FRUIT AND VEGETABLES:

FACTORS AFFECTING THEIR CONSUMPTION

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The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference is made to the work of others.

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Abstract

The purpose of this thesis was to study food choice motivations in relation to fruit and vegetable consumption. To this end, four studies were undertaken. The first was a systematic review of the literature investigating factors affecting the food choice decisions of adults in relation to fruit and vegetable consumption.

The second study examined the different health and lifestyle factors, which affect fruit and vegetable consumption in women. Participants were drawn from the UK Women's Cohort Study (UKWCS), and were all females, aged 35-69 years (n = 35,367). These women provided health and lifestyle information including a 217-item food frequency questionnaire. The strongest predictors of a high level of fruit and vegetable consumption found in the logistic regression model were: being a vegetarian or vegan, taking vitamin or mineral supplements, being married, having an A-level or degree level of education and belonging to a higher socio-economic group.

The third study explored the priorities of high consumers of fruit and vegetables compared to lower consumers, within 998 women from the UKWCS, using the Food Choice Questionnaire. In a multiple linear regression model the strongest motivations affecting specifically fruit and vegetable intake were health and natural content. This study also investigated the relationships between food choice motivations and the process of behaviour change, using the Stages of Change (SOC) Model. The SOC evaluation showed significant associations

with portions of fruit and vegetables consumed, and the findings showed that women classified in differing phases of SOC model have different food choice motivations.

The final study assessed the variability and validity of plasma nutrient levels as biomarkers of fruit and vegetable intake. Participants were 54 non-smoking women recruited from the UKWCS. Two methods, the food frequency questionnaire and the 4-day food diary were employed to assess fruit and vegetable intakes. The results implied that the practice of using plasma biomarkers simply as a *proxy* measure of dietary intake is not valid and emphasise that plasma biomarkers are not simply a reflection of dietary intake but also of a number of physiological processes.

Overall, the findings demonstrated: that health promotion interventions to increase fruit and vegetable consumption should primarily be targeted at people who smoke, live alone and are of a lower education level and socio-economic status; that higher consumers of fruit and vegetables tend to be more motivated by health concerns and the natural content of the food, and less motivated by convenience and familiarity issues, than the lower consumers of fruit and vegetables; that people classified in different Stages of Change have differing food choice motivations and finally; that plasma antioxidant levels are not biochemical markers of accurate dietary intakes, at either the food or nutrient level, however they may give a more complete assessment of diet when used in conjunction with traditional dietary assessment methods.

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Introduction

1.1 Foreword – "An apple a day..."

1.1.1 The public health killers

Cardiovascular diseases and cancers are main causes of morbidity and mortality in the UK, with cancer responsible for 127,000 deaths every year (Department Of Health 1999) and coronary heart disease killing a further 110,000 a year (Department Of Health 1999; Department Of Health 2000). The age-standardised death rates from cancers and heart disease (including Ischaemic heart disease and strokes) can be seen in Figures 1.1 and 1.2.

Figure 1.1 Age-Standardised Death Rates per million, from all cancers for England and Wales, from 1985-2000.

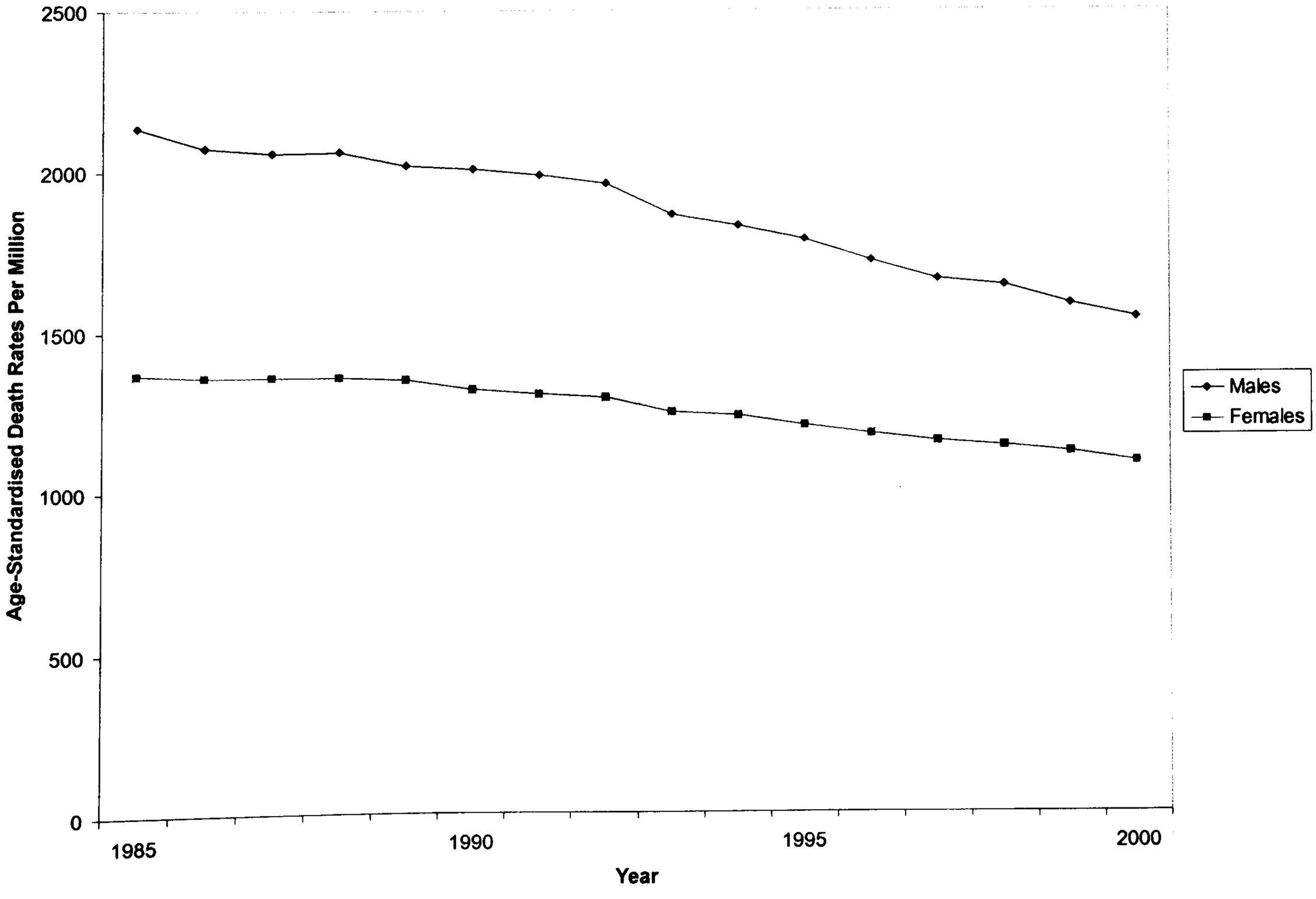
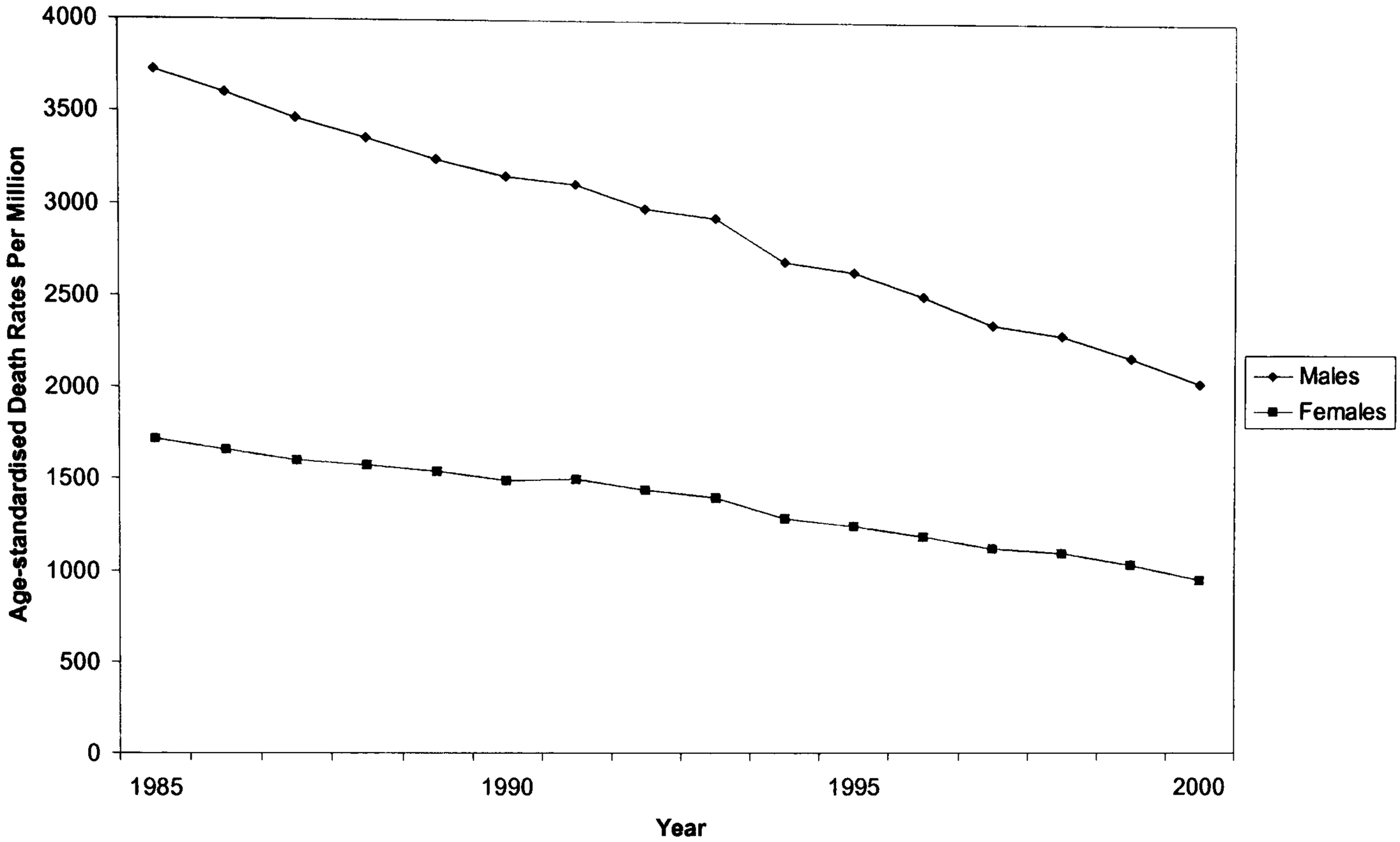


Figure 1.2 Age-Standardised Death Rates per million, from Ischaemic heart disease and stroke, for England and Wales, from 1997-2000.



Although death rates have decreased slowly every year since 1985, these diseases continue to be main causes of mortality in the UK. Decreasing the prevalence of both diseases is therefore still an important goal in the public health strategy for the UK, and this is embodied in documents such as 'Saving Lives: Our Healthier Nation' (Department Of Health 1999).

