweet taste confusion hypothesis); (2) exposure to sweetness increases desire for sweetness (sweet tooth hypothesis); (3) consumers might consciously overcompensate for 'calories saved' when they know they are consuming LCS (conscious overcompensation hypothesis). In a recent review that examines these claims (Rogers, 2018) evidence does not support these hypothesis. The results of the intervention studies comparing LCS v. sugar indicate that the effect of energy dilution outweighs any tendency LCS might conceivably have to increase energy intake. |

| Factor | Item | Theory |
|---|---|---|
| Overweight and obesity | 9. Some people who are overweight can live on 800-1200 kcal a day without losing weight. R<br>10. Physical inactivity is a major cause of regaining weight. | - Improving the Nutrition and Care of the Overweight Patient Survey' (Hankey et al., 2004).<br>- These questions explored beliefs, attitudes and knowledge about the links between obesity, nutrition and health. |
| | 11. People that are overweight/obese have a slower metabolism compared to normal weight people. R | - Daily energy expenditure is comprised of three components: the thermic effect of food, physical activity, and resting energy expenditure. Individuals with obesity: (i) have a higher thermic effect of food because of greater food intake; (ii) expend more energy for physical activity because physical activity expenditure is proportional to body weight; (iii) energy expended at rest is greater due to more metabolically active fat-free mass in addition to greater body fat (Hall & Guo, 2017). |
| Monitoring weight | 12. Regularly weighing yourself (e.g. weekly) can be useful to avoid weight gain.<br>13. It is natural for your weight to fluctuate by 1-2 kg throughout the day. | - Self-monitoring means observing oneself and one's behaviour. Regularly weighing oneself is an example of self- monitoring, as is recording the food intake consumed (Elfhag & Rössner, 2005). In weight re-gainers, self-monitoring has been shown to decline with time (McGuire, Wing, Klem, Lang, & Hill, 1999).<br>- Most of the successful WL maintainers that registered in the National Weight Control Registry reported weighing themselves every day (Daeninck & Miller, 2006).<br>- In a meta-analysis results indicated no association between self-weighing and affect, body-related attitudes or disordered eating. There was, however, a small-sized negative association between self- weighing and psychological functioning. The findings suggest that, for the most part, self-weighing is not associated with adverse psychological outcomes (Benn et al., 2016). |
| | 14. If you weigh more today than you did yesterday it means you ate too much and gained weight. R | - People tend to overestimate the speed of weight gain and WL. Research shows that this translates into a belief that weight change after reducing or adding 500 calories per day will happen two to four days faster, per pound, then it should based on the estimated rate of 3.500 calories per pound (O'Brien et al., 2018).<br>- Long-term stability of body weight is considered to be the balance between energy intake and expenditure. However, changes in body weight also include changes in body water, which may be variable, and therefore weight change may not directly represent energy imbalances, particularly over the short term. (Hall & Guo, 2017) |
| Diet beliefs | 15. Weight gain is likely to happen if you don't monitor and control what you eat. | - Whether a diet is targeted toward reducing fat or carbohydrate, or increasing protein, for WL to occur an energy deficit must be established (Thom & Lean, |

| Factor | Item | Theory |
|---|---|---|
| | 16. You can eat anything you want and not gain weight if you limit the food intake to the amount of energy/calories your body needs to carry out normal everyday activities. | 2017). Several meta-analyses have shown that long-term WL and metabolic improvements occur independent of macronutrient composition of the diet, and greater energy restriction results in greater WL, regardless of whether restrictions are mainly from protein, carbohydrate, or fat (Naude et al., 2014; Nordmann et al., 2006). |
| | 17. All women of any age and weight can eat around 2000 kcal a day and maintain a normal weight. R<br>18. All men can eat around 2500 kcal a day and maintain a healthy weight. R | - For a person maintaining their average body weight, the long-term mean energy intake equals the long-term mean energy expenditure which is proportional to the body weight. Hence, long-term changes in bodyweight are related to persistent changes in energy intake and the new equilibrium weight takes several years to be achieved (Hall et al., 2011). Hence, to maintain weight within 1 kg over several years requires that the long-term average energy intake must be accurate to within about $\varepsilon = 22$ kcal/day. |
| | 19. When attempting to maintain your weight you are not allowed to eat any high calorie foods (e.g. fries, burgers, cake, biscuits). R<br>20. To maintain your weight you should not drink any alcohol. R<br>21. Some people can eat whatever they want and not gain weight. R<br>22. Most people don't have to do anything to maintain a healthy weight. R<br>23. To maintain your weight, you must keep to a strict diet.<br>24. After losing weight you can go back to eating normally without gaining the weight back. | - Items adapted from qualitative data collected by (Kruseman et al., 2017). They interviewed WL maintainers and discovered that they experience WLM strategies as a burden. Some of the statements post the necessity of a strict diet and cutting out foods: "*I cut out all soft drinks, ice-tea, I banned all that from my diet*". Other statements imply that there are people that can eat as much as they want without gaining weight: "*I'd like to be one of those persons who can eat everything and never gain one gram*".<br>- Weight maintenance is the result of energy balance between intake and expenditure (Thom & Lean, 2017), regardless of food macronutrient composition (Naude et al., 2014). Therefore, to maintain weight, it is not necessary to cut out certain foods or alcohol entirely from diet.<br>- Research shows that self-initiated dieting may reflect both a response to a recent weight gain and a vulnerability to long-term weight gain. The findings also suggest that among normal-weight young women, the individuals at greatest risk for eating regulation problem are those who have an extensive history of weight-loss dieting but are not currently dieting to lose weight. Such individuals would presumably have a predisposition toward overeating and weight gain but would currently be doing little, if anything, to counteract it (Lowe & Timko, 2004). |
| | 25. To maintain your weight loss, you must continue doing the same things that you did when you were trying to lose weight. R | - An increase in flexible cognitive restraint during the WL intervention was related to better WLM and well-being. The more flexible restraint increased during the WLM intervention, the more psychological distress decreased. Moreover, larger |

| Factor | Item | Theory |
|---|---|---|
| | 26. It is OK to overeat by a small amount in a day if you get back on track the next day. | reduction of rigid restraint during the follow-up period (between the WLM intervention and the follow-up assessment) was related to a better maintenance of improved psychological well-being at the follow-up endpoint. These results suggest that increasing flexible control while reducing rigid control of eating after an active WL phase improves success in weight management and the psychological well-being of weight losers (Sairanen et al., 2014).<br>- Mathematical modelling of human metabolism and body weight dynamics suggests that the large day to day variations in energy intake are irrelevant for body weight regulation. Rather, persistent changes in energy intake can lead to substantial weight changes over long-time scales (Chow & Hall, 2014). |
| Physical activity | 27. Engaging in intensive cardiovascular physical exercise is necessary to maintain your weight. R | Physical activity is a treatment option for obesity, but large amounts of exercise are required for a moderate degree of WL. Physical activity influences body composition, resulting in preferential loss of body fat and maintenance of fat-free mass compared with diet-induced weight-loss (Weinheimer et al., 2010).<br>- Reduction in energy intake leads to decreased energy expenditure due to changes in body composition and the thermic effect of food (Rosenbaum & Leibel, 2010; Westerterp, 2013). This phenomenon was called adaptative thermogenesis or metabolic adaptation and was argued to be the main possible explanation for weight regain after WL (Doucet et al., 2018; Ostendorf et al., 2019). |
| | 28. Walking is a way of increasing physical activity that will help you maintain a heathy weight. | |
| | 29. Half an hour of cardiovascular exercise burns about 300 calories for everyone. R | |
| | 30. You can maintain a normal weight without doing any intensive physical activity. | |
| | 31. The number of calories you burn while doing exercise decreases as you lose weight. | |
| Caloric compensatory behaviours | 32. You can eat more than you should now if you exercise for longer later on to burn off the extra calories. | - Caloric compensation - i.e. moderating food intake and/or increasing physical activity in response to occasions of overeating—in order to maintain a neutral energy balance. The 'balance' approach accepts that occasions of overeating are likely to occur and focuses on making people aware of these occasions of overeating, and to motivate and enable them to compensate for them within a short span of time (Wammes et al., 2006).<br>- Compensatory Health Beliefs Scale (Knäuper et al., 2004) – 26 – item scale that measures compensatory health beliefs. It is a four-factor scale, measuring CHBs about: substance use, eating/sleeping habits, stress and weight regulation. For the current scale the three items that measure weight regulation CHBs non-reversed were used. Research shows that CHBs are negatively correlated with health |
| | 33. If you eat too much today, you can compensate by eating less tomorrow. | |
| | 34. Eating whatever one wants in the evening is OK, if one does not eat much during the day. | |
| | 35. If you exercise, you can eat without any restrictions. R | |

| Factor | Item | Theory |
|---|---|---|
| | | behaviours, but the relation is reversed when talking about compensatory behaviours instead of beliefs. |
| Hunger | 36. Sometimes you have to accept you feel hungry and not always eat in response to hunger. | - Apart from the behavioural challenges to WLM there are also physiological challenges (MacLean et al., 2015). Caloric restriction results in a rapid, profound reduction in circulating levels of leptin and energy expenditure and an increase in appetite. Given the increased levels of hunger, research suggests that for successful WLM it is important for individuals to understand it is not a problem to feel hunger.<br>- Studies also show that higher number of sips and longer oral transit time per gram food reduces food intake. In addition, a higher number of sips per gram food, thus smaller sips, led to faster increase in fullness per consumed gram food. Advices to consume with smaller sips or bites and to prolong the oral transit time may be helpful in body weight management (Bolhuis, Lakemond, de Wijk, Luning, & de Graaf, 2013). |
| | 37. Learning to deal with hunger is good for weight loss maintenance. | |
| | 38. If you feel hungry it means that you should eat to stay healthy. R | |
| | 39. Hunger is a sign that your body needs food to function properly. R | |
| | 40. Eating slowly helps you eat less by feeling full faster. | |

## 3.4. Study 1: Testing a new way of measuring knowledge and beliefs about weight loss maintenance

### 3.4.1. Background

Think aloud method

The think aloud method (Hartmann-Boyce, Aveyard, Koshiaris, & Jebb, 2016) is a technique whereby participants complete a questionnaire or a task while saying out loud what they are thinking. This method has been successfully used to explore how and why people arrive at the answer when completing a questionnaire (Donker & Markopoulos, 2002) and has been used to explore the validity of psychological constructs (Gadermann, Guhn, & Zumbo, 2011).

The think aloud method is a useful technique to explore the nature and extent of problems that people might have when completing a questionnaire (French et al. 2007). It is also a valuable tool to investigate the validity of a measuring tool. For example, Van Oort, Schröder and French (2011) investigated the Brief Illness Perception questionnaire and found issues with participants misinterpreting items and incorrectly using the response options.

For the present study, the think aloud method was used to assess the understanding and interpretation of the items of the WLMKB scale. This method will help inform if there are issues with the construction of the items or the language used.

### 3.4.2. Method

## Participants

The sample consisted of adults living in the UK and were selected from the general population, using a snowballing technique. The recruited sample was purposely recruited to be gender balanced. The ‘Think-aloud’ methodology does not impose sample size constraints. Following previous research (French, Cooke, Mclean, Williams, & Sutton, 2007; Gilbert et al., 2014), a minimum sample of 10 participants was deemed sufficient for the purpose of the study. Recruitment was conducted using social media adverts. To be eligible participants had to be at least 18 years old, have good English level, have lived in the UK for at least 6 months, and not have current or history of an eating disorder. Study 1 received ethical approval form the Department of Psychology ethics committee (no. 023798, 1.12.2018).

## Procedure

Adverts were distributed through social media. Participants interested in the study were directed to a questionnaire where they could book a timeslot when they were available to come to the University of Sheffield, Department of Psychology.

During the session, participants completed a questionnaire that included demographic questions (age, gender, education, nationality) and information about their weight management (weight, height, WL attempts, WLM). Self-reported measures were used for height and weight as these were used only to describe the sample and not in the analysis. Weighing participants might have caused unnecessary distress (Benn et al., 2016). Participants were then provided with the WLMKB scale and asked to read the items and say aloud what they thought while completing the WLMKB scale. A researcher was present to ensure participants were not silent for more than 10 seconds and provide further information on items when prompted. The exact instructions participants received are presented below. The sessions were voice recorded for subsequent analysis.

Instructions for participants:

*'Please read the following instruction carefully before beginning*

*Presented below are a series of statements about nutrition, physical activity and weight management. Please read them carefully and state your opinion on the matter. This means that we would like you to talk about what you think the statement is about and whether it is easy to understand. Please do not plan what you are going to say, just say whatever comes into your head. If you remain silent for more than 10 s whilst completing the questionnaire, the researcher will ask you to keep talking.*

*If you wish to leave the experiment at any time, please inform the researcher. You will be recorded during this study; however, all responses will be kept confidential and anonymous, and no one will be able to identify you.'*

## Measures

### Weight Loss Maintenance Knowledge and Beliefs scale

The WLMKB scale has 40 items and is divided into two subscales. The Knowledge subscale is comprised of 20 items and has a three-point response scale: true, false, don't know. The Beliefs subscale is comprised of 20 items and has a 6-point Likert type response scale. A higher score on each of the subscales shows more accurate knowledge and beliefs about WLM related factors.

### **Dieting and Weight History Questionnaire (DWHQ)** (Witt et al., 2013)

DWHQ (Witt et al., 2013) is a measure developed to assess the three dimensions of dieting as defined by Lowe (1993): frequency of past dieting and overeating, current dieting to lose weight and weight suppression. The DWHQ was used to characterise participants weight history, WLM and dieting status.

### 3.4.3. Results

## Participants

Participants (*n* = 16, 8 males and 8 females) had a mean age of 28.69 years (*SD*: 3.50), current BMI ranged from 20 to 30 kg/m$^2$ (*M:* 24.41 kg/m$^2$, *SD:* 2.66) and highest BMI of *M*: 27.02 kg/m$^2$ (*SD:* 4.42). Six participants were currently dieting to lose weight (3 males and 3 females). Participants had either undergraduate or postgraduate studies, and one participant had a qualification in nutrition studies.

## Data analysis

Data analysis aimed to identify any issues with items and reword accordingly to better imply what they aim to measure. After the sessions were finalised, interviews were transcribed verbatim and segmented into material related to each of the statements of the WLMKB scale. Recordings were collected using Voice Recorder App for Windows and data analysis was conducted using Excel 2016. Data was then coded to show issues found per item. Issues were then categorised by themes. Data analysis was conducted by a single researcher, the method used followed example of similar previous research (Eccles & Arsal, 2017; French, Cooke, Mclean, Williams, & Sutton, 2007).

After data analysis two types of issues were identified: specific issues, directly related to the wording of the items and general issues regarding participants way of answering questionnaire items. Examples for each type of issue are presented below, but all types and number of issues encountered per item are presented in Appendix B.

## Specific issues

1. Statements not specific enough (items: 15, 21, 27, 31, 32, 36)

Some of the statements presented were too broad and participants responded thinking of different contexts rather than the one intended. For example, item 31: “I can eat more than I should now, if I exercise for longer later to burn off the extra calories”, the participant thought about the context of losing weight rather than maintaining it (*n* = 5):

*“That is probably not a good way to go, if you want to lose some weight”*

To address this shortcoming, some items were reworded to specify a clear context for the strategy presented (e.g. To maintain my weight, I can eat more than I should now, if I exercise for longer later to burn off the extra calories.)

2. Statement contains elements that distract attention away from the intended one (items: 2, 9, 11)

For some statements, participants focused more on the numbers presented rather than what the statements was about. For example, item 9: “It is natural for your weight to fluctuate by 1-2 kg (2-3 lbs) throughout the day”. Participants focused on the amount of the fluctuation rather than whether it is normal or not for weight to fluctuate (*n* = 4):

“*I am not sure ... depends on the current weight of the person, 1-2 kg change might mean a lot for a 50 kg women while say, I have a friend who is more than 150 kg, so this might also depend on the person…”*

To overcome this limitation, items were reworded to either suggest that the numbers are an approximation, or numbers were removed where appropriate. (e.g. It is natural for your weight to fluctuate by 0.5 - 2 kg (1-3 lbs) throughout the day.)

3. Statement can be interpreted in more than one way (items: 7, 10, 22, 30, 37)

Some of the statements were interpreted in different ways by different participants. For example, item 30: “Unlike me, some people can eat whatever they want and not gain weight”.

One participant agreed because they thought that some people can eat a lot and not gain weight:

"*Yeah. Or at least it seems like that. I know people that it seems that they eat as much as I do and then they don't have the repercussions that I feel."*

While another participant agreed as well but interpreted as the fact that other people *want* to eat less compared to themselves:

*I do kind of agree with this, but I think it's in terms of saying they can eat whatever they want because some people don't want to eat that much anyway. That's why they won't gain any weight.*

Suggested action: Items were reworded to avoid multiple possible interpretations (e.g. Unlike me, some people can eat a lot and not gain weight.)

4. Statement is too long and difficult to follow (items: 15, 16, 36)

Some participants had difficulties understanding the items and stated that they might be too long and convoluted. For example item 15: "You can eat anything you want and not gain weight if you limit your food intake to the amount of calories your body needs to carry out normal everyday activities." One participant stated:

"*That feels like a long sentence, I need to look at it again. Hmm. .... I don't really know....."*

Items were reworded to be shorter and easier to follow (e.g. To maintain your weight, you can eat anything you want if you limit your calorie intake to the amount your body needs to carry out daily activities.)

## General issues

1. Participants agree with the statement based on their impact on health rather than their impact on body weight.

Example for item 1*: I think just generally people tend to say that eating too many carbohydrates aren't healthy.*

2. Participants add elements to the statement before they agree or disagree.

Example for item 2: *I have checked my own, and my own was about 2400 and I guess I classify as an average man …well for a 25-26 years old average man, so I agree.*

3. Participants say they agree but give arguments that suggest they disagree:

Example for item 19: *You should not drink any alcohol, but yeah if you drink alcohol it definitely contributes a lot. So, I would say, you should not, but again it's not necessary, but I agree.*

4. Participants agree with the statement because they engage in the behaviour, not because they think it is effective for WLM.

Example for item 31: *I sometimes do that, I eat more than I should now, because I feel like I will exercise later […] It's actually not good, so I shouldn't do that, but I agree that I do, but it's not a good thing to do.*

5. Participants just take a guess without actually knowing or having an opinion on the matter.

Example for item 8: *Hmm. …..I'm not sure on the answer. I would say I agree, but I wouldn't be able to say why.*

6. They answer correctly to the statement but give wrong arguments.

Example for item 19: *I have to disagree, but no I do agree there is a lot of alcohol that has, you know, sugar and would make you have a belly and things like that, alcohol is very general, I feel that like depends on which alcohol you drink than yeah.*

Conclusions

Study 1 results showed that some of the common issues encountered are related to item broadness, specificity and possible interpretations. After data analysis, 23 of the items of the questionnaire were reworded. Also, to address some of the general issues encountered regarding questionnaire completion, the instructions given to participants before completing the scales were changed to better target beliefs rather than behaviours and clearly specify the context of WLM.

## 3.5. Discussion

As presented earlier in this chapter, at the moment there are no available measures to assess knowledge and beliefs about WL related factors. To address this, a novel scale was developed following current theory and research on WLM (Greenway, 2015; Stubbs, 2012; Varkevisser et al., 2018), and behaviour change and maintenance (Pedersen et al., 2018; Stubbs & Lavin, 2013; Teixeira et al., 2012).

The eight-step methodology for nutrition knowledge questionnaire development was followed (Trakman et al., 2017) to develop the WLMKB scale. The scale aimed to assess knowledge and beliefs about WLM related factors. The factors covered were nutrition, overweight and obesity, monitoring weight, diet, physical activity, caloric compensatory behaviours, and hunger.

Knowledge and beliefs influence behaviour (Daigle, Gang, Kopping, & Gadde, 2019; Hartmann et al., 2016; Mitchell et al., 2021) but the evidence of the relationship between knowledge and behaviour relating to weight management is limited and shows a weak correlation (Spronk et al., 2014). Some researchers argue that this is due to the limitations of the existing scales that measure knowledge (Mötteli et al., 2016). The WLMKB scale is a new scale that measures WLM knowledge and beliefs and aims to address some of the limitations of other similar existing scales. First, the WLMKB scale includes theory driven items that cover several WLM related factors. While there are scales that cover these factors separately (Dickson-Spillmann et al., 2011; Mötteli et al., 2016; Stotland & Ztiroff, 1990), the WLMKB scale includes them all giving the possibility of using a single measure that will lower strain on the participants. Secondly, the WLMKB scale is the first scale to measure these factors specifically in relation to WLM. Measures such as the GNKQ and CoNKQ measure nutrition relating to health. This limitation was partially addressed by measures such as the WMNKQ, PKM-11 and PKB-7, but these measures either focus on just one specific factor (e.g. knowledge about calorie content) or are very extensive and include items that are difficult for the general public. Finally, the WLMKB scale, goes beyond the assessment of general guidelines and tests the understanding of the underlying processes related to WLM (e.g., calorie compensation, changes in energy expenditure with WL).

The initial item pool consisted of 51 items, that were then reduced to 40 items after further review of item content and accessibility by the research team. Study 1 tested the understanding and interpretation of the items in a sample of adults living in the UK. The ‘think aloud’ method was used to identify item specific issues and general survey responding issues. Following data analysis 23 of the items and the participant instructions were reworded to address the issues identified. This is an important step in scale development and provides confidence on the accurate understanding and interpretation of the items (Eccles & Arsal, 2017). The think aloud method is a widely used method to test psychometric scales (Gadermann et al., 2011; Gardner & Tang, 2014; Van Oort et al., 2011).

The current study has some limitations. The sample consisted of participants with higher education that were recruited using a snowballing technique. This means that the scale might not be accessible to participants with lower levels of education (Truman & Elliott, 2019). Additionally, data analysis was conducted by a single researcher. This could be a limitation as the interpretation of the content might have been biased. However, the anonymised data was made available to the research team and data analysis was checked by the supervisory team and item rewording was conducted by the whole research team.

In this study, the think aloud method was successfully used to identify issues with item misinterpretation and difficulties in understanding. This was an important first step in the development and testing of the WLMKB scale. The following step in the development of the scale was to assess the factor structure of the scale as well as test construct validity. These will be presented in more detail in Chapter 4.

# Chapter 4: Study 2: Item Pool Reduction and Dimensionality Testing of the WLMKB Scale

The previous chapter presented the development and testing of interpretation and understanding of a new WLM knowledge and beliefs scale. The next steps in scale development and testing according to guidance (Trakman et al., 2017) are item analysis, dimensionality testing of the scale and construct validity testing. This chapter will present the second study conducted as part of the thesis, that aimed to analyse the factor structure and reduce the item pool of the Weight Loss Maintenance Knowledge and Beliefs (WLMKB) scale. Additionally, the 'Known group' method was used to test the construct validity of the scale.

## 4.1. Background

Scales are assessment tools that aim to measure latent constructs that cannot be captured in a single item or assessed directly (DeVellis & Thorpe, 2012). Novel scales are necessary for science advances and testing of research questions. Scale development requires multiple steps and testing of aspects about the scale such as reliability and validity. Reliability and validity are important because the quality of the measure influences the outcomes of the research (Morgado, Meireles, Neves, Amaral, & Ferreira, 2017). There are various guidelines for scale development and validation (Boateng, Neilands, Frongillo, Melgar-Quiñonez, & Young, 2018) and for the purpose of this research these sources together with common practice were considered (Mikhail et al., 2020; Trakman et al., 2017).

As previously presented, the WLMKB scale (Chapter 3:) was developed to measure the accuracy of knowledge and beliefs regarding factors that influence WLM such as nutrition, physical activity, hunger and caloric compensation. The initial scale comprises 40 items. The scale has been through a “think aloud” task (Study 1, Chapter 3:), and in response to participant feedback ($n$ = 16), items were reworded to improve item understanding and interpretation. The current chapter will present the steps taken to analyse the items and structure of the scale and test the construct validity.

### 4.1.1. Factors

WLM is a complex process that is more difficult to achieve and research compared to WL (Stubbs et al., 2011). There are various factors that influence WLM, and these were presented in Chapter 2:. The items of the WLMKB scale were developed based on existing research, other scales and theory (Chapter 3:). The factors measured by the WLMKB scale are presented below. The factor labels were selected by the research team based on the theoretical basis and content of the items. This factor structure was later tested and some of the labels were changed (Study 2, Factor structure).

**Nutrition knowledge:** Items assessing nutrition knowledge focus on the accuracy of knowledge about the relation between food choice and weight management. The items cover information on macronutrients (fat, protein, fibre) as well as calorie content and energy balance.

**Overweight and obesity:** This factor focuses on assessing beliefs about common misconceptions about metabolism and causes of weight gain.

**Monitoring weight:** This factor focuses on the effectiveness of weight monitoring on weight management and accuracy of knowledge about weight fluctuation.

**Diet beliefs:** Items assessing beliefs about the effectiveness of certain strategies for weight management, daily calorie requirement and strategies for WLM.

**Physical activity:** This factor assesses beliefs about the effectiveness of different types of physical activity on weight management. Additionally, items focus on knowledge about calorie expenditure and its link to WLM.

**Calorie compensatory behaviours:** Items that focus on assessing individuals' beliefs about the impact of certain strategies in compensating for episodes of overeating.

**Hunger:** This factor focuses on assessing individuals' beliefs about hunger such as its causes, effects on health and the behavioural response to it.

## 4.2. Scale validation

Scale validation is a recommended step in scale development that assures a measure is able to accurately measure the concept it aims to measure (Boateng et al., 2018). There are various types of validity that test different aspects of scale measurement ability. Presented below are the types of validity that were tested in Study 2 of this thesis.

### 4.2.1. Construct Validity

Construct validity refers to the ability of the scale to measure a construct by means of the items. To test the construct validity of the scale, the known-groups comparison method was used. The 'known-group' method (Davidson, 2014) is a technique whereby responses to the scale will be compared between a specific-knowledgeable group and a 'non-specific knowledgeable' group. Previous research on the development of nutrition scales used groups of either nutritionists/dietitians and general public (Franklin et al., 2019; Mikhail et al., 2020) or nutrition students and non-nutrition students (Feren, Torheim, & Lillegaard, 2011; Jones et al., 2015; Parmenter & Wardle, 1999; Rapson et al., 2020). The WLMKB scale is a measure of knowledge and beliefs about WLM. Therefore, it is expected that people that have studied nutrition and nutrition-related modules, will score higher on the scale compared to people with no such studies.

### 4.2.2. Convergent Validity

Convergent validity refers to the extent to which responses on a scale relate to responses to conceptually similar scales (Robinson, 2018). A scale demonstrates convergent validity if it correlates with other measures related to the construct it aims to measure (Boateng et al., 2018). The WLMKB scale is a measure of the accuracy of knowledge and beliefs about WLM and is expected to predict success in weight management. The Perceived Self-Regulatory Success in Dieting Scale (Meule, Papies, & Kübler, 2012) is a measure that assesses participants' perception about their success in dieting and could be an indication of weight management success (Jonker, Bennik, & de Jong, 2021; van Koningsbruggen, Stroebe, & Aarts, 2011). Therefore, it was argued that higher scores on the WLMKB scale will correlate with higher perceived self-regulatory success in dieting.

### 4.2.3. Face Validity

Face validity refers to the idea that the scale and its items appear to measure the concept they claim to measure. This type of validity is tested in a subjective way, by asking participant or specialists in the field if the scale seems to measure the intended concept (Trakman et al., 2017). The WLMKB scale aims to measure people's knowledge and beliefs regarding factors related to WLM such as: nutrition, physical activity, hunger, monitoring. Given that the scale is aimed at the general population, and the interpretation of the scale aims can influence responses on the items (Eccles & Arsal, 2017; Lilienfeld & Strother, 2020), for the purpose of this study participants' interpretation will be used. Therefore, the scale will demonstrate face validity if participants can guess that the scale measures factors related to weight management. To this purpose, the participants were asked: "*What do you* *think this scale is trying to measure*?". The open answers will then be analysed to identify the themes and terms used to describe the aim of the scale. The scale will be deemed to have face validity if the majority of the participants give responses related to weight management nutrition knowledge and beliefs (Monaghan, 2017). There is no definite criteria for percentage of agreement, with examples in research ranging from 50% to 75% (Hardesty & Bearden, 2004). As the WLMKB scale is a multi-dimensional scale, an agreement of >60% will be deemed appropriate to provide evidence of face validity.

## 4.3. Aims

The aim of this study is to reduce the number of scale items from the initial item pool and to identify the underlying factors measured by the scale. To this purpose a factor analysis will be conducted. Another aim is to test the scale for construct validity using the "known group" technique (Davidson, 2014).

Primary hypothesis:

1. Nutrition-based students will have more accurate knowledge and personal beliefs about WLM compared to non-nutrition-based students.

Secondary hypothesis

2. There will be a positive relationship between perceived dieting success and knowledge and beliefs about WLM.
3. There will be a positive relationship between engagement in weight management strategies (number and frequency of engagement) and self-reported successful WLM.

## 4.4. Method

### 4.4.1. Design

Data was collected from an online cross-sectional survey (via Qualtrics, Provo, UT). Two groups of participants were recruited that differed in level of nutrition knowledge: nutrition based students – participants that have taken a minimum of one year nutrition related course, and non-nutrition based students – participants that report not completing any nutrition related courses, or report taking a nutrition course that lasted less than one year. Additionally, correlation analysis with three factors will be conducted: perceived dieting success, engagement in weight management strategies and knowledge and beliefs about WLM.

### 4.4.2. Participants

Participants were recruited through social media, posters and volunteer lists. Nutrition course leaders were also contacted to help distribute the survey. Eligibility criteria was as follows: Nutrition or non-nutrition based students in the UK aged 18 years or over, that do not have a current or history of eating disorders.

G* Power (version 3.1; Heinrich Heine University Düsseldorf, Germany) analysis showed a minimum requirement of $n = 30$ per group (nutrition student, non-nutrition student) to detect a medium effect size ($d = 0.5$), with 80% power at the 5% significance level. As suggested by Kline (2000), 200 participants would be the minimum necessary for a good factor analysis.

A total of 402 participants were recruited that differed in nutrition-based knowledge but were similar in age, gender, and education level (lowest $p = .08$). Also, to minimise the risk of harm, people with current or history of an eating disorder were not eligible to participate.

### 4.4.3. Measures

## Weight Loss Maintenance Knowledge and Beliefs scale

WLMKB scale is comprised of 40 items measuring the accuracy of knowledge and beliefs people have about several factors related to WLM such as: nutrition, overweight and obesity, monitoring weight, diet, calorie compensatory behaviours, physical activity and hunger (see Chapter 3). The scale has two proposed subscales, one measures accuracy of knowledge and the other measures beliefs. The Knowledge subscale has 20 items with a three-point response scale: true, false, don't know. The Beliefs subscale is comprised of 20 items with a 6-point Likert type response scale, 1 being strongly disagree and 6 strongly agree. A higher score for this measure will indicate that the person has accurate knowledge and beliefs about how certain factors and behaviours that affect WLM.

## **Dieting and Weight History Questionnaire (DWHQ)** (Witt et al., 2013)

The DWHQ (Witt et al., 2013) is a measure developed to assess the three dimensions of dieting as defined by Lowe (1993): frequency of past dieting and overeating, current dieting to lose weight and weight suppression. The DWHQ was used to characterise participants' weight history, WLM and dieting status. Successful WL maintainers should have intentionally lost at least 10% of initial body weight and maintained that WL (2 lbs/1 kg) for at least one year. To assess WLM participants were asked to report their height, current, lowest and highest weight. Additionally, participants were asked for how long they have been at their current weight and whether WL was intentional or not.

For the purpose of characterising the sample, additional items were included to measure the following dimensions: motives for WL and WLM, frequency of past dieting for weight maintenance, perceived success in dieting or weight maintenance, and type of diet that was followed.

The items added to measure motives for WL and WLM were based on a meta-analysis on the prevalence of weight control attempts and the underlying motives (Santos et al., 2017). According to the results of the meta-analysis, the most frequently reported motives for trying to maintain weight were to improve health and prevent future diseases (98%), followed by to improve wellbeing (91%), to improve fitness condition or staying fit (87%), to improve appearance (80%) and to improve self-esteem (71%). All other motives (e.g. to please or by insistence of spouse/partner, because of health professional advice) were listed by less than 50% of participants. For the purpose of this study only most frequently used motives were included, with the option for participants to write any other motive that was not included on the list.

## **Perceived Self-regulatory Success in Dieting Scale** (Meule et al., 2012)

The Perceived Self-regulatory Success in Dieting scale (PSRS) is a three-item scale that was developed by Fishbach et al. (2003). Participants were asked to rate on 7-point scales how successful they are in watching their weight, in losing weight, and how difficult it is for them to stay in shape. The PSRS scale was used as it is related to actual weight management success (Nguyen & Polivy, 2014). Reliability analysis of the PSRS scale was good, Cronbach’s alpha of .74.

## Weight management strategies

Participants were asked to report which strategies they used when trying to lose or maintain their weight. The list of strategies used was developed for the purpose of this study and was based on the Oxford Food and Activity Behaviors Taxonomy (OxFAB) (Hartmann-

Boyce et al., 2016). A total of 25 strategies were assessed and participants had the opportunity to add any strategies they use but were not listed. The response scale ranged from 1- never to 5- always.

#### 4.4.4. Procedure

Participants were asked to provide some demographic information (e.g. age, gender, nationality) and eligibility criteria was checked (direct questions on student status, eating disorders and time living in the UK). Ineligible participants were removed from participation (*n* = 111). Nutrition level was then assessed by asking participants whether they had taken a nutrition course and if so, participants were asked to name the course they had taken. Eligible participants were then asked to complete a survey that included the WLMKB scale and questions about their current weight, height, WL attempts and WLM (DWHQ), as well as their perceived success in weight management (PSRS). After this, participants were further asked to answer open ended questions about the purpose of the scale and the understanding of the items. At the end of the survey, participants were redirected to a separate survey with debrief information and offered the chance to enter a prize draw for a £50 Amazon voucher. This study protocol was pre-registered and is available at https://osf.io/fetnz. The study received ethical approval from the University of Sheffield (no. 023798). The full survey is presented in Appendix C.

### 4.5. Strategy for data analysis

To check the dimensionality of the scale, factor analysis was conducted separately on the two subscales of the scale. The analysis could not be conducted separately on the two groups of participants due to insufficient number of participants recruited in the nutrition-based students group (*n* = 105).

T-tests were conducted to compare accuracy of knowledge about WLM between participants with nutrition studies and those without. Correlational analysis using Pearson's *r* was conducted to identify relationships between knowledge and beliefs about WLM and perceived success, engagement in weight management strategies and successful WLM.

The criteria for significance was $p < .05$. For the between-subjects comparison, effect sizes are reported (Cohen's *d*: small effect = 0.2, medium effect = 0.5 large effect = 0.8). The strength of correlations was interpreted as small if Pearson's $r < .3$, medium if between .3 and .5, and large if $r > .5$ (Cohen, 1992). Reported height, weight, weight change and computed BMI values were screened for values that were outside expected ranges (height between < 1.40 – > 2.20 m, weight < 40 – > 200 kg, weight change > 40kg and computed BMI < 15 $kg/m^2$ - > 60 $kg/m^2$). Datapoints for incomplete surveys were retained up to the point participants dropped out. This data was used to compare completers from non-completers on demographic information using t-tests (e.g. age, sex, nutrition knowledge). Averages were not computed to fill in missing data points because the aim of this research is explanatory and filling the missing data points might lower effect sizes (McCoy, 2017; Montori & Guyatt, 2001). One attention check question was included in the survey '*It's important that you pay attention to this study, please tick false'*. Attention check was included to check the quality of the responses (Oppenheimer, Meyvis, & Davidenko, 2009). Participants that responded incorrectly to the attention check were removed from analysis.

Statistical analysis was carried out using IBM SPSS version 26. R studio was used to conduct reliability analysis and factor analysis on the two subscales.

## 4.6. Results

### 4.6.1. Participants

A sample of *n* = 402 was recruited (*M*: 24.71, *SD*: 7.73 years; 271 female (70.20%), 109 male (28.23%). Participants had an average self-reported BMI of 23.64 kg/m$^2$ (*SD*: 4.58). Reported BMI showed that 58.7% (*n* = 183) of participants were classified as having a normal weight, 14.7% (*n* = 46) underweight, 19.6% (*n* = 61) overweight and 7.1% (*n* = 22) with obesity. Out of the whole sample, 17.3% (*n* = 54) of participants reported being on a diet. Out of these participants, 72.2% (*n* = 39) reported dieting to lose weight and 27.8% (*n* = 15) to avoid weight gain.

Drop-out analysis was conducted on all responses collected. Out of a total number of people that accessed the link *n* = 713, 56.4% finished completing the survey (*n* = 402). The survey took on average approximately 21 minutes to complete. A summary of participant characteristics is shown in Table 4.1. Mean age of participants that dropped-out was similar to the ones who finished. A significantly higher percentage of men finished the survey (28.1%) than dropped-out (16.4%), and a higher percentage of women that dropped-out (80.5%) compared to ones that finished (70.3%). There was a significant difference between the percentage of participants that dropped out that had nutrition knowledge compared to those without nutrition knowledge. Out of the participants that reported having nutrition related studies, 35% dropped out of the study, while 20% dropped out of the non-nutrition based group.

Out of the whole sample, 458 participants provided information on how they found out about the study. Most participants that finished the survey were recruited via e-mail *n* = 292, while the second means of recruitment was social media that provided 94 participants out of which 25 have dropped out. Most participants that did not finish the survey did not give any information about dieting status or weight history.

*Table 4.1:* Drop-out analysis

| | **Completed (*n* = 402)** **Mean (SD) or n (%)** | **Dropped-out (*n* = 311)** **Mean (SD) or n (%)** | **Differences** **t or $\chi^2$** |
|---|---|---|---|
| **Age** | 24.71 (7.73) years | 23.77 (7.07) years | t(557) = 1.99 |
| | | | *p* = .055 |
| **Sex** | 271 female (70%) | 157 female (81%) | $\chi^2$ (3) = 10.6 |
| | 109 male (28%) | 32 male (16%) | *p* = .014 |
| **British** | 226 yes (59%) | 141 yes (72%) | $\chi^2$ (1) = 9.92 |
| | 156 no (41%) | 54 no (28%) | *p* < .001 |
| **Student status** | 382 students (95%) | 65 not students (21%) | $\chi^2$ (1) = 145.14 |
| | | 127 did not finish (40%) | *p* < .001 |
| **Nutrition status** | 100 nutrition (25%) | 54 Nutrition (43%) | $\chi^2$ (1) = 12.87 |
| | 287 non-nutrition (75%) | 73 non-nutrition (57%) | *p* < .001 |
| **Eating disorders** | 383 no (95%) | 46 yes (15%) | $\chi^2$ (1) = 145.26 |
| | | 72 did not finish (23%) | *p* < .001 |

### 4.6.2. Factor structure

To assess the dimensionality of the WLMKB scale, factor analysis was conducted separately on the two subscales.

## Knowledge subscale:

I. Factor Analysis using R (Field, Miles, & Field, 2012).

All 20 items were included in this analysis. Responses were coded as 1 for correct and 0 for false and don’t know. To be able to run a factorial analysis on dichotomous variables a tetrachoric correlation was created and the principal axis factor was conducted (Starkweather, 2014). In the first step of the analysis, the number of factors was set to be the same as the number of items in the scale. This helped indicate the number of factors that should be extracted. Results showed that a 2-factor extraction would be appropriate (Figure 4.1). Factor 1 consisted of items: 1, 2, 3, 5, 7, 12, 18, 19. Factor 2 included items: 13, 16, 6, 8, 9, 11, 15, 17. Items 4, 20, 10, 14 did not load on any of the factors. Items 8, 9, 16 had loading values below .4.

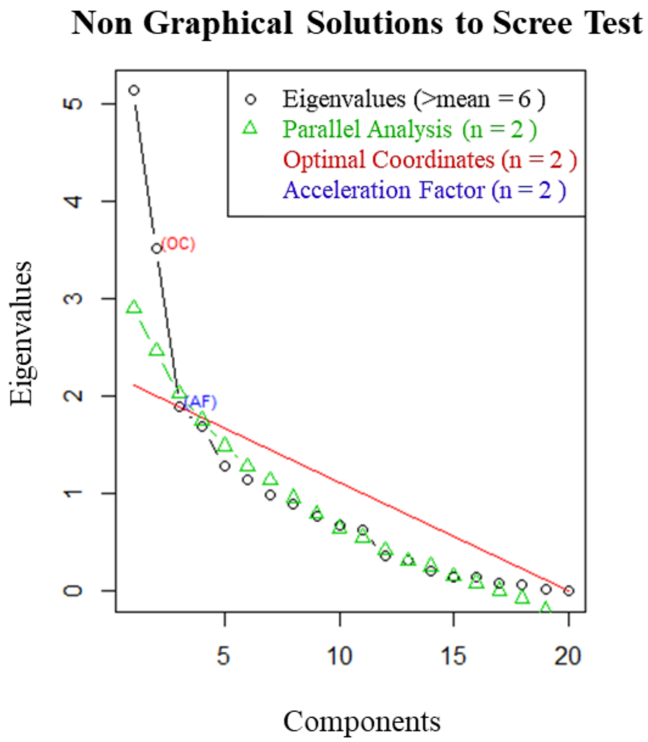



*Figure 4.1: Screeplot of the Knowledge subscale factors*

Factor analysis was conducted (principal axis factor) on the 20 items of the Knowledge subscale with orthogonal rotation (varimax). The Keiser-Meyer-Olkin measure verified the sampling adequacy for the analysis KMO = .64, items 2, 18, 10 were removed because they had values below .5. After removing those items KMO = .72. Bartlett's test of sphericity, $\chi^2$ (91) = 17148.39, $p$ < 0.001, indicated that correlations between items were sufficiently large for PFA.

An initial analysis was run to obtain eigenvalues for each component in the data. Two components were extracted after examining the screeplot (Figure 4.1) with eigenvalues above Kaiser's criterion of 1, and in combination explained 35% of variance. The screeplot was slightly ambiguous and showed inflexions that would justify retaining both two and four components. After running the analysis with 2, 3 and then 4 factor extraction, a two-factor extraction was deemed appropriate for the final analysis. Table 4.2 shows the factor loadings after rotation. First, items 2, 18 and 10 were removed due to KMO values below .5. Second, items 4, 14 and 20 were removed due to not loading on either of the factors. Third, following item difficulty testing, items 6, 7, 9 and 16 were removed for being too easy. The final model presented in Table 4.3 which shows the factor loadings of the items retained in the subscale. Item 8 was kept in the scale even though it loaded below .4 due to theoretical considerations.

*Table 4.2:* Initial factor analysis: Knowledge subscale of the WLMKB

| Item | Factor 1 | Factor 2 |
|---|---|---|
| 1 | **.42** | .26 |
| 2 | **.54** | -.03 |
| 3 | **.55** | .14 |
| 4 | .07 | .05 |
| 5 | **.60** | .27 |
| 6 | .01 | **.44** |
| 7 | **.57** | .03 |
| 8 | .08 | **.40** |
| 9 | .03 | .38 |
| 10 | .01 | .17 |
| 11 | .12 | **.67** |
| 12 | **.63** | .16 |
| 13 | .19 | **.46** |
| 14 | -.30 | .05 |
| 15 | .04 | **.51** |
| 16 | .24 | .32 |
| 17 | .08 | **.53** |
| 18 | **.43** | .03 |
| 19 | **.64** | .23 |
| 20 | .18 | .28 |

*Note:* Items in light grey were removed for KMO values below .5; Items in medium grey were removed due to loadings below .4; Items in dark grey were removed for being too easy.

The final solution suggested a two-factor structure. After assessing the items that clustered on each of the factors the following labels were proposed. Factor 1 represents knowledge about the link between food choice and weight management and was labelled Food Choice. A low score on this factor indicates a poor understanding of this relationship, and a general belief that for weight maintenance success certain foods should be banned and high intensity exercise necessary. Factor 2 measures knowledge about the energy in/energy out model of obesity and was labelled Energy Balance. A low score on this factor shows a poor understanding of the necessity of calorie balance for WLM.

*Table 4.3:* Final solution Knowledge subscale of the WLMKB

| | Factor 1 | Factor 2 |
|---|---|---|
| 1. Starchy foods such as bread, potatoes and pasta are fattening. R | **.49** | .21 |
| 3. Engaging in vigorous cardiovascular physical exercise (e.g. hiking, jogging) is necessary to maintain your weight. R | **.57** | .13 |
| 5. Eating bread causes weight gain. R | **.67** | .19 |
| 7. To maintain weight, people should cut out fat from their diet. R | **.60** | -.02 |
| 12. When attempting to maintain weight you should not eat any high calorie foods (e.g. fries, burgers, cake, biscuits). R | **.65** | .14 |
| 19. To maintain your weight you should not drink any alcohol. R | **.66** | .19 |
| 6. To maintain weight, the number of calories consumed must be equal to the number of calories expended. | .05 | **.42** |
| 8. After weight loss, the number of calories you burn while doing exercise decreases. | .09 | .39 |
| 9. It is natural for your weight to fluctuate by 0.5 - 2 kg (2-3 lbs) throughout the day. | .04 | .36 |
| 11. Replacing a regular soda (330 ml) with a diet soda will save approximately 150 kcal. | .12 | **.72** |
| 13. Some people who are overweight can live on 800-1200 kcal a day without losing weight. R | .21 | **.44** |
| 15. To maintain your weight, you can eat anything you want if you limit your calorie intake to the amount your body needs to carry out daily activities. | .13 | **.44** |
| 16. People that are overweight or obese have a slower metabolism compared to people with a healthy weight. R | .22 | .33 |
| 17. Swapping sugar with artificial sweeteners can help with weight loss maintenance. | .06 | **.59** |

*Note.* *items in grey have been removed in the final model for being too easy; R = reversed items

A final factor analysis was conducted on the remaining 10 items of the subscale. Results show that the items still loaded onto the two factors as before (*Table 4.4*). However, items 8 and 15 have loadings lower than .4. For the theoretical integrity of the scale these items were not removed from the scale. Furthermore, the scale in this form showed good internal reliability.

*Table 4.4:* Final items factor loadings Knowledge subscale of the WLMKB

| | Factor 1 | Factor 2 |
|---|---|---|
| 1. Starchy foods such as bread, potatoes and pasta are fattening. R | **.66** | .05 |
| 3. Engaging in vigorous cardiovascular physical exercise (e.g. hiking, jogging) is necessary to maintain your weight. R | **.79** | .01 |
| 5. Eating bread causes weight gain. R | **.79** | -.02 |
| 12. When attempting to maintain weight you should not eat any high calorie foods (e.g. fries, burgers, cake, biscuits). R | **.74** | .04 |
| 19. To maintain your weight you should not drink any alcohol. R | **.81** | -.05 |
| 8. After weight loss, the number of calories you burn while doing exercise decreases. | -.23 | .25 |
| 11. Replacing a regular soda (330 ml) with a diet soda will save approximately 150 kcal. | .10 | **1.02** |
| 13. Some people who are overweight can live on 800-1200 kcal a day without losing weight. R | .18 | **.44** |
| 15. To maintain your weight, you can eat anything you want if you limit your calorie intake to the amount your body needs to carry out daily activities. | .06 | .37 |
| 17. Swapping sugar with artificial sweeteners can help with weight loss maintenance. | -.05 | **.69** |

*Note:* R = reversed items.

II. Item difficulty

Items testing knowledge were measured on a true false scale. For this type of scale item difficulty is an important characteristic that helps identify items that are either too easy or too difficult (Trakman et al., 2017). For the purpose of this scale items that are too easy (have been answered correctly by more than 70% of the participants) were deleted because they are not good for differentiating people on their knowledge (Boateng et al., 2018). Easy Items: 2, 7, 18, 6, 9, and 14.

III. Reliability analysis

Reliability analysis was run separately for the two factors of the scale. Given that the response scale was dichotomous, Cronbach's alpha was calculated on the tetrachoric correlation matrix rather than the raw data (Napolitano, Callina, & Mueller, 2013). Results of the analysis show that Factor 1 has a high reliability with Cronbach's α = .87. Factor 2 has a

Cronbach's α = .68 and suggest that the removal of item 8 will increase the scale reliability to the acceptable value of .7. To maintain theoretical consistency and concept cover, the item was not removed from the scale. The overall reliability of the Knowledge subscale is deemed to be good with a Cronbach's α = .72.

## Beliefs subscale

I. Factor Analysis

Exploratory factorial analysis was conducted using SPSS 26. The extraction method used was principal axis factor with an oblique rotation, as suggested by Costello and Osborne (2005). The principal axis factor method was selected as it is a technique that gives best results on both normally and nonnormal distributions (Osborne, Osborne, Costello, & Kellow, 2011). The oblique rotation was selected because it is a method that allows for factors to correlate. The Kaiser-Meyer-Olkin measure of sampling adequacy was KMO = .67 and Bartlett's test of sphericity was significant $\chi^2$ (190) = 1174.71, $p < .001$, meaning that the items are significantly correlated. Initial analysis of the screeplot suggested a 5-factor extraction. Following this analysis 8 items were removed due to cross-loadings (item 9) and loadings below .4 (items 1, 2, 3, 4, 7, 13 and 17) (Table 4.5). After removing these items, the analysis was run again following which an additional two items (8 and 14) were removed due to loadings falling below .4. This item loading threshold was deemed appropriate because the scale aims to assess a broad concept and this threshold will allow for the inclusion of multiple items and therefore cover the multiple aspects of the concept assessed (Osborne et al., 2011).

*Table 4.5:* Item loadings by factor for the Beliefs subscale of the WLMKB scale

| | Factor | | | | |
|---|---|---|---|---|---|
| Item no. | 1 | 2 | 3 | 4 | 5 |
| 1 | .13 | .38 | -.27 | .17 | -.09 |
| 2 | .16 | .18 | -.33 | .25 | -.04 |
| 3 | -.08 | .37 | .26 | .13 | .12 |
| 4 | .08 | -.04 | .34 | .06 | .03 |
| 5 | -.14 | .02 | **.58** | .18 | .19 |
| 6 | **.64** | -.07 | .01 | -.10 | -.13 |
| 7 | .12 | -.05 | .17 | .32 | .13 |
| 8 | .04 | .14 | -.30 | **.42** | -.15 |
| 9 | **.42** | **.40** | -.15 | .31 | -.14 |
| 10 | -.10 | -.02 | .11 | -.11 | .72 |
| 11 | -.03 | **.47** | -.14 | -.10 | -.02 |
| 12 | -.19 | .20 | **.46** | .04 | .32 |
| 13 | .03 | .25 | .08 | .37 | -.09 |
| 14 | .00 | .01 | .07 | **.57** | .07 |
| 15 | **.58** | .19 | -.19 | .23 | -.26 |
| 16 | -.01 | **.51** | .07 | .17 | -.02 |
| 17 | -.21 | .31 | .16 | .29 | .13 |
| 18 | **.84** | -.02 | -.03 | .07 | -.02 |
| 19 | -.09 | -.02 | .09 | .13 | **.60** |
| 20 | .15 | **.62** | -.16 | .03 | -.13 |

*Note:* Items in light grey were removed for loadings below .4; Items in medium grey were removed for loadings falling below .4 after re-running the factor analysis; Items in dark grey were removed for cross-loadings.

The final extraction model showed a 3-factor solution that explained 41.87% of the variance. Items loading by factors are shown in Table 4.6. Items 5 and 11 showed loadings below .4 but were not removed as they covered important aspects of the assessed concept. The factors extracted were labelled as follows: hunger (3 items), calorie compensation behaviours (CCB; 3 items) and diet/obesity (4 items). Low scores on each of the factors show more inaccurate beliefs about hunger, calorie compensatory behaviours and diet/obesity in relation to WLM.

*Table 4.6:* Item loadings by factor for the Beliefs subscale of the WLMKB scale

| Items | Hunger | CCB | Diet/ obesity |
|---|---|---|---|
| 6. Hunger is a sign that my body needs food to function properly. | **.55** | -.06 | -.05 |
| 15. Sometimes I have to accept that I feel hungry and not always eat in response to hunger. | **.51** | .15 | -.17 |
| 18. If I feel hungry it means that I should eat to stay healthy. | **.99** | -.01 | .14 |
| 11. To maintain my weight, I can eat more than I should now, if I exercise for longer later to burn off the extra calories. | -.04 | .37 | -.02 |
| 16. To maintain my weight, it is ok if I overeat by a small amount in a day if I get back on track the next day. | -.01 | **.66** | .15 |
| 20. If I eat too much today, I can maintain my weight if I eat less tomorrow. | .10 | **.64** | -.07 |
| 5. If I weigh more today than I did yesterday it means I ate too much and gained weight. | -.07 | -.02 | .35 |
| 10. Unlike me, some people can eat a lot and not gain weight. | -.03 | -.05 | **.51** |
| 12. To maintain my weight, I have to strictly follow a diet. | -.12 | .13 | **.49** |
| 19. Compared to me, most people don't have to do anything to maintain a healthy weight. | -.03 | -.06 | **.52** |

*Note.* CCB = calorie compensatory behaviours

For the final stage, a principal axis factor analysis of the remaining 10 items, using oblimin rotation, was conducted, with three factors explaining 37.17% of the variance (Table 4.7). All items in this analysis loaded on the same factors as the final factor structure with loadings above .36. A single item had a factor loading of .25. This item was retained in the scale as it was deemed important for the theoretical concept assessed.

*Table 4.7:* Final factor analysis on the 10 remaining items of the Beliefs subscale

| Items | Hunger | CCB | Diet/ obesity |
|---|---|---|---|
| 6. Hunger is a sign that my body needs food to function properly. | **.54** | -.02 | -.20 |
| 15. Sometimes I have to accept that I feel hungry and not always eat in response to hunger. | **.55** | .14 | -.30 |
| 18. If I feel hungry it means that I should eat to stay healthy. | **.98** | .02 | -.11 |
| 11. To maintain my weight, I can eat more than I should now, if I exercise for longer later to burn off the extra calories. | -.02 | .39 | -.01 |
| 16. To maintain my weight, it is ok if I overeat by a small amount in a day if I get back on track the next day. | .01 | **.53** | .05 |
| 20. If I eat too much today, I can maintain my weight if I eat less tomorrow. | .15 | **.77** | -.16 |
| 5. If I weigh more today than I did yesterday it means I ate too much and gained weight. | -.12 | -.07 | .25 |
| 10. Unlike me, some people can eat a lot and not gain weight. | -.12 | -.00 | **.62** |
| 12. To maintain my weight, I have to strictly follow a diet. | -.18 | .10 | .37 |
| 19. Compared to me, most people don't have to do anything to maintain a healthy weight. | -.13 | -.08 | **.64** |

*Note.* CCB = calorie compensatory behaviours

I. Reliability analysis:

For the Beliefs scale reliability analysis was conducted on the correlation matrix and the results showed that each factor has high reliability as well as the whole scale: Hunger $\alpha$ = .87; CCB $\alpha$ = .73; Diet/obesity $\alpha$ = .73; Beliefs Scale $\alpha$ = .76. Overall analysis shows that the factorial analysis yielded good factorial solutions. Each factor of the two subscales demonstrated good reliability with Cronbach's $\alpha$ values above .7 (Table 4.6).

Table 4.8 and Table 4.9 present the factor structure of the scale and the theoretical source of each of the items. The final version of the WLMKB scale comprised of 20 items measuring the accuracy of knowledge (Knowledge subscale) and beliefs (Beliefs subscale) people have about several factors related to WLM such as: overweight and obesity, diet, calorie compensatory behaviours, hunger, food choice and calorie balance.

The Knowledge subscale is comprised of 10 items measuring knowledge about calorie balance and the relation between food choices and weight management. The Beliefs subscale contains 10 items measuring beliefs about hunger, diet, obesity and calorie compensatory behaviours.