1.1.2 The evidence-based health benefits of fruit and vegetables

A high consumption of fruit and vegetables is generally considered to be beneficial to health, and there is now a comprehensive body of evidence recognising the protective effects of high fruit and vegetable consumption on cardiovascular disease and certain cancers, particularly epithelial cancers (Block, Patterson, & Subar 1992; Ness & Powles 1997; World Cancer Research Fund & American Institute for Cancer Research 1997). Recently, using the best

estimates of relative risk, it has been calculated that over 26,000 deaths before the age of 65 years would be prevented annually in the European Union (EU) if intake was levelled between all countries up to the highest current level of 604g per person per day in Spain (Joffe & Robertson 2001).

Dietary advice to the public encouraging increased consumption of fruit and vegetables has been promoted since the 1970s, however over the years the scientific basis of this advice has changed and uncertainties still remain regarding the active ingredients and the mechanisms of action (Rayner 1998). Some of the proposed mechanisms of action are now discussed in the following sections.

1.1.3 Fruit and vegetables and cardiovascular diseases

There are a number of theories concerning the mechanism for the protective effect of fruit and vegetables against cardiovascular diseases. The three main theories are based on antioxidant compounds, fibre and folates (Brouwer et al. 1999; Eastwood 1999).

The antioxidant theory is based on the assumption that initial arterial injury, in cardiovascular disease, is caused by free radical damage to lipids in the bloodstream. Free radicals are highly reactive and unstable molecules, and as a result readily oxidise surrounding lipids. When lipids are oxidised they become damaged and are scavenged by macrophages in the artery wall. The macrophages eventually become overloaded with damaged lipids and form 'foam cells'. A build up of foam cells leads to the development of the 'fatty

streak', one of the earliest recognisable lesions of atherosclerosis (Halliday & Ashwell 1993). Antioxidants are substances that are able to scavenge for free radicals and thus inhibit the oxidation of lipids in the bloodstream. Fruit and vegetables contain a number of compounds with potent antioxidant abilities, namely the antioxidant vitamins β-carotene, C and E, along with other active phytochemicals such as flavonoids. A number of epidemiological and controlled trials have been conducted to elucidate the role of antioxidants in cardiovascular disease risk. The results are conflicting and reviews of the literature in this area remain inconclusive (Center for Reviews and Dissemination Reviewers 2001a; Center for Reviews and Dissemination Reviewers 2001b).

Other theories suggest that fruit and vegetable consumption may affect coronary heart disease risk through lowering plasma cholesterol levels by the action of soluble dietary fibre (Jenkins et al 1979; Tinker et al 1991). Fibre may also be protective in coronary heart disease and stroke by helping to reduce blood pressure (Lampe 1999). It has also been found that folic acid supplementation improves folate status and decreases elevated plasma homocysteine levels, which is considered to be a risk factor for cardiovascular disease (Brouwer et al 1999).

The findings of a review on fruit and vegetables and cardiovascular disease risk concluded that the results of studies looked at were consistent with a strong protective effect of fruit and vegetables for stroke and a weaker protective effect for coronary heart disease (Ness & Powles 1997). However when the role of

individual antioxidants or dietary fibre is examined the results are often disappointing. This is probably because the phytochemicals at work here have overlapping mechanisms, and may have synergistic, additive or inhibitory effects on each other, and these aspects have not yet been addressed in human trials (Lampe 1999). What we can conclude however is that, as a food group, fruit and vegetables are beneficial in reducing the risk of cardiovascular diseases.

1.1.4 Fruit and vegetables and cancers

Research into diet and cancer risk has tended to focus more on the food groups that may offer protection, rather than on individual nutrients, although, as with cardiovascular disease, the antioxidant theory is a strong contender. In the case of cancers, free radicals attack DNA in cells. With an accumulation of damage to the DNA, mutations can result leading to altered gene function, clonal expansion and eventually malignant disease (Rautalahati & Huttunen 1993). It is thought that food and nutrition may affect cancer progression in a number of ways, however, the specific mechanisms by which individual dietary constituents affect cancer are still not fully understood (World Cancer Research Fund & American Institute for Cancer Research 1997).

The evidence for a protective effect of fruit and vegetables on different types of cancers is variable. In 1998 the Department of Health set up a working group in order to develop a report focusing exclusively on the evidence-based influence of nutritional factors on cancer development. In relation to fruit and vegetables they found that there was moderate evidence that increased vegetable

consumption could reduce the risk of colorectal cancer, and that higher fruit and vegetable consumption would reduce the risk of gastric cancer. There is also some evidence, although weaker, that higher fruit and vegetable consumption can reduce the risk of breast cancer (Committee on Medical Aspects of Food and Nutrition Policy 1998).

These findings are backed up by the review carried out by the World Cancer Research Fund and the American Institute for Cancer Research, which found that there is a strong and consistent pattern showing that diets high in fruit and vegetables decrease the risk of many cancers (World Cancer Research Fund & American Institute for Cancer Research 1997).

1.2 The recommendations

1.2.1 How much is enough?

With the increasing recognition that fruit and vegetables are beneficial to health, official recommendations have been made as to the desirable quantities of fruit and vegetables that people should consume. In 1990 the World Health Organisation (WHO) recommended an intake of at least 400g of fruit and vegetables, per person per day, to provide protection against chronic diseases such as cardiovascular disease and certain forms of cancer (World Health Organisation 1990). However there were no national goals for fruit and vegetable consumption within the UK until the publication of the COMA report on the nutritional aspects of cardiovascular disease in 1994. This report advised a 50% increase in the mean population intake of fruit and vegetables in the UK (Committee on Medical Aspects of Food and Nutrition Policy 1994). This was

backed up by a further COMA report in 1998, focusing on the nutritional aspects of cancer, which recommended a 50% increase in fruit and vegetable consumption, to at least 5 portions per person per day (Committee on Medical Aspects of Food and Nutrition Policy 1998). This advice is in line with the WHO recommendation of 400g of fruit and vegetables per day, if we assume an average portion size of 80g (i.e. 5 portions of 80g each equals 400g). The advice is based on the fact that this is a potentially achievable goal, and will be conducive to better general health, in the absence of sufficient evidence to quantify the optimal level of intake to reduce disease risk (Cox et al 1997; Committee on Medical Aspects of Food and Nutrition Policy 1998).

1.2.2 Which fruit and vegetables are recommended?

The recommendation of five portions of fruit and vegetables per day may not be quite as straightforward as they first appear, and the general public should be made aware of exactly what constitutes a portion, and of which fruit and vegetables. The COMA report found that there was insufficient evidence to recommend particular types of fruit and vegetables (Committee on Medical Aspects of Food and Nutrition Policy 1994), and recommendations simply state that a diverse range of fruit and vegetables should be included in the daily diet. This diversity is important because different fruit and vegetables contain different types and amounts of nutrients and phytochemicals, and therefore a greater diversity of foods will lead to a greater diversity of nutrient and phytochemical intakes.

The recommendation of five portions of fruit and vegetables per day excludes potatoes because they are considered to be a starchy staple food, in dietetic terms, and for the same reason other starchy staple foods such as yam are also excluded. Fresh fruit juice can be included in the recommendation, however fruit juice should only count as one portion per day no matter how much is consumed. Beans and pulses, including baked beans, can also be counted as a portion, but as with fruit juice, they will only count as one per day no matter how much is consumed. Nuts are excluded from the recommendations. Dried fruit, canned and frozen fruit and vegetables and fruit and vegetables from composite dishes can all be included in the daily figure (Williams 1995).

1.2.3 How much is a portion?

A portion of fruit and vegetables, in terms of the recommendations, should weigh approximately 80g. However, in terms of a public health message this does not make for very user-friendly advice. Some health promotion messages have been altered to state that people should be consuming five "decent-sized" portions of fruit and vegetables per day, but perhaps this is still not very explicit. Table 1.1 shows the equivalent of approximately 80g portions of a variety of fruit and vegetables in standard household measures.

Table 1.1 80g equivalents of fruit and vegetables converted into standard household measures.

Food	**Household measures weighing approx. 80g.**
Fruit:	
Very large fruit (eg melon, pineapple)	One large slice
Large fruit (eg apple, banana)	One whole
Medium fruit (eg plum, kiwi)	Two whole
Small fruit (eg berries)	Cupful
Dried fruit (eg apricots, raisins)	Half serving spoonful
Fruit juice	Full wine glass
Vegetables:	
Green vegetables (eg broccoli, spinach)	Two serving spoonfuls
Root vegetables (eg carrots, parsnips)	Two serving spoonfuls
Small vegetables (eg peas, sweetcorn)	Three serving spoonfuls
Pulses and beans	Two serving spoonfuls
Salad	Bowlful

Reference: Williams,C. (1995) "Healthy eating: clarifying advice about fruit and vegetables." *British Medical Journal*, **310**: 1453-1455. Reproduced by permission of the BMJ.

1.3 Food choice behaviour in fruit and vegetable research

Despite health promotion attempts to increase fruit and vegetable consumption to the recommended level, UK intakes continue to fall short of the goal (Department Of Health 1999; Thompson et al. 1999). The results of the Dietary and Nutritional Survey of British Adults, in 1990, found the UK average intake of fruit and vegetables, including fruit juice to be 260g per person per day (Gregory et al. 1990). More recently the mean daily intake of fruit and vegetables, including fruit juice, in the UK has been found to be 310g per person per day, or about four portions, as measured by the National Food Survey (Ministry of Agriculture, Fisheries and Food 1999). However these figures are slightly misleading because they cover the fact that there are large variations in intakes between regions, social classes and the sexes. For example, it has been found that the lowest consumers of fruit and vegetables tend to be younger, male and smokers (Thompson et al. 1999).

Increasing fruit and vegetable consumption in the UK is an important health promotion goal, however despite previous health promotion attempts to increase consumption UK intakes are still low (Department Of Health 1999; Thompson et al. 1999). In order to identify how best to bring about this population change it is necessary to investigate peoples' food choice decisions. These food choice decisions determine which nutrients enter the body, whether it is a conscious decision or not. Eating behaviour is elaborate and complicated, and personal to each individual, but an understanding of the impact of the factors that affect food choice, in relation to fruit and vegetable consumption, is vital given the priority for population dietary change.

1.4 Underlying problems in fruit and vegetable research

One of the biggest challenges in nutritional epidemiology is making a correct measurement of dietary exposure. Yet this is a fundamental part of assessing diet-disease relationships. Traditional dietary assessment methods are problematic and measurement errors of fruit and vegetable intake have the potential to affect the measurement of risk assessment in diet-disease relationships. Traditional dietary assessment methods tend to be subjective, such as the food diary, food frequency questionnaire and the 24-hour recall. As a result these methods are prone to substantial errors from over- or under-reporting of foods, over- or under-reporting of portions sizes and inaccurate recall. Nevertheless in the absence of any easily attainable objective measures of diet it is the task of the nutritional epidemiologist to obtain the best measure of diet possible.