*Table 4.8:* Knowledge Subscale items and theory

| Factors | Items | Theory |
|---|---|---|
| Food choices | 1. Starchy foods such as bread, potatoes and pasta are fattening. R | - Items from 'Improving the Nutrition and Care of the Overweight Patient Survey' (Hankey et al., 2004).<br>- The scale contains questions that explore beliefs, attitudes and knowledge about the links between obesity, nutrition and health. Developed to document knowledge, attitudes, beliefs of health professionals. |
| | 3. Engaging in vigorous cardiovascular physical exercise (e.g. hiking, jogging) is necessary to maintain your weight. R | - Weight maintenance is the result of energy balance between intake and expenditure (Thom & Lean, 2017), regardless of food macronutrient composition (Naude et al., 2014). Physical activity is included in most obesity treatment interventions. However, dietary changes are also required and large amounts of exercise are necessary for a moderate degree of WL. |
| | 5. Eating bread causes weight gain. R | - Item from the General Nutrition Knowledge Questionnaire – Revised (Kliemann et al., 2016)<br>- The scale consists of four independent sections, each assessing a different aspect of nutrition knowledge: dietary recommendations; food groups; healthy food choices and diet, disease and weight management. |
| | 12. When attempting to maintain weight you should not eat any high calorie foods (e.g. fries, burgers, cake, biscuits). R<br>19. To maintain your weight you should not drink any alcohol. R | - Items adapted from qualitative data collected by (Kruseman et al., 2017). They interviewed WL maintainers and discovered that they experience WLM strategies as a burden. Some of the statements indicate the necessity of a strict diet and cutting out foods: "*I cut out all soft drinks, ice-tea, I banned all that from my diet*". Other statements imply that there are people that can eat as much as they want without gaining weight: "*I'd like to be one of those persons who can eat everything and never gain one gram*". |
| Energy balance | 8. After weight loss, the number of calories you burn while doing exercise decreases. | - WLM is the result of balanced energy intake and expenditure. Energy expenditure is comprised of three components: the thermic effect of food, physical activity expenditure, and resting energy expenditure. Physical activity expenditure can be volitional or incidental (the activities of daily living). The energy expended in physical activities is determined by duration, intensity and overall body weight. Thus, physical activity energy expenditure declines with WL unless its quantity or intensity increases to compensate (Hall et al., 2012). |
| | 11. Replacing a regular soda (330 ml) with a diet soda will save approximately 150 kcal. | |

| Factors | Items | Theory |
|---|---|---|
| | 13. Some people who are overweight can live on 800-1200 kcal a day without losing weight. R | - Improving the Nutrition and Care of the Overweight Patient Survey' (INCOPS) (Hankey et al., 2004).<br>- These questions explored beliefs, attitudes and knowledge about the links between obesity, nutrition and health.<br>Given that energy expenditure from physical activities depends on duration, intensity and overall body weight, people with obesity often have similar daily energy cost for physical activity as those without obesity, despite being less physically active. |
| | 15. To maintain your weight, you can eat anything you want if you limit your calorie intake to the amount your body needs to carry out daily activities. | - Whether a diet is targeted toward reducing fat or carbohydrate, or increasing protein, for WL to occur an energy deficit must be established (Thom & Lean, 2017). Several meta-analyses have shown that long-term WL and metabolic improvements occur independent of macronutrient composition of the diet, and greater energy restriction results in greater WL, regardless of whether restrictions are mainly from protein, carbohydrate, or fat (Naude et al., 2014; Nordmann et al., 2006). |
| | 17. Swapping sugar with artificial sweeteners can help with weight loss maintenance. | - Replacing the daily intake of sugar with low calorie sweeteners (LCS) can help with weight maintenance. It has been estimated that adults can prevent weight gain by reducing intake by 100 kcal/d (Hill, 2009).<br>- It is a common strategy to replace sugar with low-calorie sweeteners to facilitate weight control. This strategy enabling people to eat sweet foods, or beverages without the added calories from sugar. But in order for sweeteners to have an impact on weight management they have to be associated with a reduced energy diet (Bellisle & Drewnowski, 2007). |

*Table 4.9:* Beliefs subscale items and theory

| Factors | Items | Theory |
|---|---|---|
| Hunger | 6. Hunger is a sign that my body needs food to function properly.<br>15. Sometimes I have to accept that I feel hungry and not always eat in response to hunger.<br>18. If I feel hungry it means that I should eat to stay healthy. | - Apart from the behavioural challenges to WLM there are also physiological challenges (MacLean et al., 2015). Caloric restriction results in a rapid, profound reduction in circulating levels of leptin and energy expenditure and an increase in appetite. Given the increased levels of hunger, research suggests that for successful WLM it is important for individuals to understand it is not a problem to feel hunger. |
| Calorie compensatory behaviours | 11. To maintain my weight, I can eat more than I should now, if I exercise for longer later to burn off the extra calories.<br>16. To maintain my weight, it is ok if I overeat by a small amount in a day if I get back on track the next day.<br>20. If I eat too much today, I can maintain my weight if I eat less tomorrow. | - Caloric compensation - i.e. moderating food intake and/or increasing physical activity in response to occasions of overeating—in order to maintain a neutral energy balance. The 'balance' approach accepts that occasions of overeating are likely to occur and focuses on making people aware of these occasions of overeating, and to motivate and enable them to compensate for them within a short span of time (Wammes et al., 2006).<br>- Compensatory Health Beliefs Scale (Knäuper et al., 2004) – 26 – item scale that measures compensatory health beliefs. For the current scale the three items that measure weight regulation CHBs non-reversed were used. Research shows that CHBs are negatively correlated with health behaviours, but the relation is reversed when talking about compensatory behaviours instead of beliefs. |
| Diet/Obesity | 5. If I weigh more today than I did yesterday it means I ate too much and gained weight. | - People tend to overestimate the speed of weight gain and WL. Research shows that this translates into a belief that weight change after reducing or adding 500 calories per day will happen two to four days faster, per pound, then it should based on the estimated rate of 3.500 calories per pound (O'Brien et al., 2018).<br>- Long-term stability of body weight is considered to be the balance between energy intake and expenditure. However, changes in body weight also include changes in body water, which may be variable, and therefore weight change may not directly represent energy imbalances, particularly over the short term (Hall & Guo, 2017). |

| Factors | Items | Theory |
|---|---|---|
| | 10. Unlike me, some people can eat a lot and not gain weight. | - Items adapted from qualitative data collected by (Kruseman et al., 2017). They interviewed WL maintainers and discovered that they experience WLM strategies as a burden. Participant statements imply that there are people that can eat as much as they want without gaining weight: "*I'd like to be one of those persons who can eat everything and never gain one gram*". |
| | 12. To maintain my weight, I have to strictly follow a diet. | - An increase in flexible cognitive restraint during the WL intervention was related to better WLM and well-being. This suggest that increasing flexible control while reducing rigid control of eating after an active WL phase improves success in weight management and the psychological well-being of weight losers (Sairanen et al., 2014).<br>- Mathematical modelling of human metabolism and body weight dynamics suggests that the large day to day variations in energy intake are irrelevant for body weight regulation. Rather, persistent changes in energy intake can lead to substantial weight changes over long time scales (Chow & Hall, 2014). |
| | 19. Compared to me, most people don't have to do anything to maintain a healthy weight. | - Items adapted from qualitative data collected by (Kruseman et al., 2017). They interviewed WL maintainers and discovered that they experience WLM strategies as a burden. |

### 4.6.3. Construct Validity

The construct validity of the WLMKB scale was assessed by using 'known group' comparisons. To this aim two groups of nutrition and non-nutrition students were recruited and their scores on the WLMKB scale were compared.

Hypothesis 1: There is a difference in nutrition knowledge between students that have taken nutrition related courses compared to students who have not. Nutrition students will have higher scores on the WLMKB scale compared to non-nutrition students.

T-tests were conducted on the two subscales of the WLMKB scale. Results from these analyses are presented below.

1. Knowledge subscale

Nutrition students scored on average significantly higher than non-nutrition students on both the Food Choice and Energy Balance Knowledge scales (Table 4.10). This suggests that the Knowledge Subscale of the WLMKB scale has construct validity.

*Table 4.10:* Independent *T*-test on the Knowledge subscale in nutrition ($n$ = 106) and non-nutrition students ($n$ = 302)

| **Factor** | **Nutrition level** | **Mean ± *SD*** | ***T*-test** | ***p*** | **95% CI** | **Effect size (Cohen's *d*)** |
|---|---|---|---|---|---|---|
| Food Choice | Nutrition | 3.46 ± 1.57 | $t(406) = 3.59$ | <.001 | .27 - .95 | 0.40 |
| | Non-nutrition | 2.85 ± 1.49 | | | | |
| Energy Balance | Nutrition | 2.58 ± 1.19 | $t(406) = 3.65$ | <.001 | .23 - .76 | 0.42 |
| | Non-nutrition | 2.08 ± 1.22 | | | | |

*Note.* Results of the independent T-test to compare accuracy of knowledge about Food choice and Energy balance between nutrition students and non-nutrition students.

2. Beliefs subscale

Students who had taken nutrition courses had similar scores to students that had not taken any nutrition courses (Table 4.11).

*Table 4.11:* Independent *T*-test for the Beliefs subscale in nutrition ($n$ = 88) and non-nutrition students ($n$ = 293)

| **Factor** | **Nutrition level** | ***M* ± *SD*** | ***T*-test** | ***p*** | **95% CI** | |
|---|---|---|---|---|---|---|
| Hunger | Nutrition | 10.17 ± 2.96 | $t(379) = 1.18$ | .24 | .27 | .95 |
| | Non-nutrition | 9.75 ± 2.86 | | | | |
| CCB | Nutrition | 11.00 ± 2.82 | $t(377) = 0.11$ | .92 | .23 | .76 |
| | Non-nutrition | 10.96 ± 2.55 | | | | |
| Diet/Obesity | Nutrition | 15.95 ± 2.84 | $t(378) = 0.50$ | .62 | | |
| | Non-nutrition | 15.75 ± 3.48 | | | | |

*Note.* CCB = calorie compensatory behaviours; M = mean; SD = standard deviation; CI = confidence intervals

### 4.6.4. Convergent Validity

**Association between WLKMB and Perceived self-regulatory success in a student sample**

It was hypothesised that there would be a positive relationship between perceived dieting success and knowledge and beliefs about WLM. Results showed no significant difference in perceived self-regulatory success between nutrition student and non-nutrition students $t(308) = 1.28$, $p = .20$) . Therefore, the correlational analysis was conducted on the whole sample (Table 4.12).

For the Knowledge subscale, there was a significant medium correlation between perceived self-regulatory success and accuracy of knowledge about the link between food choice and weight management ($r = .22$, $p < .001$). Suggesting that individuals with more accurate knowledge about food choice also reported higher perceived dieting success. There was no significant correlation between perceived self-regulatory success and accuracy of knowledge about energy balance ($r = .06$, $p = .27$).

The analysis on the Beliefs subscale showed a significant medium correlation between perceived self-regulatory success and Diet/Obesity beliefs ($r = .27$, $p < .001$). Also, there was a significant weak correlation between perceived self-regulatory success and beliefs about calorie compensatory behaviours (*r* = .13, *p* = .013). Suggesting that individuals with more accurate beliefs about diet/obesity and calorie compensatory behaviours also reported higher perceived dieting success. There was no significant correlation between perceived self-regulatory success and beliefs about hunger (*r* = .01, *p* = .92).

*Table 4.12:* Correlations between WLMKB scale and PSRS, BMI and weight gain

| | | Perceived self-regulatory success | BMI | Weight gain |
|---|---|---|---|---|
| **Knowledge** | | .20** | .03 | .06 |
| | **Food Choice** | .22** | .01 | .05 |
| | **Energy Balance** | .06 | .10 | .01 |
| **Beliefs** | | .26** | -.03 | .03 |
| | **Hunger** | .01 | .10 | .09 |
| | **CCB** | .13* | -.02 | -.01 |
| | **Diet/Obesity** | .27** | -.12* | -.03 |

Results suggest that participants with higher perceived self-regulatory success scores had on average more accurate beliefs about calorie compensatory behaviours and diet/obesity but not on belief about hunger.

It was further hypothesised that there will be a positive relationship between engagement in weight management strategies and self-reported successful WLM. However, the sample size was not sufficiently powered to conduct the analysis to assess this hypothesis. Future research will aim to recruit participants actively attempting to manage their weight to be able to test this hypothesis.

### 4.6.5. Face Validity

Content analysis was conducted on the open answers participants provided when asked what they thought the scale was aiming to measure. A total of 320 participants answered the open question. Data analysis was conducted by one coder. The themes identified were related to the aim of the WLMKB scale. The major themes identified were weight (*n* = 275, 85.6%) (e.g. Students attitudes to weight maintenance and perceptions of what is thought to be good methods of losing/maintaining weight), nutrition (*n* = 119, 37.2%), knowledge (*n* = 98), beliefs (*n* = 65), diet (*n* = 110) and exercise (*n* = 21). However, there were also responses that referred to factors not intended to be assessed by the scale such as eating disorders (*n* = 4) and healthy lifestyle (*n* = 58). These themes however were less frequently mentioned.

### 4.6.6. Exploratory analyses

Exploratory analyses were conducted to analyse the relationships between perceived self-regulatory success, weight regain, BMI and knowledge and beliefs. Perceived self-regulatory success correlated negatively with weight regain ($r = -.24$, $p < .001$) and current BMI ($r = -.36$, $p < .001$). These results suggest that participants with higher perceived self-regulatory success also had better knowledge about food choice, less weight gain and lower BMI.

BMI did not significantly correlate with any of the two subscales of the Knowledge scale (Food Choice: $r = .01$, $p = .89$; Energy balance: $r = .10$, $p = .07$). The results were the same even when the data was analysed separately for people dieting or not dieting (Food Choice: $r = .13$, $p = .37$; Energy balance: $r = .14$, $p = .32$). For the Beliefs scale, there was a significant but weak negative correlation between beliefs about dieting/obesity and (historically) lowest BMI ($r$ = .11; $p$ = .049) and current BMI ($r$ = .12; $p$ = .027). These results suggest that there is a relationship between beliefs and BMI, but it is weak.

## 4.7. Discussion

The WLMKB scale was developed to measure knowledge and beliefs about WLM. The study presented in this chapter tested item difficulty, factor structure and reliability to remove unnecessary items. Published guidelines in scale development were followed to test the validity of the scale and bring evidence of face, construct, and convergent validity.

Following factor analysis, the final WLMKB scale comprised of two subscales. The Knowledge subscale consists of 10 items measuring two factors food choice and energy balance. The Beliefs subscale consists of 10 items measuring three factors: hunger, calorie compensatory behaviours and diet/obesity beliefs. Both subscales had internal consistency above .7 indicating good internal reliability (Kline, 2000).

As presented in Chapter 2:, there are various existing measures of nutrition knowledge and dieting beliefs. However, these measures do not assess all weight management related factors but focus on singular specific aspects. The WLMKB includes items that cover multiple factors related to WLM. The relationship between food choice and weight management is important (Blundell et al., 2020) as it both directly [energy density (Buckland, Dalton, et al., 2015; Stinson et al., 2018)] and indirectly [appetite (Buckland, Stubbs, & Finlayson, 2015; Hall & Kahan, 2018), reward (Espel-Huynh et al., 2018)] influences weight management. However, knowledge about this relationship is only measured by one existing measure of nutrition knowledge (Mikhail et al., 2020). The WLMKB scale includes items regarding beliefs about hunger and knowledge about food choice and energy balance. The scale will therefore allow for these factors to be assessed in a single short scale together with other related factors.

Long-term weight management is difficult to achieve and lapses are frequent (Hofmann et al., 2007; Testa & Brown, 2015). Compensating for calorie overconsumption was associated with lower weight and WL (Shimpo & Akamatsu, 2015). Furthermore, compensatory behaviours were shown to be positively related to WLM (O'Brien et al., 2018). Therefore, knowledge about what to do in response to lapses and accuracy of beliefs about compensatory behaviours is important for WLM. The WLMKB includes items that assess calorie compensatory behaviours in relation to WLM.

Existing measures of knowledge relating to weight management and nutrition focus on diet only (Mikhail et al., 2020; Mötteli et al., 2016; Mötteli, Barbey, Keller, Bucher, & Siegrist, 2017). However, energy expenditure is also important for WLM (Ostendorf et al., 2021). To overcome this limitation in currently existing scales, the WLMKB scale includes items aimed to assess beliefs about the relationship between physical activity and WLM. Guides and current practices in scale development and testing argue on the importance of using several analyses to provide evidence on the validity of a scale (Mikhail et al., 2020; Trakman et al., 2017). To test the construct validity of a scale, the most common practice is to use the 'known group' method (Davidson, 2014). In the current study, following similar scales validation processes (Jones et al., 2015; Rapson et al., 2020), comparisons were conducted between nutrition and non-nutrition students. Results showed that the scale has good construct validity with nutrition students scoring significantly higher on the Knowledge subscale of the WLMKB scale compared to non-nutrition student.

Perceived self-regulatory success was previously linked to weight management (Teixeira, Going, Sardinha, & Lohman, 2005) and was an indicator of successful weight management (Nguyen & Polivy, 2014). In the current study, convergent validity of the WLMKB scale was tested using the Perceived Self-Regulatory Success in Dieting scale. Results showed that the two subscales positively correlated but the correlations were lower than expected. These results provide evidence of the convergent validity of the WLMKB scale. Furthermore, these results suggest that participants with more accurate knowledge and beliefs about WLM perceive themselves as more successful in managing their weight. Therefore, this research brings preliminary evidence on the association between knowledge and beliefs on weight management success. Considering that the sample consisted of individuals from the general population that were not actively trying to lose weight, this relationship will further be tested on individuals actively attempting to manage their weight (Chapter 6:).

### Strengths

The WLMKB scale is the first validated scale to measure accuracy of knowledge and beliefs about weight related factors in a single short scale. The scale measures knowledge about food choice and energy balance, and beliefs about hunger, calorie compensatory behaviours and diet/obesity. The current research provides evidence of the reliability and validity of a novel measure of knowledge and beliefs about WLM.

This study has followed the consensus and recommendations on scale development and validation to test the novel WLMKB scale (Boateng et al., 2018; Trakman et al., 2017). The WLMKB demonstrated good reliability and construct validity. Furthermore, it positively correlated with individuals perceived success in managing their weight.

### Limitations

This study has some limitations. First, the sample consisted of participants that were not actively trying to manage their weight. This might have influenced the strength of the correlations between BMI, perceived dieting success and the WLMKB scale (Nguyen & Polivy, 2014; Polivy et al., 2020). Secondly, this study relied on self-reported data for weight. There is evidence that participants tend to underestimate weight (Shields, Gorber, &

Tremblay, 2008). However, research on the accuracy of self-reported weight and height showed that there is a strong correlation between self-reported weight and objective BMI values (Mathew, Anithadevi, & Shamna, 2012; Okamoto et al., 2017). Thirdly, the two comparison groups had different sample sizes due to the difficulty in recruiting nutrition-based students. However, the analysis was sufficiently powered to assess construct validity using the ‘known groups’ method. Finally, the sample size was insufficient to test whether WLM is related to knowledge and beliefs about WLM as measured by the WLMKB scale. This was due to the fact that not enough participants that qualified as successful WLM were recruited to conduct further analysis on this population.

### Implications and Future directions

The novel WLMKB scale has multiple potential applications. First, it could be used to test whether knowledge and beliefs can predict WLM. Secondly, the scale could assess the effectiveness of information-based intervention programmes. Thirdly, it could help identify individuals that might be more susceptible to weight regain. Lastly, could help identify gaps in individuals’ knowledge and beliefs to better target interventions.

The first chapters of the thesis presented the development and initial testing of the item understanding and interpretation (Chapter 3:). The current chapter presented the study on testing item difficulty, factor structure, reliability, and construct validity of the WLMKB scale. To counteract some of the limitations of the current study and further validate the WLMKB scale, the following steps will be taken (Chapter 5: and Chapter 6:): (i) evaluate the scale on a sample of participants interested in managing their weight; (ii) assess test-retest reliability; (iii) test for different types of validity: divergent and convergent validity; (iv) test predictive validity on a sample of WL maintainers and weight regainers.

# Chapter 5: Study 3: Investigating the WLMKB Scale and its relation to other lifestyle behaviours

The previous chapters presented the development (Chapter 3:), factor structure, and reliability testing (Chapter 4:) of the novel WLMKB scale. The following steps in the validation process are to assess the temporal stability of the scale and confirm construct validity. The current chapter will present an online study that aimed to test the convergent, discriminant and predictive validity, and test re-test reliability of the WLMKB scale on a sample of WL maintainers and weight regainers.

## 5.1. Background

The WLMKB scale was developed to test knowledge and beliefs about WLM related factors. Following the eight-step method for scale development and validation (Trakman et al., 2017), Chapter 2: defined the concept of WLM, Chapter 3: presented the development and testing of understanding and interpretation of the items of the scale. Chapter 4: presented the testing of the structure and dimensionality of the scale, and additionally tested the construct validity of the scale using the ‘known group’ methodology. This chapter will further present the steps taken to test the convergent, discriminant and predictive validity of the WLMKB scale. Furthermore, previous studies have used samples from the general population (Study 1, Chapter 3) and nutrition or non-nutrition students (Study 2, Chapter 4). This is a limitation of the previous studies, as the WLMKB scale was developed to assess knowledge and beliefs in individuals interested in actively managing their own weight. To address this shortcoming of previous studies, for the current study a sample of WL maintainers and weight regainers was recruited.

The WLMKB scale is a multi-dimensional measure that tests several factors related to WLM. Following structure analysis of the scale (see Chapter 4:), five factors were identified: food choice, energy balance, hunger, calorie compensatory behaviours, and diet/obesity beliefs. Additionally, the scale is comprised of two subscales with items that are measured with different response scales (see Chapter 4 for scale description), as such the validation process considered each subscale as different entities.

According to guidelines on validation of psychometric scales, there are various types of validity that need to be tested to ensure that new scales measure what they intend to measure and do so in a consistent way (Boateng et al., 2018). Presented below are the various types of validity and how these will be assessed in relation to the WLMKB scale. Threshold values stated for each type of validity are recommended by Robinson (2018).

### 5.1.1. Concurrent Validity

A scale demonstrates concurrent validity if it correlates highly with another scale measuring the same variable which was administered at the same time (Robinson, 2018). The WLMKB scale is a multidimensional scale measuring knowledge and beliefs about WLM including overweight and obesity, diet, calorie compensatory behaviours, hunger, food choice and energy balance. Currently, there are other separate measures that assess these factors but no other scales that measure the same factors in a single scale and in relation to WLM. Following the example of other research in scale validation (Mötteli et al., 2016), the concurrent validity of the scale will be tested using other conceptually similar scales. The validation process is presented below.

### 5.1.2. Convergent Validity

To show convergent validity the scale needs to be positively correlated with scales that measure related concepts (Robinson, 2018). Given that the WLMKB scale is a multidimensional scale and is split into two subscales, there is no single scale that is similar. Therefore, the convergent validity of the WLMKB scale will be tested against scales that measure the following concepts that are related to knowledge and beliefs about WLM: i) nutrition knowledge scales (Mikhail et al., 2020; Mötteli, Barbey, et al., 2017); ii) self-control (self-regulation) (Pedersen et al., 2018; West & Michie, 2020); iii) weight management strategies (Phelan et al., 2020; Santos et al., 2017); iv) dieting beliefs (Daigle et al., 2019; Hartmann et al., 2016).

Evidence of the convergent validity of the WLMKB scale was previously presented in Chapter 4:. Results showed that as expected scores on the WLMKB scale were positively associated with self-regulatory success in dieting as measured by the Perceived Self-Regulatory Success in Dieting Scale (Meule et al., 2012). The current study will further test the convergent validity of the WLMKB scale by assessing the association with other knowledge and beliefs scales. Additionally, previous research on similar scales showed that weight management nutrition knowledge was associated with dieting history, health, age and SES (Mikhail et al., 2020). Specifically, more accurate knowledge and beliefs will be associated with better health, higher SES, younger age and fewer dieting attempts. These factors will be included in the analysis to test whether similar associations occur in relation to the WLMKB scale.

Convergent validity of the Knowledge subscale will be tested with a nutrition knowledge questionnaire. Previous nutrition knowledge scales and weight management nutrition knowledge scales (Mötteli, Barbey, et al., 2017) have used other measures of nutrition knowledge (Mikhail et al., 2020) to assess convergent validity. Given that the Knowledge subscale of the WLMKB scale is a measure of nutrition related factors such as energy balance and food choice (Hall et al., 2012; Phelan et al., 2020), the convergent validity of the scale will be assessed using a measure of nutrition knowledge. Specifically, it is expected that people that have higher knowledge about WLM will also have better knowledge about the calorie content of meals. To this purpose, the Practical Knowledge About Meal Calories scale [PKM-11, (Mötteli et al., 2017)] will be used. The PKM-11 is a brief measure of basic nutrition knowledge focusing on the energy content of meals. Scores on the scale correlated moderately with a measure of general nutrition knowledge [GNKQ, (Kliemann et al., 2016)] proving it measures nutrition knowledge. To demonstrate convergent validity, it was hypothesised that there will be a strong positive correlation ($r \geq .30$) between the PKM-11 and the Knowledge subscale of the WLMKB.

To test the convergent validity of the Beliefs subscale the Dieting Beliefs Scale (Stotland & Ztiroff, 1990) will be used. This instrument distinguishes more internal from more external locus of control. A more internal locus of control in dieting refers to the belief that weight is under the individuals' control. Comparatively, an external locus of control refers to the belief that weight management is caused by external factors and is therefore out of the person's control (Stotland & Ztiroff, 1990). The Dieting Beliefs Scale has been negatively associated with the Irrational Food Beliefs Scale (Osberg et al., 2008). This suggests that an internal locus of control is associated with less irrational food beliefs. Weight locus of control was shown to be a key factor for long-term success in weight management in women with overweight or obesity (Jorge et al., 2020). It was hypothesised that there will be a strong positive correlation ($r \geq .30$) between the Dieting Beliefs Scale and the Beliefs subscale of the WLMKB scale. With more accurate beliefs about WLM being related to an internal locus of control as measured by the Dieting Beliefs Scale.

### 5.1.3. Predictive Validity

To show predictive validity a scale is expected to predict a real life characteristic or engagement in a behaviour. The relationship between knowledge and beliefs and WLM has not been previously researched. However, research on health behaviours showed a significant but low association between nutrition knowledge and behaviour (Swift et al., 2009) and WL (Mitchell et al., 2021). Therefore, to show predictive validity the WLMKB scale is expected to predict successful WLM ($r \geq .40$) (Robinson, 2018). WLM was defined as losing 10% of body weight and keeping it off for at least one year (Wing & Hill, 2001). To test for predictive validity, first participants will self-report their maximum (excluding pregnancy and other health issues), minimum and current weight, and according to the definition they will be classified as WL maintainers or weight regainers (Jospe, Haszard, Taylor, & Freedhoff, 2020). They will have to have maintained a WL of at least 5% of their maximum body weight for at least one year. Participants will be asked for how long they have been at their current weight to assess weight maintenance duration (e.g. *For about how long have you been at or close (within 2 lbs/1 kg) to your present weight?*). Amount of weight maintained was computed by calculating the difference between participant's current weight and lowest weight. WLM length was measured as suggested by Pedersen et al., (2018), whereby participants were asked to report the duration of the last WL attempt, the amount lost and length of the maintenance period. It was hypothesised that a high score on the WLMKB scale at baseline will predict better WLM. Specifically, higher scores on the WLMKB scale are expected to predict higher weight suppression and amount of weight maintenance. Weight suppression and maintenance are used in the current study as indicators of WLM (Witt et al., 2013), and percentages were used as recommended by Schaumberg et al., (2016). Previous research linked weight suppression and maintenance to dietary restraint (Johnson et al., 2012) and less endorsement of medical causes of obesity (Ogden, 2000). However, this association was not researched in relation to WLM knowledge and beliefs.

Furthermore, the WLMKB will predict weight change from baseline (first survey) and after 4-weeks. For this purpose, participants will be asked to report their weight at baseline and after 4 weeks. To further test predictive validity, higher levels of knowledge and more accurate beliefs about WLM was expected to predict engagement in weight related behaviours, specifically diet and physical activity ($r \geq .40$). Furthermore, given that the sample included participants that successfully lost weight in the past 5 years but were not necessarily engaged in a weight management attempt at the time of the survey, motivation to manage weight was controlled for in the predictive regression analyses. This was informed by the evidence of the importance of motivation in weight management and WLM (Christensen et al., 2018; Wang, Shih, & Carroll, 2015).

### 5.1.4. Discriminant Validity

For a scale to demonstrate divergent validity it is expected not to strongly correlate ($r < .20$) (Robinson, 2018) with constructs that are not supposed to be related according to theory and previous research. To demonstrate divergent validity the WLMKB scale is expected to not correlate with measures of constructs that are not related to WLM beliefs and knowledge. For this purpose, it was hypothesised that the scale would not correlate strongly ($r < .20$) with measures of food fussiness and intrinsic regulation of physical activity.

Food fussiness (FF) has been described as a tendency to be more selective in foods eaten (Smith et al., 2017). Food selectiveness goes beyond the initial encounter with a certain food and is based on food characteristics such as texture (Brown, 2010). FF is a different factor to food avoidance, resembling difference in range of foods eaten rather than under eating and small portion sizes and is not correlated with BMI (Mallan et al., 2017). Therefore, as FF is an indication of food selectiveness influenced by the direct experience with food, knowledge and beliefs about WLM are not expected to influence it.

Intrinsic regulation of physical activity refers to engaging in physical activity due to inherent satisfaction and enjoyment (Rhodes, Gray, & Husband, 2019). According to SDT

(Ryan & Deci, 2000), there are different types of motivation to regulate behaviour. Intrinsic motivation is defined as engaging in a behaviour because of its inherent satisfaction (Teixeira et al., 2012). A person that is intrinsically motivated to exercise will experience enjoyment, personal accomplishment and excitement about exercising. Intrinsic regulation of exercise is linked to better adherence to exercise programmes (Buckworth & Dishman, 2007) and exercise enjoyment (Vlachopoulos & Karageorghis, 2005). A more autonomous and intrinsic exercise motivation also seems to facilitate improvements in eating self-regulation (Silva et al., 2011). Therefore, similar to FF, intrinsic motivation of physical activity is the result of the direct experience and enjoyment of physical activity and is not expected to be influenced by knowledge and beliefs about WLM.

Given the above mentioned, to demonstrate divergent validity, it is hypothesised that the WLMKB scale is expected to have a correlation of $r < .20$ with measures of food fussiness [The Adult Eating Behaviour Questionnaire; AEBQ (Hunot et al., 2016)] and intrinsic regulation of exercise [Behavioural Regulation in Exercise Questionnaire (BREQ-3); (Markland & Tobin, 2004; Wilson, Rodgers, Loitz, & Scime, 2006)].

### 5.1.5. Test re-test reliability

To demonstrate test re-test reliability the scores of the same participant should remain similar at a subsequent testing (Polit, 2014). For this purpose, a follow-up survey was conducted (after 4 weeks) in which participants were asked to complete the WLMKB scale again. To demonstrate test re-test reliability there should be a correlation of $r \geq .80$ between the scores of the same participants (Robinson, 2018).

### 5.1.6. Aims

The current study aimed to further validate the WLMKB scale on a sample of WL maintainers and weight regainers. The types of validity tested were convergent, predictive and discriminant validity. A follow-up study was conducted to assess test re-test reliability.

**Hypotheses**

**Construct Validity (convergent)**

a. There will be a strong positive correlation ($r \geq .30$) between the PKM-11 and the Knowledge subscale (KS) of the WLMKB.
b. There will be a weak ($r < .20$) or no correlation between the Beliefs subscale (BS) and PKM-11. (divergent validity)
c. There will be a strong positive correlation ($r \geq .30$) between Dieting Beliefs and the BS.
d. There will be a weak ($r < .20$) or no correlation between Dieting Beliefs and the KS.
e. There will be a moderate positive correlation between WLMKB and health and SES.
f. There will be a moderate negative correlation between WLMKB and age and dieting history.

**Discriminant validity**

g. There will be a correlation of $r < .20$ between the WLMKB scale and measures of FF (AEBQ; Hunot et al., 2016).
h. There will be a correlation of $r < .20$ between the WLMKB scale and measures of intrinsic regulation of exercise (BREQ-3).

**Predictive validity**

i. Individuals with higher scores on the WLMKB scale will be more successful at maintaining their weight (lower BMI, longer WLM period, Higher weight suppression – based on retrospective reports reported at baseline).

j. Higher scores on the WLMKB will predict higher engagement in weight related behaviours between baseline and 4 weeks later, as well as based on retrospective reports reported at baseline (weight control strategies, higher levels of physical activity) when controlling for weight management motivation.
k. Higher scores on the WLMKB will predict WLM at T2 (4 weeks).

## 5.2. Method

### 5.2.1. Design

Data was collected from a longitudinal online study that consisted of two surveys (via Qualtrics, Provo, UT). Two groups of participants were recruited that differed in their WLM success (WL maintainers and weight regainers).

The second survey was administered after 4 weeks to assess test re-test reliability of the WLMKB scale, as well as to assess changes in weight and weight maintenance strategies. Regression models were conducted to assess the WLMKB scale ability to predict changes in weight and engagement in weight management strategies (diet and exercise).

### 5.2.2. Participants

Participants were recruited using online participant recruitment service Prolific (http://www.prolific.co), e-mail lists of participants taking part in another study reported in this thesis that agreed to be contacted for further studies (Chapter 6:, Study 4), social media sites (Facebook, Twitter), online forums (e.g. Reddit, Netmums), and recruitment websites (e.g. https://surveyswap.io/). G*Power (version 3.1; Heinrich Heine University Düsseldorf, Germany) analysis showed a minimum sample size required of $n$ = 114 per group (WL maintainers, weight regainers) for detecting a medium effect size (Ammar et al., 2020; Stapleton, 2015), with 80% power at the 5% significance level.

Eligibility criteria was as follows: adults (≥18 years old) living in the UK, who indicated that they have intentionally lost at least 10% of their body weight in the past 5 years. They should have had at least a self-reported BMI of 25 kg/m$^2$ at their highest weight (not including pregnancy or medical conditions). Participants were either WL maintainers (maintained a WL of at least 5% of their body weight for at least one year), or weight regainers (maintained less than 5% of body weight after one year). To minimise risk of harm, participants indicating a history of, or current eating disorder were excluded. This study protocol was pre-registered and is available at https://osf.io/nhcy2. This study received ethical approval from the University of Sheffield (no. 023798).

Participants were offered a chance to enter a prize draw for a £50 Amazon voucher. Participants recruited using Prolific received £1.67 as payment after completing the survey and the follow-up. Of note, since the completion of Study 2's data collection (Chapter 4), the COVID-19 pandemic happened. As such, data collection for Study 3 took place during the COVID-19 pandemic, starting 28th of October 2021 to 25th of December 2021.

### 5.2.3. Measures

**Weight Loss Maintenance Knowledge and Beliefs scale** (Chapter 4)

The WLMKB scale is comprised of 20 items measuring the accuracy of knowledge and beliefs people have about several factors related to WLM such as: overweight and obesity, diet, calorie compensatory behaviours, hunger, food choice and calorie balance (see Chapter 4).

The scale has two subscales. The Knowledge subscale is comprised of 10 items measuring knowledge about energy balance and the relation between food choices and weight management. This subscale has a three-point response scale: true, false, don't know. The

Beliefs subscale contains 10 items measuring beliefs about hunger, diet, obesity and calorie compensatory behaviours. The Beliefs subscale has a 6-point Likert type response scale, 1 being ‘strongly disagree’ and 6 ‘strongly agree’. Higher scores on both scales indicate more accurate knowledge or beliefs about WLM related factors.

## **Dieting Beliefs Scale** (Stotland & Ztiroff, 1990)

The Dieting Beliefs Scale is a measure of weight locus of control that distinguishes between internal and external locus of control in dieting. The items ask about individuals’ beliefs about their control over their weight and the impact on external factors on weight. Participants indicate on a 6–point scale the amount each item describes their beliefs where 1 = ‘not at all descriptive of my beliefs’ and 6 = ‘very descriptive of my beliefs’. Higher scores on this scale show a more internal locus of control. In this sample Cronbach’s alpha coefficient was .69.

Item examples:

1. *By restricting what one eats, one can lose weight.*
2. *A thin body is largely a result of genetics.*
3. *Most people can only diet successfully when other people push them to do it.*

## **The Practical Knowledge About Meal Calories** (Mötteli et al., 2017)

The PKM-11 scale measures practical knowledge about meal calories and was developed to measure nutrition knowledge. The scale was developed and validated in Switzerland, it was strongly correlated with the General Nutrition Knowledge scale that was developed and validated in a UK sample (Parmenter & Wardle, 1999). Therefore, most of the items do not need adaptation to be used in a UK sample. However, for items 3 and 4, the UK equivalent of certain types of foods were added in brackets (e.g. schnitzel - escalope). The scale consists of 11 items, each with multiple choice response type, with four options one of which is ‘don’t know’. A higher score on the scale is an indication of better practical knowledge of the calorie content of meals. In this sample Cronbach’s alpha coefficient was .54.

Item example:

*Which potato side dish contains the smallest amount of fat?*

1. *Potato salad*
2. *Mashed potatoes*
3. *Baked potatoes*
4. *Don’t know*

## **Single-item Physical Activity Measure** (Milton, Bull, & Bauman, 2011)

The Single-item physical activity measure was used to ask participants how many days in a week they have engaged in a 30-minute moderate physical activity. Participants were asked answer in relation to the previous week. The Single-item physical activity measure has been previously validated against objective measures of physical activity (O’Halloran et al., 2020) and in different populations (Scott et al., 2015).

## **Weight Control Strategies Scale** (WCSS, Pinto et al., 2013)

The WCSS is a self-report instrument that assesses the use of specific behaviours to facilitate WL. The scale consists of 30 items that measure four distinct factors: dietary choices, physical activity, monitoring and psychological coping. Items are rated on a 5-point Likert scale ranging from 1 = ‘never’ to 5 = ‘always’. For the purpose of this study, to lower participant burden, only the subscale related to dietary choices was used. Higher scores on the WCSS show a higher level of engagement in diet related weight management strategies. In this sample Cronbach’s alpha coefficient was .77.

Example item:

*I had several servings of fruits and/or vegetables each day.*

## Weight Management Motivation

Participants were asked how motivated they are to manage their weight. A single item was used with a 5-point Likert scale (1 = 'not at all motivated', 5 = 'very motivated'). The item was developed for the purpose of this study and follows the example of other research on motivation to engage in weight management (Nurkkala et al., 2015). Online self-report measures are commonly used in research to rate participant motivation and confidence to manage weight (Asbjørnsen et al., 2019).

## The Dieting and Weight History Questionnaire (Witt et al., 2013)

The DWHQ is a scale that assesses the three dimensions of dieting (Lowe, 1993): frequency of past dieting and overeating, current diet status (dieting to lose weight, avoid weight gain), weight suppression and weight maintenance. In the current research weight suppression refers to the percentage of WL participants maintained {[(current weight – lowest weight)/(highest weight – lowest weight)]*100}. Weight maintenance refers to the percentage of weight change from the highest weight to the current weight (weight at baseline). For the purpose of this study the DWHQ scale was used to measure weight history, WLM and dieting status. Successful WLM was identified as intentionally lost at least 10% of highest reported body weight and maintained that WL (2 lbs/1 kg) for at least one year. To assess WLM participants were asked to report their height, current, lowest and highest weight in kg. They also stated how long they had been at their current weight and whether WL was intentional or not. WLM status was calculated by first calculating the difference between highest and lowest weight to assess if it was at least 10% of highest body weight. Then, the difference between lowest weight and current weight was calculated to test whether participants maintained at least 5% WL from their highest weight. To see if this weight has been maintained for at least a year, participants were then asked for how long they have been at or close to (2lbs/1kg) to their current weight. Additionally dieting history was assessed by asking participants to report how many dieting attempts they have engaged in in the past year on a scale from 0 attempts to more than 4, with the option of detailing how many.

**The Adult Eating Behaviour Questionnaire - Food Fussiness** (Hunot et al., 2016)

The AEBQ is a measure of adult eating behaviour comprised of 8 scales assessing food approach (Hunger, Food Responsiveness, Emotional Over-eating and Enjoyment of Food) and avoidance appetitive traits (Satiety Responsiveness, Food Fussiness, Emotional Under-eating and Slowness in Eating). For the purpose of the current study only the FF subscale was used. The FF subscale is comprised of 5 items measuring individuals' tendency to be more selective with the food they eat (e.g. *I often decide that I don't like a food before tasting it.)*. The response scale ranges from 1 – 'strongly disagree' to 5 – 'strongly agree'. Higher scores on this subscale indicate higher levels of food fussiness. In this sample Cronbach's alpha coefficient was .91.

**The Behavioural Regulation in Exercise Questionnaire** (Markland & Tobin, 2004; Wilson et al. 2006)

The BREQ-3 is a measure of motivation to regulate exercise behaviour. The scale is based on the SDT (Ryan & Deci, 2000) and measures external, introjected, identified and intrinsic motivation to exercise. For this study, the Intrinsic regulation subscale was used. The subscale consists of four items measuring exercise enjoyment (e.g. *I enjoy my exercise sessions*). Response scale ranges from 0 – 'Not true for me' to 4 – 'Very true for me'. Higher scores are an indication of intrinsic motivation to regulate exercise behaviour. In this sample Cronbach's alpha coefficient was .96.

## General health

The Single Item Global Health Measure (Ware & Sherbourne, 1992) was used to assess general health. This is a measure of self-rated health that asks participants to evaluate their health status on a five-point scale. This is a widely used measure and has been previously related to mortality (Jylhä, 2009).

## Socio-economic status (SES)

SES was measured to assess whether reported changes in weight management practices varied according to SES (Clemmensen, Petersen, & Sørensen, 2020; Darmon & Drewnowski, 2008). Participants were asked to provide their postcode to determine Index of Multiple Deprivation (Scottish Government, 2020; StatsWales, 2019; UK Government, 2019). The IMD ranks small geographical areas in England, Wales and Scotland. Deciles are reported and range from '1 = most deprived' to '10 = least deprived'.

The full questionnaires are presented in Appendix D.

### 5.2.4. Procedure

After providing informed consent, participants were asked to complete demographic information (e.g. age, gender, residence, ethnicity etc.) and screening questions [dieting status (have intentionally lost at least 10% of body weight in the last 5 years) and history of eating disorders]. Ineligible respondents were excluded from participation.

Eligible participants were then invited to complete a series of questionnaires. Participation in the study involved completing two surveys 4 week apart. Responses to the two surveys were linked by using Prolific IDs for participants recruited through Prolific. All other participants were asked to generate an identification code to match their responses on the two surveys. In the first survey WLM was assessed by the first 7 items of the Dieting and

Weight History Questionnaire (Witt, Katterman, & Lowe, 2013) that asked participants to report their highest, lowest and current weight. Participants were also asked to self-report for how long they maintained their current weight. Further, participants were asked to report their perceived general health and weight status.

Other factors related to weight management were then measured to assess convergent, discriminant, and predictive validity: food fussiness (AEBQ; Hunot et al., 2016), intrinsic regulation of exercise (BREQ-3; Markland & Tobin, 2004; Wilson et al. 2006), knowledge about calorie content (PKM-11; Mötteli, Barbey, Keller, Bucher, & Siegrist, 2017), Dieting beliefs (Stotland & Ztiroff, 1990) and diet history (Witt et al., 2013). Participants also completed the WLMKB scale. These scales were administered in a randomised order and were used to characterise the sample and to test the validity of the new WLMKB scale. After completing the survey participants were redirected to the debrief where they were informed on when the follow-up survey will be.

The follow-up survey included the WLMKB scale to assess test re-test reliability. Furthermore, measures of weight and engagement in weight management strategies and physical activity were also included. After completing the follow-up survey, participants were redirected to the debrief and were given the possibility to have their emails added to the draw again.

### 5.2.5. Strategy for data analysis

Reported height, weight, weight change and computed BMI values were screened for values that were outside expected ranges (height between <1.40 – >2.20 m, weight <40 – >200 kg, weight change >8kg [based on extreme values and reported weight change in interventions (Astbury et al., 2019; Wieland et al., 2012)] and computed BMI <15 kg/m$^2$ - >60 kg/m$^2$). The criteria for significance was $p < .05$. For the between-subjects comparison, effect sizes are reported (Cohen's *d*: small effect = 0.2, medium effect = 0.5, large effect = 0.8).

Correlation analysis with eight factors was conducted: WLM knowledge and beliefs, food fussiness, dieting beliefs, practical knowledge of calorie content of meals, weight management strategies, physical activity, and exercise locus of control.

Regression analysis was conducted to test the ability of the WLMKB scale to predict WLM. Participants were split into groups based on their WLM success before the study, not based on weight change reported in the current study. WL maintainers were participants that have maintained a WL of at least 5% of maximum body weight for at least one year. Weight regainers were participants that have regained the weight they lost (maintained less than 5% of body weight after one year). Percentage of weight maintained was calculated by the difference between highest weight and current weight. To see if participants have maintained their weight for more than a year, they were asked for how long they have been at their current weight. Binary logistic regression analysis was then conducted to test whether the WLMKB can discriminate between WL maintainers and weight regainers.

Regression analysis was also conducted to identify predictors of weight change and engagement in weight management strategies between baseline (T1) and after 4 weeks (T2). Regression analysis models were run to identify predictors of weight change (T1-T2), changes in weight management strategies [physical activity (PA) and diet], and weight maintenance. The factors measured by the WLMKB were entered in the model as predictors (hierarchical method). Weight change percentage was used instead of weight in kilograms as weight change is proportionately dependent on initial body weight (Aronne et al., 2021; Hall et al., 2012). The model for weight change (%) was adjusted for motivation entered in the first step, and all other predictors entered at Step 2). Mahalanobis, Cooks and Leverage scores indicated that there were no outliers. To check for multicollinearity between predictor variables, the variance inflation factor (VIF) and tolerance statistics were assessed. There were no issues with multicollinearity as based on the VIF (<10), and tolerance values (>0.2; Tabachnick & Fidell, 2013). Statistical analysis was carried out using IBM SPSS version 26.

ANOVAs and t-tests were conducted to assess if there were significant changes in weight, engagement in weight management strategies and WLMKB scores between baseline and follow-up in the overall sample as well as on the separate groups. Correlation analyses were conducted to test discriminant and convergent validity. Correlation analyses were also used for test re-test reliability. The strength of correlations was interpreted as small if $r < .3$, medium if between .3 and.5, and large if $r > .5$ (Cohen, 1992).

Datapoints for incomplete surveys were retained up until the point the participants dropped out. Data was used to compare completers from non-completers on demographic information (e.g. age, sex, nutrition knowledge). Data analysis was conducted on the available data, averages were not computed to fill in missing datapoints. For data on weight change, 'intention to treat' (ITT) (e.g. Last Observation Carried Forward) was conducted and results were reported alongside completers data. For the ITT analysis, only data from participants that finished the first study was included (McCoy, 2017). Two attention check questions were included in the survey (e.g. What is 2+2? 3/5/4/6). These were included to check the quality of the responses (Oppenheimer et al., 2009). Participants that responded incorrectly to both attention checks were removed from analysis.

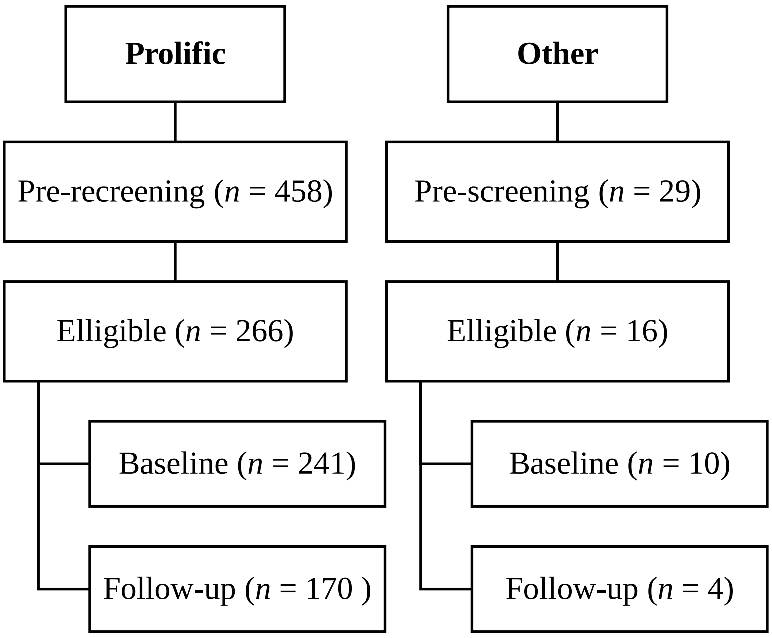
## 5.3. Results

### 5.3.1. Participants

A total sample of *n* = 270 participants were recruited (Figure 5.1). Out of these, 15 participants did not meet the eligibility criteria (eating disorder, pregnant or breastfeeding, did not lose 10% of bodyweight) and 3 participants were removed due to reported values for weight or height outside of the accepted set range. No participants were removed following the attention check. Data from participants that did not finish the survey completely (*n* = 20) were not removed from baseline analysis, but these participants were not invited to complete the follow-up survey. More participant characteristics are presented in Table 5.1.

The final sample at baseline consisted of *n* = 238 (*M*: 34.63, *SD*: 10.62 years; 46.2% male, 52.9% female and 0.8% non-conforming). The majority of the sample was white (*n* = 217, 91.2%). Most participants classified their own weight as overweight (*n* = 131, 55%), 59 (24.8%) participants reported having a healthy weight and 48 (20.2%) participants classified their weight as obese. Based on the WLM definition, 28.9% (*n* = 67) of participants were classified as WL maintainers and 71.1% (*n* = 165) as weight regainers. Weight change ranged from -6.35 kg to 6.80 kg, and the two groups did not significantly differ in their weight change from baseline to follow-up (*p* = .45). At baseline, 56% (*n* = 104) of participants reported being on a diet, with 91.3% (*n* = 95) trying to lose weight and 8.7% (*n* = 9) to avoid gaining weight. The baseline survey took on average 14.1 ± 7.66 minutes to complete and the follow-up (*n* = 180) survey took approximately 5.22 ± 3.99 minutes to complete.

For data analysis using BMI and weight change, BMI values were screened for anomalous values. The values before taking out participants with values outside the expected range are presented in Appendix D. Following data cleaning, 10 participants were removed from the analysis.




*Note.* Other = social media, online forums and volunteer list.

*Figure 5.1: Recruitment process flow-chart*

Drop-out analysis

Drop-out analysis was conducted to compare participants that completed both the baseline and follow-up surveys, and participants that did not finish the follow-up. Results are presented in Table 5.1. Results showed that there were no significant differences in SES, age, gender, weight status, WLM status and health. Participants that dropped out reported significantly higher number of dieting attempts and had more accurate beliefs about calorie compensatory behaviours.

*Table 5.1:* Study 3 Drop-out analysis

| Variable | Finished ($n$ = 180) | Dropped-out ($n$ = 58) | $t$(df) or $\chi^2$ | $p$ |
|---|---|---|---|---|
| | $M \pm SD$ or $n$ (%) | | | |
| **Age** | 34.39 ± 9.94 | 35.58 ± 12.55 | $t$(236) = 0.61 | .54 |
| **Gender** | Male 89 (49.4%) | Male 21 (36.2%) | $\chi^2$ = 4.01 | .13 |
| | Female 89 (49.4%) | Female 37 (63.8) | | |
| **SES** | 5.55 ± 2.86 | 5.62 ± 2.91 | $t$(231) = 0.17 | .87 |
| **Health** | 3.17 ± 1.00 | 3.16 ± 0.99 | $t$(236) = -0.11 | .91 |
| **Weight status** | 1.55 ± 0.76 | 1.31 ± 0.90 | $t$(87.95) = -1.82 | .07 |
| **WLM status** | WLM 48 (27.4%) | WLM 19 (33.3%) | $\chi^2$ = 0.73 | .39 |
| | WR 127 (72.6%) | WR 38 (66.7%) | | |
| **Food choice** | 2.87 ± 1.73 | 2.86 ± 1.48 | $t$(111.59) = -0.04 | .97 |
| **Energy balance** | 3.24 ± 1.27 | 3.41 ± 1.21 | $t$(236) = 0.89 | .37 |
| **Hunger** | 10.76 ± 2.61 | 10.55 ± 2.32 | $t$(236) = -0.53 | .60 |
| **CCB** | 11.34 ± 2.85 | 12.24 ± 2.99 | $t$(236) = 2.06 | .04 |
| **Diet/obesity** | 13.94 ± 3.39 | 13.82 ± 3.51 | $t$(236) = -0.25 | .80 |
| **Dieting history** | 1.72 ± 1.20 | 2.09 ± 1.33 | $t$(236) = 1.99 | .048 |
| **WMS** | 33.04 ± 6.6 | 31.97 ± 8.66 | $t$(79.46) = -0.87 | .39 |
| **PA** | 3.04 ± 2.24 | 2.53 ± 2.05 | $t$(236) = -.1.54 | .13 |
| **BMI** | 29.41 ± 6.68 | 30.44 ± 6.78 | $t$(231) = 0.17 | |

*Note.* SES: Socio-economic status based on IMD decile (1 – low SES, 10 – high SES); WLM: weight loss maintenance; CCB: Calorie compensatory behaviours; PA: Physical activity; WMS: Weight management strategies; BMI: Body mass index.
Weight status = perceived weight classification (1 – underweight, 2 – normal weight, 3 – overweight, 4 – obese)

### 5.3.2. Convergent Validity / Divergent Validity

To test the convergent validity of the WLMKB scale correlation analysis were conducted. Results are presented in Table 5.2. It was hypothesised that to demonstrate convergent validity, the subscales of the WLMKB scale are expected to correlate with similar measures. Results showed that there was a significant small positive correlation between the Knowledge subscale and the PKM-11 scale $r = .23$, $p < .001$. These results suggest that participants with higher scores on the KS also had higher scores on the PKM-11 scale. There was a significant medium correlation between the Beliefs scale and Dieting beliefs $r = .34$, $p < .001$. Suggesting that more accurate beliefs about WLM were related to more accurate dieting beliefs. These results are in the expected direction but the strength of the association for the Knowledge subscale is lower than hypothesised ($r < .3$).

It was further hypothesised that there will be a moderate positive correlation between WLMKB scale and general health and SES. Results showed small correlations with health: KS $r = .18$, $p < .001$; BS $r = .17$, $p = .01$. There was no significant correlation between SES and any of the WLMKB subscales. Suggesting that higher scores on the WLMKB scale were associated with better perceived general health, but not with SES.

As expected, there was a significant negative correlation between age and the KS, with higher scores on the KS scale being associated with older age. The BS did not correlate with age. However, more accurate beliefs about hunger were significantly correlated with older age ($r = .22$) and more accurate beliefs about calorie compensatory behaviours were significantly correlated with younger age ($r = -.18$). Dieting history correlated negatively with the BS ($r = -.15$, $p < .05$) but not with the KS ($r = -.03$, $p > .05$). These results suggest that participants with more accurate beliefs reported fewer dieting attempts.

Divergent validity was also tested. It was hypothesised that to demonstrate divergent validity the BS is not expected to correlate with measures of knowledge and the KS is not expected to correlate with measures of dieting beliefs. Results supported these hypotheses and showed that there were no significant correlations higher than .20 (Table 5.2).

These results provide evidence of the convergent and divergent validity of the WLMKB scale. Correlation analysis results showed that the concepts measured by the WLMKB scale were associated with other scales that assess theoretically similar concepts. Additionally, the WLMKB scale does not correlate with theoretically not similar concepts.

*Table 5.2:* Correlation analysis for testing the convergent validity of the WLMKB scale (*n* = 238)

| | **Nutrition Knowledge** | **Dieting Beliefs** | **Age** |
|---|---|---|---|
| **Knowledge** | .23** | .16* | -.14* |
| **Food Choice** | .14* | .12 | -.13 |
| **Energy Balance** | .25** | .15* | -.10 |
| **Beliefs** | .07 | .34** | .08 |
| **Hunger** | -.02 | .10 | .22** |
| **CCB** | .09 | .13 | -.18** |
| **Diet/Obesity** | .05 | .35** | .12 |

*Note.* ** $p < .01$; * $p < .05$
PKM-11 (Mötteli, Barbey, et al., 2017), Dieting Beliefs scale (Stotland & Ztiroff, 1990)

### 5.3.3. Discriminant validity

Results for discriminant validity are presented in Table 5.3. Correlation analysis showed that there was no significant correlation above .20 between any of the WLMKB subscales and BREQ-3 or Food Fussiness. However, the factor measuring beliefs about diet and obesity significantly correlated with intrinsic exercise motivation $r = .28$.

These results provide evidence for the discriminant validity of the WLMKB scale. This suggests that the scale has the ability to differentiate between similar but not theoretically related concepts such as motivation for exercise or food fussiness.

*Table 5.3:* Discriminant validity correlation table of the WLMKB scale ($n = 238$)

| | **Exercise Motivation** | **Food Fussiness** |
|---|---|---|
| **Knowledge** | .07 | -.03 |
| **Food Choice** | .08 | -.07 |
| **Energy Balance** | .04 | .02 |
| **Beliefs** | $.18^{**}$ | $-.17^{**}$ |
| **Hunger** | -.04 | $-.17^{*}$ |
| **CCB** | .04 | -.07 |
| **Diet/Obesity** | $.28^{**}$ | -.09 |

*Note.* ** $p < .01$; * $p < .05$
BREQ3 (Markland & Tobin, 2004; Wilson et al. 2006); Food Fussiness (AEBQ, Hunot et al., 2016)

### 5.3.4. Predictive validity

Firstly, to test predictive validity it was hypothesised that individuals with higher scores on the WLMKB scale will be more successful at maintaining their weight (lower BMI, longer WLM period, higher weight suppression). Correlations between all variables are presented in Table 5.4. Results showed that self-reported current BMI was significantly correlated with accuracy of diet and obesity beliefs ($r = -.14$, $p = .04$). This suggests that individuals with more accurate knowledge about diet and obesity also report having a lower

BMI. Beliefs about hunger and CCB, and knowledge about food choice and energy balance were not significantly correlated with current BMI. Lowest BMI was significantly negatively correlated with accuracy of beliefs ($r$ = -.14, $p$ = .038). Highest BMI was significantly positively correlated with accuracy of beliefs about hunger. This suggests that more accurate beliefs about hunger were related to higher reported highest weight.

The WLMKB scale was not correlated to WLM period measured by asking participants for how long they have been at their current weight. The WLMKB scale was also not significantly associated with weight suppression.

Given that correlations between BMI and the WLMKB scale were not above .3, regression analysis was not conducted to see if the WLMKB scale is a predictor of current BMI.

*Table 5.4:* Predictive validity correlation table for the WLMKB scale

| | **Current BMI** | **Lowest BMI** | **Highest BMI** | **WLM Period** | **Weight suppression** |
|---|---|---|---|---|---|
| **Knowledge** | -.05 | .02 | .01 | -.02 | -.08 |
| **Food Choice** | -.08 | .001 | -.02 | -.08 | -.07 |
| **Energy Balance** | .01 | .03 | .05 | -.06 | -.03 |
| **Beliefs** | -.08 | -.14* | -.002 | -.02 | -.08 |
| **Hunger** | .12 | .08 | .16* | -.07 | -.02 |
| **CCB** | -.10 | -.10 | -.08 | -.01 | -.05 |
| **Diet/Obesity** | -.14* | -.20** | -.05 | .03 | -.08 |

*Note.* ** $p$ < .01; * $p$ < .05
CCB = Calorie compensatory behaviours; BMI = Body Mass Index

## Weight change (T1-T2)

T-tests were conducted to assess whether there were significant differences in weight change, physical activity change and diet change, between participants that were currently on a diet and those that were not. Results showed that there were no significant differences between participants that were dieting at baseline compared to those that were not (lowest $p$ =

.28). Additionally, there were no differences between those that were dieting at follow-up compared to those that were not dieting (lowest $p$ = .13). Given these results, predictive analyses were conducted on the whole sample, and not separately on the two groups.

i. Per-protocol analysis

Secondly, it was hypothesised that higher scores on the WLMKB scale would predict WLM at T2 (4 weeks). Correlation analysis results showed that there were no significant correlations between the WLMKB scale and percentage weight change from baseline to follow-up (Table 5.5). Beliefs were significantly positively correlated with initial WL ($r$ = .15, $p$ = .025) and weight maintenance ($r$ = .16, $p$ = .015), and negatively correlated to dieting history ($r$ = -.16, $p$ = .015). Suggesting that more accurate beliefs were associated with higher initial WL and maintenance and fewer dieting attempts.