In addition to reporting errors, traditional dietary assessment methods rely heavily on food composition databases to convert reported food intakes into nutrient data. These databases are often incomplete for a number of nutrients and the accuracy of the databases is not questioned. If consumption of fruit and vegetables cannot be estimated accurately then it follows that nutrient intake estimates are even more unlikely to be accurate. This is perhaps the cause of the often disappointing results found when estimates of disease-risk, in particular cardiovascular disease, are compared with nutrient intakes such as the antioxidant nutrients. In order to explore the link between fruit and vegetable consumption and disease risk more fully it is essential that research focus on improving measurement error in this area.

1.5 Thesis Aims and Outline

The purpose of this thesis is to study food choice motivations in relation to fruit and vegetable consumption. In particular, the aims are:

- to review current knowledge in this area;
- to describe key health and lifestyle characteristics differentiating between high and low fruit and vegetable consumers;
- to explore food choice motivations specifically in relation to fruit and vegetable consumption; and
- to describe the measurement error associated with fruit and vegetable research by exploring plasma antioxidants as biochemical markers of fruit and vegetable consumption.

This thesis explores the factors that affect the consumption of fruit and vegetables in the UK population. The literature review undertaken in the next chapter summarises some of the models and theories used previously in this area, and describes in detail the factors that have been found to influence consumption of fruit and vegetables in previous studies.

Chapter 3 reports the results of a study investigating the health and lifestyle factors affecting fruit and vegetable consumption in women participating in the UK Women's Cohort Study (UKWCS). This is then followed, in Chapter 4, by the findings of a second study that investigated the food choice motivations influencing fruit and vegetable consumption within a sub-sample of the same women.

Chapter 5 of the thesis has a shift of focus towards experimental techniques, and improving measurement error in fruit and vegetable research. The chapter explores the use of plasma antioxidants as biochemical markers of fruit and vegetable consumption in the UKWCS.

Finally in Chapter 6 the findings from all of the studies are brought together and discussed in the context of the implications for health promotion and future research.

Chapter 2

Literature Review

2.1 Summary

This review provides an investigation into the food choice decisions made by people in relation to fruit and vegetable consumption. A comprehensive body of evidence now exists concerning the protective effect of fruit and vegetables against a number of diseases, particularly cardiovascular disease and certain forms of cancer. Current UK recommendations are to increase intakes of fruit and vegetables to 400g per person per day. In attempting to investigate food choice decisions it is necessary to first explore health behaviour theories. The review briefly describes three of the most influential models used in the literature; The Health Belief Model, The Theory of Planned Behaviour and The Transtheoretical Model. In the main body of the review the factors that affect food choice decisions of adults in relation to fruit and vegetable consumption are studied, following a suggested framework of food choice. Factors covered include sensory appeal, familiarity and habit, social interactions, cost, availability, time constraints, personal ideology, media and advertising and health.

2.2 Introduction

2.2.1 Background to the review

Concern about food choices that may have adverse effects on health is currently at the forefront of public health and is embodied in documents such as 'Saving Lives: Our Healthier Nation' (Department Of Health 1999). As already discussed in Chapter 1 a comprehensive body of scientific evidence now exists concerning the protective effect of fruit and vegetables against a number of diseases, particularly cardiovascular disease and certain forms of cancer (World Health Organisation 1990). It is the job of the health professional to take this scientific information and adapt it in such a way that meaningful behaviour change may be achieved by the public. The choices people make around foods determine which nutrients are consumed. However people do not choose their foods exclusively for the nutrients they provide. Eating behaviour is complex and an understanding of the impact of the factors that affect food choice is vital given the priority for population dietary change.

2.2.2 Aim of the review

The aim of this review is to provide a rigorous investigation into the factors affecting the food choice decisions of adults in relation to fruit and vegetable consumption. No such review has been found in the literature. Firstly studies focusing on basic demographic and lifestyle factors affecting fruit and vegetable consumption will be reviewed briefly. This will then be followed by a review of a number of health behaviour theories and models that have been used to study the psychosocial complexities of human health behaviour, particularly in the field of fruit and vegetable consumption. Following on from this a theoretical

framework will be developed describing the personal, practical, economic and social factors affecting food choice decisions. This framework will form the basis for the main body of the review, which will explore the factors affecting food choice decisions of adults in relation to fruit and vegetable consumption. Finally the implications for health promotion and future research will be considered.

2.2.3 Methodology of the review

The literature review was conducted systematically. The electronic search strategy was limited to a number of databases which were the Cochrane Database of Systematic Reviews (CDSR 1997 - present), the Database of Reviews and Effectiveness (DARE 1997 - present), MEDLINE (1990 – present), EMBASE, a major biomedical database (1980 – present), the Cummulative Index to Nursing and Allied Health (CINAHL 1982 – September 2001), PsycINFO: Psychological abstracts (1998 – July 2001) and the System for Information on Grey Literature in Europe. Within these databases all English-language papers relating to humans were sought if the abstracts included any of the following key words; fruit, vegetables or antioxidant nutrients AND food choice, health behaviour, health attitudes or eating behaviour. Appetite (1995-2001) was also searched by hand, as this is a key journal within the field. All studies were assessed for relevance and a 'snowball procedure' was employed whereby the references cited in each article were browsed for further relevant research. A total of 494 articles were retrieved and evaluated for relevance.

2.3 Demographic and lifestyle factors affecting fruit and vegetable consumption

The recommended intake of fruit and vegetables has already been discussed in Chapter 1. These recommendations suggest that an intake of 400g of fruit and vegetables should be included in the daily diet to protect against disease (World Health Organisation 1990). Currently in the UK the mean daily intake of fruit and vegetables is 310g per person (Ministry of Agriculture, Fisheries and Food 1999). However there are large variations in intake between regions, social classes and the sexes, and many differences exist between the highest and lowest consumers of fruit and vegetables.

Studies of regional differences in fruit and vegetable intakes have found that people living in Scotland and the North East of England generally consume less than people in the Midlands, South West, Wales, London and the South East (Leather 1995). These differences are larger when considering social class variations in intakes. It has been found that people with higher education, income and social status have a higher consumption of fruit and vegetables than people with lower education, income and social class status (Johansson & Andersen 1998; McClelland et al. 1998). In the Health Education Authority's Health and Lifestyle Survey of 1993 it was found that the main demographic characteristics that distinguished between low and high fruit and vegetable consumers were age, sex and smoking status (Thompson et al. 1999). It is these demographic characteristics that perhaps exhibit the strongest variations in intakes of fruit and vegetables, with women consuming more fruits and vegetables than men and older adults consuming more than the younger

generations (McClelland et al. 1998). A study of a random sample of 9003 British adults found that frequent fruit and vegetable consumption was "associated with middle age, non-manual socioeconomic groups, non- and ex-smokers, 'sensible' drinkers, small households, the south of the country and people with self-assessed 'excellent' or 'good' health" (Whichelow & Prevost 1996).

In order to improve the health of the nation fruit and vegetable intakes need to be increased, especially in those groups whose diets are particularly lacking in these important dietary components. However dietary behaviour change is challenging and difficult to achieve both for the individual making the change and for the health professional recommending it. There are many factors, other than health, that affect the food a person chooses to eat. Knowledge of all of these factors, coupled with an understanding of the process of behaviour change, is vital for the successful completion of any dietary intervention to increase the consumption of fruit and vegetables in the UK.

2.4 Health behaviour models and theories

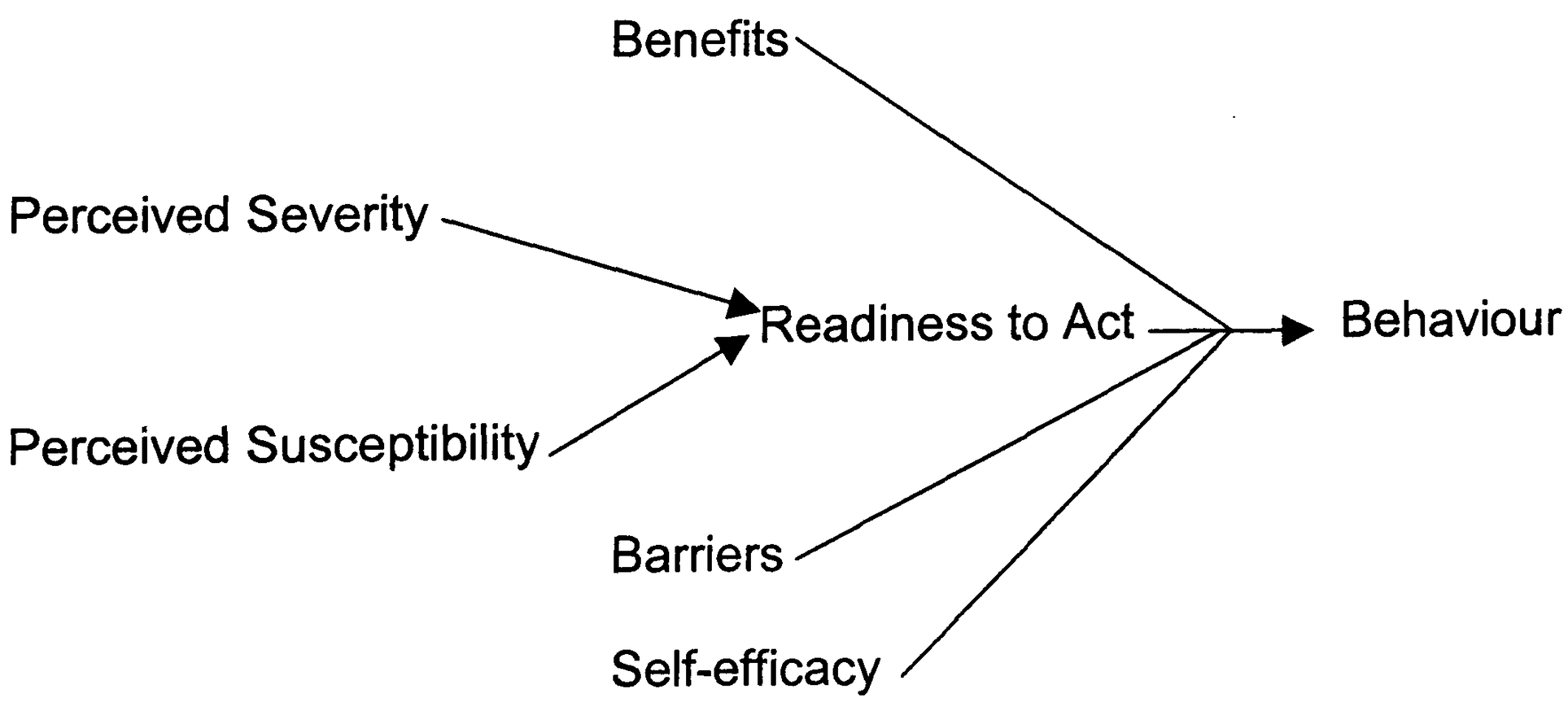
When considering health behaviours, such as eating behaviour, to focus exclusively on demographic variables such as age, social class and ethnicity, allows us to describe a population in general terms. Although this might be important it does not allow for the complexities of human health behaviour. A number of health behaviour theories and models have been described in the literature, which *do* take into account specific psychosocial aspects of behaviour. Described below are three of the most influential models that are

used in the field of health psychology, and which have been used to study the psychosocial aspects of eating behaviour.