*Table 5.5:* Correlation between WLMKB scale and percentage weight change (initial, between T1 & T2, and WLM, $n$ = 170)

| | **Weight Change (%)** | **Initial WL (%)** | **Weight Maintenance (%)** | **Dieting History** |
|---|---|---|---|---|
| **Knowledge** | .00 | -.001 | .11 | -.03 |
| **Food Choice** | .04 | -.03 | .12 | -.03 |
| **Energy Balance** | -.05 | .03 | .05 | -.03 |
| **Beliefs** | -.12 | .15* | .16* | -.16* |
| **Hunger** | -.10 | .14* | .07 | -.10 |
| **CCB** | -.06 | -.003 | .05 | .08 |
| **Diet/Obesity** | -.07 | .14* | .17** | -.26** |

*Note.* ** $p < .01$; * $p < .05$

Due to the lack of significant associations between the WLMKB scale and weight change, regression analysis was not conducted. However, to further test the hypothesis, regression analysis was conducted to identify whether the WLMKB scale is a significant predictor of percentage weight maintenance. The regression model included the Beliefs subscale and Knowledge subscale as predictors and weight maintenance (%) as the outcome.

Motivation was added to the model as a covariate in Step 1 and the predictors were entered in Step 2 (Table 5.6). The final regression model explained approximately 9% of the variance in weight maintenance *(*Adjusted $R^2 = .09$, $F(2,224) = 3.61$, $p = .03$). There was a significant positive association with the Beliefs subscale ($\beta = .15$, $p = .028$) meaning that participants with more accurate beliefs about WLM reported higher weight maintenance. Motivation to manage weight was also a significant predictor ($\beta = .59$, $p < .001$), higher motivation being associated with higher weight maintenance. Knowledge about WLM was not a significant predictor of weight maintenance ($p = .52$).

*Table 5.6:* Hierarchical linear regressions for WLMKB scores regressed on percentage weight maintenance (between highest weight and baseline)

| **Outcome variable** | **B** | ***SE* B** | **β** |
|---|---|---|---|
| **Weight Maintenance (%)** | | | |
| *Step 1* | | | |
| Constant | 3.47 | 2.28 | |
| Motivation | 2.46 | 0.59 | .27 |
| *Step 2* | | | |
| Constant | -6.71 | 4.50 | |
| Motivation | 2.46 | 0.59 | **.27** |
| Beliefs | 0.25 | 0.11 | **.15** |
| Knowledge | 0.17 | 0.26 | .04 |

*Note.* Motivation was entered (enter method) as a covariate in step 1, followed by all predictors in step 2 (hierarchical method).
For Weight maintenance: $R^2 =.07$, $p < .001$ for Step 1; $R^2 = .09$, $p < .03$ for Step 2.
B = unstandardized coefficient; B *SE* = unstandardized coefficient standard error; β = standardised coefficient

ii. Intention-to-treat analysis for WLM from highest weight to T2

Regression analysis on weight change was not conducted, as the outcome variable did not correlate with any of the predictors. However, as the WLMKB scale was correlated with weight maintenance, regression analysis was conducted on weight maintenance instead (see Section i.). Given that weight maintenance was calculated using the difference between highest weight and weight at baseline, the above analysis did not include the changes from baseline to follow-up. To address this, a new variable was computed to calculate the weight maintenance at follow-up, using the difference between highest weight and weight at follow-up. Per-protocol analysis and intention-to-treat analysis using the Last Observation Carried Forward were then conducted (Table 5.7). Results from the two analyses were similar showing that the final regression model explained approximately 9% of the variance in weight maintenance at follow-up (Per-protocol: Adjusted $R^2$ = .09, $F(2,169) = 3.97$, $p = .02$; ITT: Adjusted $R^2$ = .09, $F(2,224) = 4.39$, $p = .02$). There was a significant positive association with the Beliefs subscale meaning that participants with more accurate beliefs about WLM reported higher weight maintenance at follow-up. Motivation to manage weight was also a significant predictor, higher motivation being associated with higher weight maintenance at follow-up. Knowledge about WLM was not a significant predictor of weight maintenance ($p$ = .68).

*Table 5.7:* Hierarchical linear regressions for WLMKB scores regressed on weight maintenance at follow-up (%), per-protocol and ITT analyses

| | **Per-protocol (*n* = 173)** | | | **ITT (*n* = 228)** | | |
|---|---|---|---|---|---|---|
| **Outcome variable** | **B** | ***SE* B** | **β** | **B** | ***SE* B** | **β** |
| **Weight Maintenance T2 (%)** | | | | | | |
| *Step 1* | | | | | | |
| Constant | 3.02 | 2.81 | | 3.31 | 2.35 | |
| Motivation | 2.57 | 0.73 | .26 | 2.48 | 0.61 | .26 |
| *Step 2* | | | | | | |
| Constant | -9.34 | 5.23 | | -8.44 | 4.62 | |
| Motivation | 2.51 | 0.72 | **.25** | 2.49 | 0.61 | **.26** |
| Beliefs | 0.33 | 0.13 | **.19** | 0.30 | 0.12 | **.18** |
| Knowledge | 0.12 | 0.31 | .03 | 0.11 | 0.27 | .03 |

*Note.* Motivation was entered (enter method) as covariate in step 1, followed by all predictors in step 2 (hierarchical method).
For Weight maintenance T2; T2 = follow-up after 4 weeks
Per-protocol: $R^2$ =.06, $p$ = .001 for Step 1; $R^2$ = .09, $p$ = .02 for Step 2.
ITT = Intention to treat: $R^2$ =.06, $p$ < .001 for Step 1; $R^2$ = .09, $p$ = .01 for Step 2.
B = unstandardized coefficient; B *SE* = unstandardized coefficient standard error; β = standardised coefficient

## Weight management strategies: Diet, Physical activity (T1-T2)

Thirdly, it was hypothesised that higher scores on the WLMKB scale would predict higher engagement in weight related behaviours (weight control strategies, higher levels of physical activity) when controlling for weight management motivation.

Physical activity

Correlation analysis results showed that there was a significant positive correlation between physical activity and beliefs (*r* = .21, *p* = .001) and knowledge (*r* = .15, *p* = .022). There was no significant correlation between the WLMKB scale and changes in physical activity from baseline to follow-up (*p* = .09).

Regression analysis was then conducted to see if the WLMKB scale is a significant predictor of engagement in physical activity. The regression model included the Beliefs subscale and Knowledge subscale as predictors and physical activity as the outcome. Motivation was added to the model as a covariate in Step 1 and the predictors were entered in Step 2 (Table 5.8). The final regression model explained approximately 8% of the variance in physical activity (Adjusted $R^2$ = .08, $F(2,224) = 6.22$, *p* = .002). There was a significant positive association with the BS (β = .19, *p* = .006) meaning that participants with more accurate beliefs about WLM reported higher engagement in physical activity. Motivation to manage weight was another significant predictor of physical activity (β = .2, *p* = .003). This suggests that participants with higher motivation also reported increased engagement in physical activity. Knowledge about WLM was not a significant predictor of engagement in physical activity (*p* = .28).

*Table 5.8:* Hierarchical linear regressions for WLMKB scores regressed on physical activity

| **Outcome variable** | **B** | ***SE* B** | **β** |
|---|---|---|---|
| **Physical activity** | | | |
| *Step 1* | | | |
| Constant | 1.34 | 0.55 | |
| Motivation | 0.43 | 0.14 | .20 |
| *Step 2* | | | |
| Constant | -1.80 | 1.08 | |
| Motivation | 0.43 | 0.14 | **.20** |
| Beliefs | 0.08 | 0.03 | **.19** |
| Knowledge | 0.07 | 0.06 | .08 |

*Note.* Motivation was entered (enter method) as covariate in step 1, followed by all predictors in step 2 (hierarchical method).
For physical activity: $R^2$ =.03, *p* = .003 for Step 1; $R^2$ = .08, *p* < .002 for Step 2.
**p* < .05.
B = unstandardized coefficient; B *SE* = unstandardized coefficient standard error; β = standardised coefficient

Weight management strategies

Correlation analysis was conducted to assess associations between the WLMKB scale and engagement in weight management strategies. Results showed that there were no significant correlations between the WLMKB scale and engagement in weight management strategies (lowest $p$ = .10). Beliefs about hunger were significantly positively correlated with changes in engagement in weight management strategies ($r$ = .19, $p$ = .02). Given the lack of association or very low associations between WLMKB and weight management strategies, regression analysis was not conducted.

WLM

Binary logistic regression analysis was conducted to identify predictors of WLM status. Model 1 included the WLMKB scale factors as predictors of the odds of participants having maintained or regained WL. This model was not significant (lowest $p$ = .33). A second model was analysed where motivation to manage weight was included into the regression model (hierarchical). Results from model 2 were not significant with motivation not being a significant predictor of WLM status ($p$ = .85).

### 5.3.5. Test re-test reliability

To assess test re-test reliability correlation analysis was conducted between scores on the WLMKB scale at baseline ($n$ = 238) and after four weeks ($n$ = 180). Results showed that there was a strong positive correlation between the scores on the WLMKB scale at the two time-point (see Table 5.9). These results provide evidence of the stability over time of scores on the WLMKB scale. However, the strength of the correlations was not as strong as expected for all of the variables ($r \geq .80$).

*Table 5.9:* Test re-test reliability analysis of the WLMKB scale

| | Baseline (*n* = 225) *M*±*SD* | Follow-up (*n* = 168) *M*±*SD* | *r* |
|---|---|---|---|
| **Knowledge** | 6.12 ± 2.40 | 6.04 ± 2.49 | .75** |
| **Food Choice** | 2.88 ± 1.66 | 2.85 ± 1.73 | .71** |
| **Energy Balance** | 3.25 ± 1.26 | 3.2 ± 1.30 | .58** |
| **Beliefs** | 36.32 ± 5.54 | 36.72 ± 5.30 | .77** |
| **Hunger** | 10.74 ± 2.53 | 10.93 ± 2.64 | .69** |
| **CCB** | 11.54 ± 2.93 | 11.59 ± 2.81 | .54** |
| **Diet/Obesity** | 14.04 ± 3.41 | 14.2 ± 3.46 | .76** |

*Note*. ** $p < .01$; * $p < .05$

## 5.4. Discussion

The aim of the current study was to validate the WLMKB scale on a sample of WL maintainers and weight regainers. The results of the current research provide evidence of the construct (convergent, divergent), discriminant, and predictive validity of the WLMKB scale. Furthermore, test re-test reliability analysis showed that the scores on the WLMKB scale are stable in time. Each of these findings will now be discussed in turn.

The WLMKB scale demonstrated to have convergent validity. Scores on the WLMKB scale positively associated with other measures of theoretically similar concepts. The BS was associated with scores on the Dieting Beliefs scale (Stotland & Ztiroff, 1990), which is a measure of locus of control in dieting. Therefore, participants with more accurate beliefs about WLM also believe in having more internal locus of control in dieting. This is in line with previous research showing that a more internal locus of control in dieting is associated with less irrational food beliefs (Osberg et al., 2008). A more internal locus of control in dieting refers to the belief that weight can be controlled by the individual as opposed to being the result of an external factor (Stotland & Ztiroff, 1990). Internal locus of control was associated to a higher score on the beliefs scale, this is in line with expectations as the BS scale included items referring to the individual's belief about their agency in managing their weight (e.g. *If I eat too much today, I can maintain my weight if I eat less tomorrow. Unlike me, some people can eat a lot and not gain weight*.)

Additionally, the KS was positively associated with a measure of nutrition knowledge [PKM-11; (Mötteli, Barbey, et al., 2017)]. However, the association was lower than expected ($r < .30$). A possible explanation for the lower association might be that the KS taps into the relationship between food choice or energy balance related to WLM rather than focusing on nutrition knowledge independently. This is in line with previous research showing that the strength of the relationship between nutrition knowledge and weight management is lower due to difficulties in translating nutrition knowledge into actual behaviour (Grunert et al., 2012). Therefore, focusing on understanding and beliefs about strategies for weight management and more practical knowledge could better help predict weight management success (Koch et al., 2021).

Very low or no correlations were identified between the KS and dieting beliefs, and the BS and PKM-11, providing evidence of the divergent validity of the WLMKB scale. Knowledge and beliefs are two different aspects that affect behaviour in different ways (West & Michie, 2020). Therefore, the lack of correlations between the KS with the measure of beliefs and the low correlation between the BS with the measure of nutrition knowledge is in line with health behaviour theory (West & Michie, 2020). Furthermore, this brings evidence of the ability of the WLMKB scale to differentiate between the two different aspects, knowledge and beliefs.

Previous research has linked nutrition knowledge to diet quality (Mötteli et al., 2016), SES (Parmenter, Waller, & Wardle, 2000), and age (Mikhail et al., 2020). The current research investigated the associations between these factors and the WLMKB scale to provide further evidence of convergent validity. In line with previous research, scores on the WLMKB scale were positively related to health. However, there was no association between the WLMKB scale and SES. This lack of association may be due to the items focusing on beliefs and weight management strategies and processes rather than factual knowledge about nutrition. Furthermore, the lack of association could also be explained by the difference in measuring SES. Specifically, the current study used IMD deciles as an indicator of SES, whilst others used other factors such as income (Parmenter et al., 2000) or employment status (Matsumoto, Ishige, Sakamoto, Saito, & Ikemoto, 2019). Additionally, an alternative explanation could be that the current sample was predominantly white compared to samples used in previous research (Barbosa, Vasconcelos, Correia, & Ferreira, 2016; Mikhail et al., 2020).

Additionally, the WLMKB scale was negatively associated with dieting history, showing that participants with more accurate beliefs about WLM reported engaging in fewer dieting attempts. Given that dieting history has been previously linked to less success in long-term weight management (Kärkkäinen, Mustelin, Raevuori, Kaprio, & Keski-Rahkonen, 2018; Pasman, 1999), this could mean that more accurate beliefs lead to more successful weight management and consequently fewer dieting attempts.

Previous research showed a negative association between nutrition knowledge and age (Kliemann et al., 2016; Mikhail et al., 2020). With older participants having less accurate knowledge. Although extensive research has been conducted on the relationship between nutrition knowledge and age, possible explanations for why this might be the case have not been explored (Akkartal & Gezer, 2020; Spronk et al., 2014). In the current study associations between the WLMKB scale and age, showed that the factors of the scale have varying relationships with age. Specifically, whilst the KS was negatively associated with age as expected, beliefs about hunger were positively associated with age. These results suggesting that older participants have more accurate beliefs about hunger compared to more younger participants. Previous research has not investigated the associations between beliefs about hunger and age. This relationship suggests that older people might have more experience with hunger and dieting. Further research is necessary to further explore this association. However, the current study results showing an association between beliefs and older people is in line with previous research linking beliefs and age. For example, older people had stronger beliefs in the biological causes of obesity compared to younger people (Stapleton, 2015). However, there is also evidence of no link between weight management related beliefs and age (Knäuper et al., 2004). Given the mixed evidence regarding the relationship between knowledge, beliefs and age, further research should be conducted to better understand this association.

Discriminant validity of the WLMKB scale was tested by assessing the associations of the scale with factors that are related to weight management and eating behaviour but are conceptually not associated with knowledge and beliefs about WLMKB. The WLMKB scale demonstrated good discriminant validity, results showing that the scale did not correlate ($r < .20$) with measures of food fussiness and intrinsic regulation of exercise. However, the BS scale did correlate with the measure of intrinsic regulation of exercise. This result suggests that more accurate beliefs about WLM are related to a more intrinsic regulation of exercise. This result is in line with previous existing research and theory on physical activity adherence and intrinsic motivation (Teixeira et al., 2012). This study also showed that the BS was a significant predictor of engagement in physical activity even when controlling for motivation to manage weight. Therefore, more accurate beliefs about WLM related factors such as diet/obesity and calorie compensatory behaviours are related to higher levels of physical activity. This relationship could be explained by the relationship between accurate beliefs and a more intrinsic regulation of physical activity. Given that there is an indication of a theoretical association between the two concepts, the BREQ-3 might not have been an appropriate choice of measure to test the discriminant validity of the BS.

The predictive validity of the WLMKB scale was assessed by investigating the ability of the scale to predict WLM period/amount/status and engagement in weight management strategies for diet or physical activity. Beliefs, specifically diet/obesity beliefs were positively related to WL and WM. Suggesting that more accurate dieting and obesity beliefs are related to larger WL and more weight maintained after WL. Furthermore, beliefs were a significant predictor of weight maintained, with individuals with more accurate beliefs about WLM maintaining more weight between highest weight and the follow-up study. These results link to previous research and theory showing the importance of beliefs in weight management (Daigle et al., 2019; Teixeira et al., 2012; West & Michie, 2020). Furthermore, these results extend previous research by providing evidence of the influence of beliefs in WL and WLM. However, the WLMKB scale was not related and did not predict WLM status and engagement in diet weight management strategies. Additionally, contrary to expectations, motivation to manage weight did not differentiate between WL maintainers and weight regainers either. This could be due to other factors that were not assessed given that WLM is a complex process (Stubbs et al., 2011). Alternatively, the definition and split between the two groups might have influenced results as this was done based on the presumption of weight change that is significant for health; however, it might not be appropriate in differentiating between WL maintainers and regainers in a cross-sectional design. Furthermore, the analysis might not have been sufficiently powered as the sample size of WLM was small (WLM $n$ = 67). This suggests that WLM knowledge and beliefs do not differentiate between WL maintainers and weight regainers, and that other factors might be at play. This is in line with existing theories on WLM and the various difficulties in identifying predictors (Carraça et al., 2018; Paixão et al., 2020; Stubbs et al., 2011; Varkevisser et al., 2018).

The WLMKB scale did not differentiate between WLM and weight regainers in this sample. However, to overcome the issues with categorising individuals into two groups of WL maintainers and regainers, further analyses were conducted on the reported amount of weight maintained (from highest weight to follow-up). The WLMKB scale was positively correlated with higher WLM and was a positive predictor of engagement in physical activity. These results provide evidence of the predictive validity of the WLMKB scale, by showing its relationship to a behaviour (physical activity) and a conceptually related outcome (WLM) (Boateng et al., 2018). Contrary to expectations, the WLMKB scale was not associated with engagement in dietary weight management strategies. This could be explained by the wider variability in dietary strategies that individuals can be engaged in (Paixão et al., 2020) together with the possibility of achieving weight management while using a smaller range of strategies (e.g. calorie counting) (Mata, Todd, & Lippke, 2010; Ramage et al., 2014).

The scale demonstrated acceptable test re-test reliability, as the scores look to be stable in time with significant correlation between the scores on the two subscales higher than .70, which is an acceptable value for shorter scales (Kline, 2000). However, some of the separate factors showed lower than expected correlations. Specifically, the factors measuring knowledge about energy balance and beliefs about calorie compensatory behaviours showed correlations below .6. This could be due to the scale not measuring a stable personality characteristic (Polit, 2014), but rather knowledge and beliefs that are modifiable characteristics (Chung, Chung, & Chan, 2019; Jiménez-Cruz, De Escobar-Aznar, Castillo-Ruiz, Gonzalez-Ramirez, & Bacardí-Gascón, 2012). This method of assessing temporal stability has the limitation that motivated participants may look up answers and thereby increase their knowledge between tests (Trakman et al., 2017). The two subscales of the

WLMKB scale showed test re-test reliability with correlations between the two testing times (4 weeks apart) higher than .70. Similar other knowledge (Mötteli et al., 2016) and beliefs (Knäuper et al., 2004) scales have also used this method to test validity and deemed a correlation of .70 to be sufficient evidence of test re-test reliability.

This study has some limitations. First, the majority of the sample were white. This means that these results cannot be generalised to other populations. This limitation is an issue for research on weight management and specifically WLM, as there is evidence of differences in WLM success due to cultural or ethnic factors (Kinsey et al., 2021). Furthermore, other researchers raised the issue of underrepresentation of certain groups in weight management research (Bennett et al., 2014; Haughton et al., 2018). Secondly, the sample size of WL maintainers was small ($n$ = 67). Therefore, the results from the analysis on the separate groups might not have been sufficiently powered to find any effects. However, the percentage of the sample that was classified as WL maintainers is similar to the percentage reported in previous research (Wing & Phelan, 2005). The low percentage of participants that maintained weight shows the difficulty in achieving long-term weight management (MacLean et al., 2011) and the importance of further research on WLM. Thirdly, the current sample consisted of self-selected individuals that were successful at losing weight. Therefore, this could be a biased sample as these participants represent a minority of the general population. Furthermore, previous research conducted on successful WL maintainers has been criticised as not being representative for the population (Ikeda et al., 2005). Therefore, the applicability of these results to other individuals attempting WLM might not be appropriate. Fourthly, the factor structure of the scale was assessed on a sample of students and might differ when tested on other populations. Given that the scale shows good internal reliability, this suggests that the scale has a good factor structure. However, further testing of the factor structure of the scale could be useful to confirm it does not change across other populations. Finally, self-reported data was used for weight, height and engagement in weight management strategies. This is a limitation as there is evidence that participants tend to underestimate weight (Shields et al., 2008). However, there is evidence of a strong correlation between self-reported weight and objective BMI values (Mathew et al., 2012; Okamoto et al., 2017).

Previous chapters have presented the development (Chapter 3:), dimensionality testing and internal consistency testing (Chapter 4:) of a novel measure of knowledge and beliefs about WLM. For an overview of the see Table 7.1. The current research used a sample of WL maintainers and weight regainers to test the validity and retest reliability of the WLMKB scale. Following examples from other research (Mikhail et al., 2020; Mötteli et al., 2016; Mötteli, Barbey, et al., 2017) and generally accepted standards for scale validation (Boateng et al., 2018; Robinson, 2018; Trakman et al., 2017), the current research provides evidence of the convergent, discriminant and predictive validity of the WLMKB scale. Results showing that beliefs more than knowledge predict WLM. Specifically, higher amount of weight maintained and higher engagement in physical activity. The WLMKB scale is a reliable scale with acceptable stability over time. The current research extends existing literature on WLM by providing (i) initial evidence of the importance of WLM knowledge and beliefs in WLM; (ii) evidence of the validity of the WLMKB scale on a sample of WL maintainers and regainers; (iii) the WLMKB scale enables future research in WLM and intervention effectiveness testing.

# Chapter 6: Study 4: Individual differences and predictors of weight change during the COVID-19 lockdown

In November 2019, a new coronavirus began to infect humans in Hubei, China. The World Health Organisation (WHO) declared a pandemic three months after the first cases due to the rapid uncontrolled transmission. In the UK, a national lockdown was imposed on 23rd March 2020, with rules that may have been detrimental to health behaviours (Bakaloudi, Jeyakumar, Jayawardena, & Chourdakis, 2021; Stockwell et al., 2021).

This chapter presents a study conducted after the UK first COVID-19 lockdown. This study aimed to: (i) investigate the impact of the lockdown on weight management practices; (ii) assess the influence of knowledge and beliefs on the impact of COVID-19 lockdown; (iii) test the convergent and predictive validity of the WLMKB scale. A self-regulation framework has been used to identify individual differences that influence the negative impact of the lockdown on weight management. Additionally, knowledge and beliefs about WLM, as measured by the WLMKB scale (Chapters 3, 4 and 5), were assessed to investigate their influence on the impact of the COVID-19 lockdown on weight management practices and test the validity of the WLMKB scale.

Previous chapters have presented the development (Chapters 3 and 4) and validation (Chapters 4 and 5) of the WLMKB scale. This current study will further validate the scale on a sample of individuals engaged in a weight management attempt at the beginning of the COVID-19 lockdown. This is an important step as the scale is specifically developed to measure knowledge and beliefs about WLM, and therefore individuals attempting to manage their weight are the target population for the scale. Furthermore, investigating the predictive validity of the WLMKB scale in the context of the COVID-19 lockdown, as this is a situation of higher stress levels and lower access to professional support that could be detrimental to weight management attempts (WMA). To this purpose, the current study applied the WLMKB scale to investigate whether WLM knowledge and beliefs have an impact on weight management success in the context of a global pandemic and lockdown.

## 6.1. Background

The COVID-19 pandemic resulted in lockdown rules that can be detrimental to individuals engaged in WMA. Lockdown rules were implemented in multiple countries including the UK. These rules resulted in the closure of shops, restaurants, gyms and multiple health services (DW, 2020; UK Government, 2020). Additionally, all face-to-face WL services were suspended. Some of these services were adapted to digital delivery while others ceased entirely (UK Gov, 2020). Such changes have impacted health behaviours (Naughton et al., 2021). However, there is limited evidence on how the COVID-19 lockdown impacted individuals attempting to manage their weight. This evidence is important because, due to a high prevalence of obesity there is a considerable proportion of individuals engaged in WMA. Specifically, prior to the COVID-19 lockdown, 42% of the general population reported trying to lose weight and 23% reported trying to maintain weight (Santos et al., 2017). Furthermore, weight management has multiple health benefits, evidence showing that, even a small percentage WL of 5% of body weight can have a significant impact on health (Magkos et al., 2016). Comparatively, small weight gain in a short period of time can lead to permanent substantial weight gain over time (Schoeller, 2014). Therefore, it is important to assess the impact of the COVID-19 lockdown on individuals' WMA and their ability to self-regulate weight protective behaviours.

There is a wide variability in individuals' ability to regulate health behaviour. The next section will first explore the relationship between knowledge and beliefs and self-regulation during the COVID-19 lockdown. Furthermore, the factors that hinder or promote self-regulation will be discussed, focusing on those factors that might have been affected by the COVID-19 lockdown.

### 6.1.1. Knowledge and Beliefs and the COVID-19 lockdown

Self-regulation of health behaviours such as dietary intake and physical activity is necessary for successful weight management. Self-regulation refers to the ability to flexibly activate, monitor, inhibit, preserve and or adapt one's behaviour, attention, emotions and cognitive strategies in response to directions from internal cues, environmental stimuli and feedback from others in an attempt to attain personally relevant goals (Moilanen, 2007). Individuals widely differ in their ability to regulate health behaviours, with some individuals being able to self-regulate in times of stress while others are less able to (Heckhausen & Heckhausen, 2018).

Self-regulation for weight management requires that individuals set goals and standards for their self-regulation behaviours (Vohs & Baumeister, 2004). Successful self-regulation also requires changes in behaviours and monitoring of progress in relation to the goal. When considering self-regulation for weight management, changes are needed in weight related behaviours such as dietary intake, physical activity and weight monitoring (Lawlor et al., 2020). Therefore, given that multiple behaviour changes are needed for successful weight management, accurate knowledge and beliefs about what these changes should be and what are the mechanisms that drive weight change are necessary (West & Michie, 2020). Nutrition knowledge is widely used as part of weight management interventions (Jensen et al., 2014). However, the relationship between nutrition knowledge and eating behaviour is weak (Spronk et al., 2014). Other researchers argue that the weak relationship and little understanding of the role of nutrition knowledge in healthy eating is due to the quality and specificity of existing nutrition knowledge measures (Mötteli et al., 2017). The issues with these measures have been presented in detail in Chapter 3:, some of these issues include limitation to a single factor related to weight management, items developed on specific guidelines from different countries, or measures that are too difficult and long to be used on a general population as part of a more complex study. Additionally, engagement in weight management behaviours depends on the belief of the individual in their ability to engage in the strategies in the long term and on their confidence in the effectiveness of the strategies (Ajzen, 2011).

In the context of the COVID-19 pandemic, access to support from professionals has been limited (Ells et al., 2020). It could be argued that during this time individuals' knowledge and beliefs about WLM would be more influential on their weight management practices compared to normal times when access to professional support is available. Therefore, this study aims to investigate the effect of knowledge and beliefs as measured by the WLMKB on the impact of the COVID-19 pandemic on weight management practices.

### 6.1.2. Disinhibiting factors

## Dietary lapses

Dietary lapses are defined as disengagement or deviations from self-regulation goals and behaviours. Dietary lapses can result in feelings of shame, self-criticism and unrestrained eating (Polivy et al., 2010). Lapses in self-regulation of weight related behaviours can be caused by external cues, negative affect, or depleted resources (Wagner & Heatherton, 2014). Each of these factors that can lead to dietary lapses will now be discussed within the context of the COVID-19 pandemic.

## Cue exposure

Cue exposure and impulse control refers to the finding that people are more likely to lapse in their self-regulation attempts if they are exposed to an external cue associated with the behaviour they are trying to avoid. People attempting to control their eating behaviour are more likely to overeat after being exposed to food cues (Polivy & Herman, 2017). The COVID-19 lockdown increased stocking up of comfort foods, and the necessity to stay indoors resulted in constant exposure to these foods (Nicola et al., 2020). This lockdown situation may therefore have interfered with stimulus control and increased food intake due to constant exposure to food cues.

## Emotional distress

Emotional distress is another factor that is detrimental to self-regulation. Elevated levels of stress can stimulate eating behaviour (Sominsky & Spencer, 2014) and decrease physical activity (Brockmann & Ross, 2020). Negative emotions can also influence people to accept immediate rewards over larger delayed ones (Tice & Bratslavsky, 2000). There are various mechanisms by which emotions affect self-regulation. First, inability to regulate negative emotions leads to individuals using food to regulate their emotions (emotional eating) (Macht, 2008). Secondly, efforts to self-regulate negative emotions deplete resources needed to self-regulate health behaviours (Hofmann et al., 2007). Finally, failure to self-regulate health behaviours leads to negative emotions that can transform a lapse into total disengagement from the WMA (Wagner & Heatherton, 2014).

The COVID-19 pandemic and resulting lockdowns have negatively impacted mental health and caused emotional distress with individuals reporting increased levels of fear, stress, sadness, and guilt (Brooks et al., 2020). Individuals also reported increased energy intake to soothe negative emotions generated by the pandemic (Cherikh et al., 2020). Therefore, emotional distress and cue exposure are important to consider as they can lead to dietary lapses which are negatively correlated to weight-loss outcomes (Forman et al., 2017; Goldstein et al., 2018). Therefore, current research on the COVID-19 pandemic suggests that the lockdown rules enhanced threats to self-regulation and increased the likelihood of lapses, and consequently the lockdowns may have been detrimental to WMA.

### 6.1.3. Protective factors

However, the extent to which the COVID-19 lockdowns were detrimental to WMA likely varied across individuals. According to self-regulation theory there are various individual characteristics that can help people face adversity and continue their self-regulation attempts (Teixeira et al., 2015). In the context of weight management and the COVID-19 lockdown it was argued that some of these characteristics include a self-compassionate response to lapses, a more flexible approach to dietary restraint and stronger impulse control when faced with external cues.

## Self-compassion

A self-compassionate response to negative emotions and failure can help break lapse activated patterns and support emotional regulation to reduce emotional eating. Self-compassion refers to a kind and understanding attitude towards oneself when faced with pain or failure, as opposed to being harsh or self-critical (Neff, 2003). Self-compassion plays an important role in the regulation of health behaviours. Self-compassion helps with self-regulation by processes such as setting goals, taking action, attention and evaluation of behaviour and emotional regulation (Sirois, Kitner, & Hirsch, 2015). In the context of COVID-19, self-compassion may play an important role in the success of WMA by supporting the emotional regulation of increased stress and temporary lapses in weight management related behaviours. Given that dietary lapses can result in feelings of shame and self-criticism (Polivy et al., 2010), self-compassionate individuals may perceive these transgressions less negatively (Thøgersen-Ntoumani et al., 2020).

## Dietary restraint

Another important factor for successful weight management is dietary restraint and the ability to resist hedonic temptations. Self-regulation of behaviour for weight management usually requires a form of dietary restraint. Dietary restraint refers to the restriction of food intake with the aim of controlling body weight (Herman & Mack, 1975). Flexible dietary control involves a balanced approach to eating, by engaging in behaviours such as: choosing smaller servings and compensating at a subsequent meal if too much food was eaten earlier (Westenhoefer et al., 1999). Flexible restraint is linked with improved WL outcomes (Westenhoefer et al., 2013). Rigid restraint on the other hand is described by strict dichotomous, all-or-nothing approach to eating and weight management, and is highly correlated with disinhibited eating (Westenhoefer, 1991). Therefore, in response to the COVID-19 lockdown, individuals scoring high in flexible restraint may be better able to adapt their dietary intake. Greater flexible restraint may be associated with less uncontrolled eating, and better self-regulation and weight management during the COVID-19 lockdown. Alternatively, rigid restraint may be associated with higher uncontrolled eating and worst self-regulation and weight management.

## Craving control

Additionally, a more flexible approach to eating restraint could be beneficial to weight management by reducing the negative emotions generated by lapses, as well as being able to better accommodate food cravings in the weight management plan. Food craving has been defined as the intense desire to eat a certain food (Weingarten & Elston, 1990). Food cravings are experienced by everyone and can range from mild to extreme (Dalton et al., 2017). Studies show that higher levels of food cravings are associated with increased BMI (Taetzsch et al., 2020) and disordered eating (Hill, 2007). The ability to control cravings is also important for weight management, with poorer WL outcomes in individuals scoring low in craving control. Low craving control has also been identified as a strong predictor of increased energy intake during the COVID-19 lockdown (Buckland & Kemps, 2021; Buckland et al., 2021). In the context of the COVID-19 lockdown, being required to stay inside may have resulted in individuals being constantly exposed to food cues that could have enhanced food craving. Additionally, craving control may have been more challenging during the lockdown due to depleted resources from dealing with added routine changes and emotional distress. The ability to control eating and refrain from acting on food cravings may support the ability to manage weight (Smithson & Hill, 2017).

### 6.1.4. Weight management and COVID-19

Given the increased emotional distress, cue exposure and venue closures, the COVID-19 lockdown can be a risky time for dietary lapses for some individuals. To date, there is limited evidence on the impact of the COVID-19 lockdown on WMA. A brief report from participants of a commercial weight management programme, showed that more than half found it difficult to manage their weight during the COVID-19 lockdown (EASO, 2020). Another survey of 132 people from the UK engaged in weight management services prior to COVID-19 and living with obesity found that access to weight management services were disrupted during the COVID-19, and communication from weight management services was insufficient. Additionally, most participants reported that their diet ($n$ = 100) and physical activity ($n$ = 102) were negatively impacted during the lockdown (Brown et al., 2021).

In England, weight management services are classified on different ‘tiers’: Tier 1 provides health promotion; Tier 2 provides multiple component behaviour change support for overweight and obesity; Tier 3 provides specialist support for severe obesity; Tier 4 provides bariatric surgery. According to a Public Health England report, 60.6% of participants engaged in a Tier 2 Weight Management service, and 78.3% engaged in a Tier 3 service stated that their appointments had been cancelled or delayed (Ells et al., 2020). Other research on the impact of COVID-19 restrictions on weight related health behaviours shows that food intake and physical activity have been negatively impacted for some individuals (Ammar et al., 2020; Bakaloudi et al., 2021; Stockwell et al., 2021). Additionally, 79% of individuals reported a decline in weight related behaviours due to the COVID-19 lockdown (Robinson, Gillespie, & Jones, 2020). Successful weight management requires engagement in several strategies (goal setting, self-monitoring, and enduring challenges) that help regulate behaviour (Spreckley et al., 2021). To date, research has focused on changes in physical activity and energy intake, but further research is necessary to identify how specific weight management strategies have been impacted by the COVID-19 lockdown. Additionally, minimal research on weight related behaviours has focused on people attempting to manage their weight. This research is important given that such individuals may be susceptible to self-regulation lapses, and lockdowns are likely a risky time that can be detrimental to WMA.

Furthermore, while there have been some reports on changes to WMA during COVID-19, it remains unclear which individuals are most likely to digress from WMAs. Other work has shown individual variability in eating behaviour and physical activity during COVID-19. While a large amount of people gained weight and decreased their weight related behaviours (Ammar et al., 2020) there are some that used this period as an opportunity to change their lifestyle (Allabadi, Dabis, Aghabekian, Khader, & Khammash, 2020) and make it healthier: increased home-made cooking 40%, increased physical activity 19% and 23%

WL (Deschasaux-Tanguy et al., 2020). Research looking at the trajectory of eating behaviour shows that while the majority of participants did not change their eating (64%), participants that were more vulnerable in the first place (overweight, underweight, lower education status and depressive symptoms) tended to report overeating and undereating during the COVID-19 lockdown (Herle, Smith, Bu, Steptoe, & Fancourt, 2021). Further research shows that participants with a higher BMI reported greater overeating and lower physical activity and diet quality, experienced barriers to weight management including problems with maintaining motivation and control around food (Robinson et al., 2020). The presented evidence suggests there are individual differences in response to the lockdown. However, these studies have been conducted on general samples and not particularly on individuals attempting to manage their weight. Therefore, there is little knowledge on the nature of this individual variability in relation to WMA. These results suggest that further research is necessary to identify predictors of the COVID-19 lockdown on WMA and individual differences in self-regulation of weight related behaviours during the first COVID-19 lockdown.

Identifying the impact of COVID-19 on WMA is important because obesity is a risk factor for hospitalisation and mortality in patients with COVID-19 (Cai et al., 2020; Nakeshbandi et al., 2020; Popkin et al., 2020) and there are significant health benefits of managing a healthy weight (Goodpaster et al., 2010; Wing et al., 2011). Evidence on individual susceptibility is needed to inform interventions to support WMA and prevent weight gain during current and future viral lockdown periods. Additionally, identifying those at risk of disengagement from WMA during the lockdown will allow for the appropriate support to be provided.

### 6.1.5. Validity testing of the WLMKB scale

Previous chapters presented the development (Chapters 3 and 4) and validity testing (Chapters 4 and 5) of the WLMKB scale. Further validity was conducted in this study to test the predictive and convergent validity. An additional aim of the current study was to further validate the WLMKB scale on a sample of individuals attempting to manage their weight.

Predictive validity refers to the ability of the scale to predict a real life characteristic or behaviours. In Study 3 (Chapter 5:), predictive validity was tested on a sample of WL maintainers and weight regainers. Results showed that the WLMKB scale significantly predicted amount of weight maintained and engagement in physical activity. However, it was not predictive of weight change from baseline to after four weeks. Therefore, it was aimed to further test the predictive validity of the scale.

In the current study, predictive validity was tested by assessing whether the WLMKB scale was correlated to weight change during the COVID-19 lockdown, overall weight suppression and WMA continuation. Currently there is no evidence of this relationship. However, research on knowledge about food labels and serving sizes (Ollberding, Wolf, & Contento, 2010; Rolls, 2014) suggests that knowledge and beliefs about weight management related factors are associated with WL.

Furthermore, the relationship between the WLMKB scale and dietary restraint was also investigated. As previously explained, dietary restraint is important for weight management. This study recruited participants that were engaged in a weight management attempt right before the first COVID-19 lockdown. Therefore, all participants were attempting some form of dietary restraint at baseline, and their weight management success depended on their continued restraint during the lockdown. It is argued that in a sample of individuals interested in managing their weight, participants with more accurate WLM knowledge and beliefs understand the importance of dietary restraint and continue their engagement in weight management strategies, report continued engagement in WMA and have higher scores on the cognitive restraint scale. To date there is no evidence available of this relationship, however, this hypothesis was informed on previous research showing the importance of continued vigilance for weight management (Stubbs & Lavin, 2013). Additionally, there is evidence that individuals that were most at risk of weight regain were restrained eaters that were not engaged in dieting (Lowe & Timko, 2004). Therefore, this study gave a unique opportunity to investigate the relationship between the WLMKB scale and dietary restraint in a sample of individuals interested in managing their weight in a context of high stress, the COVID-19 lockdown.

Convergent validity tests whether the scale measures the concept is aimed to measure by assessing its relationship to similar concepts, or other factors that should theoretically be related. To assess the convergent validity of the WLMKB scale the relationship to perceived dieting successes was investigated. This relationship was explored because perceived self-regulation success was identified as an indicator of actual dieting success (Jonker et al., 2021; van Koningsbruggen et al., 2011), and there is limited but significant evidence of the importance of nutrition knowledge and beliefs in weight management success (Bessems et al., 2020; Sason et al., 2018; Swift et al., 2009; Wang & Coups, 2010). Additionally, results from Study 2 (Chapter 4:) showed that the WLMKB scale was positively correlated with perceived self-regulatory success in a student sample. The current study aims to further investigate this relationship in a sample of individuals engaged in a weight management attempt at the beginning of the COVID-19 lockdown.

### 6.1.6. Aims and hypotheses

This study aimed to identify the impact of the first UK COVID-19 lockdown on self-regulation of weight related behaviours from the framework of self-regulation theory. Specifically, the study aimed to: (i) identify changes in WMA and strategies in response to COVID-19; (ii) describe the characteristics of individuals that continued their WMA; (iii) identify predictors of WMA continuation; (iv) identify predictors of successful weight management (weight change) during the COVID-19 lockdown; (v) identify possible mediators of the negative impact of the lockdown on weight management.

First it was hypothesized that the COVID-19 lockdown would have an impact on WMA, with most participants reporting disruptions to their WMA and strategies used. Second, it was hypothesized that there would be variability in the impact of the lockdown on individuals. Higher levels of self-compassion, craving control, flexible restraint, WLM knowledge and beliefs, and lower levels of rigid restraint, stress and uncontrolled eating would be related to continuation of WMA. Finally, it was hypothesized that stress, self-compassion, craving control, flexible/rigid restraint, WLM knowledge and beliefs, and uncontrolled eating would significantly predict changes in WMA and percentage weight change in response to COVID-19 lockdown.

This study further aimed to test the predictive and convergent validity of the WLMKB. The tested hypotheses are presented below.

Predictive validity hypothesis:

1. The WLMKB is expected to predict weight change due to the COVID-19 lockdown. Specifically, individuals with more accurate knowledge and beliefs will also report lower weight gain during the COVID-19 lockdown.

2. The WLMKB scale is expected to predict WMA and dietary restraint. Specifically, individuals with more accurate knowledge and beliefs will also report continuing their WMA and higher dietary restraint.

Convergent validity hypothesis:

3. People with more accurate WLM knowledge and beliefs perceive themselves as being more successful at managing their weight. Therefore, the WLMKB scale is expected to be positively correlated with the PSRS scale.

## 6.2. Method

### 6.2.1. Participants and procedure

Data was collected from an online retrospective cross-sectional survey (via Qualtrics, Provo, UT) conducted after the first COVID-19 lockdown in the UK (September 1st – November 9th 2020). Participants were recruited through adverts posted on social media and volunteer lists. A sample size of 346 participant responses were required for a two tailed test, estimating a conservative small effect size ($r$ = .15), power 0.80 (Ellis, 2010). Eligibility criteria were as follows: Adults (aged 18 years and over) that reported active engagement in a WMA at the time the lockdown started. As the study was aiming to investigate the impact of the COVID-19 lockdown on weight management attempts, all forms of weight management were included in the analysis (weight loss, maintenance, and gain). After providing informed consent, participants were asked to complete demographic information (e.g. age, gender, residence, ethnicity etc.) and screening questions (dieting status, history of eating disorders). Participants were then asked to complete questions about the perceived changes in weight management strategies, eating behaviour and physical activity due to COVID-19 lockdown. Participants then completed measures about stress, cognitive restraint, self-compassion, weight management knowledge and beliefs in a randomised order. After completing these measures, participants were asked about their dieting history (Witt et al., 2013), postcode [to indicate socioeconomic status (SES) via the Index of Multiple Deprivation (Scottish Government, 2020; StatsWales, 2019; UK Government, 2019)], general health (Jylhä, 2009), bariatric surgery, and COVID-19 status (e.g. infected, high risk group) and COVID-19 impact (e.g. on income, caring responsibilities). At the end of the questionnaire participants were debriefed and had the opportunity to be entered into a prize draw. For safety reasons, respondents with a current or history of eating disorders were excluded. Two attention check questions were included to check if participants engaged in the task and participants that answered both incorrectly were excluded from the analysis. The study hypotheses and data analysis plan were pre-registered and are available at https://osf.io/h8tcn. The study was approved by the University of Sheffield Research Ethics Committee (no. 035956) and took on average 53.5 ± 117.7 minutes to complete.

### 6.2.2. Measures

#### Weight management attempt during the first UK COVID-19 lockdown

Dieting status in response to the lockdown was measured with a single item '*What happened to your weight management attempt in response to the COVID-19 lockdown?*' with four response options: stopped, continued, temporarily stopped or other.

#### Engagement in weight management strategies

Reported change to cognitive and behavioural strategies used for weight management practices were measured by asking participants whether engagement in a certain strategy had changed during the lockdown compared to before. The strategies used were selected from The Oxford Food and Activity Behaviours (OxFAB) taxonomy and questionnaire (Hartmann-Boyce et al., 2016). The Ox-Fab taxonomy consists of 117 strategies grouped into 23 domains providing a conceptual framework to identify the cognitive and behavioural strategies used by individuals for weight management. For this study, due to time constraints for survey completion, only a selection of these strategies were assessed (e.g. monitoring, planning, adaptation, stimulus control, information seeking, support; see Supplementary materials for list of items). Participants were asked to indicate the extent to which engagement in each of the strategies had changed from before the lockdown on a 100-point scale (0 – extremely decreased, 100 – extremely increased) with the option of not applicable. Results were evaluated at the domain level and for strategies deemed essential for weight management.

## Eating behaviour change: overall food intake, snacks and meals

Changes in eating behaviour during the COVID-19 lockdown were measured using three items. These items were adapted from previous work conducted to study dietary changes in response to the COVID-19 lockdown (Buckland et al., 2021). Participants were asked to what extent they believed their eating habits changed in response to the lockdown. The questions assessed changes to overall food intake, snack intake and meal intake. Participants first stated whether their food intake had changed or not, and then indicated the amount of change on a scale ranging from '0 = extremely decreased' to '100 = extremely increased'.

## Physical activity change:

Physical activity was measured using the Single-item physical activity measure (Milton, Bull, & Bauman, 2011). The single-item physical activity measure asks participants how many days in a week they have engaged in a 30-minute moderate physical activity. Participants were asked to think of a typical week before the lockdown and then one during. This measure was selected because it is a short measure of physical activity that focuses on assessing structured physical activity. Furthermore, it was shown to moderately correlate with hip-worn accelerometery physical activity measure. These results suggesting that the Single-item physical activity measure is a valid tool to measure changes in physical activity (O'Halloran et al., 2020). Participants also reported general changes to physical activity by indicating the change in frequency and duration of physical activity since the lockdown (100-point scale ranging from extremely disagree to extremely agree). Items were developed for the purpose of this study.

## Weight change

The Dieting and Weight History Questionnaire (DWHQ) (Witt, Katterman, & Lowe, 2013) was used to assess weight changes. Participants were asked to report their weight before the first lockdown (weight close to 23rd March 2020, first day of UK lockdown) and their current weight (kg). Percentage weight change since the beginning of lockdown, was computed by deducting current weight from weight before the lockdown, as such higher numbers represent weight gain.

## Weight management knowledge and beliefs

Weight management knowledge and beliefs were measured using the Weight Loss Maintenance Knowledge and Beliefs (WLMKB) scale (Chapter 4). The WLMKB scale is comprised of 20 items measuring the accuracy of knowledge and beliefs people have about several factors related to WLM. The scale has two subscales. The Knowledge subscale is comprised of 10 items measuring knowledge about calorie balance and the relation between food choices and weight management. The Beliefs subscale contains 10 items measuring beliefs about hunger, diet, obesity and calorie compensatory behaviours. The scale has good internal consistency with $\alpha > .70$ on all subscales.

## Perceived stress

Perceived stress during the COVID-19 lockdown was measured using the Perceived Stress Scale (PSS; Cohen, Kamarack, & Mermelstein, 1983). The PSS is a measure of general perceived stress tapping into the degree to which individuals find their lives unpredictable, uncontrollable, and overloading. The measure is composed of 14 items with a response scale from 0 (never) to 4 (very often). In this sample Cronbach's alpha coefficient was .89. Higher scores indicate higher levels of perceived stress.

## Self-compassion

The Self-Compassion Scale – Short form (Neff, 2003) was used to measure the main components of self-compassion as well as their negative counterparts: self-kindness/self-judgement, common humanity/isolation, mindfulness/over-identification. The scale consists of 12 items that start with the statement "*how I typically act toward myself during difficult times*". Responses to the items range from 1 (almost never) to 5 (almost always). Higher scores indicate higher levels of self-compassion. In line with previous evidence (Neff, 2003) in the current sample the scale demonstrated good internal consistency $\alpha = .93$.

## Flexible and Rigid restraint

To measure flexible and rigid restraint, the Flexible and Rigid Control of Dietary Restraint (Westenhoefer et al., 1999) was used. The Rigid control subscale consists of 16 items and is characterised by a dichotomous, all or nothing approach to eating and dieting and weight. In contrast, the Flexible Control scale consists of 12 items and is characterised by a more graduated approach to eating behaviour, for example, there are no forbidden foods, and all foods are eaten in limited quantities without feelings of guilt. Higher scores in each of the subscales indicate higher occurrence of that characteristic in the participant. Cronbach’s alpha coefficient for each subscale in this sample was as follows: Flexible restraint $\alpha = .79$; Rigid restraint $\alpha = .80$.

## Uncontrolled eating

Uncontrolled eating was measured using The Three Factor Eating Questionnaire: (TFEQ-R18) (Karlsson, Persson, Sjöström, & Sullivan, 2000). Disinhibited eating or uncontrolled eating as measured by the subscale of the TFEQ-R18 refers to the tendency to overeat, with the feeling of being out of control. The uncontrolled eating subscale is comprised of 9 items and higher scores indicate higher levels of uncontrolled eating. In this sample, Cronbach’s alpha coefficient was .90.

## Craving control

Craving control was assessed with the Control of Eating Questionnaire (COEQ) (Dalton, Finlayson, Hill, & Blundell, 2015). The scale consists of 5 items measuring the severity and control over food cravings an individual experiences over the previous 7 days. Assessed using 100-mm visual analogue scales (VAS). Higher scores indicate greater control over cravings. In this sample, Cronbach’s alpha coefficient was .92.

## Perceived Self-regulatory Success

The Perceived Self-Regulatory Success in dieting scale (PSRS) (Meule, Papies, & Kübler, 2012) is a three-item scale that was developed by Fishbach and colleagues (2003). Participants were asked to rate on 7-point scales how successful they are in watching their weight, in losing weight, and how difficult it is for them to stay in shape. The PSRS scale was used as an alternative measure of weight management success. Reliability analysis of the PSRS scale was good, Cronbach's alpha was .74.

**Socio-economic status**

SES was measured to assess whether reported changes in weight management practices varied according to SES (Clemmensen et al., 2020; Darmon & Drewnowski, 2008). This measure was included as evidence showed that lower SES was associated with higher BMI (Blüher, 2019) and lower nutrition knowledge (Koch et al., 2021; Mikhail et al., 2020; Parmenter et al., 2000). Furthermore, these associations might be strengthened in the COVID-19 lockdown context (Herle et al., 2021). Participants were asked to provide their postcode to determine Index of Multiple Deprivation (Scottish Government, 2020; StatsWales, 2019; UK Government, 2019). The IMD ranks small geographical areas in England, Wales and Scotland. Deciles are reported and range from '1 = most deprived' to '10 = least deprived'.

**Days passed since the lockdown started**

Days passed since the lockdown started was also added as a covariate in the regression analyses. The data was collected from 1 September to 9 November 2020 and to control for time passed, the number of days since the first day of the lockdown until participants completed the survey was computed.

### 6.2.3. Statistical analysis

Reported height, weight, weight change and computed BMI values were screened for values that were outside expected ranges (height between < 1.40 – > 2.20 m, weight < 40 – > 200 kg, weight change > 40kg and computed BMI < 15 kg/m$^2$ - > 60 kg/m$^2$). Datapoints for incomplete surveys were retained up to the point participants dropped out. To compare demographic information (e.g. age, sex) of completers and non-completers t-tests and chi-squared tests were conducted. Data analysis was conducted on the available data, and averages were not computed to fill in missing data points.

In total, responses were collected from 431 participants. Of these, 261 did not finish the study, 182 of these provided informed consent but dropped out before completing the survey. Nineteen were excluded from survey participation for having an eating disorder and 4 participants were excluded for incorrectly answering both attention check questions ($n$ = 3) or having a completion time of less than 10 minutes ($n$ = 1). Therefore, sample sizes vary for each variable reported. The criteria for significance was $p$ < .05. For the between subjects comparison, effect sizes are reported (Cohen's $d$: small effect = 0.2, medium effect = 0.5 large effect = 0.8).

To identify the impact of the COVID-19 lockdown on self-regulation of weight related behaviours the following were assessed: (i) changes to participants' WMA (e.g. stopped, continued, temporarily stopped or other); changes in engagement in strategies from each domain related to successful self-regulation; (ii) self-regulation of weight related behaviours: changes in energy intake, physical activity and weight change during the lockdown; (iii) individual differences that predict continued engagement in the WMA; (iv) individual differences that predict weight change during the COVID-19 lockdown; (v) mediators of the negative effect of the lockdown on weight change (%).

ANOVAs were conducted to describe the characteristics of individuals that continued, temporarily stopped or terminated their WMA. Correlations between perceived changes in eating behaviour and physical activity, weight change, self-compassion, flexible/rigid restraint, uncontrolled eating, perceived stress, craving control, knowledge and beliefs were explored using bivariate correlations (Pearson's *r*). The strength of correlations was interpreted as small if $r < .3$, medium if between .3 and .5, and large if $r > .5$ (Cohen, 1992). Two regression analysis models were run to identify predictors of weight change (%) and continuation of the WMA. Self-compassion, flexible/rigid restraint, uncontrolled eating, stress, and craving control were entered in the model as predictors (hierarchical method). The model for weight change (%) was adjusted for SES and days passed since the start of the lockdown entered in the first step, and all other predictors entered at step 2). Mahalanobis, Cooks and Leverage scores indicated that there were no outliers. To check for multicollinearity between predictor variables, the variance inflation factor (VIF) and tolerance statistics were assessed. There were no issues with multicollinearity as based on the VIF (<10), and tolerance values (>0.2; Tabachnick & Fidell, 2013).

Two mediation models were conducted to assess whether weight management motivation mediated relationships between WLM knowledge and beliefs and weight change during the COVID-19 lockdown. A third mediation model was conducted to assess whether perceived stress mediated the relationship between self-compassion and weight change.

Statistical analysis was carried out using IBM SPSS version 26. A single simple mediation model (Model 4) was used to assess the mediation role of perceived stress on the effect of self-compassion on weight change using PROCESS macro version 3.5 (Hayes, 2017).

## 6.3. Results

### 6.3.1. Participants

The final sample consisted of 166 adults (*M:* 31.1, *SD* = 12.2 years). Whilst this final completed sample size fell short of the planned sample size, Ellis (2010) suggests that this sample size is sufficient to detect a medium effect size correlation coefficient (*r* = 0.25). The majority of the sample was female, 70.5% (*n* = 117; male *n* = 45; prefer not to say *n* = 2; transgender male *n* = 1; non-conforming *n* = 1), from a white ethnic background (77.1%, *n* = 128) and had a high level of education (Bachelor's degree 42.8%, *n* = 71; A-levels 27.1%, *n* = 45; Doctoral or higher education 22.3%, *n* = 37) (Table 6.1).

*Table 6.1:* Study 4 Participant characteristics

| **Variable (total *n*)** | ***n* (%)** |
|---|---|
| *Education level (166)* | |
| No formal qualifications | 1 (0.6%) |
| 1-4 GCSEs or equivalent qualifications. | 5 (3%) |
| 5 GCSEs or equivalent qualifications. | 4 (2.4%) |
| Apprenticeship. | 1 (0.6%) |
| 2 or more A-levels or equivalent qualifications. | 45 (27.1%) |
| Bachelor's degree or equivalent. | 71 (42.8%) |
| Doctoral or higher education. | 37 (22.3%) |
| Other qualifications including foreign qualifications. | 2 (1.2%) |
| *Ethnic group* | |
| White | 128 (77.1%) |
| Mixed or multiple ethnic groups | 4 (2.4 %) |
| Asian or Asian British | 23 (13.9%) |
| Black, African, Caribbean, or Black British | 6 (3.6%) |
| Prefer not to say | 2 (1.2%) |
| Other | 3 (1.8%) |

When asked about COVID-19 situation, 15.7% ($n$ = 26) reported living alone and 81.2% ($n$ = 134) reported not having COVID-19 and 37.8% ($n$ = 62) reported working from home, 52.4% ($n$ = 86) reported not working and 9.8% ($n$ = 16) were key workers. All health and COVID-19 participants characteristics are available in Appendix E. Approximately 24% ($n$ = 25) of the participants had a current BMI >30, which is representative for this age group of UK individuals (NHS, 2019). Most participants ($n$ = 145; 88%) were following a self-led diet. Of note, there were no significant differences between completers and non-completers for any sample characteristic variables measured (smallest $p$ = .14; see Appendix E).