2.4.1 The Health Belief Model

The Health Belief Model was originally developed to help explain why some individuals use health services and others do not (Hochbaum 1958). The initial model has been gradually modified over the decades (Strecher & Rosenstock 1997). The model is represented schematically in Figure 2.1, adapted from Baranowski,T. et al (1999). According to this model different beliefs motivate people to take preventive health behaviour. These include the belief that a person has a 'readiness to act' and any perceived benefits or barriers to the particular health behaviour. In addition the 'readiness to act' factor takes into account the individual's concern over the health behaviour, expressed as perceived severity and perceived susceptibility of the illness.

Figure 2.1: A Schematic Representation of the Health Belief Model



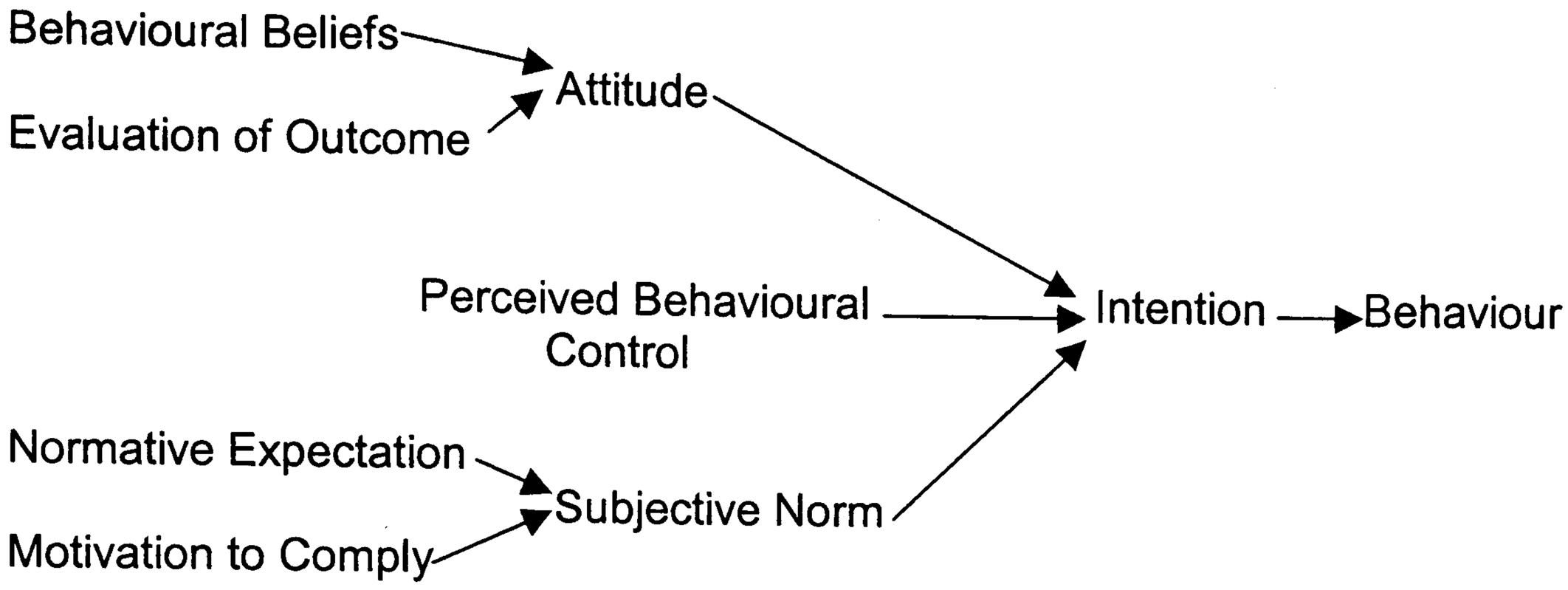
Adapted from; Baranowski,T. et al. (1999) Psychosocial Correlates of Dietary Intake: Advancing Dietary Intervention. Annu. Rev.Nutr. 19: 17-40.

The theory behind the model is that a positive health behaviour will be employed if a person perceives that they have a high susceptibility to a disease, that the severity of the disease is also perceived to be high and that the adoption of the health behaviour will reduce these perceived threats. For example, a belief in the health benefits of fruit and vegetables, such as reducing cardiovascular disease risk, could encourage increased consumption. However there may be barriers to increasing consumption of fruit and vegetables, such as cost or availability. The benefits aspect of the models must outweigh the barriers before action is taken. One study employed the principles of The Health Belief Model to identify nutrition beliefs and attitudes related to fruit and vegetable consumption. They found that 16% of the variance in fruit and vegetable intake was accounted for by attitude variables but that barriers to consumption accounted for the largest component of variability in actual consumption (Dittus, Hillers, & Beerman 1995). Self-efficacy was included into the model relatively recently and relates to the confidence a person has in their ability to adopt the health behaviour (Pitts 1993; Strecher & Rosenstock 1997).

2.4.2 The Theory of Planned Behaviour (TPB)

The Theory of Reasoned Action was proposed in 1975 (Fishbein & Ajzen 1975) and was subsequently updated to the Theory of Planned Behaviour (Ajzen 1991). The TPB differs in that it was built to include the concept of self-efficacy, or as the authors of the model called it, perceived behavioural control. The TPB can be seen represented schematically in Figure 2.2.

Figure 2.2: A Schematic Representation of the Theory of Planned Behaviour



Adapted from; Baranowski,T. et al. (1999) Psychosocial Correlates of Dietary Intake: Advancing Dietary Intervention. Annu. Rev.Nutr. 19: 17-40.

The TPB states that behavioural beliefs and evaluations of behavioural outcome lead to a person's attitude toward health behaviours. The model also takes into account the beliefs of 'important others', via the concepts of normative beliefs. A person's normative beliefs incorporate important referent individual's approval or disapproval at performing the health behaviour, which is believed to be the result of the presence and strength of impediments to health behaviour. The next stage of the theory states that the three main factors; attitudes, subjective norms and perceived behavioural control predict behavioural intention, and in turn behavioural intention will predict behaviour (Ajzen 1991; Pitts 1993; Montano, Kasprzyk, & Taplin 1997).

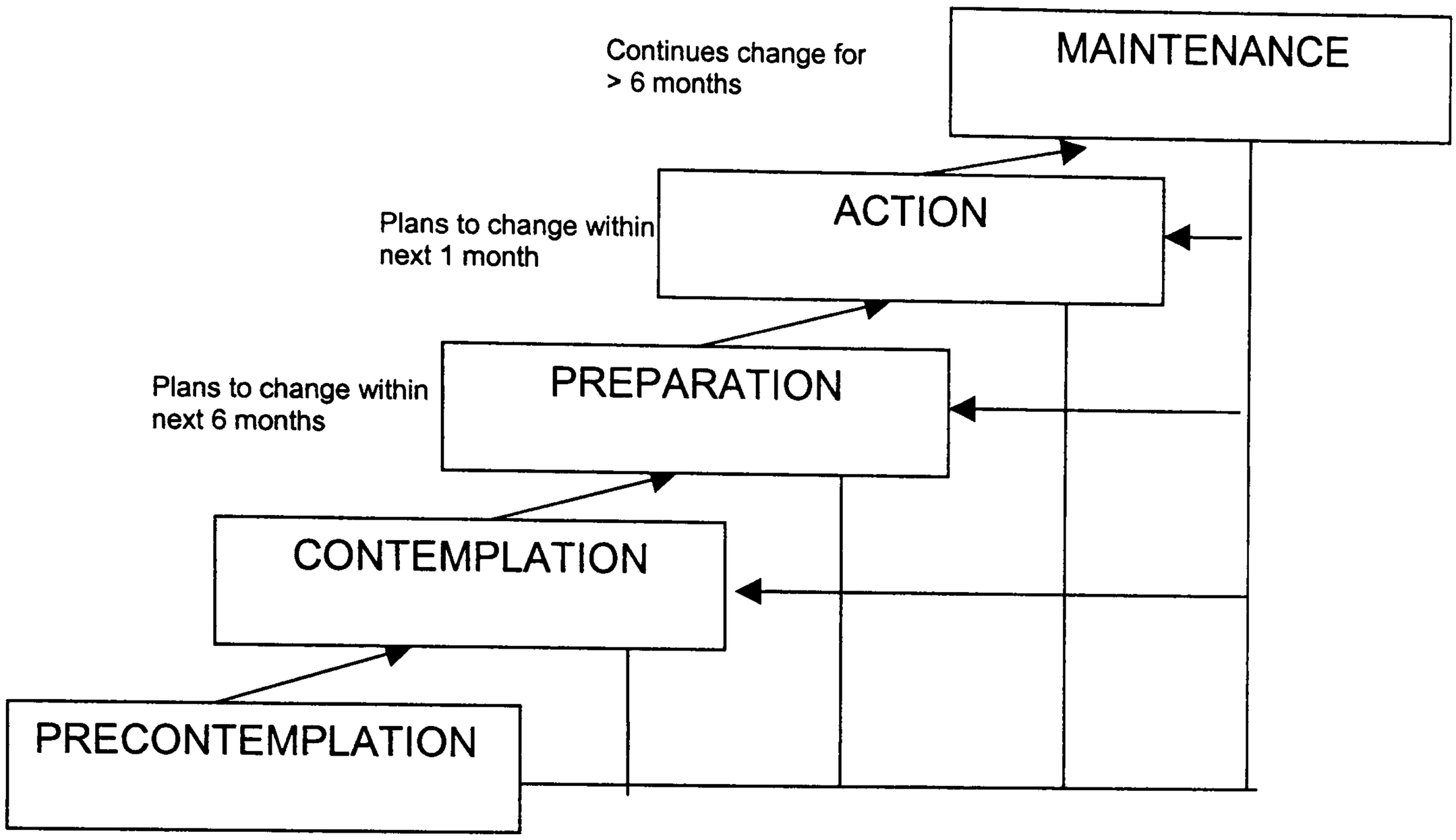
People's intentions and behaviour can be understood, and predicted by, their attitudes in combination with the constraints and motivating influences that they experience when trying to carry out the behaviour. A number of studies have employed the TPB to study barriers to increasing fruit and vegetable

consumption (Cox et al. 1996; Anderson et al. 1998; Cox et al. 1998). In general people seemed to be more certain about the health benefits of increasing fruit and vegetable consumption, but less happy about the practical issues, such as social support and shopping practicalities (Cox et al. 1996; Anderson et al. 1998). One recent study examined the application of the TPB for eating five portions of fruit and vegetables per day and found the theory to be a good predictor of intention to consume fruit and vegetables, although it was less good at predicting actual behaviour (Povey et al. 2000). This is probably a direct result of the target behaviour. When considering dietary behaviour change the change itself may come about as a result of a number of discrete changes, rather than one overall health behaviour change. For example if we compare quitting smoking as a health behaviour change, compared to consuming a healthy diet, we can see that to perform the first health behaviour we have to stop smoking. However, to perform the second health behaviour we could eat less fat, eat more fruit and vegetables or decrease our salt intake. Problems such as this make it more difficult to apply the TPB to dietary behaviour change than to other health behaviours.

2.4.3 The Transtheoretical Model (TTM)

The TTM was originally developed by Prochaska and DiClemente to describe the process of behavioural change in addictive behaviours (Prochaska & DiClemente 1984; Prochaska & DiClemente 1986). The most up-to-date model describes five stages in behavioural change and these are represented schematically in Figure 2.3.

Figure 2.3: A Schematic Representation of the Transtheoretical Model.



Adapted from; Sigman-Grant,M. (1996) Stages of Change: A Framework for Nutrition Interventions. Nutrition Today. 31, 4: 162-170.

Precontemplation is the first stage in the model. In this stage a person is not considering making the behavioural change. In the second stage, contemplation, the person is considering making the behavioural change but has not attempted the change yet. In the third stage, preparation, the person has decided and is preparing to take action within the next month. Action is the next stage. This is where the person actually changes their behaviour, but has still been doing so for less than six months, so that the behaviour change at this stage is still relatively new. The final stage is maintenance and this is where a person has been carrying out the behaviour change for over six months and is working to maintain the behaviour and to prevent relapse (DiClemente 1991; Sigman-Grant 1996; Povey et al. 1999).

The Stages of Change (SOC) model differs from the previous theories and models discussed because it is a stage-based model. Such a model enables people to be classified into specific stages of a behavioural change. If eating behaviour change follows the stages, as outlined within the model, then population groups could be identified and targeted for health promotion based on their stage of change classification. Once classified motivational interviewing strategies may be employed at each stage of change (DiClemente 1991). The idea is that people at differing stages within the model require specific advice, information or motivations in order to move to the next stage. However, although the SOC model sounds promising it was originally developed to investigate addictive behaviours and may not be appropriate for dietary behaviour changes (Povey et al. 1999). As discussed previously when looking at the TPB, dietary behaviour changes are more difficult to quantify and are more likely to come about as a result of a number of discrete changes, rather than one overall health behaviour change. So that when we compare smoking cessation as a health behaviour change with increasing fruit and vegetables in the diet, we can see that it is very easy for a person to decide whether or not they stopped smoking and when they quit. However with increasing fruit and vegetables in the diet, people do not know what constitutes a portion or how much they were previously eating, and they may increase their consumption on some days but on others they have no fruit and vegetables. Eating behaviour change is not as clear cut as other health behaviour changes. Also less research has been conducted using the SOC with eating behaviour change and it is not known if the same stages are in fact passed through when making a dietary behaviour change.

Although previous studies have reported a strong relationship between SOC, for fruit and vegetable consumption, and actual intakes (Laforge, Greene, & Prochaska 1994; Brug, Glanz, & Kok 1997), more research needs to be conducted to determine whether the TTM or the SOC model are applicable to eating behaviours (Horwath 1999).

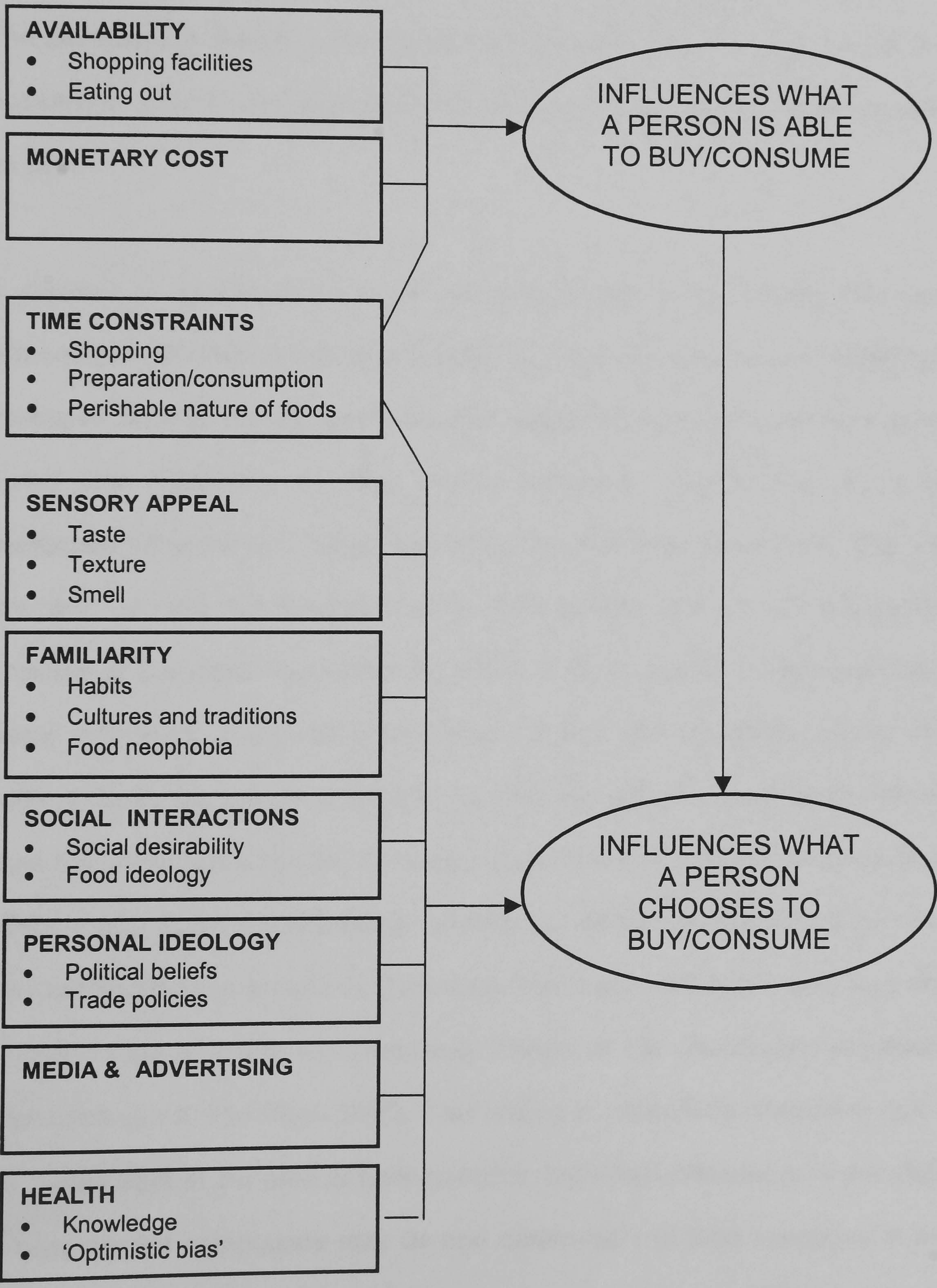
2.5 Theoretical frameworks of food choice

The health behaviour theories have been widely recorded and utilised in the field of health psychology and they have gone a long way in advancing the understanding of human food choice behaviour. However, these models were not developed solely to study food choice but rather more general health behaviours. At the point of delivery of health promotion interventions it is necessary to put the findings from health behaviour studies into the context of everyday life, removing the jargon and interpreting the results to the lay person. Although these models allow us to investigate psychosocial factors relating to behaviour change this is just one aspect of what motivates food choice. Alternative measures may tell us more about food choice on a practical level in terms of constraints and motivators for fruit and vegetable consumption. In the field of food choice there are other more personal and practical factors that will affect the food a person chooses to consume.

Figure 2.4 illustrates these practical factors in "The Food Choice Framework". Other frameworks have been developed which include some or all of these factors in different forms and to differing degrees of complexity. This simplified

framework was developed as part of the review and the review will cover, in depth, those factors illustrated.

FIGURE 2.4: THE FOOD CHOICE FRAMEWORK



2.6 Factors affecting the food choice of adults in relation to fruit and vegetable consumption

2.6.1 Sensory appeal

Food is not just eaten for its nutrient value, for many people it is a source of pleasure, an enjoyable experience and even a comforting activity (Clark 1998). The properties of individual foodstuffs, such as taste, texture, quality, smell and appearance play an important role in whether a person will choose to consume an item.

A number of studies have found sensory factors to be among the most influential in determining eating behaviour. In a pan-European survey, looking at consumer attitudes to food, nutrition and health, when consumers were asked about their influences on food choice behaviour, 'quality' was the most mentioned influence and 'taste' was within the first three mentioned. This was the case for both the European Union (EU) sample and the UK sub-sample (Institute of European Food Studies 1996a). A Dutch survey (n=29) used focus group interviews to look at determinants of fruit and vegetable intake. The authors found that, when looking at 'satisfaction' beliefs, 'good' taste was an essential prerequisite for the consumption of fruit and vegetables (Brug et al. 1995). Focus group participants in another US study indicated that good taste was perceived as a benefit of increasing fruit intake, although taste was also thought to be a barrier for increasing intakes of the cruciferous vegetables (Heimendinger & Van Duyn 1995). This finding is particularly interesting due to the recent work in the area of taste genetics. Individual differences in the ability to taste certain compounds may be one determinant of food rejections. It has

been found that the ability to taste the bitter compounds 6-*n*-propylthiouracil (PROP) and phenylthiocarbamide (PTC) is a genetically inherited trait, and that these substances are bitter to some people and tasteless to others (Fischer et al. 1961; Glanville & Kaplan 1965). More recently research has found that sensitivity to PROP solutions has been associated with more reported food dislikes. Disliked foods included the cruciferous vegetables; cabbage, brussels sprouts, broccoli, spinach and kale, as well as grapefruit juice, lemon juice and rhubarb (Drewnowski 1997). Taste preferences have been shown to influence food choice behaviour (Kaminski, Henderson, & Drewnowski 2000), however few studies have examined taste responses, food preference and intake patterns in the same free-living population.

It is uncertain what effect PROP taster status might have on current efforts to promote the consumption of cruciferous and green leafy vegetables for health. However it is clear from these findings that sensory responses to taste, smell, sight, and texture of foods are a major influence on both food preferences and eating habits. More research is needed to identify other potential genes associated with taste response and to investigate their influence on food choice.

2.6.2 Familiarity and habit

Food habits have been described as "the way in which individuals in response to social and cultural pressures select, consume, and utilise portions of the available food supply" (Khan 1981). Food habits evolve from learned experience, which leads to the development of attitudes towards food. Thus food habits become a form of self-expression. It has been said that 'modelling'

is an indispensable aspect of the learning process. This was shown to be true in a Dutch study where habit was found to be a strong determinant for the consumption of boiled vegetables, salads and fruit. Subjects stated repeatedly that "they were eating the way that they were taught at home in the past and continued eating according to those habits when they left their parents to go and live on their own or started their own family" (Brug et al. 1995).

These food habits are the reason why cultures and traditions persist so strongly. It may be said that cultures and traditional practices are the foundations on which all food choice decisions are built. Cultures and traditions give us values and beliefs in different foods and eating patterns. Some of the largest variations in food choice are due to the boundaries laid down by cultures and traditions. For many people these provide the framework within which an individual's food choice may evolve. Dietary restrictions play a part in many of the religious and cultural beliefs seen in Britain, although none of these include restrictions on fruit and vegetable intakes. However, some religious groups follow strict diets that, although not necessarily part of the religion, are believed to be beneficial. For example, many Buddhists follow a macrobiotic diet and lifestyle. This diet groups foods into the Yin (expansive) or Yang (contracted) state and diet is used to balance the "environment, lifestyle and constitution" (http://www.macrobiotic.co.uk/diet.htm 2001). Vegetables are a particular focus of this diet. Vegetables such as broccoli, leeks and carrots may be used regularly, however restrictions are put on other varieties such as celery, parsnip and peas.