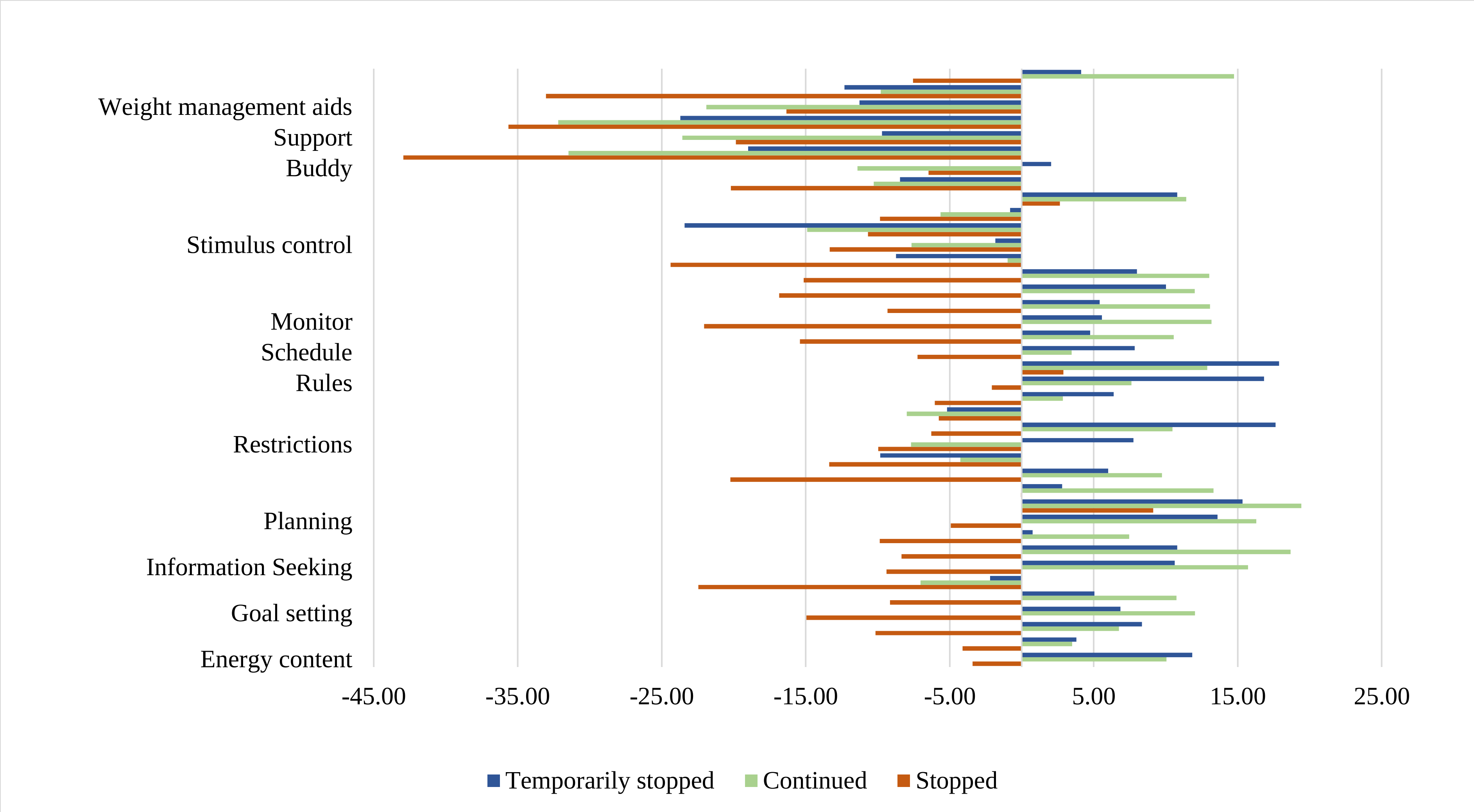
### 6.3.2. Changes in WMA and practices during COVID-19.

Before the COVID-19 lockdown: 70.5% ($n$ = 117) of participants were attempting to lose weight, 24.1% ($n$ = 40) were attempting to maintain weight and 5.4% ($n$ = 9) were trying to gain weight. Responses from participants attempting to gain weight were retained in the analyses looking at changes in WMA as the analysis sought to assess changes in engagement in specific strategies from before the lockdown to after (and included the option of not applicable). However, due to the low number of participants attempting to gain weight ($n$ = 9) no separate analyses were conducted on this sample.

When asked what happened to their WMA in response to the lockdown, 39.8% ($n$ = 66) reported continuing their WMA, 25.3% ($n$ = 42) stopped and 30.7% ($n$ = 51) stopped temporarily and started again. Approximately 28% ($n$ = 46) of the participants reported losing weight, 35.2% ($n$ = 58) reported gaining weight and 24.2% ($n$ = 40) reported that their weight fluctuated during the COVID-19 lockdown.

### 6.3.3. Weight management strategies and weight change

Changes to specific weight management strategies are shown in Figure 6.1. When looking at specific weight management strategies, approximately 42% of participants reported talking to a healthcare professional or having an online WL buddy. Additionally, participants reported the highest decrease in engagement in these strategies during to the COVID-19 lockdown. Participants reported that engagement in strategies related to planning meals, shopping and swapping foods had increased overall.




*Note.* Positive scores = increase in engagement; Negative score = decrease in engagement

*Figure 6.1: Difference in changes in weight management strategies between participants that continued, stopped, or temporarily stopped and restarted their WMA in response to the COVID-19 first UK lockdown*

Decreased engagement in weight management strategies were associated with weight gain since before the lockdown (Table 6.2).

*Table 6.2:* Correlations between weight management strategies and percentage weight change

| **Strategy** | **Weight change %** |
|---|---|
| Make up for overeating at one meal, by eating less at another | -.17 |
| Adjust the amount of food eaten based on physical activity | -.36** |
| Make up for being sedentary one day by exercising more the next day | -.10 |
| Have a set goal of how much to eat each day | -.39** |
| Have a set goal of how much physical activity to do each day | -.13 |
| Have a set goal of how much weight you want to lose each week | -.22* |
| Make food choices based on the nutritional information on the food labels | -.28** |
| Look up the nutrition information and/or calorie content of foods | -.29** |
| Look up information on how many calories you burn doing physical activity | -.29** |
| Plan meals in advance | -.23** |
| Plan food shopping in advance (e.g. use a shopping list) | -.13 |
| Walk or cycle instead of driving or taking the bus | -.03 |
| Follow an exercise plan/routine | -.30** |
| Do more chores at home/in the garden to get more exercise and lose weight | -.12 |
| Skip meals as a way to lose weight | -.15 |
| Avoid eating certain foods | -.35** |
| Avoid specific shops or aisles in the supermarket | -.10 |
| Control portion size by putting a certain amount of food on a plate or drink in a glass | -.33** |
| Drink water or a low-calorie drink/eat low-calorie food to limit the amount eaten during meals | -.29** |
| Swap one type of food or drink for another that is better for the diet (e.g. lower fat/lower sugar versions of the same foods) | -.25** |
| Plan meal times to help with weight loss plans | -.29** |
| Schedule physical activity each week | -.17 |
| Keep track of the calorie and/or nutritional content of the foods eaten | -.40** |
| Check the portion sizes | -.36** |
| Keep track of physical activity | -.12 |
| Keep track of weight by weighing regularly | -.29** |
| Measure waist (or other parts of the body) | -.16 |
| Use smaller plates, bowls or glasses when eating to help with portion control | -.24* |
| Buy food pre-packaged in individual portions | -.05 |
| Buy smaller amounts of certain foods to help with eating less | -.15 |
| Don't buy or keep at home things that don't fit with the diet | -.31** |
| Do something to prompt exercise (e.g. lay out exercise clothes the night before) | -.13 |
| Try to lose weight alongside a friend/family member/partner | .18 |
| Have an online weight loss buddy | -.11 |
| Sought help to tackle feeling stressed, down, or anxious to avoid breaking the diet | -.03 |
| Talked to a healthcare professional about weight management (e.g. doctor, nurse, psychologist) | -.03 |
| Use meal replacements (e.g. shakes, diet bars, etc.) | -.05 |
| Use the gym | -.08 |
| Exercise at home using own equipment or DVDs | -.16 |

*Note:* ***p* < .01, **p* < .05

When looking at the different domains, most participants reported a decrease in engagement in strategies related to stimulus control, use of weight management aids and seeking support and help from friends. There were significant differences in changes in engagement in weight management strategies between participants that continued or had temporary disruptions to their WMA and those that stopped. Participants that continued or had temporary disruptions to their WMA reported increased engagement in monitoring, information seeking and setting rules compared to participants that stopped in their WMA (Table 6.3).

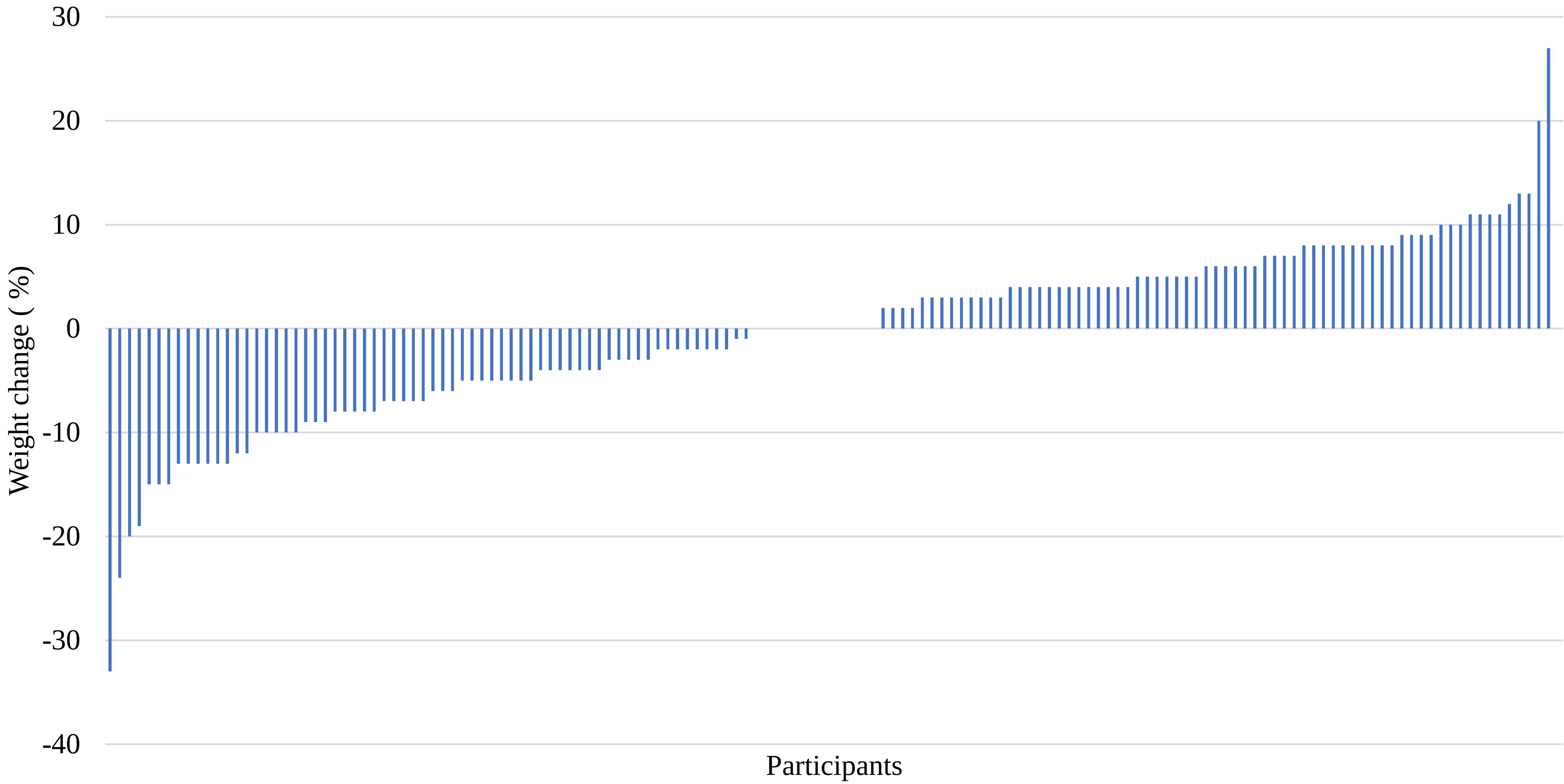
*Table 6.3:* Comparisons between participants that stopped (*n* = 42), continued (*n* = 66) or temporarily stopped (*n* = 51) their weight management attempt after the COVID-19 lockdown

| **Variable** | **Group** | ***M(SD)*** | ***F*** |
|---|---|---|---|
| **Energy intake change** | Stopped [a] | 13.36 (17.14) | 8.87** |
| | Continued [c] | -3.11 (13.64) | |
| | Temporary disruption [ad] | 9.37 (22.02) | |
| **Food amount** | Stopped [a] | 14.74 (21.67) | 6.51** |
| | Continued [c] | -2.31 (16.75) | |
| | Temporary disruption [ad] | 9.33 (23.97) | |
| **Snack amount** | Stopped [a] | 20.69 (24.81) | 6.74** |
| | Continued [c] | -0.88 (22.02) | |
| | Temporary disruption [bd] | 10.60 (28.53) | |
| **Meal change** | Stopped [a] | 4.64 (16.86) | 5.27** |
| | Continued [c] | -6.32 (16.32) | |
| | Temporary disruption [ad] | 6.66 (23.93) | |
| **Physical activity (PA) change** | Stopped [a] | -23.72 (23.94) | 12.21** |
| | Continued [c] | 4.68 (25.88) | |
| | Temporary disruption [ac] | -9.35 (22.41) | |
| **PA day per week** | Stopped [a] | -1.95 (1.87) | 18.16** |
| | Continued [c] | 1.79 (1.68) | |
| | Temporary disruption [ad] | -0.70 (2.28) | |
| **PA Time** | Stopped [a] | -25.64 (28.41) | 9.53** |

| Variable | Group | *M(SD)* | *F* |
|---|---|---|---|
| | Continued [c] | 5.83 (32.08) | |
| | Temporary disruption [ad] | -14.53 (33.29) | |
| **Structured PA** | Stopped [a] | -24.81 (30.51) | 10.87** |
| | Continued [c] | 11.03 (32.62) | |
| | Temporary disruption [bc] | -4.12 (33.23) | |
| **Incidental PA** | Stopped [a] | -20.71 (31.02) | 3.47* |
| | Continued [c] | -2.82 (27.42) | |
| | Temporary disruption [bd] | -9.39 (32.30) | |

*Note.* ** $p < .001$; * $p < .05$
[a] Significant difference compared to participants that continued their WMA ($p < .01$)
[b] Non-significant difference compared to participants that continued their WMA
[c] Significant difference compared to participants that stopped their WMA ($p < .01$)
[d] Non-significant difference compared to participants that stopped their WMA

Results from this study show that approximately 60% of the participants reported some disruption to their WMA. Participants reported a mean weight change of -0.4% (*SD:* 8.44; *M:* -0.8, *SD:* 7.59 kg). Approximately 40% of the participants managed to lose weight between pre-COVID-19 lockdown and post-lockdown (see Figure 6.2). This shows that there was large individual variability in self-regulation ability, with some participants more successful in self-regulating their behaviour during the lockdown than others.




*Note.* Negative values = weight loss; Positive values = weight gain

*Figure 6.2: Individual variability in reported weight change (%) between pre- and post-COVID-19 first lockdown*

### 6.3.4. Characteristics of individuals that stopped, continued or temporarily stopped their WMA.

Table 6.4 shows the characteristics of participants who continued, stopped and temporarily stopped their WMA in response to the lockdown. Participants that continued their WMA reported a significantly greater increase in physical activity and a significantly greater decrease in energy intake compared to participants that stopped their WMA. These changes in energy intake and physical activity were significantly correlated with reported percentage weight change (Table 6.5). Specifically, participants that continued their WMA reported losing weight and those that stopped their WMA reported weight gain (Table 6.4). When looking at individual differences, results showed that participants that continued their WMA reported significantly greater flexible restraint and craving control and significantly less uncontrolled eating and perceived stress compared to participants that stopped their WMA. There were no significant differences between participants that stopped or continued their WMA in terms of self-compassion or rigid restraint.

*Table 6.4:* Comparisons between participants that stopped ($n$ = 42), continued ($n$ = 66) or temporarily stopped (TD; $n$ = 51) their weight management attempt after the COVID-19 lockdown

| **Variable** | **Group** | ***M*(*SD*)** | ***F*** | **Cohen's *d*** |
|---|---|---|---|---|
| **Weight change%** | Stopped [a] | 5.55 (6.85) | 14.81** | 1.40 (S/C) |
| | Continued [c] | -4.76 (7.85) | | 0.74 (C/T) |
| | TD [ac] | 0.94 (7.52) | | 0.64 (S/T) |
| **Self-compassion** | Stopped | 2.68 (0.73) | 1.82 | |
| | Continued | 2.92 (0.99) | $p$ = .15 | |
| | TD | 2.55 (1.02) | | |
| **Rigid control** | Stopped | 39.61 (6.59) | 1.52 | |
| | Continued | 39.32 (8.48) | $p$ = .21 | |
| | TD | 40.36 (6.58) | | |
| **Flexible control** | Stopped [a] | 29.54 (5.92) | 3.36* | 0.47 (S/C) |
| | Continued [c] | 32.09 (4.92) | $p$ = .04 | 0.04 (C/T) |
| | TD [bd] | 31.92 (4.88) | | 0.44 (S/T) |
| **Uncontrolled eating** | Stopped [a] | 22.88 (5.26) | 5.85** | 0.58 (S/C) |
| | Continued [c] | 19.82 (5.25) | | 0.54 (C/T) |
| | TD [ad] | 22.92 (6.28) | | 0.01 (S/T) |
| **Perceived stress** | Stopped [a] | 34.95 (5.01) | 9.44** | 0.80 (S/C) |
| | Continued [c] | 30.54 (6.02) | | 0.67 (C/T) |
| | TD [ad] | 34.98 (7.25) | | 0.01 (S/T) |
| **Craving control** | Stopped [a] | 38.75 (25.92) | 4.75* | 0.56 (S/C) |
| | Continued [c] | 52.95 (24.46) | $p$ = .01 | 0.41 (C/T) |
| | TD [bd] | 43.12 (23.80) | | 0.18 (S/T) |
| **Energy intake change** | Stopped [a] | 13.36 (17.14) | 8.86** | 1.07 (S/C) |
| | Continued [c] | -3.11 (13.64) | | 0.70 (C/T) |
| | TD [ad] | 9.37 (22.02) | | 0.20 (S/T) |
| **Physical activity change** | Stopped [a] | -23.72 (23.94) | 12.21** | 1.14 (S/C) |
| | Continued [c] | 4.68 (25.88) | | 0.58 (C/T) |
| | TD [ac] | -9.35 (22.41) | | 0.62 (S/T) |

*Note.* ** $p < .001$; * $p < .05$
S = Stopped; C = continued; T/ TD = temporary disruption
[a] Significant difference compared to participants that continued their WMA ($p < .01$)
[b] Non-significant difference compared to participants that continued their WMA
[c] Significant difference compared to participants that stopped their WMA ($p < .01$)
[d] Non-significant difference compared to participants that stopped their WMA

### 6.3.5. Predictors of WMA continuation.

Multinomial logistic regression analysis was conducted to identify predictors of changes in WMA. The model included perceived stress, self-compassion, craving control, flexible/rigid control and uncontrolled eating as predictors of the odds of participants stopping, continuing or re-starting their WMA.

The final model was significant $p = .008$, and perceived stress ($p = .01$) and flexible control ($p = .04$) were identified as significant discriminants of whether participants stopped or continued their WMA. Participants scoring high in flexible restraint (B = .14, $SE = .06$, $p = .02$) and low in perceived stress (B = -.12, $SE = .05$, $p = .009$) were more likely to continue their WMA during the COVID-19 lockdown. Participants scoring high in flexible restraint (B = .12, $SE = .06$, $p = .04$) were more likely to restart their WMA after disruption during the COVID-19 lockdown.

Participants that continued their WMA were correctly predicted by the model 81.4% of the time. The model was less accurate at predicting participants that stopped (41.7%) or those that had temporary disruptions of their WMA (34.8%).

*Table 6.5:* Correlation Matrix between weight management practices and individual differences

| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
|---|---|---|---|---|---|---|---|---|
| **1. Weight Change%** | | | | | | | | |
| **2. Energy intake change** | .45** | | | | | | | |
| **3. Physical activity change** | -.20* | -.24** | | | | | | |
| **4. Craving control** | -.34** | -.40** | .11 | | | | | |
| **5. Rigid control** | -.13 | -.04 | .01 | -.10 | | | | |
| **6. Flexible control** | -.26** | -.15 | .04 | .14 | .62** | | | |
| **7. Uncontrolled eating** | .30** | .39** | -.09 | -.63** | .23** | -.09 | | |
| **8. Self-compassion** | -.16 | -.21** | .10 | .32** | -.25** | -.07 | -.37** | |
| **9. Perceived stress** | .22** | .24** | -.18* | -.47** | .30** | .10 | .45** | -.57** |

*Note.* **$p < .001$; *$p < .05$

### 6.3.6. Predictors of successful weight management during the COVID-19 lockdown.

WL percentage was interpreted as an indication of success in self-regulation of weight related behaviour. The average number of days that passed since the start of the lockdown until the data collection was 208 days (*SD* = 14.7). Given that the number of days since the lockdown varied between participants, this was added as a covariate in the regression model. Regression analysis was conducted to identify predictors of weight change (%) during the COVID-19 lockdown. The regression model included perceived stress, self-compassion, craving control, flexible/rigid eating restraint and uncontrolled eating as predictors and weight change as outcome. Socio-economic status and days passed since the start of lockdown were introduced as covariates in the model in Step 1 and the predictors were entered in Step 2 (Table 6.6). The final regression model explained approximately 23% of the variance in weight change (Adjusted $R^2 = .23$, $F(6,115) = 5.46$, $p < .001$). There was a significant negative association with flexible eating restraint ($\beta = -.24$, $p = .02$) meaning that participants with higher levels of flexible restraint reported greater WL. All other predictors and covariates were not significant (Table 6.6).

*Table 6.6*: Hierarchical linear regressions for individual characteristics regressed on weight change (%)

| **Outcome variable** | **B** | ***SE* B** | **β** |
|---|---|---|---|
| **Weight Change %** | | | |
| *Step 1* | | | |
| Constant | 6.50 | 12.21 | |
| SES | -.09 | .28 | -.03 |
| Days | -.03 | .06 | -.05 |
| *Step 2* | | | |
| Constant | 37.35 | 15.17 | |
| SES | -.35 | .26 | .002 |
| Days | -.09 | .05 | -.11 |
| Perceived stress | .10 | .14 | .08 |
| Self-compassion | -.36 | .92 | -.04 |
| Flexible restraint | -.43 | .18 | -.24* |
| Rigid restraint | -.20 | .13 | -.17 |
| Uncontrolled eating | .28 | .16 | .20 |
| Craving Control | -.08 | .04 | -.21 |

*Note.* SES = socioeconomic status and Days passed since the lockdown started were entered (enter method) as covariates in step 1, followed by all predictors in step 2 (hierarchical method).
For percentage weight change: $R^2$ =.003, $p$ = .83 for Step 1; $R^2$ = 28, $p$ < .001 for Step 2.
*$p$ < .05.
B = unstandardized coefficient; B *SE* = unstandardized coefficient standard error; β = standardised coefficient

### 6.3.7. Impact of WLM knowledge and beliefs on weight management practices during the first UK COVID-19 lockdown.

The previous section presented the impact of the COVID-19 lockdown on weight management practices and identified predictors of the changes in weight management focusing of individual differences in cognitive restraint, craving control, self-compassion and perceived stress. The next section focuses on the WLMKB scale in relation to the impact of COVID-19 on weight management practices. These analyses have two broad aims. First, to further test the predictive validity of the WLMKB scale by assessing its ability to predict changes in weight, physical activity and energy intake. Secondly, to test the convergent validity of the scale by assessing the correlations between the WLMKB scale and perceived dieting success and dietary restraint.

## Predictive Validity

To test the predictive validity of the WLMKB scale, correlational and regression analyses were conducted to investigate the associations between the WLMKB scale and WL, weight suppression, WMA continuation, and weight change in response to the COVID-19 lockdown. Correlation analyses results are presented in Table 6.7.

*Table 6.7:* Correlation matrix between the WLMKB scale and weight management and practices ($n$ = 170)

| | **Weight change (%)** | **Weight suppression** | **Weight loss** | **Physical activity** | **Energy intake** |
|---|---|---|---|---|---|
| **Knowledge** | -.13 | .20* | .12 | .09 | -.09 |
| **Food Choice** | -.12 | .10 | .01 | .09 | -.06 |
| **Energy Balance** | -.08 | .23** | .20* | .05 | -.09 |
| **Beliefs** | -.14 | .19* | .07 | .07 | -.12 |
| **Hunger** | -.07 | .22** | .26** | -.06 | -.08 |
| **CCB** | -.08 | .14 | .08 | .02 | -.05 |
| **Diet/Obesity** | -.06 | -.04 | -.19* | .11 | -.06 |

*Note.* *$p$ = .05; **$p$ = .01

It was first hypothesised that the WLMKB scale would predict weight change during the COVID-19 lockdown. Correlation analysis was conducted to identify the relationship between the WLMKB scale and weight change due to the COVID-19 lockdown. Correlation analysis with weight change during the lockdown was not significant (Table 6.7). To further investigate the relationship between the WLMKB scale and weight change and management, associations with WL and weight suppression were conducted. In this context, weight suppression refers to the amount of WL participants maintained (the difference between their highest reported weight and their current weight). Results showed that knowledge and beliefs were positively correlated with amount of weight suppression ($r$ = .20, $p$ = .016). These results suggest that higher levels of knowledge and beliefs are associated with higher weight suppression. When looking at the separate factors, only beliefs about hunger ($r$ = .22, $p$ = .008) and knowledge about energy balance ($r$ = .23, $p$ = .005) were significantly correlated to weight suppression. These results suggest that knowledge and beliefs about WLM are related to long-term weight outcomes.

Correlation analysis between knowledge and beliefs about WLM and WL showed that: beliefs about hunger were positively correlated $r = .26$, $p = .001$. Specifically, more accurate beliefs about hunger were associated with higher WL. Knowledge about energy balance and diet and obesity were negatively correlated ($r = -.19$, $p = .02$; $r = -.20$, $p = .018$). All the other factors were not significantly correlated with WL. This suggests that people with better knowledge about energy balance and diet/obesity gained more weight. But better knowledge about hunger was related to higher WL.

Given that correlation analysis shows that beliefs and knowledge about WLM were related to weight suppression, this relationship was further analysed to identify which factors significantly predicted weight suppression. This analysis was conducted to further test the predictive validity of the scale. Regression analysis showed that the subscales were not significant predictors but when individual factors were assessed, beliefs about hunger were the sole significant predictor of weight suppression $B = .85$, $t = 2.35$, $p = .02$, $R^2 = .10$, $F = 3.24$, $p = .008$.

Further analysis was conducted to see if WLM knowledge and beliefs were predictors of changes in physical activity and energy intake during the COVID-19 lockdown. Results showed that none were significant (Table 6.7). A possible explanation for this could be that participants were not actively trying to control these behaviours and having accurate knowledge and beliefs about what you need to do does not equal engagement in those behaviours. However, we argue that WLM knowledge and beliefs could have an indirect impact that is mediated by motivation to manage weight during the lockdown. To test this hypothesis, we conducted mediation analysis (Figure 6.3 and Figure 6.4).

A mediation analysis using the PROCESS macro in SPSS was conducted to test whether motivation mediated the effect of beliefs about WLM on weight change during the COVID-19 lockdown. Beliefs about WLM were entered as the independent variable along with motivation as the mediator variable. Weight change during the COVID-19 lockdown was the dependent variable.

The effect of beliefs on weight change, *B* = -0.42, *SE* = 0.18, *p* = .02, was reduced to non-significance when controlling for motivation, *B* = -0.16, *SE* = 0.16, *p* = .31. Using bootstrapping procedures, the indirect effect was found to be significant, *B* = -0.26, *SE* = -0.11, *CI* = -0.49 to -0.05. These results indicate that motivation mediated the effect of beliefs on weight change.

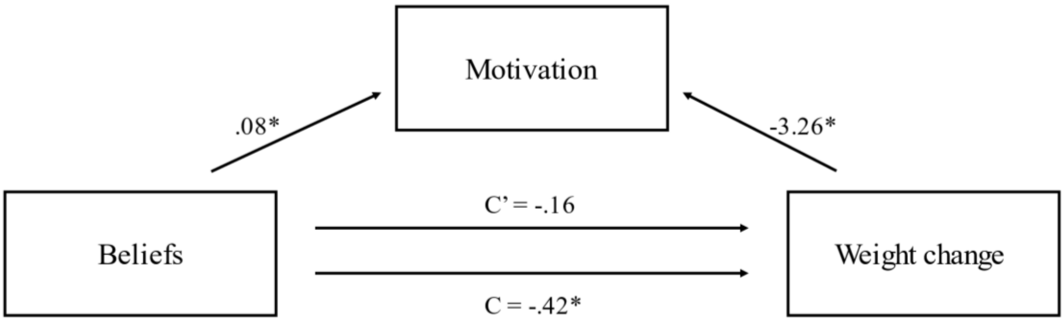



*Figure 6.3: Mediation model of the indirect effect of Beliefs on weight change mediated by Motivation*

A mediation analysis using the PROCESS macro in SPSS was conducted to test whether motivation mediated the effect of knowledge about WLM on weight change during the COVID-19 lockdown. Knowledge about WLM was entered as the independent variable along with motivation as the mediator variable. Weight change during the COVID-19 lockdown was the dependent variable.

The effect of knowledge on weight change, *B* = -0.75, *SE* = 0.36, *p* = .04, was reduced to non-significance when controlling for motivation, *B* = -0.42, *SE* = 0.31, *p* = .18. Using bootstrapping procedures, the indirect effect was found to be significant, *B* = -0.34, *SE* = 0.22, *CI* = -0.79 to -0.06. These findings therefore indicate that motivation mediated the effect of knowledge on weight change.

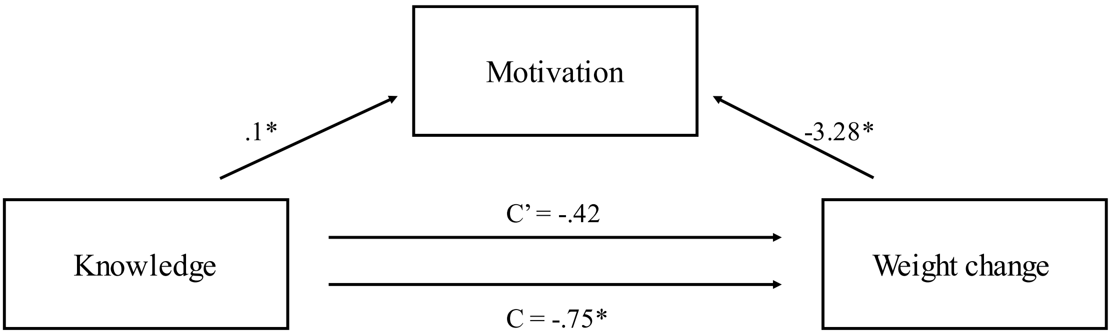



*Figure 6.4: Mediation model of the indirect effect of Knowledge on weight change mediated by Motivation*

It was further hypothesised that to show predictive validity the WLMKB scale is expected to predict WMA and dietary restraint. Specifically, individuals with more accurate knowledge and beliefs will also report continuing their WMA and higher dietary restraint.

**WLMKB and dietary restraint**

Correlation analysis showed that there was a significant correlation between knowledge and flexible restraint with knowledge about food choice being negatively correlated with flexible restraint ($r$ = -.20, $p$ = .01). This finding suggests that more accurate knowledge about food choice was associated with a less flexible approach to dieting. Knowledge about energy balance was not significantly correlated with flexible restraint ($r$ = .01, $p$ = .21). For the Beliefs scale, there was a positive correlation between flexible restraint and beliefs about hunger ($r$ = .18, $p$ = .02) and a negative correlation between diet/obesity beliefs and flexible restraint ($r$ = -.28, $p$ < .001). These results suggest that individuals with more accurate beliefs about hunger also report more flexibility in dieting. However, more accurate beliefs about dieting and obesity were related to lower flexibility in dieting. Calorie compensatory beliefs did not significantly correlate with flexible restraint ($r$ = .14, $p$ = .08).

Analysis of the relationship between the WLMKB and rigid dietary restraint showed that there were significant positive correlations with knowledge about energy balance ($r$ = .21, $p$ = .01), hunger ($r$ = .31, $p$ < .001) and diet/obesity beliefs ($r$ = -.47, $p$ < .001). There was a negative correlation between rigid restraint and food choice. Calorie compensatory beliefs did not significantly correlate with rigid restraint ($r$ = .11, $p$ = .17).

These results suggest that there was a relationship between knowledge and beliefs about WLM and cognitive restraint. However, the relationship was not either positive or negative, each factor showing to be separately related to dietary restraint. For example, better knowledge about energy balance was related to a more rigid approach to dietary restraint, while more accurate knowledge about food choice was associated with lower rigid restraint. This suggests that better knowledge about energy balance leads to more strict approach to dieting, while understanding better how food choice influences weight management leads to less rigidity in dietary restraint.

These results are in line with the hypothesis that WLMKB is related to restrained eating and provides evidence on the predictive validity of the scale. However, the associations were weaker than expected and the direction of the associations was not always as hypothesised.

**WLMKB and WMA during COVID-19**

To further test the predictive validity of the WLMKB scale, it was expected that the scale will predict WMA attempt continuation. One Way ANOVAs were conducted on the different factors of the WLMKB scale and results showed that the groups significantly differed in their knowledge about food choice and beliefs about calorie compensatory behaviours (CCB). Further t-test showed that participants that continued their WMA scored higher on the CCB scale.

Further, the WLMKB scale was added as a predictor in the regression model to predict changes in WMA. This was conducted to further test the predictive validity of the scale as well as investigate whether WLMKB have an influence on WMA when other individual factors are controlled for. The model without the WLMKB scale was presented in the previous section.

Multinomial logistic regression analysis was conducted to identify predictors of changes in WMA. The model included perceived stress, self-compassion, craving control, flexible/rigid control, uncontrolled eating, knowledge about food choice and energy balance, and beliefs about hunger, diet and obesity and calorie compensatory behaviours as predictors of the odds of participants stopping, continuing or re-starting their WMA.

The final model was significant $p = .01$, and perceived stress ($p = .015$) and CCB ($p = .017$) were identified as significant discriminants of whether participants stopped or continued their WMA. Participants scoring high on CCB (B = .23, $SE = .1$, $p = .02$) and low on perceived stress (B = -.13, $SE = .05$, $p = .01$) were more likely to continue their WMA during the COVID-19 lockdown. Participants scoring high on flexible restraint (B = .12, $SE = .06$, $p = .05$) were more likely to restart their WMA after disruption during the COVID-19 lockdown.

Participants that continued their WMA were correctly predicted by the model 81.4% of the time. The model was less accurate at predicting participants that stopped (41.7%) or those that had temporary disruptions of their WMA (37.0%).

Regression analysis on the model including the WLMKB scale, showed that the CCB factor of the scale significantly discriminated between participants that continued and those that stopped their WMA. Including the WLMKB scale to the initial model, influenced the predictive effect of flexible restraint, that became not significant.

**Convergent Validity**

As previously mentioned in Chapter 4:, to test the convergent validity of the WLMKB scale, The Perceived Self-Regulatory Success in Dieting Scale was used (Fishbach et al., 2003). It was argued that people with accurate knowledge and beliefs about WLM will perceive themselves to be more successful at managing their weight. Therefore, higher scores on the WLMKB scale should correlate with higher perceived self-regulatory success in dieting.

Correlation analysis was conducted separately on the factors of the WLMKB scale and perceived dieting success before and during the COVID-19 lockdown. Results showed that there was a positive correlation between perceived success and WLMKB. Success before the lockdown was positively associated with beliefs about diet and obesity ($r = .22$, $p < .01$), and was not significantly associated with any of the other factors. Perceived dietary success during the lockdown was positively associated with beliefs about calorie compensatory behaviours ($r = .21$, $p = .01$) and knowledge about food choice ($r = .21$, $p = .01$).

These findings replicate the results from Study 2 and suggest that there is a positive and significant correlation between perceived dietary success and knowledge and beliefs about WLM. The most significant factors being beliefs about diet and obesity, and calorie compensatory behaviours, and knowledge about food choice.

### 6.3.8. Unplanned exploratory analysis

According to self-regulation theory, self-compassion plays an important role in self-regulation of health behaviour by supporting the emotional regulation of increased stress and temporary lapses (Thøgersen-Ntoumani et al., 2020). Current results show that self-compassion was not a significant predictor of weight change. However, perceived stress was associated with disruptions in WMA. Current research on self-compassion and dietary lapses found that although self-compassion was not a significant predictor of WL, it was indirectly associated. Negative emotions were a mediator between the association of self-compassion and health behaviour regulation (Thøgersen-Ntoumani et al., 2020). As such a mediation model was proposed whereby self-compassion was expected to have an indirect effect on weight change, mediated by its effect on perceived stress.

A mediation analysis using the PROCESS macro in SPSS was conducted to test whether perceived stress mediated the effect of self-compassion on weight change during the COVID-19 lockdown. Self-compassion was entered as the independent variable along with perceived stress as the mediator variable. Weight change during the COVID-19 lockdown was the dependent variable.

The effect of self-compassion on weight change, $B$ = -1.54, $SE$ = 0.76, $p$ = .04, was reduced to non-significance when controlling for perceived stress, $B$ = -0.50, $SE$ = 0.94, $p$ = .59. Using bootstrapping procedures, the indirect effect was found to be significant, $B$ = -1.04, $SE$ = 0.47, $CI$ = -2.03 to -0.19. These findings indicate that perceived stress mediated the effect of self-compassion on weight change.

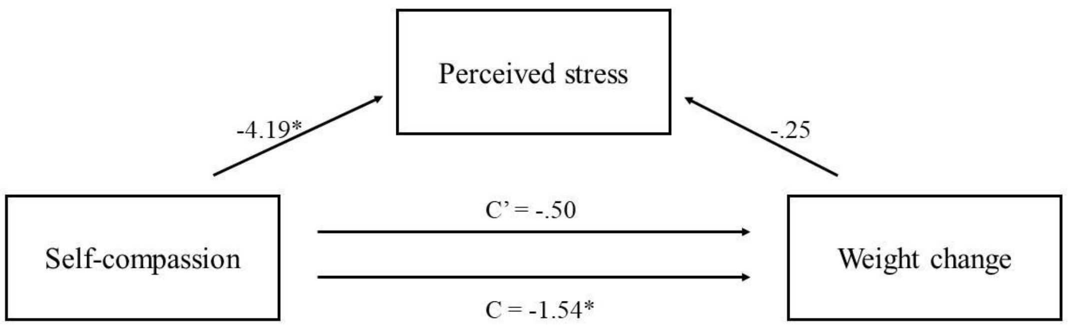



*Figure 6.5: Mediation model of the indirect effect of self-compassion on weight change mediated by perceived stress*

## 6.4. Discussion

The current study had three aims. First, it aimed to identify the impact of the first UK COVID-19 lockdown on weight management attempts and practices. Second, the relationship between WLM knowledge and beliefs and the impact of the COVID-19 lockdown was investigated. Finally, the convergent and predictive validity of the WLMKB scale was further investigated. Results for each of these aims will be summarised below. These findings will then be discussed in turn.

**Summary of results**

The impact of the COVID-19 lockdown on weight management practices

A self-regulation theoretical framework was used to explain why individuals' WMA and ability to self-regulate health behaviours may have been under threat during the lockdown. The focus was on individuals that were trying to manage their weight before the lockdown started and assessed changes in WMA and practices. This is noteworthy because extant research is mainly derived from individuals not actively trying to manage their weight.

Results showed that most participants (56%) reported disruption to their WMA due to the COVID-19 lockdown (either stopping or stopping temporarily and starting again). Individuals that stopped their WMA reported a decrease in physical activity and an increase in energy intake, that corresponded with an increase in weight. Individuals that continued their WMA scored higher in flexible restraint and craving control and lower in uncontrolled eating and perceived stress compared to those who disengaged from their WMA. Flexible restraint and perceived stress were significant predictors of WMA continuation and flexible restraint was also a significant predictor of percentage weight change during the COVID-19 lockdown. Results showed that self-compassion did not have a significant direct effect on weight change, but further exploratory analysis showed that perceived stress mediated the relationship between self-compassion and weight change.

WLM knowledge and beliefs, and the impact of COVID-19 on weight management practices

Additionally, the WLMKB scale was used to investigate the relationship between knowledge and beliefs about WLM and the impact of the COVID-19 lockdown on weight management. Results showed that knowledge and beliefs predicted WMA continuation. Suggesting that participants with more accurate knowledge and beliefs were more likely to continue their WMA during the COVID-19 lockdown. While the WLMKB scale was not related to weight change during the lockdown, there was a significant indirect effect of knowledge and beliefs on weight change that was mediated by motivation to manage weight. These results provide evidence for the predictive validity of the WLMKB scale by assessing the relationship between the WLMKB scale and successful weight management during COVID-19. Furthermore, this research provides novel evidence of the importance of WLM knowledge and beliefs in weight management success. Whilst the actual effect of these was not assessed in this study, future research should further investigate this hypothesis.

**Implications**

Reported disruptions to WMA are in line with previous research from commercial weight management programmes (EASO, 2020), and people living with obesity (Brown et al., 2021) and show that the COVID-19 lockdown had a negative impact on about half of the individuals that were attempting to manage their weight. Disruptions to WMA coincided with reported changes in energy intake, physical activity and specific weight management strategies (e.g. stimulus control, self-monitoring). The current results are in line with previous research conducted on the impact of COVID-19 lockdown on health behaviours (Ammar et al., 2020; Buckland et al., 2021), and extend current knowledge by providing further evidence on changes in specific weight management strategies as well as on disruptions to WMA in individuals from the general population that were not part of a commercial weight management programme. This evidence indicates that the COVID-19 lockdown was detrimental to WMA and resulted in weight gain for some individuals.

However, the current study also showed that responses to the COVID-19 lockdown varied largely across individuals, with some individuals reporting continued WMA and WL. Continued engagement in self-regulation of health behaviour is impaired by various factors and given that not all participants were affected by the lockdown, there are possible individual differences in certain characteristics that support individuals to continue their self-regulation attempts. Comparisons between participants that continued their WMA and those that stopped showed that participants that continued their WMA reported greater flexible restraint, calorie compensatory behaviours, knowledge about food choice and craving control and less uncontrolled eating and perceived stress compared to those who stopped their WMA. Participants that gained weight reported higher levels of perceived stress and uncontrolled eating. In line with a self-regulation framework, results showed that perceived stress impacted individuals’ ability to self-regulate their weight management behaviours. Lower levels of perceived stress were a significant predictor of continuation of WMA. This is in line with self-regulation theory stating that negative affect is a barrier to self-regulation (Wagner & Heatherton, 2014). The mechanisms through which stress is affecting self-regulation include depleting cognitive resources (Hofmann et al., 2007), increasing emotional eating (Macht, 2008) and increasing preferences for immediate rewards over larger delayed ones (Tice & Bratslavsky, 2000).

Another significant predictor of continuation of WMA was flexible restraint, with participants with higher scores in flexible restraint being more likely to continue or restart their WMA attempt during the COVID-19 lockdown. Additionally, flexible restraint appeared to be an important predictor of WL (reflecting success in self-regulation of weight). This is in line with previous research on eating restraint and weight management that suggests a positive relationship between flexible restraint and success in weight management and negative relationship to psychological distress (Sairanen et al., 2014). Flexible restraint has been previously linked to better weight management, and lower levels of eating disorders (Westenhoefer et al., 2013). A possible explanation of the role flexible restraint plays in weight management is that a more flexible control over eating behaviour corresponds with a more accepting response to lapses, that allows for planning cravings and lapses in the weight management plan. For example, initiating compensatory behaviours in response to lapses rather than generating negative emotions that can lead to disengagement from the WMA. Previous research showed the importance of flexible restraint on weight management success (Teixeira et al., 2010), but the current findings provide novel evidence that show flexible restraint is important for engagement in WMA attempts, especially during challenging times such as COVID-19.

Beliefs about calorie compensatory behaviours were also a significant predictor of WMA continuation. This result suggests that beliefs have an influence on behaviour and is in line with self-regulation theory and research (Dryer & Ware, 2014; Ng et al., 2012). Calorie compensatory beliefs have been previously linked to disordered eating and difficulties in weight management (O’Brien et al., 2018). However, the current results provide evidence for the alternative hypothesis differentiating between calorie compensatory beliefs and behaviours, with the latter being beneficial for weight management (Hartmann et al., 2016).

An interesting result was that when the WLMKB factors were entered in the prediction analysis, flexible restraint was not a significant predictor of WMA while beliefs about calorie compensatory behaviours were significant. These results imply some form of overlap between the two concepts, however the two were not significantly correlated. It can be argued that theoretically the two factors tap into the same concept of compensatory behaviour, but the flexible restraint scale measures engagement in the behaviour (Westenhoefer et al., 1999), whilst the WLMKB scale measures the belief in the effectiveness of that behaviour for weight management. Alternatively, this overlap could be explained by the fact that theoretically flexible restraint is defined as a more flexible approach to weight management and therefore might require the use of calorie compensatory behaviours (Sairanen et al., 2014). However, there currently is no evidence on the relationship between flexible restraint and knowledge and beliefs. The current research provides initial evidence of an association that needs to further be explored.

Previous research showed evidence of the role of self-compassion on weight management (Thøgersen-Ntoumani et al., 2020). Furthermore, according to theory, self-compassion is a quality that helps with self-regulation of health behaviour during challenging times because it promotes a healthy emotion regulation (Sirois et al., 2015). However, in the current research, contrary to expectations, self-compassion was not a significant predictor of continuation of WMA or weight change during the COVID-19 lockdown. However, exploratory analysis showed that self-compassion has an indirect effect on weight change through its effect on perceived stress. These results suggest that a more compassionate attitude towards oneself can be beneficial to weight management under lockdown conditions, by its influence on the ability to deal with negative emotions such as stress.

The current research provides initial evidence of the importance of WLM knowledge and beliefs in weight management. It further identified individual differences and predictors of disruptions to WMA and weight management success. These results provide evidence of the importance of psychological factors and individual differences in understanding weight management behaviour. Therefore, further research should be conducted to understand predictors of disruptions to weight management as small lapses in WMA lead to weight gain that could further result in permanent substantial weight gain over time (Schoeller, 2014).

The current research provided further evidence of the validity of the WLMKB scale. First, as previously presented, the WLMKB scale was a significant predictor of continuation of WMA during the COVID-19 lockdown. Furthermore, the WLMKB also had an indirect effect on weight change that was mediated by motivation. These results provide evidence of the predictive validity of the WLMKB scale, as it shows the ability to predict theoretically related behaviours (Robinson et al., 2018). These results are in line with previous evidence that the relationship between knowledge and behaviour is weak (Spronk et al., 2014) and shows that this could be explained by the mediating effect of motivation (Rabiau et al., 2006).

Furthermore, the study aimed test the convergent validity of the WLMKB scale. Results provide evidence that the scale has convergent validity by being positively correlated with perceived self-regulatory success in dieting. These results suggest that participants with more accurate knowledge and beliefs about WLM are also more confident in their ability to manage their weight. These results are similar to previous evidence on the relationship between the WLMKB scale and PSRS (Chapter 4). However, this current study provides additional evidence on the convergent validity of the WLMKB scale on a sample of individuals engaged in a weight management attempt at the beginning of the COVID-19 lockdown. Furthermore, as the PSRS scale is used as an alternative measure of dieting success (Meule et al., 2012), these results also suggest the WLMKB scale might be related to actual dieting success. As this relationship was not assessed in the current study, further research should be conducted to test this hypothesis.

Additionally, there were high significant correlation between rigid restraint and the factors measured by the WLMKB scale. Specifically, more accurate knowledge about energy balance and beliefs about hunger were associated with higher rigid restraint. This suggests that more accurate knowledge and beliefs could lead to a more rigid approach to dieting. However, results further showed that more accurate beliefs about diet and obesity and better knowledge about food choice were associated with lower rigid restraint. These results suggest that there are different dynamics between the factors related to WLM and dietary restraint, some of these promoting more rigid approaches (energy balance) or more flexible ones (food choice, diet and obesity). To date there is no evidence on the relationship between dietary restraint and accuracy of knowledge and beliefs. Therefore, these results provide initial evidence of this relationship. However, further research is necessary to better understand this relationship.

There are some limitations to this research. First, the data was collected retrospectively, whereby participants were required to recall their behaviour before the lockdown and compare it to their behaviour during the first lockdown. To minimise the influence of this, time passed since the lockdown to the study time, was accounted for in the analysis. Second, data collected is cross-sectional and self-reported. Research shows that individuals tend to underestimate dietary intake (Dahle et al., 2021) and overestimate physical activity (Silsbury, Goldsmith, & Rushton, 2015), and there is no information on how often or well the weight management strategies measured were used. However, associations between reported energy intake and physical activity and weight change (Table 6.5) indicate that the measures used were sensitive to detect variability in responses as they aligned with expected associations (e.g. individuals that reported increased energy intake also reported gaining weight during the lockdown $r$ = .45), suggesting validity in the measures used. Third, participants in the sample were mostly white with a higher educational level. IMD decile was on average 5.8 (*SD* = 2.86). IMD decile was used as an indication of SES because previous research showed that it positively correlated with nutrition knowledge (Mikhail et al., 2020).

Finally, no pre-COVID-19 data were collected, therefore we have no baseline data to compare the current results to. An alternative explanation to the current results could be that participants responded to the weight management questions on physical activity, energy intake, weight management strategies and WMA based on the way their weight changed.

The current study used a theoretical framework to identify predictors of continuation of WMA and weight change in the context of a viral pandemic. Novel data is therefore produced that brings evidence of important individual characteristics for the self-regulation of weight related behaviours during challenging times. While some studies have reported on the individual characteristics of increased food intake during COVID-19 (Buckland et al., 2021; Robert et al., 2022), to our knowledge this is the first study to report on the individual characteristics associated with successful weight management during COVID-19 in adults who were engaged in a WMA at the onset of the first COVID-19 lockdown. Additionally, the current study was conducted with a sample of the general population that was actively trying to manage their weight prior to the COVID-19 lockdown. This is noteworthy because extant research is mainly derived from individuals not actively trying to manage their weight. Furthermore, the limited extant data is from participants in structured weight management programmes (e.g. commercial or local authority commissioned) rather than self-led WMA, yet most people who attempt weight managements adopt self-led approaches (Santos et al., 2017). The current research is important because it expands knowledge on the impact of COVID-19 lockdown on individuals following a self-led WMA.

This research also provides novel evidence on the importance of emotion regulation and a more flexible approach to eating behaviour for weight change in the context of major disruptions to everyday life (COVID-19 lockdown). Emotional regulation and a flexible approach to eating are changeable individual characteristics that can be developed (Deschasaux-Tanguy et al., 2020; Rahimi-Ardabili et al., 2018; Sairanen et al., 2014).

Additionally, individuals scoring low in flexible eating can be targeted and provided with more support during risky time periods such as viral lockdowns. Because there is evidence that self-compassion interventions are effective for improving the self-regulation of health behaviours (Biber & Ellis, 2019) future research could also investigate the effects of promoting self-compassion for weight management in individuals susceptible to weight management lapses during stressful times such as viral lockdowns.

**Conclusions**

COVID-19 was a challenging time for individuals attempting to manage their weight. Results showed that 56% of participants reported disruptions to their weight management attempts during the COVID-19 lockdown. The negative impact was not consistent for everyone; a more flexible approach to eating, more accurate beliefs about calorie compensatory behaviours, and a higher level of self-compassion supported individuals to continue their WMA and lose weight. This study provides novel findings on the impact of the COVID-19 lockdown on weight management attempts, by using self-regulation theory to identify modifiable individual characteristics that predict continuation and success of WMA in times of added stress.

Overall, the current results indicate that perceived stress and flexible control of eating behaviour are significant predictors of engagement and success in self-regulation of weight during the COVID-19 lockdown. These results have important implications for the development of future interventions for weight management. Interventions should focus on harnessing at-risk individuals' self-compassion in response to weight management lapses and external stressors and provide strategies to increase flexibility in eating behaviour.

Furthermore, participants with more accurate beliefs about calorie compensatory behaviours and lower perceived stress were more likely to continue their WMA. Knowledge and beliefs also had an indirect effect on weight change that was mediated by motivation.

These results suggest that knowledge and beliefs about WLM have an impact on weight management attempts. Furthermore, this study provides evidence on the predictive and convergent validity of the WLMKB scale. Further research should focus on investigating the role of knowledge and beliefs and weight management practices, and the WLMKB scale will be a useful tool for this purpose.

# Chapter 7: General discussion

## 7.1. Introduction

The research presented in this thesis had three primary aims. First, to provide a comprehensive literature review on the importance, factors influencing, and difficulties in achieving long-term WLM, as well as exploring the different theories and models to explain WLM. Secondly, to explore the relationship between WLM knowledge and beliefs and WLM success. Finally, given that a WLM knowledge and beliefs scale will likely have valuable implications, but there are no existing validated measures to assess WLM knowledge and beliefs, a new scale was developed and validated.

To achieve these aims, a literature review was conducted to explore the existing knowledge and research on WLM (Chapter 2:). This literature review was the basis for developing a novel scale to measure the accuracy of knowledge and beliefs about WLM related factors (Chapter 3:). Four empirical studies were then conducted to test the reliability and validity of the WLMKB scale (Chapters 3, Chapter 4: and Chapter 5:) and explore the relationship between knowledge and beliefs and WLM success (Chapters 5 and Chapter 6:). The present chapter discusses the findings of these studies in relation to theories and research on WLM. The scale development and validation of the WLMKB scale are also discussed. Finally, possible uses for the WLMKB scale will be presented, as well as implications and conclusions of the findings in light of the strengths and limitations of the research conducted.

## 7.2. Importance of knowledge and beliefs for Weight loss maintenance

WLM is the primary evidence of successful weight management interventions to tackle obesity (Lawlor, Islam, et al., 2020). Issues with the rise in obesity levels and associated health risks were presented in Chapter 2: and made a case for the importance of weight management and specifically WLM research and interventions (Grief & Miranda, 2010; Santos et al., 2017; Stubbs et al., 2011; Wing & Phelan, 2005).

Additionally, the current thesis argued on the importance of knowledge and beliefs in WLM. First, the literature review (Chapter 2:) showed the importance of long-term adherence to weight management strategies for WLM by presenting the underlying processes that influence weight change focusing on physiological and psychological factors related to weight management (Varkevisser et al., 2018). Further, psychological predictors of WLM were explored to better understand the difference between WL and WLM and the barriers added in the WLM period (Evans et al., 2018; MacLean et al., 2015; Sainsbury et al., 2017). The literature review showed that most barriers for long-term weight management are related both to the difficulty of adhering to health behaviours in the long term (MacLean et al., 2015), as well as added physiological adaptations after WL that increase appetite and decrease energy expenditure (Müller et al., 2016). Given these two barriers, health behaviour theories, empirical evidence, and WLM theories were explored to identify predictors and strategies for better adherence to weight management strategies. Based on these theories, a case was made for the importance of knowledge and beliefs in WLM (Chapters 2 and Chapter 3:). Specifically, the necessity of knowledge regarding the relationship between behaviour and weight management (Brantley et al., 2014; Klohe-Lehman et al., 2006; Poelman et al., 2018) and beliefs regarding the effectiveness of these strategies (Miquelon et al., 2012; Ng et al., 2012) and the capacity to regulate one's own weight (Stapleton, 2015; Stotland & Ztiroff, 1990).

It was hypothesised therefore that knowledge and beliefs about WLM related factors are important for weight management success. However, a review of the existing scales relevant to WLM (Chapter 3:) showed that there were no validated scales to assess knowledge and beliefs about WLM. Therefore, to be able to research the impact of knowledge and beliefs on WLM, a new scale was developed and validated.

## 7.3. Scale development

The current research aimed to identify behavioural strategies and individual characteristics that impact WLM. The main research question was whether knowledge and beliefs about WLM related factors impact WLM success and engagement in weight-related health behaviours. Given that to date there are no measures that focus on knowledge and beliefs about WLM, a novel scale was developed and validated. The eight-step methodology (Trakman et al., 2018) was followed to develop and test the scale (see Chapter 3). The initial item pool of 51 items was generated based on current research, theory, or were adapted from other existing scales (Hankey et al., 2004). The items were then reviewed by the research team and the resulting 40 item scale was then tested on general population sample in Study 1 (Chapter 3:).

The first study of this research project (Chapter 3) used the ‘think aloud’ method (Fonteyn, Kuipers, & Grobe, 1993) to test the understanding and interpretation of the items of the scale in a sample from the general population. The ‘think aloud’ method is recognised as a useful tool as it helps make sure that participants understand the items and interpret them in the same way as they were intended (Eccles & Arsal, 2017). Furthermore, several existing scales were criticised for not considering such issues in the development process (Fonteyn et al., 1993). This method is now more widely used (Gadermann et al., 2011; Gardner & Tang, 2014; Hartmann-Boyce et al., 2016; Kaklamanou, Armitage, & Jones, 2013) and is a method recommended in guidelines for scale development and testing (Trakman et al., 2017). Based on Study 1's findings, several items were reworded and instructions for participants were changed to focus on WLM. Apart from specific issues with the items, more general issues regarding participants' way of answering questionnaire items were identified.

The second study (Chapter 4:) analysed the factor structure of the WLMKB scale and used 'known group' comparisons (Davidson, 2014) to test the construct validity of the scale (Trakman et al., 2017). The WLMKB scale was developed to comprise two separate subscales: the knowledge (KS) and beliefs (BS) subscales. Factor structure analysis showed that each of these subscales is multidimensional. The KS measures two factors. The first factor, food choice, assesses knowledge about the relationship between food and WLM. The second factor, energy balance, measures knowledge about the energy in/energy out model of weight management, and that energy balance is required for WLM. The BS measures three factors: (i) hunger: beliefs about what hunger is and what response it entails; (ii) calorie compensatory behaviours: beliefs about the effectiveness of compensatory behaviours in response to lapses or over-eating episodes; (iii) diet/obesity: beliefs about causes of obesity, and misconceptions about diet strategies. Reliability analysis showed that the two subscales, as well as the separate factors, had good internal consistency ($\alpha > .7$, Kline, 2000). Therefore, the WLMKB scale can be used either by computing total scores on the subscales or separate scores on each factor.

In Study 2, Known-group comparisons (Davidson, 2014) were conducted to test the construct validity of the WLMKB scale. Two groups of nutrition and non-nutrition students were recruited. Nutrition students scored significantly higher on the KS compared to non-nutrition students. However, there were no significant differences between the two groups on the BS. These results provide evidence of the construct validity of the scale. The lack of differences in beliefs, suggest that the two concepts of knowledge and beliefs are different, and that acquiring knowledge on a topic does not necessarily translate into beliefs or behaviour. These results are in line with the COM-B model of behaviour change and maintenance (West & Michie, 2020). The COM-B model of behaviour provides evidence on the necessity of knowledge and beliefs for a certain behaviour to happen. According to this model, there are three main components that drive behaviour: capability, motivation and opportunity (Michie, Stralen, & West, 2011). Capability refers to an individual's physical and psychological capability to facilitate behaviour and these involve psychological factors such as understanding and memory (knowledge) and physical capability such as balance and dexterity. Motivation refers to mental processes that drive and direct behaviour (beliefs and attitudes). These refer to reflective processes (conscious plans) as well as automatic processes (desires, habits). The current results are in line with this theory by bringing evidence of the difference between knowledge and beliefs. Furthermore, the COM-B theory argues on the importance of knowledge and beliefs, not them independently but rather together with other factors such as physical capability and automatic processes.

The first two studies of the thesis focused on the development of the WLMKB scale and provided evidence of the reliability and construct validity of the scale. Item analysis and factor structure were assessed. The following studies focused on testing the validity of the WLMKB scale and testing the scales' relationship to weight management behaviour and success as well as other theoretically related and unrelated factors.

## 7.4. Scale validation

Evidence of the face validity of the WLMKB scale was threefold. First, the items of the scale were reviewed by the research team for appropriateness in measuring the intended concept (Chapter 3:). Secondly, the think-aloud method was used and allowed for the assessment of the understanding and interpretation of the items (Study 1, Chapter 3). Finally, in the second study participants were asked to state the aim of the scale and results showed that most participants correctly guessed the aim of the scale as being related to weight management, knowledge, and beliefs (Chapter 4). An overview of the validation process is presented in Table 7.1.

*Table 7.1:* Overview of the validation process for the WLMKB scale

| Type of validity | Testing | Measure | Measure description | Study |
|---|---|---|---|---|
| **Face Validity**<br>- the scale seems to be measuring what it claims to be measuring | -The WLMKB scale will demonstrate face validity if participants can guess that the scale measures factors related to weight management. | - Open ended question<br>"What do you think this scale is trying to measure?" | Face validity was assessed by asking participants what they think the scale was trying to measure. | Study 2: Content analysis<br>Chapter 3 |
| **Predictive Validity**<br>- A test has predictive validity if it will predict some criterion | - To show predictive validity the scale should be able to correctly predict WL maintainers. | - reported WLM<br>- engagement in weight management strategies, physical activity | Participants will self-report their maximum, minimum and current weight. They will then be classified as WL maintainers or weight regainers. | Study 3,<br>Study 4: Regression<br>Chapter 6 |
| | - People with better WLM knowledge and beliefs will report higher engagement in weight management strategies such as dietary restraint. | - The Three-factor eating questionnaire (Stunkard & Messick, 1985) | It is a self-report measure, designed to assess three factors of eating: cognitive restraint, disinhibition and hunger. The cognitive restraint subscale was then divided into flexible and rigid control strategies of dietary restraint (Westenhoefer, 1991) and additional items were added to increase internal consistency (Westenhoefer et al., 1999). | Study 4: flexible/rigid dietary restraint<br>Chapter 6 |
| **Construct validity**<br>– if the scale has the ability to measure a construct by means of the items. | - As the scale measures knowledge and beliefs about WLM, people that have studied nutrition and nutrition related modules, should score higher on | - 'Know groups' comparisons | The scale was administered to two groups differing in nutrition knowledge: nutrition students and non-nutrition students. | Study 2: known group comparisons<br>Chapter 2 |

| Type of validity | Testing | Measure | Measure description | Study |
|---|---|---|---|---|
| | the scale compared to people with no such studies | | | |
| **Convergent validity**<br>- For a test to show convergent validity it should correlate with measures of related constructs | - People with accurate knowledge and beliefs about WLM will perceive themselves to be more successful at managing their weight.<br>-People with more accurate beliefs will also have a more internal locus of control in dieting.<br>-People with more accurate knowledge about WLM will also have better nutrition knowledge. | - Perceived Self-Regulatory Success in Dieting Scale (PSRS) (Meule, Papies, & Kübler, 2012) | Measure of individual perceived success in dieting. High scored on this scale were related to dieting success. | Study 2, 3 and Study 4: correlation analysis<br>Chapters 4, 5 and 6<br>($r \geq .30$) |
| | | - Dieting Beliefs Scale (DBS) (Stotland & Zuroff, 1990) | This instrument distinguishes more internal from more external locus of control. | |
| | | - Practical Knowledge About Meal Calories (PKM-11), (Mötteli, Barbey, Keller, Bucher, & Siegrist, 2017) | Brief measure of basic nutrition knowledge focusing on the energy content of meals. | |
| **Discriminant validity**<br>- For a scale to demonstrate discriminant validity it should not correlate with constructs that are not supposed to be related to according to theory | - Food fussiness and Intrinsic regulation of exercise are factors related to eating behaviour and exercise but not WLMKB.<br>The main reason for this being that beliefs and knowledge do not influence people's direct experience with food (cravings, hedonic hunger). | The Adult Eating Behaviour Questionnaire; AEBQ); Hunot et al., 2016) | Food fussiness subscale: Food fussiness was described as the tendency to be more selective in foods eaten (Smith et al., 2017). | Study 3: Correlation analysis<br>Chapter 5<br>($r < .20$) |
| | | Behavioural Regulation in Exercise Questionnaire (BREQ-3) (Markland & Tobin, 2004; Wilson et al. 2006) | Intrinsic regulation of exercise subscale: measure of motivation to regulate exercise behaviour. | |
| **Test-retest reliability**<br>-assessment of stability of measure in time | To demonstrate test re-test reliability the scores of the same participant should remain the same at a subsequent testing | Test re-test | Administer the scale twice to the same participants after a significant period of time has passed. | Study 3<br>Chapter 5<br>($r \geq .80$) |

Convergent validity of the WLMKB scale was tested against various measures in Studies 2, 3 and 4 (Chapters 4, 5 & 6). Associations between the PSRS and WLMKB were assessed both in a sample of students (Study 2, Chapter 4) and in individuals engaged in a weight management attempt at the beginning of the COVID-19 lockdown (Study 4, Chapter 6). Results showed a positive correlation between WLM knowledge and beliefs and perceived dieting success in both samples. These findings suggest that participants with more accurate knowledge and beliefs about WLM perceive themselves as more successful in managing their weight. This is in line with the proposed hypothesis and provides evidence of the convergent validity of the WLMKB scale. Furthermore, as perceived self-regulatory success was previously linked to weight management (Teixeira et al., 2005) and was an indicator of successful weight management (Nguyen & Polivy, 2014), the current results suggest that knowledge and beliefs might also be related to successful weight management.

In Study 3, the convergent validity of the WLMKB scale was further tested by assessing the associations of the scale with measures of theoretically similar concepts, nutrition knowledge for the KS and dieting beliefs for the BS. Results were in line with the hypothesis and provided evidence of the convergent validity of the scale. Specifically, the KS was positively correlated with the PKM-11 (Mötteli et al., 2017). This suggests that participants with better knowledge about WLM also had better knowledge about the calorie content of meals. However, the association was lower than expected ($r < .3$) (Robinson, 2018). This lower correlation could be explained by the difference in the concepts the two scales assess. The PKM-11 is a measure of knowledge about the calorie content of meals that is an indicator of more practical nutrition knowledge (Mötteli et al., 2017). Comparatively, the KS scale is a multi-dimensional scale focusing on food choice and energy balance, and scores on this scale are an indicator of understanding the relationship between these factors and WLM rather than nutrition knowledge only.

As hypothesised, the BS was associated with scores on the Dieting Beliefs scale (Stotland & Ztiroff, 1990), suggesting that participants with more accurate beliefs about WLM also have a more internal locus of control in dieting. This provides further evidence of the convergent validity of the WLMKB scale. This association was expected because the items of the BS scale (Chapter 4:) tap into individuals' beliefs in their ability to control their own weight as well as their beliefs in external or uncontrollable factors influencing weight (Chapter 5:). Furthermore, this association is in line with previous research showing that a more internal locus of control in dieting is associated with less irrational food beliefs (Osberg et al., 2008).

Furthermore, evidence showed that the two subscales of the WLMKB scale measure different aspects of WLM. Therefore, very low or no correlations between KS and dieting beliefs, and BS and PKM-11, provided evidence of the divergent validity of the WLMKB scale. This is in line with research showing that knowledge and beliefs affect behaviour in different ways (West & Michie, 2020).

Study 3 of this thesis also provided evidence of the discriminant validity of the WLMKB scale, by testing the associations with scales measuring factors related to weight management and eating behaviour but not with knowledge and beliefs. First, there were no significant correlations between the WLMKB scale and a measure of food fussiness (Hunot et al., 2016). This is in line with the theory that suggests that food fussiness is the direct response to food qualities such as texture and not to other individual characteristics such as dietary restraint or dieting beliefs (Hunot et al., 2016; Smith et al., 2017).

However, the BS scale did correlate with the measure of intrinsic regulation of exercise (Markland & Tobin, 2004; Wilson et al. 2006). More accurate beliefs about WLM were related to a more intrinsic regulation of exercise. A possible explanation for this association could be that more accurate beliefs about WLM include beliefs on the importance of exercise for weight management (Santos et al., 2017). These in turn could lead to more intrinsic motivation for exercise (Teixeira et al., 2012). This explanation is in line with the SDT (Carraça et al., 2019; Ng et al., 2012) and theory on physical activity adherence and intrinsic motivation (Teixeira et al., 2012).

Study 4 (Chapter 6) and Study 3 (Chapter 5) provided evidence of the predictive validity of the WLMKB scale. Predictive validity of the scale was tested against indicators of weight management such as: weight change, WLM, engagement in weight management strategies, and eating restraint.

Study 3 tested the predictive validity of the WLMKB scale on a sample of WL maintainers and weight regainers using a longitudinal design. In this study weight change was calculated as the change in weight from baseline to follow-up (after four weeks). Study 4 used a cross-sectional design in a sample of individuals that were attempting to manage their weight before the first COVID-19 lockdown and was based on retrospective reports of weight change from before the lockdown to after the lockdown. Results showed no relationship between the WLMKB scale and weight change in either of the two studies. These results suggest that the WLMKB scale is not a good predictor of short-term self-reported weight change. There are multiple possible explanations why this was the case. First, the WLMKB scale is a measure focused on factors related to WLM as opposed to WL. In line with evidence on the difference between the two processes, WL and WLM (MacLean et al., 2015; Sainsbury et al., 2017), different strategies are necessary for success in one compared to the other (Varkevisser et al., 2018). Therefore, as a measure of WLM knowledge and beliefs, the WLMKB scale should be a predictor of long-term weight change rather than short-term WL. Evidence supporting this explanation is provided by further correlational analysis. Specifically, in Study 3, the WLMKB scale positively correlated with the amount of weight maintained and negatively correlated with dieting history. Furthermore, in the Study 4, scores on the WLMKB scale significantly predicted continuation of weight management attempts in response to the COVID-19 first lockdown, and weight suppression. Overall, these results provide evidence of the predictive validity of the WLMKB scale, by its ability to predict WLM.

WLM requires long-term engagement in weight management strategies (Stubbs & Lavin, 2013). These include behaviours intended at lowering energy intake (Keller & Siegrist, 2015), increasing physical activity (Foright et al., 2018) or monitoring progress (Murawski et al., 2009). Study 3 and the Study 4 of the current thesis assessed engagement in weight management strategies and the association with the WLMKB scale. Results showed no significant correlations between the WLMKB scale and changes in engagement in weight management strategies. However, in Study 3, the BS was a significant predictor of engagement in physical activity. This suggests that people with more accurate beliefs about WLM engage in more physical activity. This is in line with previous research on the importance of beliefs in behaviour (Pedersen et al., 2018; Spence et al., 2020). Furthermore, improving these beliefs could be beneficial for WLM as higher engagement in physical activity was associated with successful WLM (Creasy et al., 2021; Knell et al., 2021; Paixão et al., 2020). Specifically, higher levels of physical activity were observed in WL maintainers compared to normal weight and controls with overweight or obesity (Ostendorf et al., 2019), and increased physical activity was the most consistent positive correlate of WLM according to weight control registry systematic review (Paixão et al., 2020).

Individuals that engage in or intend to engage in weight management strategies that aim to lower energy intake are usually defined as restrained eaters (Lowe & Timko, 2004; Westenhoefer, 1991). In previous research, eating restraint was associated with better weight management (Westenhoefer et al., 2013). Therefore, individuals with more accurate knowledge and beliefs about WLM were expected to understand the importance of eating restraint and restrict their food intake. Results from Study 4 showed that the WLMKB scale differentiated between people that continued and those that stopped their weight management attempt. Additionally, the WLMKB scale was significantly associated with dieting restraint. These results confirm the initial hypotheses and provide evidence of the predictive validity of the WLMKB scale.

Studies 2, 3 and 4 provided evidence of the validity of the WLMKB scale. In Study 2, the WLMKB scale demonstrated construct validity on a sample of nutrition and non-nutrition students. Specifically, following the 'known group' method, nutrition knowledge students scored significantly higher on the KS. In Study 3 and 4, the scale demonstrated convergent, discriminant and predictive validity in samples of individuals engaged in a weight management attempt at the beginning of the COVID-19 lockdown and WL maintainers and regainers. The expected associations were shown between the subscales of the WLMKB scale and other related (nutrition knowledge, dieting beliefs) or unrelated (food fussiness and exercise locus of control) factors. Additionally, the scale significantly predicted weight maintenance, engagement in physical activity (Study 3) and weight suppression and engagement in weight management attempts (Study 4).

## 7.5. Strengths and Implications

This thesis provides a number of novel contributions to the WLM literature. First, the current research developed and validated a new scale to measure WLM knowledge and beliefs. There is evidence (Hartmann et al., 2016; Mitchell et al., 2021; O'Brien et al., 2018; Vaitkeviciute, Ball, & Harris, 2015) and theories (Pelletier, Dion, Slovinec-D'Angelo, & Reid, 2004; Spence et al., 2020; Swift et al., 2009; West & Michie, 2020) that suggest knowledge and beliefs influence weight management behaviour. However, as there were no validated scales to measure these in relation to WLM the WLMKB scale was developed based on theory (Johns et al., 2014; Rosenbaum & Leibel, 2010; Williams, Wood, Collins, & Callister, 2015), empirical evidence (Fothergill et al., 2016; Hill et al., 2009; Kruseman et al., 2017; Rogers, 2018) and existing scales (Hankey et al., 2004; Kliemann et al., 2016; Knäuper et al., 2004). The scale was validated following accepted guidelines (Boateng et al., 2018; Robinson, 2018; Trakman et al., 2017) and common practice (Eccles & Arsal, 2017; Mikhail et al., 2020; Mötteli et al., 2016; Mötteli et al., 2017). Furthermore, the scale was validated in a range of samples, including, from the general population (Study 1), nutrition and non-nutrition based students (Study 2), individuals engaged in a weight management attempt at the beginning of the COVID-19 lockdown in Study 4 and WL maintainers and weight regainers in Study 3. This fact is important due to evidence suggesting that these populations differ in various important aspects from the general population including appetite (Buckland et al., 2021), external cues (Alblas, Mollen, Fransen, & Putte, 2020), cravings (Hill, 2007), and eating disinhibition (Boon et al., 2002; Ogden, Oikonomou, & Alemany, 2017). Furthermore, the WLMKB scale was validated on a relevant sample of WL maintainers. This is an important factor as the scale was specifically developed to assess WLM knowledge and beliefs in individuals attempting to maintain their weight. Additionally, evidence showed that WL maintainers differ in their weight management behaviours (Ostendorf et al., 2019; Paixão et al., 2020), represent a small percentage of the individuals that attempt to manage their weight (Stubbs, 2013), research on this sample is limited but could provide guidance for future interventions. Therefore, a better understanding of WL maintainers' knowledge and beliefs about WLM related factors is valuable for extending existing knowledge and informing future interventions.

Secondly, this thesis provided initial evidence of the importance of knowledge and beliefs on WLM success. Specifically, more accurate WLM knowledge and beliefs were associated with greater eating restraint, continuation of weight management attempts in times of stress and fewer dieting attempts. From a practical standpoint, these results suggest that improving individuals' knowledge and beliefs could lead to more successful weight maintenance by improving consistency in engagement in weight management attempts.

Thirdly, higher scores on the WLMKB scale were associated with higher amounts of weight maintained. Additionally, more accurate knowledge and beliefs were significant predictors of weight change when taking motivation into consideration. These results suggest that there is a relationship between knowledge and beliefs about WLM and weight management success. Therefore, further research should be conducted to test this association. This research would help identify at risk individuals of weight regain, inform on and help better target future interventions.

Finally, more accurate WLM knowledge and beliefs were associated with higher engagement in physical activity. Additionally, there was a small association between more accurate beliefs an intrinsic motivation to exercise. These results support the SDT on the importance of beliefs in leading to a more autonomous type of motivation (Ng et al., 2012; Williams et al., 1996). It could be argued that improving knowledge and beliefs might lead to higher levels of physical activity and therefore better WLM (Ostendorf et al., 2021).

Multiple WLM interventions have been recently developed (Delahanty et al., 2011; Saris, 2005; Scott et al., 2019), most of which are currently being tested (Huttunen-Lenz et al., 2019; Sniehotta et al., 2019). These interventions target multiple WLM related factors and include multiple behaviour and cognitive strategies, but their effectiveness remains modest (Stubbs & Driscoll, 2021). Whilst most of these interventions promote accurate knowledge and beliefs about WLM, no interventions were specifically aimed at improving knowledge and beliefs or assessing these in relation to WLM. Comparatively there is evidence of short nutrition knowledge and food literacy interventions for WL that show promising results in changing knowledge and behaviour (Appleton et al., 2019; Guasch-Ferré et al., 2013; Makiabadi, Kaveh, & Mahmoodi, 2019). Therefore, a short intervention to improve WLM knowledge and beliefs might be a useful tool. Developing and testing such an intervention might also provide on whether adding information to government guidelines on WLM might have a significant effect in improving WLM in the general population.

The WLMKB scale has the following potential uses:

(i) Assess the effectiveness on information-based interventions: Previous evidence (Chapter 3) showed that multiple current interventions for WL and WLM provide participants with nutrition information and aim to improve their knowledge on behavioural strategies required for weight management. The WLMKB scale enables the assessment of the effectiveness of these interventions in improving WLM knowledge and beliefs.

(ii) Control for WLM knowledge and beliefs in order to assess other predictors of weight management: Previous reports argue on the difficulty of identifying predictors of WLM (Stubbs, 2013). Given that theory and evidence show that knowledge and beliefs influence behaviour and weight management, these factors should be assessed and controlled for in future research on WLM.

(iii) Assess the effect of WLM knowledge and beliefs on weight management success: The studies conducted as part of this research provide only initial evidence of the association between WLM knowledge and beliefs and weight management practices and success. Further research should be conducted on larger samples of WL maintainers, using longitudinal data and objective measures of weight, physical activity and energy intake.

(iv) Identify gaps in knowledge and beliefs that need to be targeted by interventions: The WLMKB scale is a multidimensional measure that assesses multiple factors related to WLM. Therefore, the scale will be useful in assessing accuracy of knowledge and belief in distinct areas and help better target interventions to improve specific aspects either at an individual level or population level.

(v) Identify individuals at risk of weight regain: The WLMKB scale could be used to assess participants WLM knowledge and beliefs after participation in a WL intervention or before a WLM intervention to identify individuals that are at risk of regaining weight.

The current research developed and validated the WLMKB scale, and the scale advances current literature by enabling future research on the impact of knowledge and beliefs on WLM. Additionally, the current research presents initial evidence of this association. This was not possible to date due to the lack of an appropriate scale (see Chapter 2 and 3). The next section will present the strengths and limitations of the current research and provide indication of future research.

## 7.6. Limitations and Future Directions

Despite the strengths of the current thesis there are some limitations to acknowledge. First, data on weight and height were self-reported in all the studies. This could be an issue as there is evidence that participants tend to underestimate weight (Shields et al., 2008). However, there is also evidence that showed a strong correlation between self-reported weight and objectively assessed BMI values (Mathew et al., 2012; Okamoto et al., 2017). However, future research should assess the relationship between WLMKB and WLM and BMI based on objectively measured weight and height.

Secondly, the current research used cross-sectional data, and based WLM status on participants' ability to recall their weight change and changes in weight management strategies. Recall can be difficult for WLM if the initial WL happened a long time ago (Dahl & Reynolds, 2013). This could have an effect on the results and associations identified. Although, Study 3 used longitudinal data, weight change was assessed over a short-term period (i.e. 1 month) and longer-term assessments are needed for WLM (Stubbs et al., 2021). Future research should use longitudinal designs to get more accurate data on the changes in weight and weight management strategies. Given that current results show preliminary evidence of the importance of knowledge and beliefs for WLM, future research should focus on identifying the impact of these factors using longitudinal data and used in an established WLM programme (Huttunen-Lenz et al., 2019; Richards et al., 2022; Sniehotta et al., 2019).

The current research was conducted with individuals attempting to manage their weight (Study 4) and WL maintainers and weight regainers (Study 3). However, the sample size of WL maintainers was small (28%). The low percentage of WL maintainers could be explained either by the fact that there are fewer people that actually manage to maintain weight (Wing, 2005), or by the difficulty in recruiting this population. However, the first explanation seems more probable, because the low percentage in the current sample is similar to the occurrence of WLM in the general population (Wing & Phelan, 2005). Regardless of the explanation, this is still a limitation due to the lack of power to conduct more advanced types of data analysis and to identify smaller effect sizes. Future research should aim to recruit a larger and inclusive sample of WL maintainers (Ahern, Aveyard, Boyland, Halford, & Jebb, 2016). A possible strategy to do this might be to follow the method used by other countries and develop a National Weight Control Registry (Paixão et al., 2020).

## 7.7. Conclusions

This thesis aimed to explore whether knowledge and beliefs about WLM related factors influence success in WLM. To meet these aims, the WLMKB scale was developed given a gap in the literature. Four studies showed the WLMKB scale is a reliable and valid measure of knowledge and beliefs about WLM related factors (food choice, energy balance, hunger, calorie compensatory behaviours, diet/obesity). This new scale enables future research to further investigate the relationship between knowledge and beliefs and weight management, as well as providing a tool to assess nutrition knowledge focused interventions and help identify at risk individuals of weight regain.

As obesity levels rise, the importance of long-term weight management is more prominent. The current research pushes towards identifying psychological and behavioural predictors of successful WLM. For this purpose, the novel WLMKB scale was developed and validated to enable research on the WLM knowledge and beliefs as well as providing the ability to control for these factors when analysis other WLM related factors. The present thesis provides initial evidence of the impact of WLM knowledge and beliefs on WLM. These suggest that more accurate knowledge and beliefs are related to perceived dieting success, engagement in weight management strategies, WLM and weight change. Specifically, people with more accurate knowledge and beliefs about WLM show to also report higher engagement in weight management strategies and weight management success.

The novel WLMKB scale addresses a gap in the literature and enables future research in WLM. Furthermore, the current thesis advances knowledge in the WLM field by providing initial evidence of the importance of knowledge and beliefs in WLM. Therefore, the WLMKB scale and current findings have broader implications for intervention development and testing that are important for tackling the increasing levels of obesity prevalence.

# References

Adams, C. E., & Leary, M. R. (2007). Promoting Self–Compassionate Attitudes Toward Eating Among Restrictive and Guilty Eaters. *Journal of Social and Clinical Psychology*, *26*(10), 1120–1144. https://doi.org/10.1521/jscp.2007.26.10.1120

Ahern, A. L., Aveyard, P., Boyland, E. J., Halford, J. C. G., & Jebb, S. A. (2016). Inequalities in the uptake of weight management interventions in a pragmatic trial: An observational study in primary care. *British Journal of General Practice*, *66*(645), e258–e263. https://doi.org/10.3399/bjgp16X684337

Ahlgren, C., Hammarström, A., Sandberg, S., Lindahl, B., Olsson, T., Larsson, C., & Fjellman-Wiklund, A. (2016). Engagement in New Dietary Habits—Obese Women's Experiences from Participating in a 2-Year Diet Intervention. *International Journal of Behavioral Medicine*, *23*(1), 84–93. https://doi.org/10.1007/s12529-015-9495-x

Ajie, W. N., & Chapman-Novakofski, K. M. (2014). Impact of computer-mediated, obesity-related nutrition education interventions for adolescents: A systematic review. *Journal of Adolescent Health*, *54*(6), 631–645. https://doi.org/10.1016/j.jadohealth.2013.12.019

Ajzen, I. (1991). The theory of planned behavior. *Orgnizational Behavior and Human Decision Processes*, *50*, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology and Health*, *26*(9), 1113–1127. https://doi.org/10.1080/08870446.2011.613995

Akkartal, Ş., & Gezer, C. (2020). Is Nutrition Knowledge Related to Diet Quality and Obesity? *Ecology of Food and Nutrition*, *59*(2), 119–129. https://doi.org/10.1080/03670244.2019.1675654

Albertson, E. R., Neff, K. D., & Dill-Shackleford, K. E. (2015). Self-Compassion and Body Dissatisfaction in Women: A Randomized Controlled Trial of a Brief Meditation Intervention. *Mindfulness*, *6*(3), 444–454. https://doi.org/10.1007/S12671-014-0277-3/TABLES/5

Alblas, M. C., Mollen, S., Fransen, M. L., & Putte, B. Van Den. (2020). Food at first sight : Visual attention to palatable food cues on TV and subsequent unhealthy food intake in unsuccessful restrained eaters. *Appetite*, *147*(December 2019), 104574. https://doi.org/10.1016/j.appet.2019.104574

Alkhaldy, A., Alshehri, B., Albalawi, N., Alsaady, F., Alfarshooti, R., Jamal, W., … Maghrabi, A. A. (2019). General and Postbariatric Nutritional Knowledge among Patients Undergoing Bariatric Surgery. *Journal of Nutrition and Metabolism*, *2019*. https://doi.org/10.1155/2019/6549476

Allabadi, H., Dabis, J., Aghabekian, V., Khader, A., & Khammash, U. (2020). Impact of COVID-19 lockdown on dietary and lifestyle behaviours among adolescents in Palestine. *Dynamics of Human Health*, *2020*(2), 7. Retrieved from http://journalofhealth.co.nz/?page_id=2170

Ammar, A., Brach, M., Trabelsi, K., Chtourou, H., Boukhris, O., Masmoudi, L., … Cowan, D. (2020). Effects of COVID-19 home confinement on physical activity and eating behaviour Preliminary results of the ECLB-COVID19 international online-survey

Correspondant Author : Dr . Achraf Ammar , Institute for Sports Science , Otto-von-Guericke University Magde.

Amrein, M. A., Rackow, P., Inauen, J., Radtke, T., & Scholz, U. (2017). The role of Compensatory Health Beliefs in eating behavior change: A mixed method study. *Appetite*, *116*, 1–10. https://doi.org/10.1016/j.appet.2017.04.016

Amrein, M. A., Scholz, U., & Inauen, J. (2021). Compensatory health beliefs and unhealthy snack consumption in daily life. *Appetite*, *157*, 104996. https://doi.org/10.1016/J.APPET.2020.104996

Anastasiou, C. A., Fappa, E., Karfopoulou, E., Gkza, A., & Yannakoulia, M. (2015). Weight loss maintenance in relation to locus of control: The MedWeight study. *Behaviour Research and Therapy*, *71*, 40–44. https://doi.org/10.1016/j.brat.2015.05.010

Anderson, G. H., Foreyt, J., Sigman-Grant, M., & Allison, D. B. (2012). The Use of Low-Calorie Sweeteners by Adults: Impact on Weight Management. *Journal of Nutrition*, *142*(6), 1163s-1169s. https://doi.org/10.3945/jn.111.149617

Anton, S. D., Han, H., York, E., Martin, C. K., Ravussin, E., & Williamson, D. A. (2009). Effect of calorie restriction on subjective ratings of appetite. *Journal of Human Nutrition and Dietetics*, *22*(2), 141–147. https://doi.org/10.1111/J.1365-277X.2008.00943.X

Appelhans, B. M., French, S. A., Pagoto, S. L., & Sherwood, N. E. (2017). Managing temptation in obesity treatment: a neurobehavioral model of intervention strategies Bradley, 268–279. https://doi.org/10.1016/j.appet.2015.09.035.Managing

Appelhans, B. M., Waring, M. E., Schneider, K. L., Pagoto, S. L., DeBiasse, M. A., Whited, M. C., & Lynch, E. B. (2012). Delay discounting and intake of ready-to-eat and away-from-home foods in overweight and obese women. *Appetite*, *59*(2), 576–584. https://doi.org/10.1016/J.APPET.2012.07.009

Appleton, K. M., Passmore, D., Burn, I., Pidgeon, H., Nation, P., Boobyer, C., & Jiang, N. (2019). An Interactive Mobile Phone App (SMART 5-A-DAY) for Increasing Knowledge of and Adherence to Fruit and Vegetable Recommendations: Development and Pilot Randomized Controlled Trial. *JMIR Mhealth Uhealth 2019;7(11):E14380 Https://Mhealth.Jmir.Org/2019/11/E14380*, *7*(11), e14380. https://doi.org/10.2196/14380

Aronne, L. J., Hall, K. D., M. Jakicic, J., Leibel, R. L., Lowe, M. R., Rosenbaum, M., & Klein, S. (2021). Describing the Weight-Reduced State: Physiology, Behavior, and Interventions. *Obesity*, *29*(S1), S9–S24. https://doi.org/10.1002/oby.23086

Aronne, L. J., & Segal, K. R. (2003). Weight Gain in the Treatment of Mood Disorders. *J Clin Psychiatry*, *64*(8).

Asbjørnsen, R. A., Smedsrød, M. L., Solberg Nes, L., Wentzel, J., Varsi, C., Hjelmesæth, J., & van Gemert-Pijnen, J. E. (2019). Persuasive System Design Principles and Behavior Change Techniques to Stimulate Motivation and Adherence in Electronic Health Interventions to Support Weight Loss Maintenance: Scoping Review. *Journal of Medical Internet Research*, *21*(6), e14265. https://doi.org/10.2196/14265

Asher, R. C., Jakstas, T., Wolfson, J. A., Rose, A. J., Bucher, T., Lavelle, F., … Shrewsbury, V. A. (2020). Cook-ed$^{TM}$ : A model for planning, implementing and evaluating cooking programs to improve diet and health. *Nutrients*, *12*(7), 1–20.

https://doi.org/10.3390/nu12072011

Astbury, N. M., Piernas, C., Hartmann-Boyce, J., Lapworth, S., Aveyard, P., & Jebb, S. A. (2019). A systematic review and meta-analysis of the effectiveness of meal replacements for weight loss. *Obesity Reviews*, *20*(4), 569–587. https://doi.org/10.1111/obr.12816

Avenell, A., Broom, J., Brown, T., Poobalan, A., Aucott, L., Stearns, S., … Grant, A. (2004). Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement. *Health Technology Assessment*, *8*(21). https://doi.org/10.1016/S0140-6736(05)17718-6

Bakaloudi, D. R., Jeyakumar, D., Jayawardena, R., & Chourdakis, M. (2021). The impact of COVID-19 lockdown on snacking habits, fast-food and alcohol consumption: A systematic review of the evidence. *Clinical Nutrition*, (January).

Baker, C. (2021). Inside: 1. Obesity in adults, England 2. Obesity in children, *3336*(3336). Retrieved from www.parliament.uk/commons-library%7Cintranet.parliament.uk/commons-library%7Cpapers@parliament.uk%7C@commonslibrary

Baranowski, T., Cullen, K. W., & Baranowski, J. (1999, November 28). Psychosocial correlates of dietary intake: Advancing dietary intervention. *Annual Review of Nutrition*. Annual Reviews 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, USA. https://doi.org/10.1146/annurev.nutr.19.1.17

Barbosa, L. B., Vasconcelos, S. M. L., Correia, L. O. dos S., & Ferreira, R. C. (2016). Nutrition knowledge assessment studies in adults: a systematic review 449 review. *Ciencia e Saude Coletiva*, *21*(2), 449–462. https://doi.org/10.1590/1413-81232015212.20182014

Beeken, R. J., Leurent, B., Vickerstaff, V., Wilson, R., Croker, H., Morris, S., … Wardle, J. (2017). A brief intervention for weight control based on habit-formation theory delivered through primary care: Results from a randomised controlled trial. *International Journal of Obesity*, *41*(2), 246–254. https://doi.org/10.1038/ijo.2016.206

Bellisle, F., & Drewnowski, A. (2007). Intense sweeteners, energy intake and the control of body weight. *European Journal of Clinical Nutrition*, *61*(6), 691–700. https://doi.org/10.1038/sj.ejcn.1602649

Benn, Y., Webb, T. L., Chang, B. P. I., & Harkin, B. (2016). What is the psychological impact of self-weighing? A meta-analysis. *Health Psychology Review*, *10*(2), 187–203. https://doi.org/10.1080/17437199.2016.1138871

Bennett, G. G., Steinberg, D. M., Stoute, C., Lanpher, M., Lane, I., Askew, S., … Baskin, M. L. (2014). Electronic health (eHealth) interventions for weight management among racial/ethnic minority adults: a systematic review. *Obesity Reviews*, *15*, 146–158. https://doi.org/10.1111/OBR.12218

Berridge, K. C., Robinson, T. E., & Aldridge, J. W. (2009). Dissecting components of reward: “liking”, “wanting”, and learning. *Current Opinion in Pharmacology*, *9*(1), 65–73. https://doi.org/10.1016/j.coph.2008.12.014

Bessems, K. M. H. H., Linssen, E., Lomme, M., & Van Assema, P. (2020). The effectiveness of the good affordable food intervention for adults with low socioeconomic status and small incomes. *International Journal of Environmental Research and Public Health*, *17*(7). https://doi.org/10.3390/ijerph17072535

Betsch, T., Haberstroh, S., Glöckner, A., Haar, T., & Fiedler, K. (2001). The Effects of Routine Strength on Adaptation and Information Search in Recurrent Decision Making. *Organizational Behavior and Human Decision Processes*, *84*(1), 23–53. https://doi.org/10.1006/obhd.2000.2916

Biber, D. D., & Ellis, R. (2019). The effect of self-compassion on the self-regulation of health behaviors: A systematic review. *Journal of Health Psychology*, *24*(14), 2060–2071. https://doi.org/10.1177/1359105317713361

Birkenhead, K. L., & Slater, G. (2015). A Review of Factors Influencing Athletes' Food Choices. *Sports Medicine 2015 45:11*, *45*(11), 1511–1522. https://doi.org/10.1007/S40279-015-0372-1

Blüher, M. (2019). Obesity: global epidemiology and pathogenesis. *Nature Reviews Endocrinology*, *15*(5), 288–298. https://doi.org/10.1038/s41574-019-0176-8

Blundell, J. E., Gibbons, C., Beaulieu, K., Casanova, N., Duarte, C., Finlayson, G., … Hopkins, M. (2020). The drive to eat in homo sapiens: Energy expenditure drives energy intake. *Physiology and Behavior*, *219*(December 2019), 112846. https://doi.org/10.1016/j.physbeh.2020.112846

Boateng, G. O., Neilands, T. B., Frongillo, E. A., Melgar-Quiñonez, H. R., & Young, S. L. (2018). Best Practices for Developing and Validating Scales for Health, Social, and Behavioral Research: A Primer. *Frontiers in Public Health*, *6*(June), 1–18. https://doi.org/10.3389/fpubh.2018.00149

Bolhuis, D. P., Lakemond, C. M. M., de Wijk, R. A., Luning, P. A., & de Graaf, C. (2013). Both a higher number of sips and a longer oral transit time reduce ad libitum intake. *Food Quality and Preference*, *32*, 234–240. https://doi.org/10.1016/j.foodqual.2013.10.001

Bonaccio, M., Di Castelnuovo, A., Costanzo, S., De Lucia, F., Olivieri, M., Donati, M. B., … Bonanni, A. (2013). Nutrition knowledge is associated with higher adherence to Mediterranean diet and lower prevalence of obesity. Results from the Moli-sani study. *Appetite*, *68*, 139–146. https://doi.org/10.1016/j.appet.2013.04.026

Bond, T. G., & Fox, C. M. (2007). Applying the rasch model: Fundamental measurement in the human sciences: Second edition. *Applying the Rasch Model: Fundamental Measurement in the Human Sciences: Second Edition*, 1–340. https://doi.org/10.4324/9781410614575/APPLYING-RASCH-MODEL-TREVOR-BOND-CHRISTINE-FOX

Boon, B., Stroebe, W., Schut, H., & Ijntema, R. (2002). Ironic processes in the eating behaviour of restrained eaters. *British Journal of Health Psychology*, *7*(1), 1–10. https://doi.org/10.1348/135910702169303

Borg, P., Kukkonen-Harjula, K., Fogelholm, M., & Pasanen, M. (2002). Effects of walking or resistance training on weight loss maintenance in obese, middle-aged men: A randomized trial. *International Journal of Obesity*, *26*(5), 676–683. https://doi.org/10.1038/sj.ijo.0801962

Boutelle, K. N., Zucker, N., Peterson, C. B., Rydell, S., Carlson, J., & Harnack, L. J. (2014). An intervention based on Schachter's externality theory for overweight children: The regulation of cues pilot. *Journal of Pediatric Psychology*, *39*(4), 405–417. https://doi.org/10.1093/jpepsy/jst142

Brantley, P. J., Stewart, D. W., Myers, V. H., Matthews-Ewald, M. R., Ard, J. D., Coughlin, J. W., … Stevens, V. J. (2014). Psychosocial predictors of weight regain in the weight loss maintenance trial. *Journal of Behavioral Medicine*, *37*(6), 1155–1168. https://doi.org/10.1007/s10865-014-9565-6

Braun, M. M., Osecheck, M., & Joyce, N. C. (2012). Nutrition Assessment and Management in Amyotrophic Lateral Sclerosis. *Physical Medicine and Rehabilitation Clinics*, *23*(4), 751–771. https://doi.org/10.1016/J.PMR.2012.08.006

Brindal, E., Wilson, C., Mohr, P., & Wittert, G. (2012). Perceptions of portion size and energy content: Implications for strategies to affect behaviour change. *Public Health Nutrition*, *15*(2), 246–253. https://doi.org/10.1017/S1368980011001236

Brockmann, A. N., & Ross, K. M. (2020). Bidirectional association between stress and physical activity in adults with overweight and obesity. *Journal of Behavioral Medicine*, *43*(2), 246–253. https://doi.org/10.1007/s10865-020-00145-2

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The Lancet*, *395*(10227), 912–920. https://doi.org/10.1016/S0140-6736(20)30460-8

Brown, A., Flint, S. W., Kalea, A. Z., O'Kane, M., Williams, S., & Batterham, R. L. (2021). Negative impact of the first COVID-19 lockdown upon health-related behaviours and psychological wellbeing in people living with severe and complex obesity in the UK. *EClinicalMedicine*, *34*, 100796. https://doi.org/10.1016/j.eclinm.2021.100796

Brown, R. D. (2010). Food Texture Analysis. *American Laboratory*, *1*.

Brownell, K. D., Brownell, K. D., & LEARN Education Center. (2000). LEARN program for weight management 2000, 312. https://doi.org/10.3/JQUERY-UI.JS

Bryant, E. J., King, N. A., & Blundell, J. E. (2008). Disinhibition: Its effects on appetite and weight regulation. *Obesity Reviews*, *9*(5), 409–419. https://doi.org/10.1111/j.1467-789X.2007.00426.x

Buckland, N. J., Camidge, D., Croden, F., Lavin, J. H., Stubbs, R. J., Hetherington, M. M., … Finlayson, G. (2018). A low energy-dense diet in the context of a weight-management program affects appetite control in overweight and obese women. *Journal of Nutrition*, *148*(5), 798–806. https://doi.org/10.1093/jn/nxy041

Buckland, N. J., Camidge, D., Croden, F., Myers, A., Lavin, J. H., Stubbs, R. J., … Finlayson, G. (2019). Women with a low satiety phenotype show impaired appetite control and greater resistance to weight loss. *British Journal of Nutrition*, 1–22. https://doi.org/10.1017/s000711451900179x

Buckland, N. J., Dalton, M., Stubbs, R. J., Hetherington, M. M., Blundell, J. E., & Finlayson, G. (2015). Associations between nutritional properties of food and consumer perceptions related to weight management. *Food Quality and Preference*, *45*, 18–25. https://doi.org/10.1016/j.foodqual.2015.04.009

Buckland, N. J., Finlayson, G., Edge, R., & Hetherington, M. M. (2014). Resistance reminders: Dieters reduce energy intake after exposure to diet-congruent food images compared to control non-food images. *Appetite*, *73*, 189–196. https://doi.org/10.1016/j.appet.2013.10.022

Buckland, N. J., James Stubbs, R., & Finlayson, G. (2015). Towards a satiety map of common foods: Associations between perceived satiety value of 100 foods and their objective and subjective attributes. *Physiology and Behavior*, *152*, 340–346. https://doi.org/10.1016/j.physbeh.2015.07.001

Buckland, N. J., & Kemps, E. (2021). Low craving control predicts increased high energy density food intake during the COVID-19 lockdown : result replicated in an Australian sample. *Appetite*, *166*.

Buckland, N. J., Swinnerton, L. F., Ng, K., Price, M., Wilkinson, L. L., Myers, A., & Dalton, M. (2021). Susceptibility to increased high energy dense sweet and savoury food intake in response to the COVID-19 lockdown: The role of craving control and acceptance coping strategies. *Appetite*, *158*(November 2020), 105017. https://doi.org/10.1016/j.appet.2020.105017

Buckworth, J., & Dishman, R. K. (2007). Exercise adherence. In *Handbook of Sport Psychology* (pp. 509–536). Retrieved from https://psycnet.apa.org/record/2007-01666-031

Buijsse, B., Feskens, E. J. M., Schulze, M. B., Forouhi, N. G., Wareham, N. J., Sharp, S., … Boeing, H. (2009). Fruit and vegetable intakes and subsequent changes in body weight in European populations: results from the project on Diet, Obesity, and Genes (DiOGenes). *The American Journal of Clinical Nutrition*, *90*(1), 202–209. https://doi.org/10.3945/AJCN.2008.27394

Burger, K., & Stice, E. (2011). Variability in Reward Responsivity and Obesity: Evidence from Brain Imaging Studies. *Current Drug Abuse Reviews*, *1*, 105–112.

Butryn, M. L., Kerrigan, S., Arigo, D., Raggio, G., & Forman, E. M. (2018). Pilot Test of an Acceptance-Based Behavioral Intervention to Promote Physical Activity During Weight Loss Maintenance. *Behavioral Medicine*, *44*(1), 77–87. https://doi.org/10.1080/08964289.2016.1170663

Butryn, M. L., Phelan, S., Hill, J. O., & Wing, R. R. (2007). Consistent self-monitoring of weight: A key component of successful weight loss maintenance. *Obesity*, *15*(12), 3091–3096. https://doi.org/10.1038/oby.2007.368

Cai, Q., Chen, F., Wang, T., Luo, F., Liu, X., Wu, Q., … Xu, L. (2020). Obesity and COVID-19 Severity in a Designated Hospital in Shenzhen, China. *Diabetes Care*, *43*(7), 1392–1398. https://doi.org/10.2337/dc20-0576

Camps, S. G. J. A., Verhoef, S. P. M., & Westerterp, K. R. (2013). Weight loss, weight maintenance, and adaptive thermogenesis. *American Journal of Clinical Nutrition*, *97*(5), 990–994. https://doi.org/10.3945/AJCN.112.050310

Canetti, L., Bachar, E., & Berry, E. M. (2002). Food and emotion. *Behavioural Processes*, *60*(2), 157–164. https://doi.org/10.1016/S0376-6357(02)00082-7

Carels, R. A., Konrad, K., & Harper, J. (2007). Individual differences in food perceptions and calorie estimation: An examination of dieting status, weight, and gender. *Appetite*, *49*(2), 450–458. https://doi.org/10.1016/J.APPET.2007.02.009

Carraça, E. V., Santos, I., Mata, J., & Teixeira, P. J. (2018). Psychosocial Pretreatment

Predictors of Weight Control: A Systematic Review Update. *Obesity Facts*, *11*(1), 67–82. https://doi.org/10.1159/000485838

Carrard, I., & Kruseman, M. (2016). Qualitative analysis of the role of self-weighing as a strategy of weight control for weight-loss maintainers in comparison with a normal, stable weight group. *Appetite*, *105*, 604–610. https://doi.org/10.1016/j.appet.2016.06.035

Champion, V. L., & Skinner, C. S. (2008). The health belief model. In *Health behavior and health education: Theory, research, and practice* (pp. 465–485). Jossey-Bass. Retrieved from http://riskybusiness.web.unc.edu/files/2015/01/Health-Behavior-and-Health-Education.pdf#page=503

Chen, R., Li, D. P., Turel, O., Sørensen, T. A., Bechara, A., Li, Y., & He, Q. (2018). Decision making deficits in relation to food cues influence obesity: A triadic neural model of problematic eating. *Frontiers in Psychiatry*, *9*(JUN), 1–8. https://doi.org/10.3389/fpsyt.2018.00264

Cherikh, F., Frey, S., Bel, C., Attanasi, G., Alifano, M., & Iannelli, A. (2020). Behavioral Food Addiction During Lockdown: Time for Awareness, Time to Prepare the Aftermath. *Obesity Surgery*, *30*(9), 3585–3587. https://doi.org/10.1007/s11695-020-04649-3

Chow, C. C., & Hall, K. D. (2014). Short and long-term energy intake patterns and their implications for human body weight regulation. *Physiology and Behavior*, *134*(C), 60–65. https://doi.org/10.1016/j.physbeh.2014.02.044

Christensen, B. J., Iepsen, E. W., Lundgren, J., Holm, L., Madsbad, S., Holst, J. J., & Torekov, S. S. (2018). Instrumentalization of Eating Improves Weight Loss Maintenance in Obesity. *Obesity Facts*, *10*(6), 633–647. https://doi.org/10.1159/000481138

Chung, L. M. Y., Chung, J. W. Y., & Chan, A. P. C. (2019). Building healthy eating knowledge and behavior: An evaluation of nutrition education in a skill training course for construction apprentices. *International Journal of Environmental Research and Public Health*, *16*(23). https://doi.org/10.3390/ijerph16234852

Chung, L. M. Y., Fong, S. S. M., & Law, Q. P. S. (2021). Younger adults are more likely to increase fruit and vegetable consumption and decrease sugar intake with the application of dietary monitoring. *Nutrients*, *13*(2), 1–12. https://doi.org/10.3390/nu13020333

Clemmensen, C., Petersen, M. B., & Sørensen, T. I. A. (2020). Will the COVID-19 pandemic worsen the obesity epidemic? *Nature Reviews Endocrinology*, *16*(9), 469–470. https://doi.org/10.1038/s41574-020-0387-z

Cleobury, L., & Tapper, K. (2014). Reasons for eating 'unhealthy' snacks in overweight and obese males and females. *Journal of Human Nutrition and Dietetics*, *27*(4), 333–341. https://doi.org/10.1111/JHN.12169

Clifton, P. M., Condo, D., & Keogh, J. B. (2014). Long term weight maintenance after advice to consume low carbohydrate, higher protein diets - A systematic review and meta analysis. *Nutrition, Metabolism and Cardiovascular Diseases*, *24*(3), 224–235. https://doi.org/10.1016/j.numecd.2013.11.006

Cohen, J. (1992). Statistical Power Analysis. *Current Directions in Psychological Science*, *1*(3), 98–101.

Cohen, S., Kamarack, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385–396.

Cools, J., Schotte, D. E., & McNally, R. J. (1992). Emotional Arousal and Overeating in Restrained Eaters. *Journal of Abnormal Psychology*, *101*(2), 348–351. https://doi.org/10.1037/0021-843X.101.2.348

Cooper, Z., & Fairburn, C. G. (2001). A new cognitive behavioural approach to the treatment of obesity. *Behaviour Research and Therapy*, *39*(5), 499–511. https://doi.org/10.1016/S0005-7967(00)00065-6

Cornier, M. A., Von Kaenel, S. S., Bessesen, D. H., & Tregellas, J. R. (2007). Effects of overfeeding on the neuronal response to visual food cues. *American Journal of Clinical Nutrition*, *86*(4), 965–971. https://doi.org/10.1371/journal.pone.0006310

Coughlin, J. W., Brantley, P. J., Champagne, C. M., Vollmer, W. M., Stevens, V. J., Funk, K., … Appel, L. J. (2016). The impact of continued intervention on weight: Five-year results from the weight loss maintenance trial. *Obesity*, *24*(5), 1046–1053. https://doi.org/10.1002/oby.21454

Creasy, S. A., Hibbing, P. R., Cotton, E., Lyden, K., Ostendorf, D. M., Willis, E. A., … Catenacci, V. A. (2021). Temporal patterns of physical activity in successful weight loss maintainers. *International Journal of Obesity 2021 45:9*, *45*(9), 2074–2082. https://doi.org/10.1038/s41366-021-00877-4

Daeninck, E., & Miller, M. (2006). What can the national weight control registry teach us? *Current Diabetes Reports*, *6*(5), 401–404. https://doi.org/10.1007/s11892-006-0013-z

Dahle, J. H., Ostendorf, D. M., Zaman, A., Pan, Z., Melanson, E. L., & Catenacci, V. A. (2021). Underreporting of energy intake in weight loss maintainers, 1–10.

Daigle, K. M., Gang, C. H., Kopping, M. F., & Gadde, K. M. (2019). Relationship Between Perceptions of Obesity Causes and Weight Loss Expectations Among Adults. *Journal of Nutrition Education and Behavior*, *51*(1), 86–90. https://doi.org/10.1016/j.jneb.2018.08.015

Daley, A. J. (2014). Regular self-weighing to promote weight maintenance after intentional weight loss: a quasi-randomized controlled trial. *Journal of Public Health (Oxford, England)*, *36*(2), 259–267. https://doi.org/10.1093/pubmed/fdt061

Dalton, M., Finlayson, G., Hill, A., & Blundell, J. (2015). Preliminary validation and principal components analysis of the Control of Eating Questionnaire (CoEQ) for the experience of food craving. *European Journal of Clinical Nutrition*, *69*(12), 1313–1317. https://doi.org/10.1038/ejcn.2015.57

Dalton, M., Finlayson, G., Walsh, B., Halseth, A. E., Duarte, C., & Blundell, J. E. (2017). Early improvement in food cravings are associated with long-term weight loss success in a large clinical sample. *International Journal of Obesity*, *41*(8), 1232–1236. https://doi.org/10.1038/ijo.2017.89

Darmon, N., & Drewnowski, A. (2008). Does social class predict diet quality? *American Journal of Clinical Nutrition*, *87*(5), 1107–1117. https://doi.org/10.1093/ajcn/87.5.1107

Das, S. K., Gilhooly, C. H., Golden, J. K., Pittas, A. G., Fuss, P. J., Cheatham, R. A., … Roberts, S. B. (2007). Long-term effects of 2 energy-restricted diets differing in glycemic load on dietary adherence, body composition, and metabolism in CALERIE: A

1-y randomized controlled trial. *American Journal of Clinical Nutrition*, *85*(4), 1023–1030. https://doi.org/10.1093/ajcn/85.4.1023

Davidson, M. (2014). Known-Groups Validity. In A. C. Michalos (Ed.), *Encyclopedia of Quality of Life and Well-Being Research* (pp. 3481–3482). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-0753-5_1581

Delahanty, L. M., Hill, J. O., Ph, D., Krakoff, J., Otto, A., Ryan, D. H., & Vitolins, M. Z. (2011). Four-Year Weight Losses in the Look AHEAD Study: Factors Associated with Long-Term Success. *Obesity*, *19*(10), 1987–1998. https://doi.org/10.1038/oby.2011.230.Four-Year

Deschasaux-Tanguy, M., Druesne-Pecollo, N., Esseddik, Y., Szabo de Edelenyi, F., Alles, B., Andreeva, V. A., … Touvier, M. (2020). Diet and physical activity during the COVID-19 lockdown period (March-May 2020): results from the French NutriNet-Sante cohort study. *MedRxiv*, (June), preprint. https://doi.org/10.1101/2020.06.04.20121855

DeVellis, R. F., & Thorpe, C. T. (2012). *Scale development : theory and applications*. Los Angeles: SAGE Publications Ltd.

Dickson-Spillmann, M., Siegrist, M., & Keller, C. (2011). Development and validation of a short, consumer-oriented nutrition knowledge questionnaire. *Appetite*, *56*(3), 617–620. https://doi.org/10.1016/j.appet.2011.01.034

Dohm, F. A., Beattie, J. A., Aibel, C., & Striegel-Moore, R. H. (2001). Factors differentiating women and men who successfully maintain weight loss from women and men who do not. *Journal of Clinical Psychology*, *57*(1), 105–117. https://doi.org/10.1002/1097-4679(200101)57:1<105::AID-JCLP11>3.0.CO;2-I

Dombrowski, S. U., Knittle, K., Avenell, A., Araújo-Soares, V., & Sniehotta, F. F. (2014). Long term maintenance of weight loss with non-surgical interventions in obese adults: Systematic review and meta-analyses of randomised controlled trials. *BMJ (Online)*, *348*(May), 1–12. https://doi.org/10.1136/bmj.g2646

Donker, A., & Markopoulos, P. (2002). A Comparison of Think-aloud, Questionnaires and Interviews for Testing Usability with Children. *People and Computers XVI - Memorable Yet Invisible*, 305–316. https://doi.org/10.1007/978-1-4471-0105-5_18

Doucet, McInis, K., & Mahmoodianfard, S. (2018). Compensation in response to energy deficits induced by exercise or diet. *Obesity Reviews*, *19*, 36–46. https://doi.org/10.1111/OBR.12783

Dryer, R., & Ware, N. (2014). Beliefs about causes of weight gain, effective weight gain prevention strategies, and barriers to weight management in the Australian population. *Health Psychology and Behavioral Medicine*, *2*(1), 66–81. https://doi.org/10.1080/21642850.2013.872036

Duarte, C., Gilbert, P., Stalker, C., Catarino, F., Basran, J., Scott, S., … Stubbs, R. J. (2019). *Effect of adding a compassion-focused intervention on emotion, eating and weight outcomes in a commercial weight management programme*. *Journal of Health Psychology*. https://doi.org/10.1177/1359105319890019

DW. (2020). Coronavirus: What are the lockdown measures across Europe? | Europe| News and current affairs from around the continent | DW | 14.04.2020. Retrieved January 19, 2022, from https://www.dw.com/en/coronavirus-what-are-the-lockdown-measures-across-europe/a-52905137

EASO. (2020). More than half of people struggled to manage their weight during COVID-19 lockdown , suggests UK survey, 1–2.

Ebbeling, C., Swain, J., & Feldman, H. (2012). Effects of dietary composition on energy expenditure during weight-loss maintenance. *Jama*, *307*(24), 2627–2634. Retrieved from http://archneur.jamanetwork.com/article.aspx?articleid=1199154

Eccles, D. W., & Arsal, G. (2017). The think aloud method: what is it and how do I use it? *Qualitative Research in Sport, Exercise and Health*, *9*(4), 514–531. https://doi.org/10.1080/2159676X.2017.1331501

Elfhag, K., & Rössner, S. (2005). Who succeeds in maintaining weight loss ? A conceptual review of factors associated with weight loss maintenance and weight regain. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, *6*(1), 67–85. https://doi.org/10.1111/j.1467-789X.2005.00170.x

Ellis, P. D. (2010). *The Essential Guide to Effect Sizes: Statistical Power, Meta-Analysis, and the Interpretation of Research Results.*

Ells, L. K., Radley, D., Matu, J., Clare, K., Blackshaw, J., Feeley, A., … Brown, A. (2020). Supporting weight management services during the COVID-19 pandemic Phase I insights. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/915274/WMS_Report.pdf

Ely, A. V., Howard, J., & Lowe, M. R. (2015). Delayed discounting and hedonic hunger in the prediction of lab-based eating behavior. *Eating Behaviors*, *19*, 72–75. https://doi.org/10.1016/j.eatbeh.2015.06.015

Epstein, L. H., Jankowiak, N., Fletcher, K. D., Carr, K. A., Nederkoorn, C., Raynor, H. A., & Finkelstein, E. (2014). Women who are motivated to eat and discount the future are more obese. *Obesity*, *22*(6), 1394–1399. https://doi.org/10.1002/OBY.20661

Espel-Huynh, H. M., Muratore, A. F., & Lowe, M. R. (2018). A narrative review of the construct of hedonic hunger and its measurement by the Power of Food Scale. *Obesity Science and Practice*, *4*(3), 238–249. https://doi.org/10.1002/osp4.161

Evans, E. H., Sainsbury, K., Kwasnicka, D., Bolster, A., Araujo-Soares, V., & Sniehotta, F. F. (2018). Support needs of patients with obesity in primary care: A practice-list survey. *BMC Family Practice*, *19*(1), 1–9. https://doi.org/10.1186/s12875-017-0703-4

Eyles, H. C., & Mhurchu, C. N. (2009). Does tailoring make a difference? A systematic review of the long-term effectiveness of tailored nutrition education for adults. *Nutrition Reviews*, *67*(8), 464–480. https://doi.org/10.1111/j.1753-4887.2009.00219.x

Fahey, M. C., Klesges, R. C., Kocak, M., Wayne Talcott, G., & Krukowski, R. A. (2018). Changes in the Perceptions of Self-weighing Across Time in a Behavioral Weight Loss Intervention. *Obesity*, *26*(10), 1566–1575. https://doi.org/10.1002/oby.22275

Faries, M. D. (2016). Why we don't "Just do it": Understanding the Intention-Behaviour Gap in Lifestyle Medicine.

Faries, M. D., & Abreu, A. (2017). Medication Adherence, When Lifestyle Is the Medicine. *American Journal of Lifestyle Medicine*, *11*(5), 397–403.

https://doi.org/10.1177/1559827617697922

Fathabadi, J., Mona, I., Taghavi, D., Shalani, B., & Sadeghi, S. (2017). Prediction the risk of obesity based on irrational beliefs, health locus of control and health-oriented lifestyle. *Journal of Research in Psychological Health*, *12*(1).