The impact of culture on food choice is immense and varied, however there are still many differences in food choices, and in food likes and dislikes, among members of the same culture (Rozin & Vollmecke 1986). The genetic influence of taste has already been discussed, however in the case of food neophobia, that is the initial rejection of novel foods, rejection can be overcome by repeated exposure to and consumption of the novel food item (Koivisto Hursti & Sjoden 1997). This suggests that although familial resemblance in food neophobia has been found this is likely to be due to familiarity and habit as opposed to heredity. Some idea about why people see some foods as edible, and reject other foods, is needed before food choice behaviour is fully understood. An American study was carried out to investigate the psychological basis of food rejection. The subjects were university students (n=47). The results of the study showed that food rejection behaviour could be categorised into four areas. The authors named these categories as 'distaste', 'danger', 'disgust' and 'inappropriate'. 'Distaste' meant that the person disliked the sensory characteristics of the substance. The 'danger' category was used if the person felt that there would be negative consequences after consuming the food. 'Disgust' was where the person found the idea of eating something offensive and the 'inappropriate' category was used where a person classified a substance as not edible (Fallon & Rozin 1983). A Scottish study, using focus group sessions, found that the participants had a strong preference for familiar vegetables and were "wary" of new varieties. The results of the focus groups were utilised to design a questionnaire that was sent to 1,011 adults. The results of this questionnaire discovered that subjects thought that opportunities

to try unfamiliar fruits and vegetables in supermarket taste sessions could be a good way to help increase consumption (Anderson et al. 1994a).

2.6.3 Social interactions

Food is a major focus for social interactions. In one German study it was found that pleasure from food was only partly determined by the sensory aspects of the food items. Factors such as atmosphere, the table, mood and people were all important aspects of the pleasure gained from eating occasions (Westenhoefer & Pudel 1993). Many eating occasions occur in company and eating in this way may affect the types and amounts of foods eaten. One study conducted in the UK (n=5553) discovered that lower consumers of fruit and vegetables had a tendency to consume more of their meals in the living room in front of the television compared with other rooms (Thompson et al. 1999). A second study found that subjects did not "take the trouble" to prepare boiled vegetables and salads if they were eating alone. If they were preparing food for others however, this would encourage them to prepare vegetables for the meal (Brug et al. 1995). This could explain the differences in intakes observed in a number of studies between people with differing marital status. It has been found that being married is associated with increased fruit and vegetable intakes, whilst being single, separated or divorced may be associated with lower intakes (Billson, Pryer, & Nichols 1999).

Social pressures have been described in the UK for groups of the population to consume or indeed to avoid certain foods. Results from studies on fruit and vegetables are encouraging. One study found that subjects who thought they

consumed high amounts of fruit and vegetables were more positive in attitude and experienced more social influence to consume fruit and vegetables than lower consumers (Lechner et al. 1997). A second study using the Theory of Planned Behaviour to predict intention to increase fruit and vegetable intake found that the perceived social pressure to increase consumption was low. However where a social pressure was felt it was positive towards increasing fruit and vegetable intake (Cox et al. 1998).

The large differences in intakes of fruit and vegetables between differing social classes may be mainly due to monetary concerns, however there is some thought that it could partly be due to differing social pressures and interactions. One study, conducted in Sweden, investigated how social networks and social support affected the socio-economic differences in fruit and vegetable consumption. The social network variables explored social participation within various formal and informal groups in society and also social anchorage, which dealt with feelings of membership within particular groups. The study found that low social participation was able to explain some of the differences in consumption of vegetables between differing socio-economic groups (Lindstrom et al. 2001). Perhaps without social participation, and thus social support, it is much more difficult to adapt diet and change to incorporate dietary recommendations. This has been found in the area of obesity management, where a lack of social support was found to be a barrier to successful weight loss (Perri, Sears, & Clark 1993).

The food choice literature commonly refers to a food 'hierarchy' or food 'ideology' existing, particularly in the UK (Charles & Kerr 1988; O'Doherty & Holm 1999). The differing positions foods hold within this hierarchy does, to some extent affect whether or not that food is consumed, particularly in higher socio-economic groups (Barker, Thompson, & McClean 1995). Another part of this food 'ideology', as described by Charles and Kerr (1988) describes how some foods at the top of the food hierarchy, such as red meat and alcohol, are particularly related to 'maleness' and as such are a symbol of masculinity (Charles & Kerr 1988). Contrary to the view of meat, vegetables are seen as "women's food" and therefore undesirable to men. Although these ideas might seem somewhat out-of-date the observations are supported by a number of studies throughout Europe. These studies concluded that a greater proportion of the energy consumed by men came from meat, animal products and alcohol, while that of women comes from vegetable products and fruit (O'Doherty & Holm 1999). Perhaps this food 'ideology' may account for some of the differences found in fruit and vegetable intake patterns between men and women.

The general area of social interactions and food can be summed up by the following quote taken from 'A sociology of food and nutrition: the social appetite' (1999). The author writes "...people can seek to differentiate themselves from others, or alternatively, convey their membership of a particular social group through their food consumption. Ordering a vegetarian meal, eating a meat pie, dining at a trendy café, or eating an exotic cuisine may be used and interpreted as social 'markers' of the individual's social status and group membership"

(Germov & Williams 1999). Social interactions play a huge role in food choice behaviour and these factors need taking into account when attempting dietary change.

2.6.4 Monetary cost of food

The cost of food is a major factor in determining food choice, affecting some groups of the population more than others. A Mintel report on the market drivers of fresh fruit and vegetables (2001) reports an ongoing shift in the fruit and vegetable market from loose to prepacked, prepared and ready to cook products. Over 60% of the expenditure in the vegetable sector is now on pre-packaged produce. These products are more expensive than loose produce but, according to Mintel, consumers have been "...willing to take in the extra cost in a trade-off for convenience" (Mintel 2001a). However there are still some customers who are unable to "take in the extra cost". Price, not suprisingly, has been found to be most influential on the food choice of people in lower socio-economic groups, for example students, retired and unemployed people (Reicks, Randall & Haynes 1994; Reid 1995; Lennernas et al. 1997; Johansson & Andersen 1998). It has also been found that those in lower socio-economic groups consume less fruit and vegetables than those in higher socio-economic groups (Ministry Agriculture, Fisheries and Food 1999; Anderson & Morris 2000). One particular study found that recommended foods following UK national dietary guidelines were more expensive than alternative foodstuffs, particularly in deprived areas (Mooney 1990). Another UK study, set up to investigate direct and indirect costs of a healthy diet, found a healthy diet to be more expensive in monetary terms. Women were assigned to groups according

to where they scored on a Healthy Diet Indicator (HDI). The groups ranged from HDI 0 to HDI 8, with group 8 having the healthiest diet. Subjects with the healthiest diets spent three times as much on fruit and vegetables than those with the lowest healthy diet score. The results showed that the maximum differences in cost were found between HDI groups 0 and 7 at £1.69 per day. This equates to £617 per year (Cade et al. 1999).

In a study of European subjects a wide geographical variation existed as to the number of subjects who mentioned price as an important barrier to healthy eating. In the overall European Union sample 15% mentioned 'price' as a factor, but UK respondents were at the top end of the range with 23% of respondents considering price as a barrier (Lappalainen et al. 1997). It has been shown previously and mentioned a number of times within this review that those in lower socio-economic groups consume less fruit and vegetables than those in higher socio-economic groups (Ministry of Agriculture, Fisheries and Food 1999; Anderson & Morris 2000). In order to increase consumption in these groups it is important that intervention messages take price into account. A UK-based study concluded that it would be appropriate to emphasise balancing the perceived higher cost of fruit with less expensive vegetable-based dishes (Anderson et al. 1998). However eating more vegetables, in the form of vegetable-based dishes does require some degree of skill and probably experimentation with new recipes and varieties of vegetables. In low-income households there is a risk in experimenting with new varieties in case the family do not like them, then a replacement meal must be found and this can become

expensive. In-store cooking demonstrations and food tasting could provide opportunities for people to try new fruits and vegetables at no cost.

Unfortunately health promotion strategies, such as those suggested, have rarely been evaluated in the past, possibly due to a lack of funding. There is little published literature evaluating cooking demonstrations and taste sessions, however a systematic review conducted by the Health Education Authority did conclude that supermarket interventions were effective, in terms of increasing market share of the targeted product, in the short-term (Health Education Authority 1997).

Increased imports of fruit and vegetables have meant that year-round availability is now the norm for many varieties of fruit and vegetables. As a result seasonality, once a strong feature of the produce market, is no longer seen as important. However imported produce has a major effect on the price of products and this could be off-putting for low-income consumers, who feel that fruit and vegetables are more expensive than they necessarily need to be. If people are educated into how to find and buy 'in-season' fruit and vegetables this may make purchasing cheaper.

2.6.5 Availability

This factor relates to the availability of shops, of food within shops and also to the physical effort required to obtain the food. In the 1980's there was a migration of many shopping facilities, including supermarkets, out of city and town centres. This drive has caused many local and smaller retailers within

cities to either close down or increase prices. In the year 2000 supermarkets had 83% of the market share in fresh fruit and vegetables, compared to 11% for independent greengrocers and 3% for market stalls (Mintel 2001a). Once again it is the low-income groups who suffer because it is the local retailers on whom families on low incomes, and those without transport, rely for their weekly food shopping. This means that these families have to either pay higher prices for foods, or pay to use public transport to travel to the new out-of-town supermarkets. Those families without means of transport, in 1995, nationally represented a third of all households (Leather 1995). In relation to fruit and vegetable consumption, theoretically, availability could account for a large proportion of the food choice process. For people dependent on public transport or walking to shops, fruit and vegetables are heavy and bulky to carry and for people shopping in local and smaller shops less variety and, for some items, higher prices can be expected. The sheer bulk of food purchased and experiences relating to transport were frequently mentioned factors in one UK study using focus group sessions to discuss increasing fruit and vegetable intakes (Anderson & Cox 2000).

Availability not only affects the lower socio-economic groups. A study, which investigated perceived barriers to increasing fruit and vegetable consumption, found that the participants were finding limited availability of vegetables, salad and fruit at work, when eating out, having take-away and at friends' houses. This was considered by the participants to be a barrier to increasing intakes (Cox et al. 1998). This was also found in an American study where the women

interviewed frequently mentioned difficulties in consuming fruit and vegetables when away from home (Treiman et al. 1996).