Feller, S., Müller, A., Mayr, A., Engeli, S., Hilbert, A., & De Zwaan, M. (2015). What distinguishes weight loss maintainers of the German Weight Control Registry from the general population? *Obesity*, *23*(5), 1112–1118. https://doi.org/10.1002/oby.21054

Feren, A., Torheim, L. E., & Lillegaard, I. T. L. (2011). Development of a nutrition knowledge questionnaire for obese adults. *Food and Nutrition Research*, *55*, 1–7. https://doi.org/10.3402/fnr.v55i0.7271

Festinger, L. (1962). Cognitive Dissonance. *Scientific American*, *207*(4). Retrieved from http://www.jstor.org/stable/24936719

Field, A., Miles, J., & Field, Z. (2012). *Discovering statistics using R. Annals of Internal Medicine* (Vol. 165). https://doi.org/10.7326/M16-0968

Finlayson, G., King, N., & Blundell, J. E. (2007). Liking vs. wanting food: Importance for human appetite control and weight regulation. *Neuroscience and Biobehavioral Reviews*, *31*(7), 987–1002. https://doi.org/10.1016/j.neubiorev.2007.03.004

Fishbach, A., Friedman, R. S., & Kruglanski, A. W. (2003). Leading Us Not Unto Temptation: Momentary Allurements Elicit Overriding Goal Activation. *Journal of Personality and Social Psychology*, *84*(2), 296–309. https://doi.org/10.1037/0022-3514.84.2.296

Fisher, G., & Rangel, A. (2014). Symmetry in Cold-to-Hot and Hot-to-Cold Valuation Gaps. *Psychological Science*, *25*(1), 120–127. https://doi.org/10.1177/0956797613502362

Fisher, N., Lattimore, P., & Malinowski, P. (2016). Attention with a mindful attitude attenuates subjective appetitive reactions and food intake following food-cue exposure. *Appetite*, *99*, 10–16. https://doi.org/10.1016/j.appet.2015.12.009

Fjeldsoe, B., Neuhaus, M., Winkler, E., & Eakin, E. (2011). Systematic Review of Maintenance of Behavior Change Following Physical Activity and Dietary Interventions. *Health Psychology*, *30*(1), 99–109. https://doi.org/10.1037/a0021974

Flegal, K. M., Shepherd, J. A., Looker, A. C., Graubard, B. I., Borrud, L. G., Ogden, C. L., … Schenker, N. (2009). Comparisons of percentage body fat, body mass index, waist circumference, and waist-stature ratio in adults. *American Journal of Clinical Nutrition*, *89*(3), 500–508. https://doi.org/10.3945/ajcn.2008.26847.INTRODUCTION

Flynn, M. A. T. (2015). Empowering people to be healthier: Public health nutrition through the Ottawa Charter. *Proceedings of the Nutrition Society*, *74*(3), 303–312. https://doi.org/10.1017/S002966511400161X

Fogel, A., Mccrickerd, K., Fries, L. R., Goh, A. T., Quah, P. L., Chan, M. J., … Forde, C. G. (2018). Eating in the absence of hunger: Stability over time and associations with eating behaviours and body composition in children. *Physiology and Behavior*, *192*(December 2017), 82–89. https://doi.org/10.1016/j.physbeh.2018.03.033

Fonteyn, M., Kuipers, B., & Grobe, S. (1993). A Description of Think Aloud Method and Protocol Analysis.pdf. *Qualitative Health Research*, *3*(4), 430–441.

Foright, R. M., Presby, D. M., Sherk, V. D., Kahn, D., Checkley, L. A., Giles, E. D., … MacLean, P. S. (2018). Is regular exercise an effective strategy for weight loss maintenance? *Physiology and Behavior*, *188*(November 2017), 86–93. https://doi.org/10.1016/j.physbeh.2018.01.025

Forman, E. M., Hoffman, K. L., McGrath, K. B., Herbert, J. D., Brandsma, L. L., & Lowe, M. R. (2007). A comparison of acceptance- and control-based strategies for coping with food cravings: An analog study. *Behaviour Research and Therapy*, *45*(10), 2372–2386. https://doi.org/10.1016/j.brat.2007.04.004

Forman, E. M., Schumacher, L. M., Crosby, R. D., Manasse, S. M., Goldstein, S., Butryn, M. L., … Thomas, J. G. (2017). Ecological momentary assessment of dietary lapses across behavioral weight loss treatment: characteristics, predictors, and relationships with weight change. *Annals of Behavioural Medicine*, *51*(5), 741–753. https://doi.org/10.1007/s12160-017-9897-x.Ecological

Fothergill, E., Guo, J., Howard, L., Kerns, J. C., Knuth, N. D., Brychta, R., … Hall, K. D. (2016). Persistent metabolic adaptation 6 years after “The Biggest Loser” competition. *Obesity*, *24*(8), 1612–1619. https://doi.org/10.1002/oby.21538

Franklin, J., Holman, C., Tam, R., Gifford, J., Prvan, T., Stuart-Smith, W., … O’Connor, H. (2019). Validation of the e-NutLit, an Electronic Tool to Assess Nutrition Literacy. *Journal of Nutrition Education and Behavior*, *000*(000). https://doi.org/10.1016/j.jneb.2019.10.008

Franz, M. J., VanWormer, J. J., Crain, A. L., Boucher, J. L., Histon, T., Caplan, W., … Pronk, N. P. (2007). {A figure is presented}Weight-Loss Outcomes: A Systematic Review and Meta-Analysis of Weight-Loss Clinical Trials with a Minimum 1-Year Follow-Up. *Journal of the American Dietetic Association*, *107*(10), 1755–1767. https://doi.org/10.1016/j.jada.2007.07.017

Freedhoff, Y., & Hall, K. D. (2016). Weight loss diet studies: we need help not hype. *The Lancet*, *388*(10047), 849–851. https://doi.org/10.1016/S0140-6736(16)31338-1

French, D. P., Cooke, R., Mclean, N., Williams, M., & Sutton, S. (2007). What do people think about when they answer theory of planned behaviour questionnaires? A “think aloud” study. *Journal of Health Psychology*, *12*(4), 672–687. https://doi.org/10.1177/1359105307078174

Gadermann, A. M., Guhn, M., & Zumbo, B. D. (2011). Investigating the Substantive Aspect of Construct Validity for the Satisfaction with Life Scale Adapted for Children: A Focus on Cognitive Processes. *Social Indicators Research*, *100*(1), 37–60. https://doi.org/10.1007/s11205-010-9603-x

Gardner, B., & Tang, V. (2014). Reflecting on non-reflective action: An exploratory think-aloud study of self-report habit measures. *British Journal of Health Psychology*, *19*(2), 258–273. https://doi.org/10.1111/bjhp.12060

Gianini, L. M., White, M. A., & Masheb, R. M. (2013). Eating pathology, emotion regulation, and emotional overeating in obese adults with binge eating disorder. *Eating Behaviors*, *14*(3), 309–313. https://doi.org/10.1016/J.EATBEH.2013.05.008

Gillison, F., Stathi, A., Reddy, P., Perry, R., Taylor, G., Bennett, P., … Greaves, C. (2015). Processes of behavior change and weight loss in a theory-based weight loss intervention program: A test of the process model for lifestyle behavior change. *International*

*Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 1–15. https://doi.org/10.1186/S12966-014-0160-6/TABLES/2

Golay, A. (2015). [Weight loss maintenance]. *Revue Medicale Suisse*, *11*(467), 686.

Goldstein, S. P., Zhang, F., Thomas, J. G., Butryn, M. L., Herbert, J. D., & Forman, E. M. (2018). Application of Machine Learning to Predict Dietary Lapses During Weight Loss. *Journal of Diabetes Science and Technology*, *12*(5), 1045–1052. https://doi.org/10.1177/1932296818775757

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist*, *54*(7), 493–503. https://doi.org/10.1037/0003-066X.54.7.493

Goodpaster, B., DeLany, J. P., Otto, A. D., Kuller, L., Vockley, J., Jeannette E. South-Paul, S. B. T., … Jakicic, J. M. (2010). Effects of Diet and PA intervention on WT loss and Cardiometabolic risk factor in very obese adults. *Jama*, *304*(16), 1795–1802. https://doi.org/10.1001/jama.2010.1505.Effects

Gratz, K. L., & Roemer, L. (2004). Multidimensional Assessment of Emotion Regulation and Dysregulation: Development, Factor Structure, and Initial Validation of the Difficulties in Emotion Regulation Scale. *Journal of Psychopathology and Behavioral Assessment 2004 26:1*, *26*(1), 41–54. https://doi.org/10.1023/B:JOBA.0000007455.08539.94

Greaves, C., Poltawski, L., Garside, R., & Briscoe, S. (2017). Understanding the challenge of weight loss maintenance: a systematic review and synthesis of qualitative research on weight loss maintenance. *Health Psychology Review*, *11*(2), 145–163. https://doi.org/10.1080/17437199.2017.1299583

Greenway, F. L. (2015). Physiological adaptations to weight loss and factors favouring weight regain. *International Journal of Obesity*, *39*(8), 1188–1196. https://doi.org/10.1038/ijo.2015.59

Gribben, J. L., Ilonzo, N., Neifert, S., & Leitman, I. M. (2018). Predictors of reoperation and failure to rescue in bariatric surgery. *Journal of the Society of Laparoendoscopic Surgeons*, *22*(1). https://doi.org/10.4293/JSLS.2017.00074

Grief, S. N., & Miranda, R. L. F. (2010). Weight loss maintenance. *American Family Physician*, *82*(6), 630–634. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=rzh&AN=105104845&site=ehost-live

Gross, J. J. (1999). Emotion regulation: Past, present, future. *Cognition and Emotion*, *13*(5), 551–573. https://doi.org/10.1080/026999399379186

Grunert, K. G., Wills, J., Celemín, L. F., Lähteenmäki, L., Scholderer, J., & Storcksdieck genannt Bonsmann, S. (2012). Socio-demographic and attitudinal determinants of nutrition knowledge of food shoppers in six European countries. *Food Quality and Preference*, *26*(2), 166–177. https://doi.org/10.1016/j.foodqual.2012.04.007

Guasch-Ferré, M., Bulló, M., Martínez-González, M. Á., Ros, E., Corella, D., Estruch, R., … Salas-Salvadó, J. (2013). Frequency of nut consumption and mortality risk in the PREDIMED nutrition intervention trial. *BMC Medicine*, *11*(1), 1–11. https://doi.org/10.1186/1741-7015-11-164/FIGURES/1

Hagger, M. S. (2016). Non-conscious processes and dual-process theories in health psychology. *Health Psychology Review*, *10*(4), 375–380.

https://doi.org/10.1080/17437199.2016.1244647

Hainer, V., & Hainerová, I. A. (2012). Do we need anti-obesity drugs? *Diabetes/Metabolism Research and Reviews*, *28*(SUPPL.2), 8–20. https://doi.org/10.1002/dmrr.2349

Hainer, V., Toplak, H., & Mitrakou, A. (2008). Treatment Modalities of Obesity What fits whom ? *Diabetes Care*, *31*. https://doi.org/10.2337/dc08-s265

Halkjær, J., Olsen, A., Overvad, K., Jakobsen, M. U., Boeing, H., Buijsse, B., … Tjønneland, A. (2010). Intake of total, animal and plant protein and subsequent changes in weight or waist circumference in European men and women: the Diogenes project. *International Journal of Obesity 2011 35:8*, *35*(8), 1104–1113. https://doi.org/10.1038/ijo.2010.254

Hall, K. D., & Guo, J. (2017). Obesity Energetics: Body Weight Regulation and the Effects of Diet Composition. *Gastroenterology*, *152*(7), 1718–1727. https://doi.org/10.1053/j.gastro.2017.01.052

Hall, K. D., Heymsfield, S. B., Kemnitz, J. W., Klein, S., Schoeller, D. A., & Speakman, J. R. (2012). Energy balance and its components: Implications for body weight regulation. *American Journal of Clinical Nutrition*, *95*(4), 989–994. https://doi.org/10.3945/ajcn.112.036350

Hall, K. D., & Kahan, S. (2018). Maintenance of Lost Weight and Long-Term Management of Obesity. *Medical Clinics of North America*, *102*(1), 183–197. https://doi.org/10.1016/j.mcna.2017.08.012

Hall, K. D., Sacks, G., Chandramohan, D., Chow, C. C., Wang, Y. C., Gortmaker, S. L., & Swinburn, B. A. (2011). Quantification of the effect of energy imbalance on bodyweight. *The Lancet*, *378*(9793), 826–837. https://doi.org/10.1016/S0140-6736(11)60812-X

Handjieva-Darlenska, T., Handjiev, S., Larsen, T. M., Van Baak, M. A., Jebb, S., Papadaki, A., … Astrup, A. (2010). Initial weight loss on an 800-kcal diet as a predictor of weight loss success after 8 weeks: the Diogenes study. *European Journal of Clinical Nutrition 2010 64:9*, *64*(9), 994–999. https://doi.org/10.1038/ejcn.2010.110

Hankey, C., Eley, S., Leslie, W., Hunter, C., & Lean, M. (2004). Eating habits, beliefs, attitudes and knowledge among health professionals regarding the links between obesity, nutrition and health. *Public Health Nutrition*, *7*(02), 337–343. https://doi.org/10.1079/PHN2003526

Hansen, T. T., Andersen, S. V., Astrup, A., Blundell, J., & Sjödin, A. (2019). Is reducing appetite beneficial for body weight management in the context of overweight and obesity? A systematic review and meta-analysis from clinical trials assessing body weight management after exposure to satiety enhancing and/or hunger reducing pro. *Obesity Reviews*, (February), 983–997. https://doi.org/10.1111/obr.12854

Hardesty, D. M., & Bearden, W. O. (2004). The use of expert judges in scale development. Implications for improving face validity of measures of unobservable constructs. *Journal of Business Research*, *57*(2), 98–107. https://doi.org/10.1016/S0148-2963(01)00295-8

Harrison, A., Sullivan, S., Tchanturia, K., & Treasure, J. (2010). Emotional functioning in eating disorders: attentional bias, emotion recognition and emotion regulation. *Psychological Medicine*, *40*(11), 1887–1897.

https://doi.org/10.1017/S0033291710000036

Hartmann-Boyce, J., Aveyard, P., Koshiaris, C., & Jebb, S. A. (2016). Development of tools to study personal weight control strategies: OxFAB taxonomy. *Obesity*, *24*(2), 314–320. https://doi.org/10.1002/oby.21341

Hartmann-Boyce, J., Aveyard, P., Piernas, C., Koshiaris, C., Velardo, C., Salvi, D., & Jebb, S. A. (2018). Cognitive and behavioural strategies for weight management in overweight adults: Results from the Oxford Food and Activity Behaviours (OxFAB) cohort study. *PLoS ONE*, 185–201. https://doi.org/10.5287/bodleian

Hartmann-Boyce, J., Boylan, A. M., Jebb, S. A., & Aveyard, P. (2019). Experiences of Self-Monitoring in Self-Directed Weight Loss and Weight Loss Maintenance: Systematic Review of Qualitative Studies. *Qualitative Health Research*, *29*(1), 124–134. https://doi.org/10.1177/1049732318784815

Hartmann-Boyce, J., Theodoulou, A., Oke, J. L., Butler, A. R., Scarborough, P., Bastounis, A., … Aveyard, P. (2021). Association between characteristics of behavioural weight loss programmes and weight change after programme end: systematic review and meta-analysis. *BMJ*, *374*, 1840. https://doi.org/10.1136/BMJ.N1840

Hartmann, C., Dohle, S., & Siegrist, M. (2015). A self-determination theory approach to adults' healthy body weight motivation: A longitudinal study focussing on food choices and recreational physical activity. *Http://Dx.Doi.Org/10.1080/08870446.2015.1006223*, *30*(8), 924–948. https://doi.org/10.1080/08870446.2015.1006223

Hartmann, C., Keller, C., & Siegrist, M. (2016). Compensatory beliefs, nutrition knowledge and eating styles of users and non-users of meal replacement products. *Appetite*, *105*, 775–781. https://doi.org/10.1016/j.appet.2016.07.013

Haughton, C. F., Silfee, V. J., Wang, M. L., Lopez-Cepero, A. C., Estabrook, D. P., Frisard, C., … Lemon, S. C. (2018). Racial/ethnic representation in lifestyle weight loss intervention studies in the United States: A systematic review. *Preventive Medicine Reports*, *9*, 131–137. https://doi.org/10.1016/J.PMEDR.2018.01.012

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach.* Guilford publications.

Heckerman, C. L., Brownell, K. D., & Westlake, R. J. (1978). Self and external monitoring of weight. *Psychological Reports*, *43*(2), 375–378. https://doi.org/10.2466/pr0.1978.43.2.375

Heckhausen, J., & Heckhausen, H. (2018). *Motivation and action, third edition*. *Motivation and Action, Third Edition*. https://doi.org/10.1007/978-3-319-65094-4

Herle, M., Smith, A. D., Bu, F., Steptoe, A., & Fancourt, D. (2021). Trajectories of eating behavior during COVID-19 lockdown: Longitudinal analyses of 22,374 adults. *Clinical Nutrition ESPEN*, *42*, 158–165. https://doi.org/10.1016/j.clnesp.2021.01.046

Herman, C. P., & Mack, D. (1975). Restrained and unrestrained eating. *Journal of Personality*, *43*(4), 647–660.

Herman, C. Peter, & Mack, D. (1975). Restrained and unrestrained eating. *Journal of Personality*, *43*(4), 647–660. https://doi.org/10.1111/J.1467-6494.1975.TB00727.X

Hetherington, M. M., Cunningham, K., Dye, L., Gibson, E. L., Gregersen, N. T., Halford, J.

C. G., … Van Trijp, H. C. M. (2013). Potential benefits of satiety to the consumer: Scientific considerations. *Nutrition Research Reviews*, *26*(1), 22–38. https://doi.org/10.1017/S0954422413000012

Hill, A. J. (2007). The psychology of food craving: Symposium on molecular mechanisms and psychology of food intake. *Proceedings of the Nutrition Society*, *66*(2), 277–285. https://doi.org/10.1017/S0029665107005502

Hill, J. O. (2009). Special Task Force Report: Can a small-changes approach help address the obesity epidemic ? *American Journal of Clinical Nutrition*, *89*(C), 477–484. https://doi.org/10.3945/ajcn.2008.26566.2

Hill, J. O., Peters, J. C., & Wyatt, H. R. (2009). Using the Energy Gap to Address Obesity: A Commentary. *Journal of the American Dietetic Association*, *109*(11), 1848. https://doi.org/10.1016/J.JADA.2009.08.007

Hofmann, W., Rauch, W., & Gawronski, B. (2007). And deplete us not into temptation: Automatic attitudes, dietary restraint, and self-regulatory resources as determinants of eating behavior. *Journal of Experimental Social Psychology*, *43*(3), 497–504. https://doi.org/10.1016/j.jesp.2006.05.004

Hopkins, M., Duarte, C., Beaulieu, K., Finlayson, G., Gibbons, C., Johnstone, A. M., … Stubbs, R. J. (2019). Activity energy expenditure is an independent predictor of energy intake in humans. *International Journal of Obesity*. https://doi.org/10.1038/s41366-018-0308-6

Houston, M., Van Dellen, M., & Cooper, J. A. (2019). Self-weighing Frequency and Its Relationship with Health Measures. *American Journal of Health Behavior*, *43*(5), 975–993. https://doi.org/10.5993/AJHB.43.5.9

Hunot, C., Fildes, A., Croker, H., Llewellyn, C. H., Wardle, J., & Beeken, R. J. (2016). Appetitive traits and relationships with BMI in adults: Development of the Adult Eating Behaviour Questionnaire. *Appetite*, *105*, 356–363. https://doi.org/10.1016/j.appet.2016.05.024

Huttunen-Lenz, M., Hansen, S., Larsen, T. M., Christensen, P., Drummen, M., Adam, T., … Schlicht, W. (2019). The PREVIEW Study. *Https://Doi.Org/10.1027/2512-8442/A000026*, *26*(1), 10–20. https://doi.org/10.1027/2512-8442/A000026

Ikeda, J., Amy, N. K., Ernsberger, P., Gaesser, G. A., Berg, F. M., Clark, C. A., … Peters, P. (2005). The national weight control registry: A critique. *Journal of Nutrition Education and Behavior*, *37*(4), 203–205. https://doi.org/10.1016/S1499-4046(06)60247-9

Jakicic, J. M. (2021). Is More Exercise Better to Prevent Weight Regain? The Jury is Still Out. *Obesity*, *29*(1), 16. https://doi.org/10.1002/OBY.23053

James, B. L., Roe, L. S., Loken, E., & Rolls, B. J. (2018). Early predictors of weight loss in a 1-year behavioural weight-loss programme. *Obesity Science and Practice*, *4*(1), 20–28. https://doi.org/10.1002/osp4.149

James, W. P. T. (2008). The epidemiology of obesity: The size of the problem. *Journal of Internal Medicine*, *263*(4), 336–352. https://doi.org/10.1111/j.1365-2796.2008.01922.x

Janssen, I., Katzmarzyk, P. T., & Ross, R. (2004). Waist circumference and not body mass index explains obesity-related health risk. *American Journal of Clinical Nutrition*, *79*(3), 379–384. https://doi.org/10.1093/ajcn/79.3.379

Janz, N. K., & Becker, M. (1984). “The Health Belief Model: A Decade Later”. Health Education Behavior. *Health Education Quarterly*, *11*(1), 1–47. https://doi.org/doi.org/10.1177/109019818401100101

Jensen, M. D., Ryan, D. H., Apovian, C. M., Ard, J. D., Comuzzie, A. G., Donato, K. A., … Yanovski, S. Z. (2014a). 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: A report of the American college of cardiology/American heart association task force on practice guidelines and the obesity society. *Journal of the American College of Cardiology*, *63*(25 PART B), 2985–3023. https://doi.org/10.1016/j.jacc.2013.11.004

Jensen, M. D., Ryan, D. H., Apovian, C. M., Ard, J. D., Comuzzie, A. G., Donato, K. A., … Yanovski, S. Z. (2014b). 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: A report of the American College of cardiology/American Heart Association task force on practice guidelines and the obesity society. *Circulation*, *129*(25 SUPPL. 1), 102–138. https://doi.org/10.1161/01.cir.0000437739.71477.ee

Jiménez-Cruz, A., De Escobar-Aznar, Y. M., Castillo-Ruiz, O., Gonzalez-Ramirez, R., & Bacardí-Gascón, M. (2012). Beliefs about causes and consequences of obesity among women in two mexican cities. *Journal of Health, Population and Nutrition*, *30*(3), 311–316. https://doi.org/10.3329/jhpn.v30i3.12295

Job, J. R., Fjeldsoe, B. S., Eakin, E. G., & Reeves, M. M. (2018). Effectiveness of extended contact interventions for weight management delivered via text messaging: a systematic review and meta-analysis. *Obesity Reviews*, *19*(4), 538–549. https://doi.org/10.1111/obr.12648

Johannsen, D. L., Knuth, N. D., Huizenga, R., Rood, J. C., Ravussin, E., & Hall, K. D. (2012). Metabolic slowing with massive weight loss despite preservation of fat-free mass. *Journal of Clinical Endocrinology and Metabolism*, *97*(7), 2489–2496. https://doi.org/10.1210/JC.2012-1444

Johns, D. J., Hartmann-Boyce, J., Jebb, S. A., & Aveyard, P. (2014). Diet or exercise interventions vs combined behavioral weight management programs: A systematic review and meta-analysis of directcom parisons. *Journal of the Academy of Nutrition and Dietetics*, *114*(10), 1557–1568. https://doi.org/10.1016/j.jand.2014.07.005

Johnson, F., Pratt, M., & Wardle, J. (2012). Dietary restraint and self-regulation in eating behavior. *International Journal of Obesity*, *36*(5), 665–674. https://doi.org/10.1038/ijo.2011.156

Johnson, S. S., Paiva, A. L., Cummins, C. O., Johnson, J. L., Dyment, S. J., Wright, J. A., … Sherman, K. (2008). Transtheoretical Model-based multiple behavior intervention for weight management: Effectiveness on a population basis. *Preventive Medicine*, *46*(3), 238–246. https://doi.org/10.1016/j.ypmed.2007.09.010

Joki, A., Mäkelä, J., & Fogelholm, M. (2017). Permissive flexibility in successful lifelong weight management: A qualitative study among Finnish men and women. *Appetite*, *116*, 157–163. https://doi.org/10.1016/j.appet.2017.04.031

Jolly, K., Lewis, A., Beach, J., Denley, J., Adab, P., Deeks, J. J., … Aveyard, P. (2011). Comparison of range of commercial or primary care led weight reduction programmes with minimal intervention control for weight loss in obesity: Lighten Up randomised controlled trial. *BMJ (Online)*, *343*(7832), 1035. https://doi.org/10.1136/bmj.d6500

Jones, A. M., Lamp, C., Neelon, M., Nicholson, Y., Schneider, C., Wooten Swanson, P., & Zidenberg-Cherr, S. (2015). Reliability and validity of nutrition knowledge questionnaire for adults. *Journal of Nutrition Education and Behavior*, *47*(1), 69–74. https://doi.org/10.1016/j.jneb.2014.08.003

Jones, B. J., & Bloom, S. R. (2015). The New Era of Drug Therapy for Obesity: The Evidence and the Expectations. *Drugs*, *75*(9), 935–945. https://doi.org/10.1007/s40265-015-0410-1

Jonker, N. C., Bennik, E. C., & de Jong, P. J. (2021). Why Dieters Succeed or Fail: The Relationship Between Reward and Punishment Sensitivity and Restrained Eating and Dieting Success. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/FPSYG.2021.636432

Jorge, R., Santos, I., Tomás, R., Silva, M. N., Carraça, E. V., Teixeira, V. H., & Teixeira, P. J. (2020). Behavioural and psychological pretreatment predictors of short- and long-term weight loss among women with overweight and obesity. *Eating and Weight Disorders*, *25*(5), 1377–1385. https://doi.org/10.1007/s40519-019-00775-9

Jospe, M. R., Haszard, J. J., Taylor, R. W., & Freedhoff, Y. (2020). A tool for assessing the satisfaction of a diet: Development and preliminary validation of the Diet Satisfaction Score. *Nutrition and Dietetics*, *77*(2), 268–273. https://doi.org/10.1111/1747-0080.12591

Jylhä, M. (2009). What is self-rated health and why does it predict mortality? Towards a unified conceptual model. *Social Science and Medicine*, *69*(3), 307–316. https://doi.org/10.1016/j.socscimed.2009.05.013

Kaklamanou, D., Armitage, C. J., & Jones, C. R. (2013). A further look into compensatory health beliefs: A think aloud study. *British Journal of Health Psychology*, *18*(1), 139–154. https://doi.org/10.1111/j.2044-8287.2012.02097.x

Karademas, E. C., Paschali, A., Hadjulis, M., & Papadimitriou, A. (2016). Maladaptive health beliefs, illness-related self-regulation and the role of the information provided by physicians. *Journal of Health Psychology*, *21*(6), 994–1003. https://doi.org/10.1177/1359105314544072

Kärkkäinen, U., Mustelin, L., Raevuori, A., Kaprio, J., & Keski-Rahkonen, A. (2018). Successful weight maintainers among young adults—A ten-year prospective population study. *Eating Behaviors*, *29*(February), 91–98. https://doi.org/10.1016/j.eatbeh.2018.03.004

Karlsson, J., Persson, L. O., Sjöström, L., & Sullivan, M. (2000). Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. *International Journal of Obesity*, *24*(12), 1715–1725. https://doi.org/10.1038/sj.ijo.0801442

Keith, S. W., Redden, D. T., Katzmarzyk, P. T., Boggiano, M. M., Hanlon, E. C., Benca, R. M., … Allison, D. B. (2006). Putative contributors to the secular increase in obesity: Exploring the roads less traveled. *International Journal of Obesity*, *30*(11), 1585–1594. https://doi.org/10.1038/sj.ijo.0803326

Keller, C., & Hartmann, C. (2016). Not merely a question of self-control: The longitudinal effects of overeating behaviors, diet quality and physical activity on dieters' perceived diet success. *Appetite, 107,* 213–221. https://doi.org/10.1016/j.appet.2016.08.007

Keller, C., & Siegrist, M. (2015). The weight management strategies inventory (WMSI). Development of a new measurement instrument, construct validation, and association with dieting success. *Appetite, 92,* 322–336. https://doi.org/10.1016/j.appet.2015.05.037

Kiernan, M., Brown, S. D., Schoffman, D. E., Lee, K., King, A. C., Taylor, C. B., … Perri, M. G. (2013). Promoting healthy weight with "stability skills first": a randomized trial. *Journal of Consulting and Clinical Psychology*, *81*(2), 336–346. https://doi.org/10.1037/A0030544

King, N. A., Caudwell, P. P., Hopkins, M., Stubbs, J. R., Naslund, E., & Blundell, J. E. (2009). Dual-process action of exercise on appetite control: Increase in orexigenic drive but improvement in meal-induced satiety. *American Journal of Clinical Nutrition*, *90*(4), 921–927. https://doi.org/10.3945/ajcn.2009.27706

Kinsey, A. W., Phillips, J., Desmond, R., Gowey, M., Jones, C., Ard, J., … Dutton, G. R. (2021). Factors Associated with Weight Loss Maintenance and Weight Regain Among African American and White Adults Initially Successful at Weight Loss. *Journal of Racial and Ethnic Health Disparities*, 1–20. https://doi.org/10.1007/S40615-021-00985-X/FIGURES/5

Kirk, S. F. L., Penney, T. L., McHugh, T. L. F., & Sharma, A. M. (2012). Effective weight management practice: A review of the lifestyle intervention evidence. *International Journal of Obesity*, *36*(2), 178–185. https://doi.org/10.1038/ijo.2011.80

Kleine, H. D., Mccormack, L. A., Drooger, A., & Meendering, J. R. (2019). Barriers to and Facilitators of Weight Management in Adults Using a Meal Replacement Program That Includes Health Coaching. https://doi.org/10.1177/2150132719851643

Kliemann, N., Wardle, J., Johnson, F., & Croker, H. (2016). Reliability and validity of a revised version of the General Nutrition Knowledge Questionnaire. *European Journal of Clinical Nutrition*, *70*(10), 1174–1180. https://doi.org/10.1038/ejcn.2016.87

Kline, P. (2000). Psychometric theory and method. In *The handbook of psychological testing* (pp. 70–97). London: Routledge. Retrieved from http://solo.bodleian.ox.ac.uk/OXVU1:oxfaleph013703390

Kline, P. (2015). *A Handbook of Test Construction (Psychology Revivals): Introduction to Psychometric Design.* United Kingdom: Taylor & Francis.

Klohe-Lehman, D. M., Freeland-Graves, J., Anderson, E. R., McDowell, T., Clarke, K. K., Hanss-Nuss, H., … Milani, T. J. (2006). Nutrition knowledge is associated with greater weight loss in obese and overweight low-income mothers. *Journal of the American Dietetic Association*, *106*(1), 65–75. https://doi.org/10.1016/j.jada.2005.09.047

Knäuper, B., Rabiau, M., Cohen, O., & Patriciu, N. (2004). Compensatory health beliefs: Scale development and psychometric properties. *Psychology and Health*, *19*(5), 607–624. https://doi.org/10.1080/0887044042000196737

Knell, G., Li, Q., Morales-Marroquin, E., Drope, J., Gabriel, K. P., & Shuval, K. (2021). Physical Activity, Sleep, and Sedentary Behavior among Successful Long-Term Weight Loss Maintainers: Findings from a U.S. National Study. *International Journal of Environmental Research and Public Health 2021*, *Vol. 18*, *Page 5557*, *18*(11), 5557.

https://doi.org/10.3390/IJERPH18115557

Koch, F., Hoffmann, I., & Claupein, E. (2021). Types of Nutrition Knowledge, Their Socio-Demographic Determinants and Their Association With Food Consumption: Results of the NEMONIT Study. *Frontiers in Nutrition*, *8*(February), 1–11. https://doi.org/10.3389/fnut.2021.630014

Kronick, I., Auerbach, R. P., Stich, C., & Knäuper, B. (2011). Compensatory beliefs and intentions contribute to the prediction of caloric intake in dieters. *Appetite*, *57*(2), 435–438. https://doi.org/10.1016/j.appet.2011.05.306

Kruseman, M., Schmutz, N., & Carrard, I. (2017). Long-Term Weight Maintenance Strategies Are Experienced as a Burden by Persons Who Have Lost Weight Compared to Persons with a lifetime Normal, Stable Weight. *Obesity Facts*, *10*(4), 373–385. https://doi.org/10.1159/000478096

Larsen, S. C., Horgan, G., Mikkelsen, M. L. K., Palmeira, A. L., Scott, S., Duarte, C., … Heitmann, B. L. (2020). Consistent sleep onset and maintenance of body weight after weight loss: An analysis of data from the NoHoW trial. *PLoS Medicine*, *17*(7), 1–18. https://doi.org/10.1371/journal.pmed.1003168

Larsen, T. M., Dalskov, S., Van Baak, M., Jebb, S., Kafatos, A., Pfeiffer, A., … Astrup, A. (2010). The Diet, Obesity and Genes (Diogenes) Dietary Study in eight European countries – a comprehensive design for long-term intervention. *Obesity Reviews*, *11*(1), 76–91. https://doi.org/10.1111/J.1467-789X.2009.00603.X

Lavelle, F., Bucher, T., Dean, M., Brown, H. M., Rollo, M. E., & Collins, C. E. (2020). Diet quality is more strongly related to food skills rather than cooking skills confidence: Results from a national cross-sectional survey. *Nutrition and Dietetics*, *77*(1), 112–120. https://doi.org/10.1111/1747-0080.12583

Lawlor, E. R., Hughes, C. A., Duschinsky, R., Pountain, G. D., Hill, A. J., Griffin, S. J., & Ahern, A. L. (2020). Cognitive and behavioural strategies employed to overcome “lapses” and prevent “relapse” among weight-loss maintainers and regainers: A qualitative study. *Clinical Obesity*, *10*(5), 1–11. https://doi.org/10.1111/cob.12395

Lawlor, E. R., Islam, N., Bates, S., Griffin, S. J., Hill, A. J., Hughes, C. A., … Ahern, A. L. (2020). Third-wave cognitive behaviour therapies for weight management: A systematic review and network meta-analysis. *Obesity Reviews*, *21*(7), 1–21. https://doi.org/10.1111/obr.13013

Leary, M. R., Tate, E. B., Adams, C. E., Allen, A. B., & Hancock, J. (2007). Self-compassion and reactions to unpleasant self-relevant events: The implications of treating oneself kindly. *Journal of Personality and Social Psychology*, *92*(5), 887–904. https://doi.org/10.1037/0022-3514.92.5.887

Lewin, K. (2004). Intention, will and need. In *Organization and pathology of thought: Selected sources.* (pp. 95–153). Columbia University Press. https://doi.org/10.1037/10584-005

Lilienfeld, S. O., & Strother, A. N. (2020). Psychological measurement and the replication crisis: Four sacred cows. *Canadian Psychology*, *61*(4), 281–288. https://doi.org/10.1037/cap0000236

Llewellyn, C., & Wardle, J. (2015). Behavioral susceptibility to obesity: Gene-environment interplay in the development of weight. *Physiology and Behavior*, *152*, 494–501. https://doi.org/10.1016/j.physbeh.2015.07.006

Long, C. L., Nelson, K. M., Weinsier, R. L., & Schutz, Y. (1992). Prediction of resting energy expenditure from fat-free mass and fat mass. *The American Journal of Clinical Nutrition*, *56*(5), 848–856. https://doi.org/10.1093/ajcn/56.5.848

Lowe, M. R. (1993). The effect of dieting on eating behavior: A three-factor model. *Psychological Bulletin*, *114*(1).

Lowe, M. R. (2003). Self-Regulation of Energy Intake in the Prevention and Treatment of Obesity: Is It Feasible? *Obesity Research*, *11*(S10), 44S-59S. https://doi.org/10.1038/OBY.2003.223

Lowe, M. R., & Butryn, M. L. (2007). Hedonic hunger: A new dimension of appetite? *Physiology and Behavior*, *91*(4), 432–439. https://doi.org/10.1016/j.physbeh.2007.04.006

Lowe, M. R., & Timko, C. A. (2004). What a difference a diet makes: Towards an understanding of differences between restrained dieters and restrained nondieters. *Eating Behaviors*, *5*(3), 199–208. https://doi.org/10.1016/j.eatbeh.2004.01.006

Lv, N., Azar, K. M. J., Rosas, L. G., Wulfovich, S., Xiao, L., & Ma, J. (2017). Behavioral lifestyle interventions for moderate and severe obesity: A systematic review. *Preventive Medicine*, *100*, 180–193. https://doi.org/10.1016/j.ypmed.2017.04.022

Macht, M. (2008). How emotions affect eating: A five-way model. *Appetite*, *50*(1), 1–11. https://doi.org/10.1016/j.appet.2007.07.002

MacLean, P. S., Bergouignan, A., Cornier, M. A., & Jackman, M. R. (2011). Biology's response to dieting: The impetus for weight regain. *American Journal of Physiology - Regulatory Integrative and Comparative Physiology*, *301*(3). https://doi.org/10.1152/ajpregu.00755.2010

MacLean, P. S., Wing, R. R., Davidson, T., Epstein, L., Goodpaster, B., Hall, K. D., … Ryan, D. (2015). NIH working group report: Innovative research to improve maintenance of weight loss. *Obesity (Silver Spring, Md.)*, *23*(1), 7–15. https://doi.org/10.1002/oby.20967

MacMahon, S., Baigent, C., Duffy, S., Rodgers, A., Tominaga, S., Chambless, L., … Whitlock, G. (2009). Body-mass index and cause-specific mortality in 900 000 adults: Collaborative analyses of 57 prospective studies. *The Lancet*, *373*(9669), 1083–1096. https://doi.org/10.1016/S0140-6736(09)60318-4

Magkos, F., Fraterrigo, G., Yoshino, J., Luecking, C., Kirbach, K., Kelly, S. C., … Klein, S. (2016). Effects of Moderate and Subsequent Progressive Weight Loss on Metabolic Function and Adipose Tissue Biology in Humans with Obesity. *Cell Metabolism*, *23*(4), 591–601. https://doi.org/10.1016/j.cmet.2016.02.005

Makiabadi, E., Kaveh, M. H., & Mahmoodi, M. R. (2019). Enhancing Nutrition-Related Literacy , Knowledge and Behavior among University Students : A Randomized Controlled Trial, *4*(September), 122–129.

Mallan, K. M., Fildes, A., de la Piedad Garcia, X., Drzezdzon, J., Sampson, M., & Llewellyn, C. (2017). Appetitive traits associated with higher and lower body mass index: Evaluating the validity of the adult eating behaviour questionnaire in an Australian sample. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(1), 1–8. https://doi.org/10.1186/s12966-017-0587-7

Mann, T., Tomiyama, A. J., Westling, E., Lew, A. M., Samuels, B., & Chatman, J. (2007). Medicare's Search for Effective Obesity Treatments: Diets Are Not the Answer. *American Psychologist*, *62*(3), 220–233. https://doi.org/10.1037/0003-066X.62.3.220

Mantzios, M., & Wilson, J. C. lare. (2015). Mindfulness, Eating Behaviours, and Obesity: A Review and Reflection on Current Findings. *Current Obesity Reports*, *4*(1), 141–146. https://doi.org/10.1007/s13679-014-0131-x

Markland, D., & Tobin, V. (2004). A Modification to the Behavioural Regulation in Exercise Questionnaire to Include an Assessment of Amotivation. *Journal of Sport and Exercise Psychology*, *26*(2), 191–196. https://doi.org/10.1123/JSEP.26.2.191

Martins, C., Morgan, L., & Truby, H. (2008). A review of the effects of exercise on appetite regulation: An obesity perspective. *International Journal of Obesity*, *32*(9), 1337–1347. https://doi.org/10.1038/ijo.2008.98

Martins, C., Dutton, G. R., Hunter, G. R., & Gower, B. A. (2020). Revisiting the Compensatory Theory as an explanatory model for relapse in obesity management. *The American Journal of Clinical Nutrition*, *112*(5), 1170–1179. https://doi.org/10.1093/AJCN/NQAA243

Martins, C., Gower, B. A., Hill, J. O., & Hunter, G. R. (2020). Metabolic adaptation is not a major barrier to weight-loss maintenance. *The American Journal of Clinical Nutrition*, *112*(3), 558–565. https://doi.org/10.1093/AJCN/NQAA086

Martins, C., Roekenes, J., Salamati, S., Gower, B. A., & Hunter, G. R. (2020). Metabolic adaptation is an illusion, only present when participants are in negative energy balance. *The American Journal of Clinical Nutrition*, *112*(5), 1212–1218. https://doi.org/10.1093/AJCN/NQAA220

Mata, J., Todd, P. M., & Lippke, S. (2010). When weight management lasts. Lower perceived rule complexity increases adherence. *Appetite*, *54*(1), 37–43. https://doi.org/10.1016/j.appet.2009.09.004

Mathew, A. C., Anithadevi, T. S., & Shamna, R. (2012). Validity of self-reported height and weight and factors associated with errors in self-report, (November).

Matsumoto, M., Ishige, N., Sakamoto, A., Saito, A., & Ikemoto, S. (2019). Nutrition knowledge related to breakfast skipping among Japanese adults aged 18-64 years: A cross-sectional study. *Public Health Nutrition*, *22*(6), 1029–1036. https://doi.org/10.1017/S1368980018003014

Mauro, M., Taylor, V., Wharton, S., & Sharma, A. M. (2008). Barriers to obesity treatment. *European Journal of Internal Medicine*, *19*(3), 173–180. https://doi.org/10.1016/j.ejim.2007.09.011

McCoy, C. E. (2017). Understanding the Intention-to-treat Principle in Randomized Controlled Trials. *Western Journal of Emergency Medicine*, *18*(6), 1075. https://doi.org/10.5811/WESTJEM.2017.8.35985

McGuire, M. T., Wing, R. R., Klem, M. L., Lang, W., & Hill, J. O. (1999). What predicts weight regain in a group of successful weight losers? *Journal of Consulting and Clinical Psychology*, *67*(2), 177–185.

Mcguire, M. T., Wing, R. R., Klem, M. L., Seagle, H. M., & Hill, J. O. (1998). Long-term maintenance of weight loss : Do people who lose weight through various weight loss methods use different behaviors to maintain their weight. *International Journal of Obesity*, (July). https://doi.org/10.1038/sj.ijo.0800627

Melby, C. L., Paris, H. L., Drew Sayer, R., Bell, C., & Hill, J. O. (2019). Increasing Energy Flux to Maintain Diet-Induced Weight Loss. *Nutrients 2019, Vol. 11, Page 2533*, *11*(10), 2533. https://doi.org/10.3390/NU11102533

Meule, A., Papies, E. K., & Kübler, A. (2012). Differentiating between successful and unsuccessful dieters. Validity and reliability of the Perceived Self-Regulatory Success in Dieting Scale. *Appetite*, *58*(3), 822–826. https://doi.org/10.1016/j.appet.2012.01.028

Michie, S., Stralen, M. Van, & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *42*(6). https://doi.org/10.1001/archderm.1985.01660070119033

Mikhail, D., Rolls, B., Yost, K., Margaret, J. B., Kristen, G., Paul, B., … Jensen, M. (2020). Development and validation testing of a weight management nutrition knowledge questionnaire for adults. *International Journal of Obesity*. https://doi.org/10.1038/s41366-019-0510-1

Milton, K., Bull, F. C., & Bauman, A. (2011). Reliability and validity testing of a single-item physical activity measure. *British Journal of Sports Medicine*, *45*(3), 203–208. https://doi.org/10.1136/bjsm.2009.068395

Miquelon, P., Knäuper, B., & Vallerand, R. J. (2012). Motivation and goal attainment. The role of compensatory beliefs. *Appetite*, *58*(2), 608–615. https://doi.org/10.1016/j.appet.2011.12.025

Mitchell, E. S., Yang, Q., Ho, A. S., Behr, H., May, C. N., Deluca, L., & Michaelides, A. (2021). Self-reported nutritional factors are associated with weight loss at 18 months in a self-managed commercial program with food categorization system: Observational study. *Nutrients*, *13*(5), 1–15. https://doi.org/10.3390/nu13051733

Moilanen, K. L. (2007). The adolescent Self-Regulatory inventory: The development and validation of a questionnaire of short-Term and long-term self-Regulation. *Journal of Youth and Adolescence*, *36*(6), 835–848. https://doi.org/10.1007/s10964-006-9107-9

Monaghan, G. (2017). Exploring Distorted Thinking About Food and Dietary Misinformation in Nonclinical Samples: Instrument and Intervention Development and Validation. Retrieved from https://www.ruor.uottawa.ca/handle/10393/36895

Montori, V. M., & Guyatt, G. H. (2001). Montori, Guyatt - 2001 - Intention-to-treat principle, *165*(10), 1339–1341.

Morgado, F. F. R., Meireles, J. F. F., Neves, C. M., Amaral, A. C. S., & Ferreira, M. E. C. (2017). Scale development: ten main limitations and recommendations to improve future research practices. *Psicologia: Reflexão e Crítica 2017 30:1*, *30*(1), 1–20. https://doi.org/10.1186/S41155-016-0057-1

Mötteli, S., Barbey, J., Keller, C., Bucher, T., & Siegrist, M. (2016). Measuring practical knowledge about balanced meals: Development and validation of the brief PKB-7 scale. *European Journal of Clinical Nutrition*, *70*(4), 505–510. https://doi.org/10.1038/ejcn.2015.173

Mötteli, S., Barbey, J., Keller, C., Bucher, T., & Siegrist, M. (2017). Development and Validation of a Brief Instrument to Measure Knowledge About the Energy Content of Meals. *Journal of Nutrition Education and Behavior*, *49*(3), 257-263.e1. https://doi.org/10.1016/j.jneb.2016.12.002

Mötteli, S., Siegrist, M., & Keller, C. (2017). Women's social eating environment and its associations with dietary behavior and weight management. *Appetite*, *110*, 86–93. https://doi.org/10.1016/j.appet.2016.12.014

Müller, M. J., Enderle, J., & Bosy-Westphal, A. (2016). Changes in Energy Expenditure with Weight Gain and Weight Loss in Humans. *Current Obesity Reports*, *5*(4), 413–423. https://doi.org/10.1007/s13679-016-0237-4

Murawski, M. E., Vanessa, M. A., Ross, K. M., Rickel, K. A., Debraganza, N., Gibbons, L. M., & Perri, M. G. (2009). Problem Solving, Treatment Adherence, and Weight-Loss Outcome Among Women Participating in Lifestyle Treatment for Obesity. *Eating Behaviors*, *10*(3), 146–151. https://doi.org/10.1016/j.eatbeh.2009.03.005.Problem

Nakeshbandi, M., Maini, R., Daniel, P., Rosengarten, S., Parmar, P., Wilson, C., … Breitman, I. (2020). The impact of obesity on COVID-19 complications: a retrospective cohort study. *International Journal of Obesity*, *44*(9), 1832–1837. https://doi.org/10.1038/s41366-020-0648-x

Napolitano, C. M., Callina, K. S., & Mueller, M. K. (2013). Comparing Alternate Approaches to Calculating Reliability for Dichotomous Data: The Sample Case of Adolescent Selection, Optimization, and Compensation. *Applied Developmental Science*, *17*(3), 148–151. https://doi.org/10.1080/10888691.2013.804372

Naude, C. E., Schoonees, A., Senekal, M., Young, T., Garner, P., & Volmink, J. (2014). Low carbohydrate versus isoenergetic balanced diets for reducing weight and cardiovascular risk: A systematic review and meta-analysis. *PLoS ONE*, *9*(7). https://doi.org/10.1371/journal.pone.0100652

Naughton, F., Ward, E., Khondoker, M., Belderson, P., Marie Minihane, A., Dainty, J., … Notley, C. (2021). Health behaviour change during the UK COVID-19 lockdown: Findings from the first wave of the C-19 health behaviour and well-being daily tracker study. *British Journal of Health Psychology*. https://doi.org/10.1111/bjhp.12500

Neal, D. T., Wood, W., & Drolet, A. (2013). How do people adhere to goals when willpower is low? The profits (and pitfalls) of strong habits. *Journal of Personality and Social Psychology*, *104*(6), 959–975. https://doi.org/10.1037/a0032626

Neal, D. T., Wood, W., Wu, M., & Kurlander, D. (2011). The pull of the past: When do habits persist despite conflict with motives? *Personality and Social Psychology Bulletin*, *37*(11), 1428–1437. https://doi.org/10.1177/0146167211419863

Neff, K. D. (2003). Self-Compassion: An Alternative Conceptualization of a Healthy Attitude Toward Oneself. *Self and Identity*, *2*(2), 85–101. https://doi.org/10.1080/15298860309032

Neff, K. D. (2003). The Development and Validation of a Scale to Measure Self-Compassion. *Self and Identity*, *2*(3), 223–250. https://doi.org/10.1080/15298860309027

Neff, K. D., & Germer, C. K. (2013). A Pilot Study and Randomized Controlled Trial of the Mindful Self-Compassion Program. *Journal of Clinical Psychology*, *69*(1), 28–44.

https://doi.org/10.1002/JCLP.21923

Ng, J. Y. Y., Ntoumanis, N., Thøgersen-Ntoumani, C., Deci, E. L., Ryan, R. M., Duda, J. L., & Williams, G. C. (2012). Self-Determination Theory Applied to Health Contexts: A Meta-Analysis. *Perspectives on Psychological Science*, *7*(4), 325–340. https://doi.org/10.1177/1745691612447309

Nguyen, C., & Polivy, J. (2014). Eating behavior, restraint status, and BMI of individuals high and low in perceived self-regulatory success. *Appetite*, *75*, 49–53. https://doi.org/10.1016/j.appet.2013.12.016

NHS. (2019). Statistics on Obesity, Physical Activity and Diet England 2019 Statistics on Obesity, Physical Activity and Diet: England 2019. *Statistics on Obesity, Physical Activity and Diet*, *17*(May), 24. Retrieved from https://digital.nhs.uk/data-and-information/publications/statistical/statistics-on-obesity-physical-activity-and-diet/statistics-on-obesity-physical-activity-and-diet-england-2019

NICE. (2014). Weight management: lifestyle services for overweight or obese adults. Public health guideline [PH53]. Retrieved January 12, 2022, from https://www.nice.org.uk/guidance/ph53/chapter/1-Recommendations

Nicola, M., Alsafi, Z., Sohrabi, C., Kerman, A., Al-Jabir, A., Iosifidis, C., … Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International Journal of Surgery*, (January), 19–21. https://doi.org/10.1007/s00134-020-05991-x.Bizzarro

Nikčević, A. V., Marino, C., Caselli, G., & Spada, M. M. (2017). The importance of thinking styles in predicting binge eating. *Eating Behaviors*, *26*, 40–44. https://doi.org/10.1016/j.eatbeh.2017.01.002

Noar, S. M., & Zimmerman, R. S. (2005). Health Behavior Theory and cumulative knowledge regarding health behaviors: Are we moving in the right direction? *Health Education Research*, *20*(3), 275–290. https://doi.org/10.1093/her/cyg113

Nolan, L. J., & Jenkins, S. M. (2019). Food Addiction Is Associated with Irrational Beliefs via Trait Anxiety and Emotional Eating. *Nutrients 2019, Vol. 11, Page 1711*, *11*(8), 1711. https://doi.org/10.3390/NU11081711

Nordmann, A. J. A., Nordmann, A. J. A., Briel, M., Keller, U., Yancy, W. S., Brehm, B. J., & Bucher, H. C. (2006). Effects of Low-Carbohydrate vs Low-Fat Diets on Weight Loss and Cardiovascular Risk Factors. *Archives of Internal Medicine*, *166*(3), 285. https://doi.org/10.1001/archinte.166.3.285

Nordmo, M. M., Danielsen, Y. S., Nordmo, M. M., Sørebø, Y., & Magnus, D. (2020). The challenge of keeping it off, a descriptive systematic review of high-quality, follow-up studies of obesity treatments. *Obesity Reviews*, *21*(1), 1–15. https://doi.org/10.1111/obr.12949

Nurkkala, M., Kaikkonen, K., Vanhala, M. L., Karhunen, L., Keränen, A. M., & Korpelainen, R. (2015). Lifestyle intervention has a beneficial effect on eating behavior and long-term weight loss in obese adults. *Eating Behaviors*, *18*, 179–185. https://doi.org/10.1016/j.eatbeh.2015.05.009

Nymo, S., Coutinho, S. R., Rehfeld, J. F., Truby, H., Kulseng, B., & Martins, C. (2019). Physiological Predictors of Weight Regain at 1-Year Follow-Up in Weight-Reduced

Adults with Obesity. *Obesity*, *00*(00), 1–7. https://doi.org/10.1002/oby.22476

O'Brien, G., & Davies, M. (2007). Nutrition knowledge and body mass index. *Health Education Research*, *22*(4), 571–575. https://doi.org/10.1093/her/cyl119

O'Brien, J. D., Kahn, R. M., Zenko, Z., Fernandez, J. R., & Ariely, D. (2018). Naïve models of dietary splurges: Beliefs about caloric compensation and weight change following non-habitual overconsumption. *Appetite*, *128*(June), 321–332. https://doi.org/10.1016/j.appet.2018.06.016

O'Brien, P. E., Hindle, A., Brennan, L., Skinner, S., Burton, P., Smith, A., … Brown, W. (2019). Long-Term Outcomes After Bariatric Surgery: a Systematic Review and Meta-analysis of Weight Loss at 10 or More Years for All Bariatric Procedures and a Single-Centre Review of 20-Year Outcomes After Adjustable Gastric Banding. *Obesity Surgery*, *29*(1), 3–14. https://doi.org/10.1007/s11695-018-3525-0

O'Halloran, P., Kingsley, M., Nicholson, M., Staley, K., Randle, E., Wright, A., & Bauman, A. (2020). Responsiveness of the single item measure to detect change in physical activity. *PLoS ONE*, *15*(6 June), 1–13. https://doi.org/10.1371/journal.pone.0234420

Ogden, J. (2000). The correlates of long-term weight loss: a group comparison study of obesity. *International Journal of Obesity and Related Metabolic Disorders : Journal of the International Association for the Study of Obesity*, *24*(8), 1018–1025. https://doi.org/10.1038/sj.ijo.0801354

Ogden, J., Oikonomou, E., & Alemany, G. (2017). Distraction, restrained eating and disinhibition: An experimental study of food intake and the impact of "eating on the go." *Journal of Health Psychology*, *22*(1), 39–50. https://doi.org/10.1177/1359105315595119

Okamoto, N., Hosono, A., Shibata, K., Tsujimura, S., Oka, K., Fujita, H., … Suzuki, S. (2017). Accuracy of self-reported height, weight and waist circumference in a Japanese sample. *Obesity Science & Practice*, *3*(4), 417–424. https://doi.org/10.1002/osp4.122

Ollberding, N., Wolf, R., & Contento, I. (2010). Food label use and its relation to–diatery intake among US adults. *Journal of American Dietetic Association*, *110*(8).

Oppenheimer, D. M., Meyvis, T., & Davidenko, N. (2009). Instructional manipulation checks: Detecting satisficing to increase statistical power. *Journal of Experimental Social Psychology*, *45*(4), 867–872. https://doi.org/10.1016/j.jesp.2009.03.009

Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology*, *29*(4), 374–383. https://doi.org/10.1037/a0019596

Osberg, T. M., & Eggert, M. (2012). Direct and indirect effects of stress on bulimic symptoms and BMI: The mediating role of irrational food beliefs. *Eating Behaviors*, *13*(1), 54–57. https://doi.org/10.1016/j.eatbeh.2011.09.008

Osberg, T. M., Poland, D., Aguayo, G., & MacDougall, S. (2008). The Irrational Food Beliefs Scale: Development and validation. *Eating Behaviors*, *9*(1), 25–40. https://doi.org/10.1016/j.eatbeh.2007.02.001

Osborne, J., Osborne, J. W., Costello, A. B., & Kellow, J. T. (2011). Best Practices in Exploratory Factor Analysis. *Best Practices in Quantitative Methods*, 86–99. https://doi.org/10.4135/9781412995627.d8

Ostendorf, D. M., Blankenship, J. M., Grau, L., Arbet, J., Mitchell, N. S., Creasy, S. A., … Catenacci, V. A. (2021). Predictors of long-term weight loss trajectories during a behavioral weight loss intervention: An exploratory analysis. *Obesity Science & Practice*, *7*(5), 569–582. https://doi.org/10.1002/OSP4.530

Ostendorf, D. M., Caldwell, A. E., Creasy, S. A., Pan, Z., Lyden, K., Bergouignan, A., … Catenacci, V. A. (2019). Physical Activity Energy Expenditure and Total Daily Energy Expenditure in Successful Weight Loss Maintainers. *Obesity*, *27*(3), 496–504. https://doi.org/10.1002/oby.22373

Ostendorf, D. M., Melanson, E. L., Caldwell, A. E., Creasy, S. A., Pan, Z., Maclean, P. S., … Catenacci, V. A. (2018). No consistent evidence of a disproportionately low resting energy expenditure in long-term successful weight-loss maintainers. *American Journal of Clinical Nutrition*, *108*(4), 658–666. https://doi.org/10.1093/ajcn/nqy179

Pacanowski, C. R., Bertz, F., & Levitsky, D. A. (2014). Daily self-weighing to control body weight in adults: A critical review of the literature. *SAGE Open*, *4*(4). https://doi.org/10.1177/2158244014556992

Paixão, C., Dias, C. M., Jorge, R., Carraça, E. V., Yannakoulia, M., de Zwaan, M., … Santos, I. (2020). Successful weight loss maintenance: A systematic review of weight control registries. *Obesity Reviews*, (January), 2008–2011. https://doi.org/10.1111/obr.13003

Parmenter, K., Waller, J., & Wardle, J. (2000). Demographic variation in nutrition knowledge in England. *Health Education Research*, *15*(2), 163–174. https://doi.org/10.1093/her/15.2.163

Parmenter, K., & Wardle, J. (1999). Development of a general nutrition knowledge questionnaire for adults. *European Journal of Clinical Nutrition*, *53*(4), 298–308. https://doi.org/10.1038/sj.ejcn.1600726

Pasman, W. J. (1999). Predictors of weight maintenance. *Obesity Research*, *7*(1), 43–50. https://doi.org/10.1002/j.1550-8528.1999.tb00389.x

Pedersen, S., Sniehotta, F. F., Sainsbury, K., Evans, E. H., Marques, M. M., Stubbs, R. J., … Lähteenmäki, L. (2018). The complexity of self-regulating food intake in weight loss maintenance. A qualitative study among short- and long-term weight loss maintainers. *Social Science and Medicine*, *208*, 18–24. https://doi.org/10.1016/j.socscimed.2018.05.016

Pelletier, L. G., Dion, S. C., Slovinec-D'Angelo, M., & Reid, R. (2004). Why do you regulate what you eat? Relationships between forms of regulation, eating behaviors, sustained dietary behavior change, and psychological adjustment. *Motivation and Emotion*, *28*(3), 245–277. https://doi.org/10.1023/B:MOEM.0000040154.40922.14

Phelan, S., Halfman, T., Pinto, A. M., & Foster, G. D. (2020). Behavioral and Psychological Strategies of Long-Term Weight Loss Maintainers in a Widely Available Weight Management Program. *Obesity*, *28*(2), 421–428. https://doi.org/10.1002/oby.22685

Pi-Sunyer, X. (2009). The medical risks of obesity. *Postgraduate Medicine*, *121*(6), 21–33. https://doi.org/10.3810/pgm.2009.11.2074

Pinto, A. M., Fava, J. L., Raynor, H. A., Larose, J. G., & Wing, R. R. (2013). Development and validation of the weight control strategies scale. *Obesity*, *21*(12), 2429–2436. https://doi.org/10.1002/oby.20368

Poelman, M. P., Dijkstra, S. C., Sponselee, H., Kamphuis, C. B. M., Battjes-Fries, M. C. E., Gillebaart, M., & Seidell, J. C. (2018). Towards the measurement of food literacy with respect to healthy eating: The development and validation of the self perceived food literacy scale among an adult sample in the Netherlands. *International Journal of Behavioral Nutrition and Physical Activity*, *15*(1), 1–12. https://doi.org/10.1186/s12966-018-0687-z

Poelman, M. P., Vermeer, W. M., Vyth, E. L., & Steenhuis, I. H. (2013). I don't have to go to the gym because I ate very healthy today: The development of a scale to assess diet-related compensatory health beliefs. *Public Health Nutrition*, *16*(2), 267–273. https://doi.org/10.1017/S1368980012002650

Polit, D. F. (2014). Getting serious about test-retest reliability: A critique of retest research and some recommendations. *Quality of Life Research*, *23*(6), 1713–1720. https://doi.org/10.1007/s11136-014-0632-9

Polivy, J., & Herman, C. P. (2017). Restrained Eating and Food Cues: Recent Findings and Conclusions. *Current Obesity Reports*, *6*(1), 79–85. https://doi.org/10.1007/s13679-017-0243-1

Polivy, J., Herman, C. P., & Deo, R. (2010). Getting a bigger slice of the pie. Effects on eating and emotion in restrained and unrestrained eaters. *Appetite*, *55*(3), 426–430. https://doi.org/10.1016/j.appet.2010.07.015

Polivy, J., Herman, C. P., & Mills, J. S. (2020). What is restrained eating and how do we identify it? *Appetite*, *155*(July), 104820. https://doi.org/10.1016/j.appet.2020.104820

Polivy, J., Herman, C. P., & Warsh, S. (1978). Internal and external components of emotionality in restrained and unrestrained eaters. *Journal of Abnormal Psychology*, *87*(5), 497–504. https://doi.org/10.1037/0021-843X.87.5.497

Pool, E., Brosch, T., Delplanque, S., & Sander, D. (2016). Article Attentional Bias for Positive Emotional Stimuli : A Meta-Analytic Investigation Reference Attentional Bias for Positive Emotional Stimuli : A Meta-Analytic Investigation. *Psychological Bulletin*, *142*(1), 79–106. https://doi.org/10.1037/bul0000026

Popkin, B. M., Du, S., Green, W. D., Beck, M. A., Algaith, T., Herbst, C. H., … Shekar, M. (2020). Individuals with obesity and COVID-19: A global perspective on the epidemiology and biological relationships. *Obesity Reviews*, *21*(11), 1–17. https://doi.org/10.1111/obr.13128

Prentice, A. M., & Jebb, S. A. (2001). Beyond body mass index. *Obesity Reviews*, *2*(3), 141–147. https://doi.org/10.1046/j.1467-789x.2001.00031.x

Prestwich, A., Kellar, I., Prestwich, A., Kellar, I., Parker, R., Macrae, S., … Macrae, S. (2013). How can self-efficacy be increased ? Meta- analysis of dietary interventions How can self-efficacy be increased ? Meta-analysis of dietary interventions, (December 2015). https://doi.org/10.1080/17437199.2013.813729

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology*, *51*(3), 390–395. https://doi.org/10.1037/0022-006X.51.3.390

Rabiau, M. A. (2007). *Balancing temptations and health goals: The role of compensatory health beliefs. Dissertation Abstracts International: Section B: The Sciences and*

*Engineering* (Vol. 68). Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2007-99018-392&site=ehost-live

Rabiau, M., Knäuper, B., & Miquelon, P. (2006). The eternal quest for optimal balance between maximizing pleasure and minimizing harm: The compensatory health beliefs model. *British Journal of Health Psychology*, *11*(1), 139–153. https://doi.org/10.1348/135910705X52237

Radtke, T., Inauen, J., Rennie, L., Orbell, S., & Scholz, U. (2014). Trait Versus State. *Http://Dx.Doi.Org/10.1026/0943-8149/A000125*, *22*(4), 156–164. https://doi.org/10.1026/0943-8149/A000125

Radtke, T., Kaklamanou, D., Scholz, U., Hornung, R., & Armitage, C. J. (2014). Are diet-specific compensatory health beliefs predictive of dieting intentions and behaviour? *Appetite*, *76*, 36–43. https://doi.org/10.1016/j.appet.2014.01.014

Rahimi-Ardabili, H., Reynolds, R., Vartanian, L. R., McLeod, L. V. D., & Zwar, N. (2018). A Systematic Review of the Efficacy of Interventions that Aim to Increase Self-Compassion on Nutrition Habits, Eating Behaviours, Body Weight and Body Image. *Mindfulness*, *9*(2), 388–400. https://doi.org/10.1007/s12671-017-0804-0

Ramage, S., Farmer, A., Apps Eccles, K., & McCargar, L. (2014). Healthy strategies for successful weight loss and weight maintenance: a systematic review. *Applied Physiology, Nutrition, and Metabolism*, *39*(1), 1–20. https://doi.org/10.1139/apnm-2013-0026

Ramezanzade, H., & Arabnarmi, B. (2019). The role of irrational beliefs in the sport behavior of female student in different stages of exercise behavior change. *Sports Psychology*, *4*(2), 1–18. https://doi.org/10.29252/MBSP.4.2.1

Rapson, J., Conlon, C., Beck, K., von Hurst, P., & Ali, A. (2020). The development of a psychometrically valid and reliable questionnaire to assess nutrition knowledge related to pre-schoolers. *Nutrients*, *12*(7), 1–10. https://doi.org/10.3390/nu12071964

Rasch, G. (1993). *Probabilistic models for some intelligence and attainment tests*. Retrieved from https://eric.ed.gov/?id=ED419814

Rhodes, R. E., Gray, S. M., & Husband, C. (2019). Experimental manipulation of affective judgments about physical activity: a systematic review and meta-analysis of adults. *Health Psychology Review*, *13*(1), 18–34. https://doi.org/10.1080/17437199.2018.1530067

Richards, R., Jones, R. A., Whittle, F., Hughes, C. A., Hill, A. J., Lawlor, E. R., … Ahern, A. L. (2022). Development of a Web-Based, Guided Self-help, Acceptance and Commitment Therapy–Based Intervention for Weight Loss Maintenance: Evidence-, Theory-, and Person-Based Approach. *JMIR Formative Research*, *6*(1), e31801. https://doi.org/10.2196/31801

Robert, M., Deschasaux-Tanguy, M. M., Shankland, R., Druesne-Pecollo, N., Esseddik, Y., Peneau, S., … Péneau, S. (2022). Positive psychological traits are associated with changes in dietary behavior related to COVID-19 lockdown in a general population-based study. *Appetite*, *169*, 105507. https://doi.org/10.1016/J.APPET.2021.105507

Robinson, E., Boyland, E., Chisholm, A., Harrold, J., Maloney, N. G., Marty, L., …

Hardman, C. A. (2020). Obesity, eating behavior and physical activity during COVID-19 lockdown: A study of UK adults. *Appetite*, *156*(June 2020), 104853. https://doi.org/10.1016/j.appet.2020.104853

Robinson, E., Gillespie, S., & Jones, A. (2020). Weight-related lifestyle behaviours and the COVID-19 crisis: An online survey study of UK adults during social lockdown. *Obesity Science and Practice*, (June), 1–6. https://doi.org/10.1002/osp4.442

Robinson, M. A. (2018). Using multi-item psychometric scales for research and practice in human resource management. *Human Resource Management*, *57*(3), 739–750. https://doi.org/10.1002/hrm.21852

Rodriguez, N. R., DiMarco, N. M., & Langley, S. (2009). Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. *Journal of the American Dietetic Association*, *109*(3), 509–527. https://doi.org/10.1016/J.JADA.2009.01.005

Rogers, P. J. (2018). The role of low-calorie sweeteners in the prevention and management of overweight and obesity: Evidence v. conjecture. *Proceedings of the Nutrition Society*, *77*(3), 230–238. https://doi.org/10.1017/S0029665117004049

Rojo-Tirado, M. A., Benito, P. J., Ruiz, J. R., Ortega, F. B., Romero-Moraleda, B., Butragueño, J., … Gómez-Candela, C. (2021). Body Composition Changes after a Weight Loss Intervention: A 3-Year Follow-Up Study. *Nutrients 2021, Vol. 13, Page 164*, *13*(1), 164. https://doi.org/10.3390/NU13010164

Rolls, B. J. (2014). What is the role of portion control in weight management? *International Journal of Obesity 2014 38:1*, *38*(1), S1–S8. https://doi.org/10.1038/ijo.2014.82

Rolls, B. J., Drewnowski, A., & Ledikwe, J. H. (2005). Changing the energy density of the diet as a strategy for weight management. *Journal of the American Dietetic Association*, *105*(5 SUPPL.), 98–103. https://doi.org/10.1016/j.jada.2005.02.033

Rom, O., Reznick, A. Z., Keidar, Z., Karkabi, K., & Aizenbud, D. (2015). Smoking cessation-related weight gain-beneficial effects on muscle mass, strength and bone health. *Addiction*, *110*(2), 326–335. https://doi.org/10.1111/add.12761

Rosenbaum, M., & Leibel, R. L. (2010). Adaptive thermogenesis in humans. *International Journal of Obesity*, *34*(0 1), S47–S55. https://doi.org/10.1038/ijo.2010.184

Rosenbaum, M., Sy, M., Pavlovich, K., Leibel, R. L., & Hirsch, J. (2008). Leptin reverses weight loss–induced changes in regional neural activity responses to visual food stimuli. *The Journal of Clinical Investigation*, *118*(7), 2583–2591. https://doi.org/10.1172/JCI35055.relevant

Ross, K. M., Graham Thomas, J., & Wing, R. R. (2016). Successful weight loss maintenance associated with morning chronotype and better sleep quality. *Journal of Behavioral Medicine*, *39*(3), 465–471. https://doi.org/10.1007/s10865-015-9704-8

Rothman, A. J., Sheeran, P., & Wood, W. (2009). Reflective and automatic processes in the initiation and maintenance of dietary change. *Annals of Behavioral Medicine*, *38*(SUPPL.), 4–17. https://doi.org/10.1007/s12160-009-9118-3

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*, *25*(1), 54–67. https://doi.org/10.1006/CEPS.1999.1020

Ryan, R. M., Patrick, H., Deci, E. L., & Williams, G. C. (2008a). Facilitating health behaviour change and its maintenance : Interventions based on Self-Determination Theory. *The European Health Psychologist*, *10*, 2–5. https://doi.org/10.1080/17509840701827437

Ryan, R. M., Patrick, H., Deci, E. L., & Williams, G. C. (2008b). Facilitating health behaviour change and its maintenance : Interventions based on Self-Determination Theory original article Ryan , Patrick , Deci , and Williams ( cont ' d ). *The European Health Psychologist*, *10*, 2–5.

Sadler, J. R., Thapaliya, G., Jansen, E., Aghababian, A. H., Smith, K. R., & Carnell, S. (2021). for Stress-Related Palatable Food Intake in U . S . Adults. *Nutrients*, 1–19.

Sainsbury, K., Cleland, C. L., Evans, E. H., Adamson, A., Batterham, A., Dombrowski, S. U., … Araújo-Soares, V. (2017). Supporting the transition from weight loss to maintenance: development and optimisation of a face-to-face behavioural intervention component. *Health Psychology and Behavioral Medicine*, *5*(1), 66–84. https://doi.org/10.1080/21642850.2016.1269233

Sainsbury, K., Evans, E. H., Pedersen, S., Marques, M. M., Teixeira, P. J., Lähteenmäki, L., … Sniehotta, F. F. (2018). Attribution of weight regain to emotional reasons amongst European adults with overweight and obesity who regained weight following a weight loss attempt. *Eating and Weight Disorders*, *0*(0), 1–11. https://doi.org/10.1007/s40519-018-0487-0

Sairanen, E., Lappalainen, R., Lapveteläinen, A., Tolvanen, A., & Karhunen, L. (2014). Flexibility in weight management. *Eating Behaviors*, *15*(2), 218–224. https://doi.org/10.1016/j.eatbeh.2014.01.008

Santos, I., Sniehotta, F. F., Marques, M. M., Carraça, E. V., & Teixeira, P. J. (2017). Prevalence of personal weight control attempts in adults: a systematic review and meta-analysis. *Obesity Reviews*, *18*(1), 32–50. https://doi.org/10.1111/obr.12466

Santos, I., Vieira, P. N., Silva, M. N., Sardinha, L. B., & Teixeira, P. J. (2017). Weight control behaviors of highly successful weight loss maintainers: the Portuguese Weight Control Registry. *Journal of Behavioral Medicine*, *40*(2), 366–371. https://doi.org/10.1007/s10865-016-9786-y

Saris, W. H. M. (2005). DiOGenes: An integrated multidisciplinary approach to the obesity problem in Europe. *Nutrition Bulletin*, *30*(2), 188–193. https://doi.org/10.1111/j.1467-3010.2005.00496.x

Sason, A., Adelson, M., Herzman-Harari, S., & Peles, E. (2018). Knowledge about nutrition, eating habits and weight reduction intervention among methadone maintenance treatment patients. *Journal of Substance Abuse Treatment*, *86*, 52–59. https://doi.org/10.1016/j.jsat.2017.12.008

Saunders, K. H., Igel, L. I., Shukla, A. P., & Aronne, L. J. (2016). Drug-induced weight gain: Rethinking our choices. *The Journal of Family Practice*, *65*(11). Retrieved from https://www.mdedge.com/familymedicine/article/116575/obesity/drug-induced-weight-gain-rethinking-our-choices

Schafer, M., & Ferraro, K. (2011). The Stigma of Obesity : Does Perceived Weight Discrimination Affect Identity and Physical Health ? Author ( s ): Markus H . Schafer and Kenneth F . Ferraro Source : Social Psychology Quarterly , Vol . 74 , No . 1 (

MARCH 2011 ), pp . 76-97. *Social Psychology Quarterly*, *74*(1), 76–97.

Schaumberg, K., Anderson, L. M., Reilly, E. E., Gorrell, S., Anderson, D. A., & Earleywine, M. (2016). Considering alternative calculations of weight suppression. *Eating Behaviors*, *20*, 57–63. https://doi.org/10.1016/j.eatbeh.2015.11.003

Schoeller, D. A. (2014). The effect of holiday weight gain on body weight. *Physiology and Behavior*, *134*(C), 66–69. https://doi.org/10.1016/j.physbeh.2014.03.018

Schreiber, M., Bucher, T., Collins, C. E., & Dohle, S. (2020). The Multiple Food Test: Development and validation of a new tool to measure food choice and applied nutrition knowledge. *Appetite*, *150*(February), 104647. https://doi.org/10.1016/j.appet.2020.104647

Schwartz, M., Woods, S., Porte, D., Seeley, R., & Baskin, D. (2000). Central nervous system control of food intake. *Nature*, *404*. https://doi.org/10.1038/35007534

Schwartz, N. E., Hecht, L. M., & Haedt-Matt, A. A. (2021). Nutrition knowledge moderates the association between perfectionism and shape/weight concerns. *European Journal of Clinical Nutrition*. https://doi.org/10.1038/s41430-021-00866-w

Sciamanna, C. N., Kiernan, M., Rolls, B. J., Boan, J., Stuckey, H., Kephart, D., … Dellasega, C. (2011). Practices associated with weight loss versus weight-loss maintenance: Results of a national survey. *American Journal of Preventive Medicine*, *41*(2), 159–166. https://doi.org/10.1016/j.amepre.2011.04.009

Scott, S. E., Duarte, C., Encantado, J., Evans, E. H., Harjumaa, M., Heitmann, B. L., … Stubbs, R. J. (2019). The NoHoW protocol: a multicentre 2×2 factorial randomised controlled trial investigating an evidence-based digital toolkit for weight loss maintenance in European adults. *BMJ Open*, *9*(9), e029425. https://doi.org/10.1136/BMJOPEN-2019-029425

Sharafi, M., Alamdari, N., Wilson, M., Leidy, H. J., & Glynn, E. L. (2018). Effect of a High-Protein, High-Fiber Beverage Preload on Subjective Appetite Ratings and Subsequent Ad Libitum Energy Intake in Overweight Men and Women: A Randomized, Double-Blind Placebo-Controlled, Crossover Study. *Current Developments in Nutrition*, *2*(6), 1–8. https://doi.org/10.1093/cdn/nzy022

Sharma, A. M., & Padwal, R. (2010). Obesity is a sign - Over-eating is a symptom: An aetiological framework for the assessment and management of obesity. *Obesity Reviews*, *11*(5), 362–370. https://doi.org/10.1111/j.1467-789X.2009.00689.x

Sheeran, P., Gollwitzer, P. M., & Bargh, J. A. (2013). Nonconscious Processes and Health. *Health Psychology*, *32*(5), 460–473. https://doi.org/10.1037/a0029203

Shields, M., Gorber, S., & Tremblay, M. S. (2008). Estimates of obesity based on self-report versus direct measures. *Sustainability Energy Options for Business*, *19*(2). https://doi.org/10.5848/dos.978-1-909293-44-1_8

Shimpo, M., & Akamatsu, R. (2015). The development of an Aftermath of Dietary Lapses Coping Questionnaire for weight control. *Health Education Journal*, *74*(5), 616–626. https://doi.org/10.1177/0017896914550169

Sikorski, C., Luppa, M., Kaiser, M., Glaesmer, H., Schomerus, G., König, H. H., & Riedel-Heller, S. G. (2011). The stigma of obesity in the general public and its implications for public health - A systematic review. *BMC Public Health*, *11*.

https://doi.org/10.1186/1471-2458-11-661

Silsbury, Z., Goldsmith, R., & Rushton, A. (2015). Systematic review of the measurement properties of self-report physical activity questionnaires in healthy adult populations. *BMJ Open*, *5*(9), 1–10. https://doi.org/10.1136/bmjopen-2015-008430

Silva, M. N., Markland, D., Carraça, E. V, Vieira, P. N., Si´, S., Coutinho, S. R., … Teixeira, P. J. (2011). Exercise Autonomous Motivation Predicts 3-yr Weight Loss in Women. *Med. Sci. Sports Exerc*, *43*(4), 728–737. https://doi.org/10.1249/MSS.0b013e3181f3818f

Sim, A. Y., Lee, L. L., & Cheon, B. K. (2018). When exercise does not pay: Counterproductive effects of impending exercise on energy intake among restrained eaters. *Appetite*, *123*, 120–127. https://doi.org/10.1016/j.appet.2017.12.017

Sirois, F. M., Kitner, R., & Hirsch, J. K. (2015). Self-compassion, affect, and health-promoting behaviors. *Health Psychology : Official Journal of the Division of Health Psychology, American Psychological Association*, *34*(6), 661–669. https://doi.org/10.1037/hea0000158

Smith, A. D., Herle, M., Fildes, A., Cooke, L., Steinsbekk, S., & Llewellyn, C. H. (2017). Food fussiness and food neophobia share a common etiology in early childhood. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *58*(2), 189–196. https://doi.org/10.1111/jcpp.12647

Smithson, E. F., & Hill, A. J. (2017). It is not how much you crave but what you do with it that counts: Behavioural responses to food craving during weight management. *European Journal of Clinical Nutrition*, *71*(5), 625–630. https://doi.org/10.1038/ejcn.2016.235

Sniehotta, F. F., Evans, E. H., Sainsbury, K., Adamson, A., Rothman, A. J., Batterham, A., … Arau, V. (2019). Behavioural intervention for weight loss maintenance versus standard weight advice in adults with obesity : A randomised controlled trial in the UK ( NULevel Trial ), 1–18. https://doi.org/10.1371/journal.pmed.1002793

Sob, C., Siegrist, M., Hagmann, D., & Hartmann, C. (2021). A longitudinal study examining the influence of diet-related compensatory behavior on healthy weight management. *Appetite*, *156*, 104975. https://doi.org/10.1016/J.APPET.2020.104975

Soleymani, T., Daniel, S., & Garvey, W. T. (2016). Weight maintenance: Challenges, tools and strategies for primary care physicians. *Obesity Reviews*, *17*(1), 81–93. https://doi.org/10.1111/obr.12322

Sominsky, L., & Spencer, S. J. (2014). Eating behavior and stress: A pathway to obesity. *Frontiers in Psychology*, *5*(MAY), 1–8. https://doi.org/10.3389/fpsyg.2014.00434

Spence, J. C., Rhodes, R. E., McCurdy, A., Mangan, A., Hopkins, D., & Mummery, W. K. (2020). Determinants of physical activity among adults in the United Kingdom during the COVID-19 pandemic: The DUK-COVID study. *British Journal of Health Psychology*, 1–18. https://doi.org/10.1111/bjhp.12497

Spreckley, M., Seidell, J., & Halberstadt, J. (2021). Perspectives into the experience of successful, substantial long-term weight-loss maintenance: a systematic review. *International Journal of Qualitative Studies on Health and Well-Being*, *16*(1), 1862481. https://doi.org/10.1080/17482631.2020.1862481

Spronk, I., Kullen, C., Burdon, C., & O'Connor, H. (2014). Relationship between nutrition knowledge and dietary intake. *British Journal of Nutrition*, *111*(10), 1713–1726. https://doi.org/10.1017/S0007114514000087

Stapleton, P. (2015). Beliefs about Causes of Obesity: A Comparison of Australian Doctors, Psychologists and Community Members. *Journal of Obesity & Weight Loss Therapy*, *05*(01), 1–7. https://doi.org/10.4172/2165-7904.1000246

Starkweather, J. (2014). Factor Analysis with Binary items : A quick review with, (September).

Stewart, T. M., Martin, C. K., & Williamson, D. A. (2022, January 3). The Complicated Relationship between Dieting, Dietary Restraint, Caloric Restriction, and Eating Disorders: Is a Shift in Public Health Messaging Warranted? *International Journal of Environmental Research and Public Health*. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/ijerph19010491

Stice, E., & Burger, K. (2019). Neural vulnerability factors for obesity. *Clinical Psychology Review*, *68*(April 2018), 38–53. https://doi.org/10.1016/j.cpr.2018.12.002

Stice, E., & Yokum, S. (2016). Gain in body fat is associated with increased striatal response to palatable food cues, whereas body fat stability is associated with decreased striatal response. *Journal of Neuroscience*, *36*(26), 6949–6956. https://doi.org/10.1523/JNEUROSCI.4365-15.2016

Stinson, E. J., Piaggi, P., Ibrahim, M., Venti, C., Krakoff, J., & Votruba, S. B. (2018). High Fat and Sugar Consumption During Ad Libitum Intake Predicts Weight Gain. *Obesity*, *26*(4), 689–695. https://doi.org/10.1002/oby.22124

Stockwell, S., Trott, M., Tully, M., Shin, J., Barnett, Y., Butler, L., … Smith, L. (2021). Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: A systematic review. *BMJ Open Sport and Exercise Medicine*, *7*(1), 1–8. https://doi.org/10.1136/bmjsem-2020-000960

Stotland, S., & Ztiroff, D. C. (1990a). A New Measure of Weight Locus of Control: The Dieting Beliefs Scale. *Journal of Personality Assessment*, *54*(1–2), 191–203. https://doi.org/10.1080/00223891.1990.9673986

Stotland, S., & Ztiroff, D. C. (1990b). A New Measure of Weight Locus of Control: The Dieting Beliefs Scale. *Journal of Personality Assessment*, *54*(1–2), 191–203. https://doi.org/10.1080/00223891.1990.9673986

Stroebe, W., Mensink, W., Aarts, H., Schut, H., & Kruglanski, A. W. (2008). Why dieters fail: Testing the goal conflict model of eating. *Journal of Experimental Social Psychology*, *44*, 21–41. https://doi.org/10.4324/9781315141817

Stroebe, W., Van Koningsbruggen, G. M., Papies, E. K., & Aarts, H. (2017). Why most dieters fail but some succeed: A goal conflict model of eating behavior. *The Goal Conflict Model of Eating Behaviour: Selected Works of Wolfgang Stroebe*, *120*(1), 181–238. https://doi.org/10.4324/9781315141817

Stubbs, J., Whybrow, S., Teixeira, P., Blundell, J., Lawton, C., Westenhoefer, J., … Raats, M. (2011a). Problems in identifying predictors and correlates of weight loss and maintenance: Implications for weight control therapies based on behaviour change. *Obesity Reviews*, *12*(9), 688–708. https://doi.org/10.1111/j.1467-789X.2011.00883.x

Stubbs, J., Whybrow, S., Teixeira, P., Blundell, J., Lawton, C., Westenhoefer, J., … Raats, M. (2011b). Problems in identifying predictors and correlates of weight loss and maintenance: Implications for weight control therapies based on behaviour change. *Obesity Reviews*, *12*(9), 688–708. https://doi.org/10.1111/j.1467-789X.2011.00883.x

Stubbs, J. (2012). Behavioural and Motivational Factors Associated with Weight Loss and Maintenance in a Commercial Weight Management Programme. *The Open Obesity Journal*, *4*(1), 35–43. https://doi.org/10.2174/1876823701204010035

Stubbs, J., Duarte, C., O'Driscoll, R., Turicchi, J., Kwasnicka, D., Sniehotta, F. F., … Heitmann, B. L. (2021). The H2020 "noHoW Project": A Position Statement on Behavioural Approaches to Longer-Term Weight Management. *Obesity Facts*, *14*(2), 246–258. https://doi.org/10.1159/000513042

Stubbs, R. J., & Lavin, J. H. (2013). The challenges of implementing behaviour changes that lead to sustained weight management. *Nutrition Bulletin*, *38*(1), 5–22. https://doi.org/10.1111/nbu.12002

Stunkard, A. J., & Messick, S. (1985). The three-factor eating questionnaire. *Journal of Psychosomatic Research*, *29*(I), 71–83.

Sumithran, P., Prendergast, L. A., Delbridge, E., Purcell, K., Shulkes, A., Kriketos, A., & Proietto, J. (2011). Long-Term Persistence of Hormonal Adaptations to Weight Loss. *New England Journal of Medicine*, *365*(17), 1597–1604. https://doi.org/10.1056/NEJMoa1105816

Svetkey, L. P., Stevens, V. J., Brantley, P. J., Appel, L. J., Hollis, J. F., Loria, C. M., … Aicher, K. (2008). Comparison of Strategies for Sustaining Weight Loss. *Journal of the American Medical Association*, *299*(10), 1139–1148.

Swift, J. A., Glazebrook, C., & Macdonald, I. (2006). Validation of a brief, reliable scale to measure knowledge about the health risks associated with obesity. *International Journal of Obesity*, *30*(4), 661–668. https://doi.org/10.1038/sj.ijo.0803165

Swift, J., Glazebrook, C., Novak, N., & Anness, A. (2007). Beliefs regarding the consequences of obesity and ideal weight: An instrument development study. *Patient Education and Counseling*, *68*(2), 200–207. https://doi.org/10.1016/j.pec.2007.06.007

Swift, J., Glazebrook, C., Anness, A., & Goddard, R. (2009). Obesity-related knowledge and beliefs in obese adults attending a specialist weight-management service: Implications for weight loss over 1 year. *Patient Education and Counseling*, *74*(1), 70–76. https://doi.org/10.1016/j.pec.2008.07.045

Tabachnick, B., & Fidell, L. (2013). *Using Multivariate Statistics.* Boston, MA: Allyn & Baco.

Taetzsch, A., Roberts, S. B., Gilhooly, C. H., Lichtenstein, A. H., Krauss, A. J., Bukhari, A., … Das, S. K. (2020). Food cravings: Associations with dietary intake and metabolic health. *Appetite*, *152*(September 2019), 104711. https://doi.org/10.1016/j.appet.2020.104711

Teasdale, S. B., Burrows, T. L., Hayes, T., Hsia, C. Y., Watkins, A., Curtis, J., & Ward, P. B. (2020). Dietary intake, food addiction and nutrition knowledge in young people with mental illness. *Nutrition and Dietetics*, *77*(3), 315–322. https://doi.org/10.1111/1747-0080.12550

Teixeira, P. J., Going, S. B., Sardinha, L. B., & Lohman, T. G. (2005). A review of psychosocial pre-treatment predictors of weight control. *Obesity Reviews*, *6*(1), 43–65. https://doi.org/10.1111/j.1467-789X.2005.00166.x

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *9*. https://doi.org/10.1186/1479-5868-9-78

Teixeira, P. J., Carraça, E. V., Marques, M. M., Rutter, H., Oppert, J. M., De Bourdeaudhuij, I., … Brug, J. (2015). Successful behavior change in obesity interventions in adults: A systematic review of self-regulation mediators. *BMC Medicine*, *13*(1), 1–16. https://doi.org/10.1186/s12916-015-0323-6

Teixeira, P. J., Silva, M. N., Coutinho, S. R., Palmeira, A. L., Mata, J., Vieira, P. N., … Sardinha, L. B. (2010). Mediators of weight loss and weight loss maintenance in middle-aged women. *Obesity*, *18*(4), 725–735. https://doi.org/10.1038/oby.2009.281

Teixeira, P. J., Silva, M. N., Mata, J., Palmeira, A. L., & Markland, D. (2012). Motivation, self-determination, and long-term weight control. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 1–13. https://doi.org/10.1186/1479-5868-9-22/FIGURES/2

Terry, M. L., & Leary, M. R. (2011). Self-compassion, self-regulation, and health. *Self and Identity*, *10*(3), 352–362. https://doi.org/10.1080/15298868.2011.558404

Testa, R. J., & Brown, R. T. (2015). Self-regulatory Theory and Weight-Loss Maintenance. *Journal of Clinical Psychology in Medical Settings*, *22*(1), 54–63. https://doi.org/10.1007/s10880-015-9421-z

Thøgersen-Ntoumani, C., Dodos, L. A., Stenling, A., & Ntoumanis, N. (2020). Does self-compassion help to deal with dietary lapses among overweight and obese adults who pursue weight-loss goals? *British Journal of Health Psychology*, 1–22. https://doi.org/10.1111/bjhp.12499

Thom, G., & Lean, M. (2017). Is There an Optimal Diet for Weight Management and Metabolic Health? *Gastroenterology*, *152*(7), 1739–1751. https://doi.org/10.1053/j.gastro.2017.01.056

Thomas, J. G., Bond, D. S., Phelan, S., Hill, J. O., & Wing, R. R. (2014). Weight-loss maintenance for 10 years in the national weight control registry. *American Journal of Preventive Medicine*, *46*(1). https://doi.org/10.1016/j.amepre.2013.08.019

Tice, D. M., & Bratslavsky, E. (2000a). Giving in to Feel Good : in the Context The Place of Emotion Regulation of General. *Psychological Inquiry*, *11*(3), 149–159. https://doi.org/10.1207/S15327965PLI1103_03

Tice, D. M., & Bratslavsky, E. (2000b). Giving in to feel good: The place of emotion regulation in the context of general self-control. *Psychological Inquiry*, *11*(3), 149–159. https://doi.org/10.1207/S15327965PLI1103_03

Townshend, T., & Lake, A. (2017). Obesogenic environments: Current evidence of the built and food environments. *Perspectives in Public Health*, *137*(1), 38–44. https://doi.org/10.1177/1757913916679860

Trakman, G. L., Forsyth, A., Devlin, B. L., & Belski, R. (2016). A systematic review of athletes' and coaches' nutrition knowledge and reflections on the quality of current nutrition knowledge measures. *Nutrients*, *8*(9). https://doi.org/10.3390/nu8090570

Trakman, G. L., Forsyth, A., Hoye, R., & Belski, R. (2017a). Developing and validating a nutrition knowledge questionnaire: Key methods and considerations. *Public Health Nutrition*, *20*(15), 2670–2679. https://doi.org/10.1017/S1368980017001471

Trakman, G. L., Forsyth, A., Hoye, R., & Belski, R. (2017b). The nutrition for sport knowledge questionnaire (NSKQ): Development and validation using classical test theory and Rasch analysis. *Journal of the International Society of Sports Nutrition*, *14*(1), 1–11. https://doi.org/10.1186/S12970-017-0182-Y/TABLES/3

Trakman, G. L., Forsyth, A., Hoye, R., & Belski, R. (2018). Development and validation of a brief general and sports nutrition knowledge questionnaire and assessment of athletes' nutrition knowledge. *Journal of the International Society of Sports Nutrition*, *15*(1), 1–8. https://doi.org/10.1186/s12970-018-0223-1

Troop, N. A., Treasure, J. L., & Serpell, L. (2002). A further exploration of disgust in eating disorders. *European Eating Disorders Review*, *10*(3), 218–226. https://doi.org/10.1002/ERV.444

Truman, E., & Elliott, C. (2019). Barriers to Food Literacy: A Conceptual Model to Explore Factors Inhibiting Proficiency. *Journal of Nutrition Education and Behavior*, *51*(1), 107–111. https://doi.org/10.1016/j.jneb.2018.08.008

Turicchi, J., O'Driscoll, R., Finlayson, G., Beaulieu, K., Deighton, K., & Stubbs, R. J. (2019). Associations between the rate, amount, and composition of weight loss as predictors of spontaneous weight regain in adults achieving clinically significant weight loss: A systematic review and meta-regression. *Obesity Reviews*, (February), 935–946. https://doi.org/10.1111/obr.12849

Turicchi, J., O'Driscoll, R., Finlayson, G., Duarte, C., Hopkins, M., Martins, N., … James Stubbs, R. (2020). Associations between the proportion of fat-free mass loss during weight loss, changes in appetite, and subsequent weight change: results from a randomized 2-stage dietary intervention trial. *The American Journal of Clinical Nutrition*, *111*(3), 536–544. https://doi.org/10.1093/AJCN/NQZ331

UK Government. (2020). Staying at home and away from others (social distancing). Retrieved January 19, 2022, from https://www.gov.uk/government/publications/full-guidance-on-staying-at-home-and-away-from-others

Vaitkeviciute, R., Ball, L. E., & Harris, N. (2015). The relationship between food literacy and dietary intake in adolescents: A systematic review. *Public Health Nutrition*, *18*(4), 649–658. https://doi.org/10.1017/S1368980014000962

van't Riet, J., Sijtsema, S. J., Dagevos, H., & de Bruijn, G. J. (2011). The importance of habits in eating behaviour. An overview and recommendations for future research. *Appetite*, *57*(3), 585–596. https://doi.org/10.1016/j.appet.2011.07.010

van Baak, M. A., Hul, G., Astrup, A., & Saris, W. H. (2021). Physical Activity, Weight Loss, and Weight Maintenance in the DiOGenes Multicenter Trial. *Frontiers in Nutrition*, *8*, 389. https://doi.org/10.3389/FNUT.2021.683369/BIBTEX

van Koningsbruggen, G. M., Stroebe, W., & Aarts, H. (2011). Through the eyes of dieters: Biased size perception of food following tempting food primes. *Journal of Experimental*

*Social Psychology*, *47*(2), 293–299. https://doi.org/10.1016/j.jesp.2010.10.012

Van Oort, L., Schröder, C., & French, D. P. (2011). What do people think about when they answer the brief illness perception questionnaire? A "think-aloud" study. *British Journal of Health Psychology*, *16*(2), 231–245. https://doi.org/10.1348/135910710X500819

Vansteenkiste, M., Braet, C., Bachman, C., & Deci, E. L. (2007). Promoting maintained weight loss through healthy lifestyle changes among severely obese children: An experimental test of the self-determination theory, (144), 16–32.

Varkevisser, R. D. M. M., van Stralen, M. M., Kroeze, W., Ket, J. C. F. F., & Steenhuis, I. H. M. M. (2018). *Determinants of weight loss maintenance: a systematic review*. *Obesity Reviews* (Vol. 20). https://doi.org/10.1111/obr.12772

Vartanian, L. R., Reily, N. M., Spanos, S., McGuirk, L. C., Herman, C. P., & Polivy, J. (2017). Hunger, taste, and normative cues in predictions about food intake. *Appetite*, *116*, 511–517. https://doi.org/10.1016/j.appet.2017.05.044

Verplanken, B., & Aarts, H. (2011). Habit, Attitude, and Planned Behaviour: Is Habit an Empty Construct or an Interesting Case of Goal-directed Automaticity? *Https://Doi.Org/10.1080/14792779943000035*, *10*(1), 101–134. https://doi.org/10.1080/14792779943000035

Vlachopoulos, S. P., & Karageorghis, C. I. (2005). Interaction of External, Introjected, and Identified Regulation With Intrinsic Motivation in Exercise: Relationships With Exercise Enjoyment. *Journal of Applied Biobehavioral Research*, *10*(2), 113–132. https://doi.org/10.1111/J.1751-9861.2005.TB00007.X

Vogels, N., Diepvens, K., & Westerterp-Plantenga, M. S. (2005). Predictors of Long-term Weight Maintenance. *Obesity Research*, *13*(12), 2162–2168. https://doi.org/10.1038/OBY.2005.268

Vohs, K. D., & Baumeister, R. F. (2004). *Understanding Self Regulation*. *Handbook of Self-Regulation : Research, Theory, and Applications*.

Voils, C. I., Olsen, M. K., Gierisch, J. M., McVay, M. A., Grubber, J. M., Gaillard, L., … Yancy, W. S. (2017). Maintenance of weight loss after initiation of nutrition training: A randomized trial. *Annals of Internal Medicine*, *166*(7), 463–471. https://doi.org/10.7326/M16-2160

Vreeland, B., Minsky, S., Menza, M., Radler, D. R., Roemheld-Hamm, B., & Stern, R. (2003). A program for managing weight gain association with atypical antipsychotics. *Psychiatric Services*, *54*(8), 1155–1157. https://doi.org/10.1176/appi.ps.54.8.1155

Wagner, D. D., & Heatherton, T. F. (2014). Self-regulation and its failure: The seven deadly threats to self-regulation. *APA Handbook of Personality and Social Psychology, Volume 1: Attitudes and Social Cognition.*, *1*, 805–842. https://doi.org/10.1037/14341-026

Wammes, B., French, S., & Brug, J. (2007). What young Dutch adults say they do to keep from gaining weight: Self-reported prevalence of overeating, compensatory behaviours and specific weight control behaviours. *Public Health Nutrition*, *10*(8), 790–798. https://doi.org/10.1017/S1368980007258537

Wammes, B., Breedveld, B., Kremers, S., & Brug, J. (2006). The "balance intervention" for promoting caloric compensatory behaviours in response to overeating: A formative evaluation. *Health Education Research*, *21*(4), 527–537.

https://doi.org/10.1093/her/cyl003

Wang, C., & Coups, E. J. (2010). Causal beliefs about obesity and associated health behaviors: Results from a population-based survey. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 1–7. https://doi.org/10.1186/1479-5868-7-19

Wang, J., Shih, P. C., & Carroll, J. M. (2015). *Life After Weight Loss: Design Implications for Community-based Long-term Weight Management*. *Computer Supported Cooperative Work: CSCW: An International Journal* (Vol. 24). https://doi.org/10.1007/s10606-015-9226-5

Wardle, J., Parmenter, K., & Waller, J. (2000). Nutrition knowledge and food intake. *Appetite*, *34*(3), 269–275. https://doi.org/10.1006/APPE.1999.0311

Wardle, J. (1987). Eating style: A validation study of the Dutch eating behaviour questionnaire in normal subjects and women with eating disorders. *Journal of Psychosomatic Research*, *31*(2), 161–169. https://doi.org/10.1016/0022-3999(87)90072-9

Ware, J. E. J., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36): Conceptual framework and item selection. *Medical Core*, *30*(6), 473–483.

Washburn, R. A., Szabo-Reed, A. N., Gorczyca, A. M., Sullivan, D. K., Honas, J. J., Mayo, M. S., … Donnelly, J. E. (2021). A Randomized Trial Evaluating Exercise for the Prevention of Weight Regain. *Obesity*, *29*(1), 62–70. https://doi.org/10.1002/OBY.23022

Weingarten, H. P., & Elston, D. (1990). The phenomenology of food cravings. *Appetite*, *15*(3), 231–246. https://doi.org/10.1016/0195-6663(90)90023-2

Weinheimer, E. M., Sands, L. P., & Campbellnure, W. W. (2010). A systematic review of the separate and combined effects of energy restriction and exercise on fat-free mass in middle-aged and older adults: Implications for sarcopenic obesity. *Nutrition Reviews*, *68*(7), 375–388. https://doi.org/10.1111/j.1753-4887.2010.00298.x

Weinsier R, Nagy T, Hunter G, Darnell B, Hensrud D, W. H. (2000). Do adaptive changes in metabolic rate favor weight re- gain in weight-reduced individuals? An examination of the set point theory. *Am J Clin Nutr*, *72*(May), 1088–1094. https://doi.org/10.1093/acjn/72.5.1088

West, J. S., Guelfi, K. J., Dimmock, J. A., & Jackson, B. (2018). Testing the Feasibility and Preliminary Efficacy of an 8-Week Exercise and Compensatory Eating Intervention. *Nutrients 2018, Vol. 10, Page 923*, *10*(7), 923. https://doi.org/10.3390/NU10070923

West, R., & Michie, S. (2020). A brief introduction to the COM-B Model of behaviour and the PRIME Theory of motivation. *Qeios*. https://doi.org/10.32388/WW04E6.2

Westenhoefer, J. (1991). Dietary restraint and disinhibition: is restraint a homogeneous construct? *Appetite*, *16*(1), 45–55.

Westenhoefer, J., Engel, D., Holst, C., Lorenz, J., Peacock, M., Stubbs, J., … Raats, M. (2013). Cognitive and weight-related correlates of flexible and rigid restrained eating behaviour. *Eating Behaviors*, *14*(1), 69–72. https://doi.org/10.1016/j.eatbeh.2012.10.015

Westenhoefer, J., Stunkard, A. J., & Pudel, V. (1999). Validation of the flexible and rigid control dimensions of dietary restraint. *International Journal of Eating Disorders*, *26*(1), 53–64. https://doi.org/10.1002/(SICI)1098-108X(199907)26:1<53::AID-EAT7>3.0.CO;2-N

Westerterp-Plantenga, M. S., Kempen, K. P. G., & Saris, W. H. M. (1998). Determinants of weight maintenance in women after diet-induced weight reduction. *International Journal of Obesity*, *22*(1), 1–6. https://doi.org/10.1038/sj.ijo.0800536

Westerterp-Plantenga, M. S., Luscombe-Marsh, N., Lejeune, M. P. G. M., Diepvens, K., Nieuwenhuizen, A., Engelen, M. P. K. J., … Westerterp, K. R. (2006). Dietary protein, metabolism, and body-weight regulation: Dose-response effects. *International Journal of Obesity*, *30*(SUPPL. 3), 16–23. https://doi.org/10.1038/sj.ijo.0803487

Westerterp, K. R. (2013). Metabolic adaptations to over - and underfeeding - Still a matter of debate? *European Journal of Clinical Nutrition*, *67*(5), 443–445. https://doi.org/10.1038/ejcn.2012.187

Westerterp, K. R. (2017). Control of energy expenditure in humans. *European Journal of Clinical Nutrition*, *71*(3), 340–344. https://doi.org/10.1038/ejcn.2016.237

Wieland, L. S., Falzon, L., Sciamanna, C. N., Trudeau, K. J., Brodney, S., Schwartz, J. E., & Davidson, K. W. (2012). Interactive computer-based interventions for weight loss or weight maintenance in overweight or obese people. *Cochrane Database of Systematic Reviews*, *2012*(8), Art. No.: CD007675. https://doi.org/http://dx.doi.org/10.1002/14651858.CD007675.pub2

Williams, G. C., Grow, V. M., Freedman, Z. R., Ryan, R. M., & Deci, E. L. (1996). Motivational predictors of weight loss and weight maintenance. *Journal of Personality and Social Psychology*, *70*(1), 115–126. https://doi.org/10.1037/0022-3514.70.1.115

Williams, R. L., Wood, L. G., Collins, C. E., & Callister, R. (2015). Effectiveness of weight loss interventions - is there a difference between men and women: A systematic review. *Obesity Reviews*, *16*(2), 171–186. https://doi.org/10.1111/obr.12241

Wilson, P. M., Rodgers, W. M., Loitz, C. C., & Scime, G. (2006). "It's Who I Am … Really!' The Importance of Integrated Regulation in Exercise Contexts1. *Journal of Applied Biobehavioral Research*, *11*(2), 79–104. https://doi.org/10.1111/J.1751-9861.2006.TB00021.X

Wing, R., Bahnson, J., Bray, G., Clark, J., Coday, M., & Egan, C. (2011). Long Term Effects of a Lifestyle Intervention on Weight and Cardiovascular Risk Factors in Individuals with Type 2 Diabetes. *Arch Intern Med.*, *170*(17), 1566–1575. https://doi.org/10.1001/archinternmed.2010.334.Long

Wing, R., & Hill, J. (2001). Successful weight loss maintenance. *Annu Rev Nutr*, (21), 323–341.

Wing, R. R., & Phelan, S. (2005). Long-term weight loss maintenance. *The American Journal of Clinical Nutrition*, *82*(1), 222S-225S. https://doi.org/10.1093/ajcn/82.1.222S

Winik, C. L., & Bonham, C. E. (2018). Weight management: A concept analysis. *Nursing Forum*, *53*(1), 93–99. https://doi.org/10.1111/nuf.12220

Witt, A. A., Katterman, S. N., & Lowe, M. R. (2013). Assessing the three types of dieting in the Three-Factor Model of dieting. The Dieting and Weight History Questionnaire. *Appetite*, *63*, 24–30. https://doi.org/10.1016/j.appet.2012.11.022

Wolfe, B. M., Kvach, E., & Eckel, R. H. (2016). Treatment of Obesity: Weight Loss and Bariatric Surgery. *Circulation Research*, *118*(11), 1844–1855. https://doi.org/10.1161/CIRCRESAHA.116.307591

Wright, C., Mutsekwa, R. N., Hamilton, K., Campbell, K. L., & Kelly, J. (2021). Are eHealth interventions for adults who are scheduled for or have undergone bariatric surgery as effective as usual care? A systematic review. *Surgery for Obesity and Related Diseases*, *17*(12), 2065–2080. https://doi.org/10.1016/J.SOARD.2021.07.020

Wright, S. M., & Aronne, L. J. (2012). Causes of obesity. *Abdominal Imaging*, *37*(5), 730–732. https://doi.org/10.1007/s00261-012-9862-x

# Appendices

## Appendix A: Study 1 Materials

**Participants information and consent form**

**Testing a new way of measuring weight management**

**What are the aims of the study?**

This research study aims to test a new questionnaire that measures weight loss maintenance knowledge and beliefs. We are interested to assess how the questions are interpreted and whether they are easily understood by the general population.

**Can I take part?**

To take part in this study you must be 18 years old or over, have lived in the UK for at least 6 months and have a good level of English. Please note that if you have a current or history of an eating disorder you are not eligible to participate.

**What will happen if you agree to take part?**

If you decide to participate, you will first be asked to complete a survey containing demographic information. You will then complete the new questionnaire. While you are completing the questionnaire, you will be asked to talk out loud the thoughts that go through your mind. The task will take approximately 15 - 20 minutes to complete (although individual completion times may vary) and it will be **voice recorded**.

Upon completion you will be given a £5 Amazon voucher. This survey is entirely **voluntary** and all responses will be **anonymous** and kept **confidential**. The study findings may be published in a peer review journal article, however the data reported will be for the overall response from all respondents and your response will remain anonymous.

You may **withdraw** from the survey at any point by letting the researcher know you don't want to continue. Withdrawal from the study is only possible while completing the task as once completed it will be impossible to remove the anonymous data.

For more information on weight management please follow the links below.

**National Institute for Health and Care Excellence:**

https://www.nice.org.uk/guidance/ph53

**NHS Healthy weight:**

https://www.nhs.uk/live-well/healthy-weight/start-the-nhs-weight-loss-plan/

If you feel distressed by any of the questions in this study you may find the following resources useful. If the distress continues we advise you to seek support from your GP:

**NHS choices counselling:**

https://www.nhs.uk/conditions/counselling/

**NHS choices wellbeing:**

https://www.nhs.uk/conditions/stress-anxiety-depression/improve-mental-wellbeing/

According to data protection legislation, we are required to inform you that the legal basis we are applying in order to process your personal data is that 'processing is necessary for the performance of a task carried out in the public interest' (Article 6(1)(e)). Further information can be found in the University's Privacy Notice https://www.sheffield.ac.uk/govern/data-protection/privacy/general.

This research is conducted by Denisa Lungu (dlungu1@sheffield.ac.uk), PhD student in the Department of Psychology, and supervisors: Dr Nicola Buckland (n.buckland@sheffield.ac.uk), Department of Psychology , and Dr Fuschia Sirois (f.sirois@sheffield.ac.uk), Department of Psychology. The survey has received full ethical approval from the University of Sheffield Department of Psychology (1.12.2018).

If you have any questions regarding this study, its purpose or procedures, please feel free to contact Denisa Lungu (dlungu1@sheffield.ac.uk). If you would like to make a complaint, please feel free to contact project supervisors; Dr Nicola Buckland (n.buckland@sheffield.ac.uk), and Dr Fuschia Sirois (f.sirois@sheffield.ac.uk).

## Consent

| *Please tick the appropriate boxes* | Yes | No |
|---|---|---|
| **Taking Part in the Project** | | |
| I have read and understood the project information sheet dated 1.12.2018 (If you will answer No to this question please do not proceed with this consent form until you are fully aware of what your participation in the project will mean.) | ☐ | ☐ |
| I have been given the opportunity to ask questions about the project. | ☐ | ☐ |
| I agree to take part in the project. I understand that taking part in the project will include completing a questionnaire. | ☐ | ☐ |
| I understand that my taking part is voluntary and that I can withdraw from the study anytime up to the point that I submit my survey. I do not have to give any reasons for why I no longer want to take part and there will be no adverse consequences if I choose to withdraw. | ☐ | ☐ |
| **How my information will be used during and after the project** | | |
| I understand my personal details such as name, phone number, address and email address etc. will not be revealed to people outside the project. | ☐ | ☐ |
| I understand and agree that my anonymous words may be quoted in publications, reports, web pages, and other research outputs. | ☐ | ☐ |
| I understand and agree that other authorised researchers will have access to this anonymous data only if they agree to preserve the confidentiality of the information as requested in this form. | ☐ | ☐ |
| I understand and agree that other authorised researchers may use my anonymous data in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form. | ☐ | ☐ |
| I give permission for the anonymous data that I provide to be deposited in the Dept. of Psychology at the University of Sheffield so it can be used for future research and learning. | ☐ | ☐ |
| **So that the information you provide can be used legally by the researchers** | | |
| I agree to assign the copyright I hold in any materials generated as part of this project to The University of Sheffield. | ☐ | ☐ |

To acknowledge that you have read and understood this information and would like to continue with the research study, please sign below:

Participant signature: Date:

Researcher signature: Date:

**Please read the following instruction carefully before beginning**

Presented below are a series of statements about nutrition, physical activity and weight management. Please read them carefully and state your opinion on the matter. This means that we would like you to talk about what you think the statement is about and whether it is easy to understand. Please do not plan what you are going to say, just say whatever comes into your head. If you remain silent for more than 10 s whilst completing the questionnaire, the researcher will ask you to keep talking.

If you wish to leave the experiment at any time, please inform the researcher. You will be recorded during this study; however, all responses will be kept confidential and anonymous and no one will be able to identify you.

**Please read each statement and comment on whether you agree with the statement or not**

Some useful definitions before you start

- **Weight loss maintenance** is defined as losing weight (at least 10% of initial body weight) and keeping it off (±2-3 kg/5 lbs) for a longer period of time (**more than 1 year**).
- **Vigorous-intensity physical activity** requires a large amount of effort and causes rapid breathing and a **substantial increase in heart rate** (e.g. hiking, jogging, shovelling, carrying heavy loads, bicycling fast) (WHO).

1. Starchy foods such as bread, potatoes and pasta are fattening.
2. Most men of any age can eat around 2500 kcal a day and maintain a healthy weight.
3. Engaging in vigorous cardiovascular physical exercise is necessary to maintain your weight.
4. High sugar intake is a greater cause of obesity than a high fat intake.
5. Eating bread always causes weight gain.

6. To maintain weight, the number of calories consumed must be equal to the number of calories expended.
7. To maintain a healthy weight people should cut out fat entirely from their diet.
8. The number of calories you burn while doing exercise decreases as you lose weight.
9. It is natural for your weight to fluctuate by 1-2 kg (2-3 lbs) throughout the day.
10. Eating fibre can reduce the chances of gaining weight.
11. Replacing a regular soda (330 ml) with a diet soda will save approximately 150 kcal.
12. When attempting to maintain your weight you are not allowed to eat any high calorie foods (e.g. fries, burgers, cake, biscuits).
13. Some people who are overweight can live on 800-1200 kcal a day without losing weight.
14. Physical inactivity is a major cause of regaining weight.
15. You can eat anything you want and not gain weight if you limit your food intake to the amount of calories your body needs to carry out normal everyday activities.
16. People that are overweight or obese have a slower metabolism compared to normal weight people.
17. Swapping sugar with artificial sweeteners can help with weight loss maintenance.
18. Most women of any age and weight can eat around 2000 kcal a day and maintain a normal weight.
19. To maintain your weight you should not drink any alcohol.
20. Half an hour of cardiovascular exercise burns about 300 calories for everyone.
21. I can eat whatever I want in the evening, if I didn’t eat much during the day.
22. Regularly weighing myself (e.g. weekly) can be useful to avoid weight gain.
23. It is possible for me to maintain my weight without doing any intensive physical activity.
24. To maintain my weight loss, I must continue doing the same things I did when I was trying to lose weight.
25. If I weigh more today than I did yesterday it means I ate too much and gained weight.
26. Hunger is a sign that my body needs food to function properly.
27. If I exercise, I can eat without any restrictions.
28. I am likely to gain weight if I don’t monitor and control what I eat.
29. Learning to deal with hunger can help me maintain weight loss.
30. Unlike me, some people can eat whatever they want and not gain weight.
31. I can eat more than I should now, if I exercise for longer later to burn off the extra calories.
32. To maintain my weight I have to keep to a strict diet.
33. Eating slowly can help me eat less by making me feel full faster.
34. After losing weight I can go back to eating how I ate before I lost weight without gaining the weight back.
35. Sometimes I have to accept that I feel hungry and not always eat in response to hunger.
36. It is OK if I overeat by a small amount in a day if I get back on track the next day
37. Walking is a way of increasing physical activity that can help me maintain a healthy weight.
38. If I feel hungry it means that I should eat to stay healthy.
39. Compared to me, most people don’t have to do anything to maintain a healthy weight.
40. If I eat too much today, I can compensate by eating less tomorrow.

The next questions are about your weight and how it changed in time. For the purpose of this questionnaire diet is defined as current intentions to alter eating behaviour (e.g. increase vegetable consumption, restrict high-fat foods, smaller portion sizes) in order to lose weight.

1. What is your height?

   _______ m

   _______ft

2. What is the **most** you have ever weighed since reaching your current height? (do not count any weight gains due to pregnancy, medical conditions or medications).

The most I have weighed since reaching my current height is:

   _______ lbs

   _______kg

3. What is the **least** you have ever weighed since reaching your current height? (do not count any weight losses due to pregnancy, medical conditions or medication).

The least I have weighed since reaching my current height is:

   _______lbs

   _______kg

4. For about how long have you been at or close (within 2 lbs/1 kg) to your **lowest** weight?

   __________

5. What is your **current** weight?

   _______lbs

   _______kg

6. For about how long have you been at or close (within 2 lbs/1 kg) to your **present** weight?

   __________

7. If your current weight is lower than your heaviest weight, please circle which statement best describes this difference between your highest and lowest weight.
   A. The difference between my highest weight and my current weight is due to weight that I lost on purpose.
   B. The difference between my highest weight and my current weight is due to weight I lost even though I wasn't trying to.
   C. I'm not sure why I weigh less than I once did.

8. Which of these statements best describes what has happened to your weight during the past 12 months? (circle one)
    A. My weight has stayed about the same
    B. I've been losing weight
    C. I've been gaining weight
    D. MY weight has fluctuated a lot
9. Are you currently on a diet? (circle one)

    ☐Yes ☐No (if no, go to #15).
10. Are you currently dieting to lose weight or to avoid gaining weight? (circle one)

    ☐To lose weight ☐To avoid gaining weight

11. How long have you been on your current diet? ________
12. How much longer do you anticipate being on your diet? ________
13. How much weight (if any) have you lost on your current diet? ________
14. How much more weight do you intend to lose on your current diet? ________
15. Answer #15 only if you are not currently dieting:
    Have you ever been on a diet to lose weight?

    ☐Yes ☐No

**If the answer is No, skip the rest of the section and go to question 27 (last page).**

16. About how long ago were you last on a diet to lose weight? (if you are currently dieting, refer to the most recent diet prior to your current diet) ________
17. How long did the last diet last? _________
18. On that diet, how much weight did you lose?

    ________lbs

    ________kg

19. For how long did you manage to maintain the weight loss (within 2 lbs/1 kg)? ______
20. Choose from the list below the strategies that you used while trying to lose weight? (Santos et al., 2017)
    - ☐ Eat/drink low-calorie foods/beverages
    - ☐ Eat more/regularly fruit and vegetables
    - ☐ Increased physical activity
    - ☐ Skip meals
    - ☐ Eat less fatty foods
    - ☐ Eat less sugary foods
    - ☐ Followed a special diet
    - ☐ Drink less alcoholic beverages
    - ☐ Eat less fried/junk foods
    - ☐ Eat less high-carbohydrates foods
    - ☐ Eat less meat
    - ☐ Limit snaking
    - ☐ Eat more frequently
    - ☐ Eat slowly
    - ☐ Choose small portions

- ☐ Reduced amount of food eaten
- ☐ Count calories
- ☐ Attended a weight control programme or group
- ☐ Received advice from a healthcare professional
- ☐ Use weight loss pills or supplements
- ☐ Use laxatives or diuretics
- ☐ Eat diet foods or products
- ☐ Use meal replacements
- ☐ Vitamins
- ☐ Devices
- ☐ Surgery
- ☐ Fasting
- ☐ Vomiting
- ☐ Smoking
- ☐ Other _________

21. About how old were you when you went on your first diet?
    ________ years old.
22. How many weight loss attempts have you had in the past 12 months?
    _________
23. How many times have you started a diet to maintain your weight in the past 12 months?
    _________
24. Please estimate as best you can the number of times in your life you have dieted and purposely lost the amount of weight listed.