2.6.6 Time constraints

Studies show conflicting opinions on all aspects of time constraints and how they affect food choice decisions. Issues include time available to go shopping and thus the perishable nature of foodstuffs, and also the time available for preparation and consumption of foods and therefore the convenience of foodstuffs. Fruit and vegetables seem to have opposing qualities. An American investigation using focus group interviews found that fruit was viewed as convenient but was considered perishable and expensive when out of season. For vegetables preparation time was considered to be a barrier to increasing consumption (Heimendinger & Van Duyn 1995). In a UK study, focus group discussants who were low vegetable consumers saw storage and wastage as a problem, with frozen vegetables as a possible solution, and they also regarded preparation as time-consuming (Kilcast, Cathro, & Morris 1996). A second UK study found that participants felt that to increase fruit and vegetable consumption they would have to increase the number of visits made to the shops for food. The same study population also commented that they would need to try more than one retail outlet in order to get the quality they wanted in their fruit and vegetables. Also for people who worked throughout the day there were problems with shopping in the evening when fruit and vegetables tended to run out (Anderson & Cox 2000).

Among EU subjects 'lengthy preparation' and 'healthy foods being more perishable' were barriers which were not considered to be important, although the main perceived barriers were related to time, including 'irregular work hours' and 'busy lifestyle' (Kearney & McElhone 1999). This conflicting evidence is probably due to the fact that time constraints will be more important to some groups of the population than others, for example in the EU sample it was found that younger and more highly educated people reported food preparation more frequently as a barrier to a healthy diet (Lappalainen et al. 1997). Some people, more than others will find their food choice is dominated by their lifestyles. Changes in meal patterns in families, from sitting down to a meal together to more increased frequencies of snacking and 'grazing', in order to fit in around hectic lifestyles, has led to an increase in consumer demand for ready-made and convenience foods. This can be clearly seen in the rise in prepacked and prepared salad and vegetable items in supermarkets (Mintel 2001a).

It seems then that time constraints are a big issue in food choice and that people make constant conscious choices around issues of convenience.

2.6.7 Personal ideology

Personal ideologies may affect food choice decisions, particularly those of the more affluent consumer (Holt 1993). Issues surrounding organic produce, genetically modified foods, even down to the type of packaging used can influence an individual's food choice decisions and public concern over food safety issues has been shown to be high (Frewer et al. 1998).

Safety concerns over food might include concern about pesticide use. Pesticides are chemical substances used in agriculture for a variety of different purposes, which generally protect plants against damage from pests, insects and the environment. For the farmer pesticides have meant higher productivity and yields and for the consumer they have resulted in the better appearance and longer shelf life of many food products. However many consumers are concerned about the accumulation in the body of pesticide residues from foods including fruits and vegetables (National Consumer Council 1998). Organic fruit and vegetables have been grown without the use of pesticides, and this sector of the market has increased dramatically over recent years, despite the rising costs. There was a rise in sales of organic produce in the UK of 40% between 1998 and 1999 (The Soil Association 1999), and in the summer of 2000 over one third of adults brought organic produce (Mintel 2001a). A study commissioned by The Soil Association and Baby Organix found that of the people that do buy organic produce 43% do so because of preferred taste, 28% because it is environmentally friendly and 24% because it is animal welfare friendly. The study also found that fruit and vegetables were the commonly purchased organic products (The Soil Association 1999).

A second area of personal ideology that affects the food choice decisions of a large number of British adults is vegetarianism. There are roughly 4 million vegetarians in the UK, about 7% of the adult population, and an estimated 5000 people a week in the UK become vegetarian. On top of this an estimated 10 million people in the UK no longer eat red meat (http://www.vegsoc.org 2002). One study on ecological eating, food ideology and food choice found that the

most significant influence on reducing meat and meat products in the diet was health reasons. However the results showed that strict vegetarianism was strongly connected with animal welfare concerns (Holt 1993). Other influences on a person's decision to become vegetarian are the quality of the food supply, environmental concerns and the influence of friends (Draper 1992; Santos & Booth 1996; Worsley & Skrzypiec 1998). A study conducted to examine the motives underlying healthy eating utilised the Food Choice Questionnaire. This questionnaire measures the reported importance to a given individual of nine factors underlying food choice (Steptoe, Pollard, & Wardle 1995). The respondents were classified as having 'standard' diets, diets 'low in red meats' and 'vegetarian'. It was found that although those subjects with diets low in red meats attributed greater importance to health, natural content, weight control and ethical concern in their food choice decisions, vegetarians differed from the 'standard' diets only on the score for ethical concern (Pollard, Steptoe, & Wardle 1998).

Personal ideology also incorporates any political beliefs or concerns that people may possess and use when deciding what food items to purchase. For example, individuals may boycott certain manufacturers because of their trade policies (Burger 1997). Many people will only buy British or local produce in support of British industry and farming. Also many of the fruit and vegetables in our supermarkets are imported, both in- and out-of-season and travel for many miles before arriving on our plates. This "travelling" adds costs in terms of higher energy costs in transportation, and social and economic costs to certain

food producers, who are producing food for export rather than for themselves (Nestle 2000).

Some people in the UK have strong concerns and opinions on all aspects of personal ideology and the food system, however the higher costs and inconvenience of putting their ideologies into practice means that for many people food choices based on personal ideologies are not always a practical option.

2.6.8 Media and advertising

In the UK people are exposed to a wide range of messages concerning food, and sometimes nutrition, many of which can be contradictory. Information about diet and food is available from a variety of different sources and the media, for example TV, radio, magazines and newspapers, is widely used in the UK. According to a pan-EU survey when people in the UK look for healthy eating information they go first to magazines, then to TV and radio, followed by newspapers, food packaging, health professionals, advertising and finally government agencies (Institute of European Food Studies 1996b).

A Scottish study found that many people have perceptions of fruit and vegetables as being “boring”, “associated with slimming”, “lacking in taste” and “old fashioned” (Anderson et al. 1994b). Designers and advertisers know how to subtly market different foods, attaching certain connotations to them in order to manipulate consumer tastes (McKee 1995). The low branding of fruit and vegetables means that they are comparatively poorly promoted, and the money

spent on advertising fruit and vegetables is decreasing. In 1996 £8.6 million was spent on the combined media advertising of fresh fruit and vegetables and in 2000 this decreased to just £4.5 million (Mintel 2001a). Analysis of snacking behaviour has shown that snack eating has increased, and that most of these snacks are of the 'designer food and drink' variety which have been skilfully promoted by clever advertising. To put fruit and vegetable advertising into context in the same year £25.1 million was spent on media advertising of vitamin and mineral supplements (Mintel 2001b), and £35.3 million was spent on media advertising of crisps and snacks (Mintel 2001c). Fruit and vegetables have to compete in the market place against other products that, as can be seen by these figures, are far more heavily promoted and advertised. Innovative marketing strategies to promote fruit and vegetables are much needed to help in efforts to increase consumption levels. One Scottish study found that 48% of focus group discussants thought that advertising to encourage higher consumption of fruit and vegetables was a good idea (Anderson et al. 1994a). The image of fruit and vegetables needs to be redesigned using sophisticated marketing techniques to make them more attractive to the consumer.

2.6.9 Health

For some, health may be an important consideration when making choices about which foods to eat. In the Health Education Authority's health and lifestyle survey, lower consumers of fruit and vegetables were more likely to disagree with the statement "healthy foods are enjoyable" and more likely to agree with the statement "I don't really care what I eat" (Thompson et al. 1999). In a study looking at perceived important influences on food choice of adults in the

European Union (n = 14,331) the five most important factors were quality, price, taste, family preferences and trying to eat healthily (Lennernas et al. 1997). A second investigation found that a belief in the health benefits of fruit and vegetables may well increase consumption, and found that an individual's concern about nutrition is positively related to their dietary behaviour (Dittus, Hillers, & Beerman 1995). From these results it might be thought that advertising and encouraging the benefits of increasing fruit and vegetable consumption should result in an increased intake. However as observed in the introduction this is not happening uniformly across the UK. One explanation for this apparent contradiction could be 'optimistic bias', where people believe they are less at risk than a comparable member of society (Weinstein 2000). This 'optimistic bias' has been seen in many studies and in many other areas of health-related behaviour, for example smoking behaviour. One study (n = 22,043) found that 69% of participants thought that their diets were already healthy and thus they had no reason to make dietary changes (Cotugna et al. 1992). Another investigation of European subjects (n = 14,331) reported that 71% of subjects agreed with the statement 'I do not need to make changes to the food I eat, it is already healthy enough' (Kearney et al. 1997). A third study of a random sample of 741 British adults found that over 50% felt that they were consuming sufficient quantities of fruit and vegetables even when eating less than 2 portions per day (Cox et al. 1998). In a study reporting discrepancy between two methods of assessing fruit and vegetable consumption in an adult Dutch population (n = 367), it was found that participants rated their own intakes as much higher than their estimated objective intake. Those participants who rated their own intake as high, had positive beliefs about fruit and vegetable

consumption, experienced positive social influence and had a high perceived self-efficacy (Lechner et al. 1997).

2.6.10 Food Choice Behaviour in High and Low Fruit and Vegetable Consumers.

All of the factors described in this review have been found, in previous studies, to play a role in the food choice process in relation to fruit and vegetable intake. The size of the role each of these factors play, and the relationships between them, will differ from person to person. When making food choices an individual must consider the factors most important to them and make compromises between a number of these factors. The sets of priorities that people hold will be unique to each individual. However different groups of people may hold similar sets of priorities.

A few studies have attempted to categorise sub-samples of the population according to the factors that affect their food choice decisions (Kirk & Gillespie 1990; Stewart & Tinsley 1995). However only one such study was found in the literature looking solely at fruit and vegetable intakes and food choice decisions in categories of the population. This study simply divided the subjects into high and low vegetable consumers. The high consumers were defined as consuming more than five portions of fruit and vegetables per day, and the low consumers were defined as consuming less than two portions per day. The results showed some key attitudinal differences between the two groups. These differences were related to control over family eating habits and how the caregiver approached meal planning and cooking responsibilities. The high consumers of

fruit and vegetables tended to feel more in control of family members' eating habits, be more food-focused and more experimental in their food preparation. They also planned ahead more in terms of food preparation and meal planning compared to the low consumers. High consumers of fruit and vegetables tended to have a more positive approach to their families' diet with a higher self-esteem in this area. In contrast low fruit and vegetable consumers seemed to lack control over family members eating habits and possessed feelings of guilt over the family diet. In comparison to the high consumers, the low consumers of fruit and vegetables seemed not to plan the families diet and these diets seemed to be more repetitive. In the low consumers group, family members tended to eat different foods at different times thereby sabotaging any attempts at planning meals (Kilcast, Cathro, & Morris 1996). The sample size of this study was however a limitation, as only 19 subjects were interviewed. More of this type of research is required in order to fully explore food choice in relation to fruit and vegetable consumption.

2.7 Practical applications of the review

2.7.1 Application of the review to health promotion

The content of this review shows just how complex the food choice process can be when taking into account issues such as sensory appeal, familiarity and habit, social interactions, monetary cost, availability, media and advertising, time constraints and health. When considering fruit and vegetables in the context of food choice we can see that all of these issues, either consciously or sub-consciously, will affect whether or not a person decides to consume fruit and vegetables at any particular time or meal event. It can be seen that some of

these issues will be more influential than others but that different people will have different influences on their food choice motivations. Consideration of the food choice process in relation to fruit and vegetables is particularly important when trying to put into effect coherent and practical dietary advice for the public. Any advice has to be realistic and must take into account, and try and deal with, any personal influences on food choice decisions. Some practical techniques and ideas, for health promotion strategies, to come from this review include supermarket fruit and vegetable promotions and taste sessions and more sophisticated and trendy advertising and marketing campaigns for fresh fruit and vegetables. More generally, people need to be made aware of their own personal consumption levels of fruit and vegetables in order for health promotion messages to be considered personally relevant. Health promotion strategies, such as those suggested, need to be fully evaluated for both short-term and long-term effects.