How many times in your life have you dieted and lost:

1-4 lbs/1-2 kg? ________times

5-10 lbs/ 3-5 kg? ________times

11-20 lbs/ 6-10? ________times

21 or more lbs/11 or more kg? _______times

25. Choose from the list below the best options that describe your reasons for losing weight
    - ☐ improve appearance
    - ☐ improve health/prevent diseases
    - ☐ improve wellbeing
    - ☐ improve fitness condition/stay fit
    - ☐ improve self-esteem
    - ☐ health professional advice
    - ☐ please/insistence of spouse or partner
    - ☐ improve social life/avoid discrimination
    - ☐ improve professional file/fulfil specific professional requirements
    - ☐ please/ insistence of family
    - ☐ decrease disease risk (e.g. heart attack)

- ☐ special event/season (e.g. holiday, summer)

26. Choose from the list below the best options that describe your reasons for maintaining your weight.
    - ☐ improve appearance
    - ☐ improve health/prevent diseases
    - ☐ improve wellbeing
    - ☐ improve fitness condition/stay fit
    - ☐ improve self-esteem
    - ☐ health professional advice
    - ☐ please/insistence of spouse or partner
    - ☐ improve social life/avoid discrimination
    - ☐ improve professional file/fulfil specific professional requirements
    - ☐ please/ insistence of family
    - ☐ decrease disease risk (e.g. heart attack)
    - ☐ special event/season (e.g. holiday, summer)

27. On a scale from 1 (unsuccessful) to 7 (very successful) rate the following questions.

    1. How successful are you in watching your weight?

       1 2 3 4 5 6 7

    2. How successful are you in losing extra weight?

       1 2 3 4 5 6 7

    3. How difficult do you find it to stay in shape?

       Very difficult Very easy

       1 2 3 4 5 6 7

**General understanding**

1. What do you think this survey was trying to measure?
2. Please state any comments you have regarding the questions in the questionnaire.
3. If you have any general comments about the survey, please detail below.

**Study debrief**

Thank you for taking part in this study. This study aimed to investigate people's understanding of a new scale measuring beliefs and knowledge about weight loss maintenance. Weight loss maintenance has been defined as intentionally losing at least 10% of body weight and keeping it off for at least 1 year (Wing & Hill, 2001). Studies indicate that the key to weight management success is long-term adherence to a diet and exercise programme (Grief & Miranda, 2010). Research also shows that people's beliefs about weight loss maintenance can influence their engagement in weight control behaviours (Ryan, Patrick, Deci, & Williams, 2008). Therefore, we have developed a new scale to measure these beliefs.

If you would like a summary of the results please email Miss Denisa Lungu (dlungu1@sheffield.ac.uk)

For more information on weight management please follow the links below.

**National Institute for Health and Care Excellence:**

https://www.nice.org.uk/guidance/ph53

**NHS Healthy weight:**

https://www.nhs.uk/live-well/healthy-weight/start-the-nhs-weight-loss-plan/

If you feel distressed by any of the questions in this study, you may find the following resources useful. If the distress continues, we advise you to seek support from your GP:

**NHS choices counselling:**

https://www.nhs.uk/conditions/counselling/

**NHS choices wellbeing:**

https://www.nhs.uk/conditions/stress-anxiety-depression/improve-mental-wellbeing/

# Appendix B: Supplementary data analysis for Study 1

## Specific issues

| Item no | Initial item | Issues found | Extracted comments | Proposed formulation |
|---|---|---|---|---|
| 1 | **Starchy foods such as bread, potatoes and pasta are fattening.** | One participant had problems understanding the statement and the task. Had to rephrase statement to*: Do you think that if you eat bread, potatoes and pasta you are going to gain weight?*<br>- referred to the effect on health rather than WLM (*n*: 1).<br>- added external elements to the statement (*n*: 1).<br>- problems understanding the item (*n*: 2). | | |
| 2 | **Most men of any age can eat around 2500 kcal a day and maintain a healthy weight.** | - focus on number of calories (*n*: 1)<br>- add elements to the statement (*n*: 3). | Participants focus too much on the number of calories, they get stuck and don't analyse the statement if they don't know the exact amount. | Most men of any weight and age can eat around the same amount a day and maintain a healthy weight. |
| 3 | **Engaging in vigorous cardiovascular physical exercise is necessary to maintain your weight.** | - suggestion to give some examples of types of exercises (*n*: 1).<br>- agree with the statement then argue that it is not really necessary (*n*: 2). | Participants might have different understanding on what vigorous cardiovascular physical exercise is. Reworded statement should include examples of exercises. | Engaging in vigorous cardiovascular physical exercise (e.g. hiking, jogging) is necessary to maintain your weight. |

| Item no | Initial item | Issues found | Extracted comments | Proposed formulation |
|---|---|---|---|---|
| **4** | **High sugar intake is a greater cause of obesity than a high fat intake.** | - agree or disagree with statement without an explanation, only having a vague idea about the issue, that they heard somewhere (*n*: 5). | | |
| **5** | **Eating bread always causes weight gain.** | - statement is vague (*n*: 1). | Correct answer to this statement is too obvious. Suggest taking out "always" from statement. | Eating bread causes weight gain. |
| **6** | **To maintain weight, the number of calories consumed must be equal to the number of calories expended.** | | Most participants tend to agree with this statement. | |
| **7** | **To maintain a healthy weight people should cut out fat entirely from their diet.** | Most participants talk about the fact that it's not healthy to cut out fat, because the body needs it for health reasons (n: 12). They don't say anything about whether you can lose weight or maintain your weight while eating fat. | Should take the word "healthy" out of the statement and make the statement less extreme as to allow more variance in responses. | To maintain weight, people should cut out fat from their diet. |
| **8** | **The number of calories you burn while doing exercise decreases as you lose weight.** | - statement was difficult to understand (*n*: 1).<br>- just take a guess (*n*: 4). | Statement was difficult for some participants. Statement should be reworded to make it clearer. | After weight loss, the number of calories you burn while doing exercise decreases. |
| **9** | **It is natural for your weight to fluctuate by 1-2 kg (2-3 lbs) throughout the day.** | - focus on the amount of the fluctuation rather than whether it is normal or not for weight to fluctuate (*n:* 7). | Take out the numbers or lower the amount of fluctuation. | It is natural for your weight to fluctuate by 0.5 - 2 kg (2-3 lbs). |

| Item no | Initial item | Issues found | Extracted comments | Proposed formulation |
|---|---|---|---|---|
| **10** | **Eating fibre can reduce the chances of gaining weight.** | - interpreted it as: If you eat fibre, regardless of your diet it will help you not gain weight (*n:* 2).<br>- refer to health (*n*: 2).<br>- not sure on answers (*n*: 4). | Statement is too broad. It suggests a direct relation between fibre and body weight. Item should be reworded. | Diets high in fibre can reduce the chances of gaining weight. |
| **11** | **Replacing a regular soda (330 ml) with a diet soda will save approximately 150 kcal.** | - focus on the number of calories (*n:* 5).<br>- Talk about impact on health (*n:* 2). | Leave the statement as is, to measure attention and knowledge regarding calorie labels. | |
| **12** | **When attempting to maintain your weight you are not allowed to eat any high calorie foods (e.g. fries, burgers, cake, biscuits).** | - talk about weight loss rather than weight maintenance (*n*: 2).<br>- tend to not agree more because of the expression "not allowed" even if they perceive the said foods as "cheat foods" or foods that should not be eaten while trying to manage your weight (*n:* 3). | Statement should be changed to not include expression "not allowed" | When attempting to maintain weight you should not eat any high calorie foods (e.g. fries, burgers, cake, biscuits). |
| **13** | **Some people who are overweight can live on 800-1200 kcal a day without losing weight.** | - add elements to the statement (*n*: 2).<br>- misunderstood statement (*n*: 1). | | |
| **14** | **Physical inactivity is a major cause of regaining weight.** | - provide no explanation for answer (*n*: 3).<br>- confused about the statement (*n*: 1).<br>- talks about weight loss (*n*: 1). | Statement is too broad and should be made more specific as to what physical inactivity would mean. | A low level of physical activity is a major cause of regaining weight. |

| Item no | Initial item | Issues found | Extracted comments | Proposed formulation |
|---|---|---|---|---|
| 15 | **You can eat anything you want and not gain weight if you limit your food intake to the amount of calories your body needs to carry out normal everyday activities.** | - tend to think about the effect of food composition on health rather than weight (*n*: 5).<br>- statement is long and difficult to follow (*n:* 2). | Statement should be shortened, and a clear context should be provided. | To maintain your weight, you can eat anything you want if you limit your calorie intake to the amount your body needs to carry out daily activities. |
| 16 | **People that are overweight or obese have a slower metabolism compared to normal weight people.** | - correct answer but wrong argument (*n*: 3).<br>- participants don't understand what metabolism is (*n*: 3).<br>- statement is unclear (*n*: 1). | Suggested action: Provide definition | |
| 17 | **Swapping sugar with artificial sweeteners can help with weight loss maintenance.** | - talk about weight loss instead of weight loss maintenance (*n*: 3). | | |
| 18 | **Most women of any age and weight can eat around 2000 kcal a day and maintain a normal weight.** | - focus on number of calories (*n*: 2)<br>- add elements to the statement (*n*: 2) | | |
| 19 | **To maintain your weight you should not drink any alcohol.** | - correct answer wrong argument (*n*: 1).<br>- impact on health rather than WLM (*n*: 2).<br>- answers in a way but arguments the other (*n*: 1). | | |

| Item no | Initial item | Issues found | Extracted comments | Proposed formulation |
|---|---|---|---|---|
| **20** | **Half an hour of cardiovascular exercise burns about 300 calories for everyone.** | - stuck on number of calories (*n*: 1).<br>- adds elements to the statement (*n*: 1).<br>- correct answer wrong argument (*n*: 2) | The use of the word "everyone" suggests that the statement is not correct. Therefore, statement might not clearly differentiate between participants with clear understanding and the others. | Half an hour of cardiovascular exercise burns about 300 calories for most people. |
| **21** | **I can eat whatever I want in the evening, if I didn't eat much during the day.** | - include a purpose for monitoring food intake (e.g. WLM).<br>- more specific as to the amount of food eaten in the evening (*n*: 3). | Add context and specific amount of food eaten. | To maintain my weight, if I don't eat much during the day I can eat a small portion of whatever I want in the evening. |
| **22** | **Regularly weighing myself (e.g. weekly) can be useful to avoid weight gain.** | - suggest that weighing does not have a direct impact on weight (*n*: 2). | | Regularly weighing myself (e.g. weekly) can be useful to prevent weight gain. |
| **23** | **It is possible for me to maintain my weight without doing any intensive physical activity.** | - has different definition for intensive physical activity (even if definition was provided) (*n*: 1).<br>- suggest that this is different from one person to another (*n*: 2). | Answers differ on personal opinion and preference. But is good for the purpose of the scale, the belief that for you WLM is not possible without intensive physical activity might create a barrier to success. | It is possible for me to maintain my weight without doing any vigorous physical activity. |
| **24** | **To maintain my weight loss, I must continue doing the same things I did when I was trying to lose weight.** | - confused about the meaning of WLM (*n*: 1). | | |

| Item no | Initial item | Issues found | Extracted comments | Proposed formulation |
|---|---|---|---|---|
| **25** | **If I weigh more today than I did yesterday it means I ate too much and gained weight.** | - suggests that you gain weight but not fat (*n*: 1). | Correct answer to this statement is too obvious. | |
| **26** | **Hunger is a sign that my body needs food to function properly.** | - answer in a way but arguments support the other (*n*: 2) | | |
| **27** | **If I exercise, I can eat without any restrictions.** | - correct answer but wrong argument (*n*: 2)<br>- focused on diet composition (*n*: 1)<br>- think about another context rather than WLM (*n*: 4) | The statement does not present a context. Also, statement should be clearer on the amount of exercise. | When trying to maintain weight loss, If I exercise regularly (e.g. 3-4 times a week), I can eat without any restrictions. |
| **28** | **I am likely to gain weight if I don't monitor and control what I eat.** | The statement is aimed at people with a tendency to overeat. Therefore, it can be correct for some of the participants and incorrect for others (*n*: 2).<br>- correct answer but gives an extreme example of what will cause the weight gain (*n*: 1) | Provide context to focus attention on WLM. | After weight loss, I am likely to gain weight if I don't monitor and control what I eat. |
| **29** | **Learning to deal with hunger can help me maintain weight loss.** | - statement is not very clear (*n*: 3). | Statement should be more specific as to what "deal with hunger" means. | Learning to manage hunger can help me maintain weight loss. |

| Item no | Initial item | Issues found | Extracted comments | Proposed formulation |
|---|---|---|---|---|
| 30 | **Unlike me, some people can eat whatever they want and not gain weight.** | There is a difference between people in measures of appetite (*n*: 1).<br>- think about people that have health issues (*n*: 2)<br>- agrees then argues as if he disagrees (*n*: 1) | Because of individual difference in appetite, statement should instead include an indicator of food quantity. | Unlike me, some people can eat a lot and not gain weight. |
| 31 | **I can eat more than I should now, if I exercise for longer later to burn off the extra calories.** | - specify context (*n*: 5).<br>- agrees because they engage in the behaviour (*n*: 1).<br>- questions the actual engaging in the future proposed behaviour (*n*: 1).<br>- says statement is true but then disagrees to it (*n*: 1). | Specify context of WLM. | To maintain my weight, I can eat more than I should now, if I exercise for longer later to burn off the extra calories. |
| 32 | **To maintain my weight I have to keep to a strict diet.** | - talks about weight loss (*n*: 2).<br>- talks about engaging in the behaviour compared to its efficacy (*n*: 1).<br>- agrees but arguments as if disagreeing (*n*: 2). | Participant answers suggest different understanding about what a strict diet is. Statement should include examples. | To maintain my weight I have to strictly follow a diet. |
| 33 | **Eating slowly can help me eat less by making me feel full faster.** | | Most participants tend to agree with this statement. | |
| 34 | **After losing weight I can go back to eating how I ate before I lost weight without gaining the weight back.** | | | |

| Item no | Initial item | Issues found | Extracted comments | Proposed formulation |
|---|---|---|---|---|
| 35 | **Sometimes I have to accept that I feel hungry and not always eat in response to hunger.** | - problems understanding the statement (*n*: 1). | | |
| 36 | **It is OK if I overeat by a small amount in a day if I get back on track the next day.** | - problems understanding the statement (*n*: 1).<br>- add elements to the statement (*n*: 2). - think of other contexts such as WL (*n*: 1). | Item needs to state purpose for food intake control. | To maintain my weight, it is ok if I overeat by a small amount in a day if I get back on track the next day. |
| 37 | **Walking is a way of increasing physical activity that can help me maintain a healthy weight.** | Statement implies that you can increase physical activity by walking, which is not necessary for all the people, depends on baseline (*n*: 1). | | Walking is a type of physical activity that can help me maintain a healthy weight. |
| 38 | **If I feel hungry it means that I should eat to stay healthy.** | - state an opinion and then arguments the opposite (*n*: 2) | | |
| 39 | **Compared to me, most people don't have to do anything to maintain a healthy weight.** | - statement might distress some people that are overweight or obese (*n*: 1). | Swich the focus from comparison to other to decrease distress. | |
| 40 | **If I eat too much today, I can compensate by eating less tomorrow.** | - statement is not specific enough (*n*: 1).<br>- talk about engaging in the behaviour (*n*: 2)<br>- talk about other contexts (*n*: 3) | Specify context of WLM. | If I eat too much today, I can maintain my weight if I eat less tomorrow. |

**General issues**

| | |
|---|---|
| Participants tend to agree on statements based on their impact on health rather than their impact on body weight (f=10) | Q1: I think just generally people tend to say that eating too many carbohydrates aren't healthy. |
| Participants add elements to the statement before they agree or disagree (f=9). | Q2: I have checked my own, and my own was about 2400 and I guess I classify as an average man …well for a 25-26 years old average man, so I agree. |
| Participants say they agree, but they give arguments that suggest they disagree (f=6). | Q19: You should not drink any alcohol, but yeah if you drink alcohol it definitely contributes a lot. So I would say, you should not, but again it's not necessary, but I agree. |
| Participants agree with the statement because they engage in the behaviour, not that they think it is good for WLM (f=3). | Q31: I sometimes too, I eat more than I should now, because I feel like I will exercise. However, here I just cost the trade off between I don't know, getting the sweet desert let's say and just putting myself off: oh I will go gym later on, so I will exercise later on. It's not good actually this, so I shouldn't do that, but I agree that I do, but it's not a good thing to do. |
| Participants just take a guess without actually knowing or having an opinion on the matter (f=4). | Q8: Hmm. …..I'm not sure on the answer. I would say I agree, but I wouldn't be able to say why. |
| They answer correctly to the statement but give wrong arguments. | Q19: I have to disagree, but no I do agree there is a lot of alcohol that has, you know, sugar and would make you have a belly and things like that, alcohol is very general, I feel that like depends on which alcohol you drink than yeah. |

# Appendix C: Study 2 Materials

**Demographic information**

- Age ____
- Gender Female/Male/Other
- Nationality _____
- Level of study: Undergraduate/MSc/PhD
- Year of study 1/2/3/4
- Department ______
- Did you take any courses in nutrition or nutrition related subjects? Yes/No
- If yes please state name of course: _______
- Do you have a current or history of an eating disorder? Yes/No
- Where did you hear about the study?
    - E-mail
    - Poster
    - Friend

**WLMKB**

The statements below present either facts or fiction about nutrition, physical activity and weight management. Please read each statement and indicate whether you believe the statement is true or false.

**Weight loss maintenance** is defined as losing weight (at least 10% of initial body weight) and keeping it off (±2-3 kg/5 lbs) for a longer period of time (**more than 1 year**).

**Vigorous-intensity physical activity** requires a large amount of effort and causes rapid breathing and a **substantial increase in heart rate** (e.g. hiking, jogging, shovelling, carrying heavy loads, bicycling fast) (WHO).

**Knowledge**

1. Starchy foods such as bread, potatoes and pasta are fattening.

2. Most men of any age can eat around 2500 kcal a day and maintain a healthy weight.
3. Engaging in vigorous cardiovascular physical exercise is necessary to maintain your weight.
4. High sugar intake is a greater cause of obesity than a high fat intake.
5. Eating bread always causes weight gain.
6. To maintain weight, the number of calories consumed must be equal to the number of calories expended.
7. To maintain a healthy weight people should cut out fat entirely from their diet
8. The number of calories you burn while doing exercise decreases as you lose weight.
9. It is natural for your weight to fluctuate by 1-2 kg (2-3 lbs) throughout the day.
10. Eating fibre can reduce the chances of gaining weight.
11. Replacing a regular soda (330 ml) with a diet soda will save approximately 150 kcal.
12. When attempting to maintain your weight you are not allowed to eat any high calorie foods (e.g. fries, burgers, cake, biscuits).
13. Some people who are overweight can live on 800-1200 kcal a day without losing weight.
14. Physical inactivity is a major cause of regaining weight.
15. You can eat anything you want and not gain weight if you limit your food intake to the amount of calories your body needs to carry out normal everyday activities.
16. People that are overweight or obese have a slower metabolism compared to normal weight people.
17. Swapping sugar with artificial sweeteners can help with weight loss maintenance.
18. Most women of any age and weight can eat around 2000 kcal a day and maintain a normal weight.
19. To maintain your weight you should not drink any alcohol.
20. Half an hour of cardiovascular exercise burns about 300 calories for everyone.

**Beliefs**

Below are a series of statements. Please read each statement and on a scale from 1 (strongly disagree) to 6 (strongly agree) choose the degree to which you agree or disagree with each statement.

1. I can eat whatever I want in the evening, if I didn’t eat much during the day.
2. Regularly weighing myself (e.g. weekly) can be useful to avoid weight gain.
3. It is possible for me to maintain my weight without doing any intensive physical activity.
4. To maintain my weight loss, I must continue doing the same things I did when I was trying to lose weight.
5. If I weigh more today than I did yesterday it means I ate too much and gained weight.
6. Hunger is a sign that my body needs food to function properly.
7. If I exercise, I can eat without any restrictions.
8. I am likely to gain weight if I don’t monitor and control what I eat.
9. Learning to deal with hunger can help me maintain weight loss.
10. Unlike me, some people can eat whatever they want and not gain weight.
11. I can eat more than I should now, if I exercise for longer later to burn off the extra calories.
12. To maintain my weight I have to keep to a strict diet.

13. Eating slowly can help me eat less by making me feel full faster.
14. After losing weight I can go back to eating how I ate before I lost weight without gaining the weight back.
15. Sometimes I have to accept that I feel hungry and not always eat in response to hunger.
16. It is OK if I overeat by a small amount in a day if I get back on track the next day.
17. Walking is a way of increasing physical activity that can help me maintain a healthy weight.
18. If I feel hungry it means that I should eat to stay healthy.
19. Compared to me, most people don't have to do anything to maintain a healthy weight.
20. If I eat too much today, I can compensate by eating less tomorrow.

**DWHQ**

The next questions are about your weight and how it changed in time. For the purpose of this questionnaire diet is defined as current intentions to alter eating behaviour (e.g. increase vegetable consumption, restrict high-fat foods, smaller portion sizes) in order to lose weight.

28. What is your height?

    _______ m

    _______ft

29. What is the most you have ever weighed since reaching your current height? (do not count any weight gains due to pregnancy, medical conditions or medications).

The most I have weighed since reaching my current height is:

    _______ lbs

    _______kg

30. What is the least you have ever weighed since reaching your current height? (do not count any weight losses due to pregnancy, medical conditions or medication).

The least I have weighed since reaching my current height is:

    _______lbs

    _______kg

31. What is your current weight?

    _______lbs

    _______kg

32. If your current weight is lower than your heaviest weight, please indicate which statement best describes this difference between your highest and lowest weight.

D. The difference between my highest weight and my current weight is due to weight that I lost on purpose.
E. The difference between my highest weight and my current weight is due to weight I lost even though I wasn't trying to.
F. I'm not sure why I weigh less than I once did.

33. For about how long have you been at or close (within 2 lbs/1 kg) to your present weight?

    ___________

34. For about how long have you been at or close (within 2 lbs/1 kg) to your lowest weight?

    ___________

35. Which of these statements best describes what has happened to your weight during the past 6 months (12 months)? (circle one)
    E. My weight has stayed about the same
    F. I've been losing weight
    G. I've been gaining weight
    H. MY weight has fluctuated a lot
36. Are you currently on a diet? (circle one)   Yes   No (if no, go to #15).
37. Are you currently dieting to lose weight or to avoid gaining weight? (circle one)

    To lose weight   To avoid gaining weight

38. How long have you been on your current diet? ________
39. How much longer do you anticipate being on your diet? ________
40. How much weight (if any) have you lost on your current diet? ________
41. How much more weight do you intend to lose on your current diet? ________
42. Answer #15 only if you are not currently dieting:
    Have you ever been on a diet to lose weight?Yes   No (If no, go to #23)
43. About how long ago were you last on a diet to lose weight? (if you are currently dieting, refer to the most recent diet prior to your current diet) ________
44. How long did the last diet last? _________
45. On that diet, how much weight did you lose? _________
46. For how long did you manage to maintain the weight loss (within 2 lbs/1 kg)? ______
47. Choose from the list below the strategies that you used while trying to lose weight? (Santos et al., 2017)
    - ☐ Eat/drink low-calorie foods/beverages
    - ☐ Eat more/regularly fruit and vegetables
    - ☐ Increased physical activity
    - ☐ Skip meals
    - ☐ Eat less fatty foods
    - ☐ Eat less sugary foods
    - ☐ Followed a special diet
    - ☐ Drink less alcoholic beverages
    - ☐ Eat less fried/junk foods
    - ☐ Eat less high-carbohydrates foods

-  Eat less meat
-  Limit snaking
-  Eat more frequently
-  Eat slowly
-  Choose small portions
-  Reduced amount of food eaten
-  Count calories
-  Attended a weight control programme or group
-  Received advice from a healthcare professional
-  Use weight loss pills or supplements
-  Use laxatives or diuretics
-  Eat diet foods or products
-  Use meal replacements
-  Vitamins
-  Devices
-  Surgery
-  Fasting
-  Vomiting
-  Smoking
-  Other …………..

48. About how old were you when you went on your first diet? _______ years old.
49. How many weight loss attempts have you had in the past 12 months?
50. How many times have you started a diet to maintain your weight in the past 12 months?
51. Please estimate as best you can the number of times in your life you have dieted and purposely lost the amount of weight listed.

    How many times in your life have you dieted and lost:

    1-4 lbs/1-2 kg? _______times

    5-10 lbs/ 3-5 kg? _______times

    11-20 lbs/ 6-10? _______times

    21 r more lbs/11 or more kg? ______times

52. Choose from the list below the best options that describe your reasons for losing weight
    -  improve appearance
    -  improve health/prevent diseases
    -  improve wellbeing
    -  improve fitness condition/stay fit
    -  improve self-esteem
    -  health professional advice
    -  please/insistence of spouse or partner
    -  improve social life/avoid discrimination
    -  improve professional file/fulfil specific professional requirements

- please/ insistence of family
- decrease disease risk (e.g. heart attack)
- special event/season (e.g. holiday, summer)

53. Choose from the list below the best options that describe your reasons for maintaining your weight.
    - improve appearance
    - improve health/prevent diseases
    - improve wellbeing
    - improve fitness condition/stay fit
    - improve self-esteem
    - health professional advice
    - please/insistence of spouse or partner
    - improve social life/avoid discrimination
    - improve professional file/fulfil specific professional requirements
    - please/ insistence of family
    - decrease disease risk (e.g. heart attack)
    - special event/season (e.g. holiday, summer)

**Perceived Self-regulatory success in dieting scale (PSRS)**

On a scale from 1 (unsuccessful) to 7 (very successful) rate the following questions.

1. How successful are you in watching your weight?
2. How successful are you in losing extra weight?
3. How difficult do you find it to stay in shape?

**General understanding (open questions)**

1. What do you think this survey was trying to measure?
2. Please state any comments you have regarding the questions in the questionnaire.
3. If you have any general comments about the survey, please detail below.

# Appendix D: Supplementary materials for Study 3

Table D1: BMI descriptive statistics (Study 3) before and after removing extreme values

| BMI | *n* = 238 | | *n* = 228 | |
|---|---|---|---|---|
| | *M*±*SD* | Range | *M*±*SD* | Range |
| Current | 30.21 ± 7.61 | 19.21 to 62.33 | 29.4 ± 6.65 | 19.21 to 49.23 |
| Lowest | 24.86 ± 4.97 | 13.53 to 53.56 | 24.57 ± 4.29 | 16.44 to 39.36 |
| Highest | 34.56 ± 7.79 | 21.79 to 67.97 | 33.71 ± 6.56 | 24.28 to 52.87 |

**Survey Questions Prolific**

**Section 1: Pre-screening**

**A:** Study description

**Participate in our research on weight management**

Have you intentionally lost weight in the past five years [at least 10% of initial body weight, e.g. at least 13.6 kg (30 lbs) for a person weighing 136 kg (300 lbs)]? If the answer is **YES**, we would like to invite you to participate in a study that investigates beliefs and knowledge about weight-related factors (e.g. nutrition, hunger, physical activity). To take part, you need to be **18 years or over, living in the UK** and **must not report a current or history of eating disorders**.

Taking part involves completing three surveys:

1. This first survey will check your eligibility to take part in the study.
2. If eligible, you will be sent a second survey that will take **15 minutes to complete** and you will be asked questions about **behaviours related to weight management,** as well as some demographic information (e.g. age, gender, weight).
3. The third study will be sent after **4 weeks** and will take around **5 minutes to complete.**

The principal investigator for this project is Denisa Genes. If you have questions, please email (dlungu1@sheffield.ac.uk)

**B:** Screening

**Pre-existing: Only participants with the following characteristics will receive the study advert.**

1. Individuals living in the UK.
2. Adults: 18 – 100 years old
3. Fluent English

Custom questions:

1. Do you have a current or history of an eating disorder?
2. Have you intentionally lost 10% (e.g. ≥13.6 kg (30 lbs) for a person weighing 136 kg (300 lbs)) or more of your body weight in the past 5 years?
3. What is your current height? (answer in feet and inches or in metres)?
4. What is your **current** weight? (answer in stones and pounds or in kilograms)?
5. What is the **most** you have ever weighed since reaching your current height? (do not count any weight gains due to pregnancy, medical conditions or medications). The most I have weighed since reaching my current height is (answer in stones and pounds or in kilograms):
6. What is the **least** you have ever weighed since reaching your current height? (do not count any weight losses due to pregnancy, medical conditions or medication). The least I have weighed since reaching my current height is (answer in stones and pounds or in kilograms):

Note: Participants that have not lost at least 10% of their body weight, and their highest BMI is less than 25 will not be contacted to participate in the study.

**Section 2: First survey**

**A: Demographic information**

***Start of survey***

1. What gender do you identify as? (male, female, transgender male, transgender female, non-conforming, other, prefer not to say)
2. What is your age (drop down box)?
3. What ethnic group do you most identify with? (White; Mixed or multiple ethnic groups; Asian or Asian British; Black, African, Caribbean, or Black British; Prefer not to say; other)

4. For how long have you been living in the UK?
   a) Not currently living in the UK
   b) Less than 6 months
   c) 6-12 months
   d) More than a year
5. Which postcode do you live in?

6. Please select any that currently apply to you:

- Pregnant
- Breastfeeding
- Had weight loss surgery (e.g. gastric bypass, stomach stapling)
- Have diabetes
- Have heart disease
- Have an under or overactive thyroid
- Regular smoker
- Have another heath condition (please detail)
- None apply

7. How would you rate your overall current health? (check one most appropriate box)

(Excellent, very good, good, fair, poor)

**B**: WLMKB: Knowledge and beliefs about energy balance, diet flexibility, calorie compensatory behaviours, hunger and obesity (Genes, Sirois & Buckland, in preparation).

The statements below present either facts or fiction about nutrition, physical activity and weight management. Please read each statement and indicate whether you believe the statement is true or false.

**Weight loss maintenance** is defined as losing weight (at least 10% of initial body weight) and keeping it off (±2-3 kg/5 lbs) for a longer period of time (**more than 1 year**).

**Vigorous-intensity physical activity** requires a large amount of effort and causes rapid breathing and a **substantial increase in heart rate** (e.g. hiking, jogging, shovelling, carrying heavy loads, bicycling fast) (WHO).

Knowledge subscale

1. Starchy foods such as bread, potatoes and pasta are fattening.
2. Engaging in vigorous cardiovascular physical exercise (e.g. hiking, jogging) is necessary to maintain your weight.
3. Eating bread causes weight gain.
4. When attempting to maintain weight you should not eat any high calorie foods (e.g. fries, burgers, cake, biscuits).
5. To maintain your weight, you should not drink any alcohol.
6. After weight loss, the number of calories you burn while doing exercise decreases.

7. Replacing a regular soda (330 ml) with a diet soda will save approximately 150 kcal.
8. Some people who are overweight can live on 800-1200 kcal a day without losing weight.
9. To maintain your weight, you can eat anything you want if you limit your calorie intake to the amount your body needs to carry out daily activities.
10. Swapping sugar with artificial sweeteners can help with weight loss maintenance.
11. It’s important that you pay attention to this study, please tick “false”.

Beliefs subscale

1. Hunger is a sign that my body needs food to function properly.
2. Sometimes I have to accept that I feel hungry and not always eat in response to hunger.
3. If I feel hungry it means that I should eat to stay healthy.
4. To maintain my weight, I can eat more than I should now, if I exercise for longer later to burn off the extra calories.
5. To maintain my weight, it is ok if I overeat by a small amount in a day if I get back on track the next day.
6. If I eat too much today, I can maintain my weight if I eat less tomorrow.
7. If I weigh more today than I did yesterday it means I ate too much and gained weight.
8. Unlike me, some people can eat a lot and not gain weight.
9. To maintain my weight, I have to strictly follow a diet.
10. Compared to me, most people don't have to do anything to maintain a healthy weight.

**C: Dieting Beliefs Scale (Stotland & Zuroff, 1990)**

Please respond to the following statements by indicating how well each statement describes your beliefs. Place a number from 1 (not at all descriptive of my beliefs) to 6 (very descriptive of my beliefs) in the space provided before each statement.

1. By restricting what one eats, one can lose weight.
2. When people gain weight, it is because of something they have done or not done.
3. A thin body is largely a result of genetics.
4. No matter how much effort one puts into dieting, one’s weight tends to stay about the same.

5. One’s weight is, to a great extent, controlled by fate.
6. There is so much fattening food around that losing weight is almost impossible.
7. Most people can only diet successfully when other people push them to do it.
8. Having a slim and fit body has very little to do with luck.
9. People who are overweight lack the willpower necessary to control their weight.
10. Each of us is directly responsible for our weight.
11. Losing weight is simply a mater of wanting to do it and applying yourself.
12. People who are more than a couple of pounds overweight need professional help to lose weight.
13. By increasing the amount one exercises, one can lose weight.
14. Most people are at their present weight because that is the weight level that is natural for them.
15. Unsuccessful dieting is due to lack of effort.
16. In order to lose weight people must get a lot of encouragement from others.

**D: Food Fussiness (AEBQ)**

Please indicate your agreement or disagreement with each of the following statements.

Rate each statement on a scale from 1 - Strongly disagree to 5 - Strongly agree.

1. I often decide that I don’t like a food before tasting it.
2. I refuse new foods at first.
3. I enjoy tasting new foods.
4. I am interested in tasting new food I haven’t tasted before.
5. I enjoy a wide variety of foods.

**E:** DWHQ

The next questions are about your weight and how it has changed over time. For the purpose of this questionnaire "diet" is defined as current intentions to alter eating behaviour (e.g. increase vegetable consumption, restrict high-fat foods, smaller portion sizes) in order to lose weight.

1. What is your current height?

________ meters
________feet
________inches

2. What is your current weight?

________stones
________pounds
________kilograms

3. How would you classify your own weight? (underweight, healthy weight, overweight, obese)
4. For about how long have you been at or close (within 2 lbs/1 kg) to your present weight?

   - Less than 2 months
   - 2-6 months
   - 7-11 months
   - 1-2 years
   - More than 2 years

5. What is the most you have ever weighed since reaching your current height? (do not count any weight gains due to pregnancy, medical conditions or medications).

The most I have weighed since reaching my current height is:

________stones

________pounds

________kilograms

6. What is the least you have ever weighed since reaching your current height? (do not count any weight losses due to pregnancy, medical conditions or medication).

The least I have weighed since reaching my current height is:

________stones

_______pounds

_______kilograms

7. How long ago have you been at your lowest weight?

   - Less than 2 months
   - 2-6 months
   - 7-11 months
   - 1-2 years
   - More than 2 years

8. For about how long have you been at or close (within 2 lbs/1 kg) to your lowest weight?

- Less than 2 months
- 2-6 months
- 7-11 months
- 1-2 years
- More than 2 years

9. If your current weight is lower than your heaviest weight, please indicate which statement best describes this difference between your highest and lowest weight.

   A. The difference between my highest weight and my current weight is due to weight that I lost on purpose.
   B. The difference between my highest weight and my current weight is due to weight I lost even though I wasn't trying to.
   C. I'm not sure why I weigh less than I once did.

10. Which of these statements best describes what has happened to your weight during the past 12 months? (circle one)

   A. My weight has stayed about the same
   B. I've been losing weight
   C. I've been gaining weight
   D. My weight has fluctuated a lot

11. Are you currently on a diet? (Yes/No)

   a. IF YES: Are you currently dieting to lose weight or to avoid gaining weight? (lose weight / avoid gaining weight / gain weight
   b. Please describe the type of weight management programme you are following (e.g. commercial such as Slimming World or Weight Watchers, reduced calorie, balanced diet etc.)

12. How motivated are you to manage your weight? (1 – not at all motivated; 5 – very motivated)

**F: Practical Knowledge of meal calories - PKM-11**

The following questions are about the caloric content of meals. Please indicate the answer that is correct in your opinion.

1. Which potato side dish contains the smallest amount of fat?
    a. Potato salad
    b. Mashed potatoes
    c. Baked potatoes
    d. Don’t know
2. Which of the following cheese sandwiches has the lowest fat content?
    a. Sandwich with cream cheese
    b. Sandwich with hard cheese
    c. Sandwich with hard cheese
    d. Dont’s know
3. Which of these sandwiches is lower in calories?
    a. Ham sandwich
    b. Schnitzel sandwich
    c. Both similar
    d. Don’t know
4. Which of the following meals contains fewest calories for equal portion sizes?
    a. Trout fillet with boiled potatoes and broccoli
    b. Breaded vegetarian schnitzel with pasta and peas
    c. Both similar
    d. Don’t know
5. Which of the following wraps (sandwich made with a soft flatbread) has the lowest fat content?
    a. Chicken wrap with salad and guacamole (avocado cream)
    b. Chicken wrap with salad tomato salsa
    c. Chicken wrap with sour cream
    d. Don’t know
6. Which snack contains the smallest amount of fat for equal portion sizes?
    a. Puff pastry
    b. Tortilla (corn) chips
    c. Salted pretzel sticks
    d. Don’t know
7. Which dessert contains the smallest amount of fat?
    a. Chocolate mousse
    b. Mixed berry tiramisu
    c. Caramel pudding
    d. Don’t know
8. Which desert contains the smallest amount of calories for equal portion sizes?
    a. Fresh raspberries with mascarpone
    b. Fresh raspberries with whipped cream
    c. Both similar
    d. Don’t know
9. Which of the following beverages contains less sugar for equal portion sizes?
    a. Energy drink
    b. Orange juice
    c. Both similar
    d. Don’t know
10. Which of the following meals is lower in calories?

a. Fish, rice and green beans
b. Chicken, pasta, and carrots
c. Both similar
d. Don't know

11. What is 2+2?
    a. 3
    b. 4
    c. 5
    d. 6
12. Which meat dish contains the smallest amount of fat?
    a. Lamb chops with roasted potatoes and broccoli
    b. Minced beef with roasted potatoes and broccoli
    c. Pork medallion (not breaded with roasted potatoes and broccoli
    **d.** Don't know

**G: Single-item physical activity measure (Milton, Bull, & Bauman, 2011)**

In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate. This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job. (0-7 days)

**H: Weight control strategies scale (WCSS, Pinto et al., 2013)**

Thinking of your behaviours in the past week, rate on a scale from 1 (never) to 5 (always) the frequency to which you engaged in the following behaviours.

1. I had several servings of fruits and/or vegetables each day.
2. I kept high calorie, high fat foods (e.g., chips, cookies, and cakes) out of sight so they would not tempt me.
3. I avoided fried foods.
4. I kept low-calorie foods (e.g., fruit, raw vegetables, and unbuttered popcorn) accessible for a healthy snack.
5. I limited my intake of regular soda.
6. I ate lower-fat meats (e.g., chicken, turkey, and fish) or meat substitutes (e.g., lentils).
7. When eating dairy products (e.g., milk, yogurt, and cheese), I chose reduced fat or fat-free options.
8. I ate meat, fish, or vegetables that were baked, broiled, or grilled.
9. I chose low-calorie and/or low-fat foods to eat instead of higher calorie options.
10. I ate high-fiber foods (e.g., whole grain breads or cereals, fruit, and vegetables).

**I: Intrinsic regulation of exercise (BREQ-3)**

We are interested in the reasons underlying peoples' decisions to engage or not engage in physical exercise. Using the scale below, please indicate to what extent each of the following items is true for you. Please note that there are no right or wrong answers and no trick questions. We simply want to know how you personally feel about exercise. Your responses will be held in confidence and only used for our research purposes.

0 - Not true for me 4 - Very true for me

1. I exercise because it's fun.
2. I enjoy my exercise sessions.
3. I find exercise a pleasurable activity.
4. I get pleasure and satisfaction from participating in exercise.

**Section 3:** Follow up survey

**A: Participant information sheet**

You are being invited to participate in the second part of the study: Investigating a new measure of weight management and its relation to other lifestyle behaviours. This research study aims to investigate weight management beliefs and understand how these are related to other lifestyle behaviours.

Taking part in this study involves completing a survey containing questions regarding your lifestyle, beliefs and knowledge about weight loss maintenance as well as some demographic information, including weight, height and dieting history. The surveys will each take approximately 5 minutes to complete (although individual completion times may vary).

This survey is entirely voluntary, and all responses will be anonymous and kept confidential. The study findings may be published in a peer review journal article, however the data reported will be for the overall response from all respondents and your response will remain anonymous.

You may withdraw from the survey at any point by closing your browser. You can withdraw your completed or partial data from the study by contacting the researcher and providing your Prolific ID.

If you feel distressed by any of the questions in this study, you may find the following resources useful. If the distress continues, we advise you to seek support from your GP:

**NHS choices counselling:**

https://www.nhs.uk/conditions/counselling/

**NHS choices wellbeing:**

https://www.nhs.uk/conditions/stress-anxiety-depression/improve-mental-wellbeing/

This research is conducted by Denisa Genes (dlungu1@sheffield.ac.uk), PhD student in the Department of Psychology, Dr Nicola Buckland (n.buckland@sheffield.ac.uk), Department of Psychology, and Dr Fuschia Sirois (f.sirois@sheffield.ac.uk), Department of Psychology. The survey has received ethical approval from the University of Sheffield Department of Psychology.

If you have any questions regarding this study, its purpose or procedures, please feel free to contact Denisa Genes (dlungu1@sheffield.ac.uk). If you are dissatisfied with any aspect of the research and wish to make a complaint, please contact Dr Nicola Buckland (n.buckland@sheffield.ac.uk), and Dr Fuschia Sirois (f.sirois@sheffield.ac.uk) in the first instance. If you feel your complaint has not been handled in a satisfactory way you can contact the Head of the Department of Psychology, Professor Elizabeth Milne (psy-hod@sheffield.ac.uk). If the complaint relates to how your personal data has been handled, you can find information about how to raise a complaint in the University's Privacy Notice: https://www.sheffield.ac.uk/govern/data-protection/privacy/general.

If you wish to make a report of a concern or incident relating to potential exploitation, abuse or harm resulting from your involvement in this project, please contact the project's Designated Safeguarding Contact, Dr Nicola Buckland (n.buckland@sheffield.ac.uk). If the concern or incident relates to the Designated Safeguarding Contact, or if you feel a report you have made to this Contact has not been handled in a satisfactory way, please contact the Head of the Department of Psychology, Professor Elizabeth Milne (psy-hod@sheffield.ac.uk and/or the University's Research Ethics & Integrity Manager (Lindsay Unwin; l.v.unwin@sheffield.ac.uk).

If you would like a hard copy of this information page, then please use the "print" function on your browser or email the Principal Investigator: dlungu1@sheffield.ac.uk.

**B**: Weight change

**The next questions are about your weight and how it has changed over time. For the purpose of this questionnaire "diet" is defined as current intentions to alter eating behaviour (e.g. increase vegetable consumption, restrict high-fat foods, smaller portion sizes) in order to lose weight.**

1. What is your current weight? Kg/lbs
2. How would you classify your own weight? (underweight, healthy weight, overweight, obese)
3. Which of these statements best describes what has happened to your weight during the past 4 weeks? (circle one)

    A. My weight has stayed about the same
    B. I've been losing weight (intentionally)
    C. I've been losing weight (unintentionally)
    D. I've been gaining weight
    E. My weight has fluctuated a lot

4. Are you currently on a diet? (Yes/No)

    a) IF YES: Are you currently dieting to lose weight or to avoid gaining weight? (lose weight / avoid gaining weight / gain weight
    b) Please describe the type of weight management programme you are following (e.g. commercial such as Slimming World or Weight Watchers, reduced calorie, balanced diet etc.)
    c) How long have you been on your current diet?
    d) How much weight (if any) have you lost on your current diet?

5. Please select any that currently apply to you:
- Pregnant
- Breastfeeding
- Had weight loss surgery (e.g. gastric bypass, stomach stapling)
- Have diabetes
- Have heart disease
- Have an under or overactive thyroid
- Regular smoker
- Have another heath condition (please detail)
- None apply
6. How would you rate your overall current health? (check one most appropriate box)
(Excellent, very good, good, fair, poor)
7. How motivated are you to manage your weight? (1 – not at all motivated; 5 – very motivated)

**C**: WLMKB: Knowledge and beliefs about energy balance, diet flexibility, calorie compensatory behaviours, hunger and obesity (Genes, Sirois & Buckland, in preparation).

The statements below present either facts or fiction about nutrition, physical activity and weight management. Please read each statement and indicate whether you believe the statement is true or false.

**Weight loss maintenance** is defined as losing weight (at least 10% of initial body weight) and keeping it off (±2-3 kg/5 lbs) for a longer period of time (**more than 1 year**).

**Vigorous-intensity physical activity** requires a large amount of effort and causes rapid breathing and a **substantial increase in heart rate** (e.g. hiking, jogging, shovelling, carrying heavy loads, bicycling fast) (WHO).

Knowledge subscale

1. Starchy foods such as bread, potatoes and pasta are fattening.
2. Engaging in vigorous cardiovascular physical exercise (e.g. hiking, jogging) is necessary to maintain your weight.
3. Eating bread causes weight gain.
4. When attempting to maintain weight you should not eat any high calorie foods (e.g. fries, burgers, cake, biscuits).
5. To maintain your weight you should not drink any alcohol.
6. After weight loss, the number of calories you burn while doing exercise decreases.

7. Replacing a regular soda (330 ml) with a diet soda will save approximately 150 kcal.
8. Some people who are overweight can live on 800-1200 kcal a day without losing weight.
9. To maintain your weight, you can eat anything you want if you limit your calorie intake to the amount your body needs to carry out daily activities.
10. Swapping sugar with artificial sweeteners can help with weight loss maintenance.

Beliefs subscale

1. Hunger is a sign that my body needs food to function properly.
2. Sometimes I have to accept that I feel hungry and not always eat in response to hunger.
3. If I feel hungry it means that I should eat to stay healthy.
4. To maintain my weight, I can eat more than I should now, if I exercise for longer later to burn off the extra calories.
5. To maintain my weight, it is ok if I overeat by a small amount in a day if I get back on track the next day.
6. If I eat too much today, I can maintain my weight if I eat less tomorrow.
7. If I weigh more today than I did yesterday it means I ate too much and gained weight.
8. Unlike me, some people can eat a lot and not gain weight.
9. To maintain my weight, I have to strictly follow a diet.
10. Compared to me, most people don't have to do anything to maintain a healthy weight.

**D: Single-item physical activity measure (Milton, Bull, & Bauman, 2011)**

In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate. This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job. (0-7 days)

**E: Weight control strategies scale (WCSS, Pinto et al., 2013)**

Thinking of your behaviours in the past week, rate on a scale from 1 (never) to 5 (always) the frequency to which you engaged in the following behaviours.

1. I had several servings of fruits and/or vegetables each day.
2. I kept high calorie, high fat foods (e.g., chips, cookies, and cakes) out of sight so they would not tempt me.
3. I avoided fried foods.
4. I kept low-calorie foods (e.g., fruit, raw vegetables, and unbuttered popcorn) accessible for a healthy snack.
5. I limited my intake of regular soda.
6. I ate lower-fat meats (e.g., chicken, turkey, and fish) or meat substitutes (e.g., lentils).
7. When eating dairy products (e.g., milk, yogurt, and cheese), I chose reduced fat or fat-free options.
8. I ate meat, fish, or vegetables that were baked, broiled, or grilled.
9. I chose low-calorie and/or low-fat foods to eat instead of higher calorie options.
10. I ate high-fiber foods (e.g., whole grain breads or cereals, fruit, and vegetables).

# Appendix E: Supplementary materials for Study 4

Table S1: Cronbach's Alpha

| **Scale** | **Cronbach's α** |
|---|---|
| Perceived Stress Scale | .89 |
| The Self-Compassion Scale | .93 |
| Flexible restraint | .79 |
| Rigid restraint | .80 |
| Uncontrolled eating | .90 |
| Craving control | .92 |

Table S2: Sample health characteristics

Participant health characteristics.

| Variable (total *n*) | *n* (%) or *M* ± *SD* (95% CI) |
|---|---|
| ***WMA before COVID-19 lockdown*** | |
| To gain weight | 9 (5.4%) |
| Lose weight | 117 (70.5%) |
| Avoid gaining weight | 40 (24.1%) |
| ***WMA response to COVID-19 lockdown*** | |
| Continued WMA | 66 (39.8%) |
| Stopped WMA | 42 (25.3%) |
| Temporarily stopped WMA | 51 (30.7%) |
| Other | 7 (4.2%) |
| ***Health*** | |
| Pregnant | 2 (1.2%) |
| Breastfeeding | 1 (.6%) |
| Smoking | 12 (7.2%) |
| Diabetes | 3 (1.8%) |
| Heart disease | 1 (.6%) |
| Under or overactive thyroid | 10 (6 %) |
| Other health condition | 20 (12 %) |
| No health condition | 123 (74.1%) |
| ***Current health rating*** | |
| Excellent | 14 (8.4%) |
| Very good | 50 (30.1%) |
| Good | 67 (40.4%) |
| Fair | 29 (17.5%) |
| Poor | 6 (3.6%) |
| ***Own weight classification*** | |
| Underweight | 3 (1.8%) |
| Healthy weight | 76 (45.8%) |
| Overweight | 64 (38.6%) |
| Obese | 23 (13.9%) |

WMA = Weight management attempt

Table S3: Sample COVID-19 characteristics

Participant COVID-19 characteristics.

| Variable (total *n*) | *n* (%) or *M* ± *SD* (95% CI) |
|---|---|
| ***COVID-19 lockdown status*** | |
| Self-isolated | 20 (12%) |
| Went outside for essentials only | 128 (77.1%) |
| Key worker | 16 (9.6%) |
| Went to social gatherings | 1 (.6%) |
| ***COVID-19 Status*** | |
| Contracted, confirmed by test | 6 (3.6%) |
| Contracted, self-diagnosed | 2 (1.2%) |
| Possibly contracted | 23 (13.9%) |
| Not contracted, confirmed by test | 29 (17.6%) |
| Don’t think so | 105 (63.6%) |
| ***Living situation*** | |
| Alone | 26 (15.7%) |
| Partner/spouse | 80 (48.2%) |
| Children | 29 (17.5%) |
| Friend(s) | 6 (3.6%) |
| Parent(s) | 51 (30.7%) |
| Siblings | 29 (17.5%) |
| Grandparent(s) | 3 (1.8%) |
| Housemate(s) | 17 (10.2%) |
| Other | 5 (3%) |
| ***COVID-19 employment status (164)*** | |
| Key worker | 16 (9.8%) |
| Work from home | 62 (37.8%) |
| Unable to work but is paid | 9 (5.5%) |
| Did not work during first lockdown | 7 (4.3%) |
| Not working, not being paid | 6 (3.7%) |
| Made redundant | 1 (.6%) |
| Not applicable | 38 (23.2%) |
| Other | 17 (10.4%) |
| Prefer not to say | 8 (4.9%) |

Table S4: Drop-out analysis

| Participant characteristics. | | |
|---|---|---|
| Variable | *n* (%) or *M* ± *SD* (95% CI) | |
| | Completers (171) | Drop-outs (182) |
| Age | 30.88 (12.05) | 29.06 (11.14) |
| ***Gender*** | | |
| Male | 45 (27.1%) | 42 (23.1%) |
| Female | 117 (70.5%) | 130 (71.4%) |
| Other | 4 (2.4%) | 10 (5.5%) |
| ***Education level (166)*** | | |
| No formal qualifications | 1 (.6%) | 3 (1.9%) |
| 1-4 GCSEs or equivalent qualifications. | 5 (3%) | 3 (1.9%) |
| 5 GCSEs or equivalent qualifications. | 4 (2.4%) | 4 (2.5%) |
| Apprenticeship. | 1 (.6%) | |
| 2 or more A-levels or equivalent qualifications. | 45 (27.1%) | 63 (39.1%) |
| Bachelor’s degree or equivalent. | 71 (42.8%) | 54 (33.5%) |
| Doctoral or higher education. | 37 (22.3%) | 32 (19.9%) |
| Other qualifications including foreign qualifications. | 2 (1.2%) | 2 (1.2%) |
| ***Ethnic group*** | | |
| White | 128 (77.1%)) | 121 (75.2%) |
| Mixed or multiple ethnic groups | 4 (2.4 %) | 8 (5%) |
| Asian or Asian British | 23 (13.9%) | 22 (13.7%) |
| Black, African, Caribbean, or Black British | 6 (3.6%) | 5 (3.1%) |
| Prefer not to say | 2 (1.2%) | 2 (1.2%) |
| Other | 3 (1.8%) | 3 (1.9%) |

**Table S7:** Mean (SD) differences in changes in weight management strategies (WMS) domains by weight management attempt (WMA) status (stopped (S), continued (C) or temporary disruption (T))

| WMS domain | Stopped | Continued | Temporary disruption | S/T | S/C | C/T |
|---|---|---|---|---|---|---|
| Information seeking | -9.28 (30.36) | 13.50 (22.30) | 7.65 (26.33) | t(65) = -2.42** | t(78) = 3.79*** | t(93) = 1.17 |
| Rules | -0.63 (33.05) | 9.50 (22.98) | 16.94 (21.98) | t(76) = -2.80** | t(82) = 1.66 | t(88) = -1.56 |
| Monitoring | -14.52 (26.42) | 9.88 (20.95) | -0.19 (19.78) | t(52) = -2.28** | t(61) = 4.04*** | t(69) = 2.06* |
| Support | -31.58 (23.14) | -32.38 (19.06) | -19.90 (25.29) | t(39) = -1.54 | t(48) = -0.14 | t(35) = -1.91 |

****p*<.001; ***p*<.01; **p*<.05

**Table S8:** Correlation Matrix

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| **1. Weight Change%** | | | | | | | | | |
| **2. Energy intake change** | .45** | | | | | | | | |
| **3. Physical activity change** | -.20* | -.24** | | | | | | | |
| **4. Craving control** | -.34** | -.40** | .11 | | | | | | |
| **5. Rigid control** | -.13 | -.04 | .01 | -.10 | | | | | |
| **6. Flexible control** | -.26** | -.15 | .04 | .14 | .62** | | | | |
| **7. Uncontrolled eating** | .30** | .39** | -.09 | -.63** | .23** | -.09 | | | |
| **8. Self-compassion** | -.16 | -.21** | .10 | .32** | -.25** | -.07 | -.37** | | |
| **9. Perceived stress** | .22** | .24** | -.18* | -.47** | .30** | .10 | .45** | -.57** | |

***p*<.001 **p*<.05

Appendix SA: The Oxford Food and Activity Behaviours (OxFAB) taxonomy and questionnaire (Hartmann-Boyce, Aveyard, Koshiaris, & Jebb, 2016).

The following questions are about changes in weight management strategies since the COVID 19 lockdown. When answering the questions, please consider your TYPICAL weight management practices before the lockdown and compare these to your TYPICAL weight management practices since the lockdown.

To answer the questions, please indicate on each scale the point that best represents your response to the question.

Each scale ranges from the extreme of ‘0 = I so this a lot less’, ‘50 = I do this the same amount’ to ‘100 = I do this a lot more’).

To what extent do you use the following strategies to manage your weight.

Response scale

☐Does not apply at all

| | |
|---|---|
| 0 | 100 |
| I do this a lot less | a lot more |

1. Make up for overeating at one meal, by eating less at another.
2. Adjust the amount of food eaten based on physical activity.
3. Make up for being sedentary one day by exercising more the next day.
4. Have a set goal of how much to eat each day.
5. Have a set goal of how much physical activity to do each day.
6. Have a set goal of how much weight you want to lose each week.
7. Make food choices based on the nutritional information on the food labels.
8. Look up the nutrition information and/or calorie content of foods.
9. Look up information on how many calories you burn doing physical activity.
10. Plan meals in advance.
11. Plan food shopping in advance (e.g. use a shopping list).
12. Walk or cycle instead of driving or taking the bus.
13. Follow an exercise plan/routine.
14. Do more chores at home/in the garden to get more exercise and lose weight.
15. Skip meals as a way to lose weight.
16. Avoid eating certain foods.
17. Avoid specific shops or aisles in the supermarket.
18. Control portion size by putting a certain amount of food on a plate or drink in a glass.
19. Drink water or a low-calorie drink or eat low-calorie food to limit the amount eaten during meals.
20. Swap one type of food or drink for another that is better for the diet (e.g. lower fat or lower sugar versions of the same foods).
21. Plan meal times to help with weight loss plans.
22. Schedule physical activity each week.
23. Keep track of the calorie and/or nutritional content of the foods eaten.

24. Check the portion sizes.
25. Keep track of physical activity.
26. Keep track of weight by weighing regularly.
27. Measure waist (or other parts of the body).
28. Use smaller plates, bowls or glasses when eating to help with portion control.
29. Buy food pre-packaged in individual portions.
30. Buy smaller amounts of certain foods to help with eating less.
31. Don't buy or keep at home things that don't fit with the diet.
32. Do something to prompt exercise (e.g. lay out exercise clothes the night before).
33. Try to lose weight alongside a friend/family member/partner.
34. Have an online weight loss buddy.
35. Sought help to tackle feeling stressed, down, or anxious to avoid breaking the diet.
36. Talked to a healthcare professional about weight management (e.g. doctor, nurse, dietitian, physiotherapist, psychologist).
37. Use meal replacements (e.g. shakes, diet bars, etc.).
38. Use the gym.
39. Exercise at home using own equipment or DVDs.
40. Please state any other strategies that you use to manage your weight.
41. Please use the comments box below to detail your experience of how the lockdown has affected your weight management attempt, this might include changes to the types and amounts of food you have eaten, physical activity or weight monitoring. If there are no changes, please type 'no changes' and move on to the next page.