2.7.2. Application of the review to future research

Health promotion techniques can be better targeted towards certain groups of people, all holding similar sets of values when making food choice decisions. In order to provide effective nutrition education programmes food choice in relation to fruit and vegetable intake needs to be studied in more depth, in particular the sets of priorities that different sub-groups of the population consider when making food choice decisions. These sub-groups could be based upon demographic data (e.g. men and women), intake data (e.g. low and high consumers of fruit and vegetables) or on health behaviour models (e.g. stages of change data), or a combination of all. To investigate this further the following

chapter describes a study that analyses the health and lifestyle factors that affect fruit and vegetable consumption in women.

Chapter 3

Health and lifestyle factors affecting fruit and vegetable consumption in women

3.1 Summary

The UK Women's Cohort Study was originally set up to look at morbidity and mortality data on subjects with a wide range of dietary intakes including vegans, vegetarians, non-red meat eaters and red meat eaters. The aim of the present study was to investigate the health and lifestyle factors that affect fruit and vegetable consumption within this particular cohort of women. Females, ages 35 – 69 years taking part in the study (n = 35,367), provided health and lifestyle information including a 217-item food frequency questionnaire. Univariate analysis was carried out on the data followed by a multiple logistic regression model in order to determine predictors of high fruit and vegetable consumption. The strongest predictors of a higher level of consumption, found in the logistic regression model were: being a vegetarian or vegan, taking vitamin or mineral supplements, being married, having an A-level or degree level of education and belonging to a higher socio-economic group. Conversely smokers were found to be only half as likely as non-smokers to be high fruit and vegetable consumers. These results show some clear lifestyle distinctions among three categories of fruit and vegetable consumption levels. These findings are relevant for the targeting of future health promotion strategies.

3.2 Introduction and study rationale

From the literature review in Chapter 2 it was determined that different people have different influences on their food choice behaviour. It was also concluded that health promotion techniques, to increase fruit and vegetable consumption, may be better targeted towards certain sub-groups of the population, who all hold similar sets of values when making food choice decisions.

If we wish to categorise people into sub-groups of the population this can be done initially using basic demographic information. We know already, from the literature review, that there are large variations in fruit and vegetable intakes between regions, social classes and the sexes – so who are the high or low fruit and vegetable consumers?

In this chapter basic demographic information is described to determine which health and lifestyle factors affect fruit and vegetable consumption, and how. The population under study was drawn from the UK Women's Cohort Study (UKWCS). This is a ten-year prospective study investigating cancer morbidity and mortality in women with a variety of dietary habits, such as vegetarians, fish eaters and meat eaters. The cohort consists of 35,000 women, across England, Wales and Scotland, aged between 35 and 69 years. The cohort under study is a large sample generating wide variation in fruit and vegetable intakes among the study population. Coupled with this the UKWCS was designed to maximise dietary variation by deliberately recruiting a large number of vegetarians, as well as fish eaters and meat eaters. These factors make it an ideal study population for identifying factors affecting fruit and vegetable consumption, at all levels of

intake. However this obviously means that any results generated will not be generalisable to men.

3.3 Aims and objectives

The aim of this study was to investigate the health and lifestyle factors that affect fruit and vegetable consumption within the UKWCS. The objectives were to describe the lifestyle, socio-economic and demographic characteristics that differentiate between the high and low consumers of fruit and vegetables.

3.4 Methods

3.4.1 Sample

The cohort participants were obtained from responders to the World Cancer Research Fund's (WCRF) mail survey. The original mail survey included people living in England, Wales and Scotland, used direct mail lists and was targeted towards females. Seventy five per cent of the respondents indicated that they would be willing to participate in a more detailed survey. Only women aged between 35 and 69 years were included in the cohort. From the respondents to the original survey, all self-reported vegetarians and non-red meat eaters were included in the cohort. Comparison groups were selected from the remaining eligible women by selecting for each vegetarian, the next non-vegetarian in the list within the same 10-year age band. Further women were recruited during baseline data collection by asking participants to volunteer friends and relatives of a similar age group who are vegetarians and meat eaters. The cohort was designed to detect a protective effect of a vegetarian diet, compared to fish eaters and meat eaters, on overall cancer registration, of relative risk 0.8 with

adequate power (>80%). All subjects were flagged with the Office of National Statistics (ONS) for notification of death or cancer registration.

3.4.2 Research design

184 Local Research Ethics Committees (LREC) were contacted and approval was obtained to carry out the baseline study. A total of 61,000 women, nationwide, were contacted at baseline in 1995-98. Baseline data were collected via a postal questionnaire for each subject in the cohort (see Appendix A for the full questionnaire). The self-administered questionnaires consisted of a detailed assessment of diet using a 217-item food frequency questionnaire (FFQ) and an in-depth health and lifestyle questionnaire. The FFQ was designed to capture food intake over the past year and was adapted from the FFQ used in the European Prospective Investigation into Cancer (EPIC) study (Riboli 1992). Subjects were asked to score how frequently they consumed each of the 217 items by selecting one of ten categories, ranging from 'never' to 'six times per day'. Data entry was carried out by a professional data entry company and was validated by double data entry. For each food item listed on the FFQ the portion weight, nutrient composition and subject's frequency of consumption were used to calculate nutrient intakes for the purpose of analysis (Margetts, Cade, & Osmond 1989).

3.4.3 Data analysis

Using the FFQ data the number of portions of fruit and vegetables consumed per person per day were calculated. This daily figure included fruit and vegetables from composite dishes and allowed for one portion of fruit juice per

day but excluded potatoes. Standard portion sizes were employed for calculation of amounts consumed using standard food portion sizes (Crawley 1994). Initial analyses were carried out using the Statistical Packages for the Social Sciences (SPSS) Version 9.0 (SPSS Inc., 1998).

For the purpose of analysis median intakes of fruit and vegetables were examined due to the skewed nature of the data. Median intakes of portions of fruit and vegetables were compared with socio-economic, demographic and lifestyle variables using the Kruskal Wallis or Mann Whitney test as appropriate. To allow for the skewed distribution, bootstrapped confidence intervals were then calculated using STATA Version 6 (StataCorp, 1999). The subjects were subsequently divided into tertiles (referred to as T1, T2 and T3) according to their fruit and vegetable consumption. T1 comprised those with the lowest intakes and T3 represented the consumers with the highest intakes. The distribution of socio-economic, demographic and lifestyle variables between the tertiles was examined and analysed using one-way analysis of variance and chi-squared tests where appropriate.

Analysis was initially carried out using combined fruit and vegetable portions, and was then executed again on fruit and vegetable intakes as two separate variables. Finally a multiple logistic regression model was used to determine predictors of high fruit and vegetable consumption. All variables used within the univariate analysis were included in the regression model.

3.5 Results

3.5.1 Fruit and vegetable consumption

Out of the 61,000 women contacted, 35,374 subjects responded. This is a response rate of 58%. Subsequently seven subjects, considered to be extreme outliers due to unreliable data, were excluded from the analysis. The dataset for analysis therefore contained 35,367 subjects.

Mean intakes of fruit and vegetables, as measured by the FFQ, were far higher then might be expected within the UK population (Table 3.1). However the mean intake of overall fruit and vegetable consumption in T3 (17.1 portions per day) was over three times greater than in T1 (5.4 portions per day) so comparisons between higher and lower consumers of fruit and vegetables could be investigated. The increase in fruit and vegetable consumption in T3 can be seen to be primarily as a result of the increase in fruit consumption.

Table 3.1 Reported fruit and vegetable intakes, as measured by the food frequency questionnaire (portions/day)

	All	**T1**	**T2**	**T3**
n	35, 367	11, 790	11, 789	11, 788
Fruit and vegetables				
Mean	11	5	10	17
25th Percentile	7	4	9	13
75th Percentile	13	7	11	19
SD	6.2	1.6	1.2	6.4
Fruit				
Mean	5	2	4	9
25th Percentile	3	2	3	6
75th Percentile	7	3	5	10
SD	4.2	0.8	0.7	5.0
Vegetables				
Mean	5	3	5	7
25th Percentile	3	2	4	6
75th Percentile	7	4	6	9
SD	3.0	0.8	0.6	3.0

The distribution of various characteristics within tertiles of fruit and vegetable consumers were studied (Table 3.2).

Table 3.2 Distribution of lifestyle characteristics and nutrients within tertiles of fruit and vegetable consumption.

	Fruit and vegetables			
	T1	**T2**	**T3**	***p*-value**
n	11, 790	11, 789	11, 788	
Age (median number of years)	50.4	51.0	51.7	<0.01
BMI (mean)	24.7	24.4	24.2	<0.01
PAL* (median number of hours per day)	0.3	0.3	0.3	<0.01
Median no. of different varieties of f&v** eaten >1 week	6	12	19	<0.01
Nutrient intakes (median value/1000Kcal)				
Protein (g)	38.0	37.4	36.5	<0.01
Carbohydrate (g)	126.2	131.0	137.3	<0.01
Total fat (g)	37.4	36.3	34.8	<0.01
Saturated fat (g)	13.5	12.4	11.2	<0.01
Polyunsaturated fat (g)	6.3	6.6	6.9	<0.01
Monounsaturated fat (g)	11.9	11.5	11.0	<0.01
Fibre (g)	8.7	10.4	12.3	<0.01
Vitamin C (mg)	48.1	65.8	86.5	<0.01
Vitamin A (μg)	386.8	435.6	474.0	<0.01
Vitamin E (mg)	2.9	3.3	3.7	<0.01

*PAL = Physical Activity Level **f&v = fruit and vegetables

Age was found to be significantly associated with tertile of fruit and vegetable intake. The women in T1 had a lower median age of 50.4 years and the women appearing in T3 were slightly older with a median age of 51.7 years ($p<0.01$). Body Mass Index (BMI) was also significantly associated with fruit and

vegetable consumption, so that fruit and vegetable consumption increased with decreasing BMI ($p<0.01$), though differences between the tertiles were small.

3.5.2 Lifestyle Characteristics

3.5.2.1 Food and Nutrient Intakes

Subjects classified in the highest tertile of fruit and vegetable consumption were found to consume a much larger variety of fruit and vegetables than those in the lowest tertile of intake. Higher consumers had a median intake of 19 different varieties of fruit and vegetables, which were consumed more than once per week, compared to just 6 different varieties in the lower consumers. When nutrient levels, per 1000Kcals, were investigated the higher consumers of fruit and vegetables had greater median intakes of all the antioxidant vitamins, carbohydrate, fibre and polyunsaturated fats, and lower intakes of protein, total fat, saturated fat and monounsaturated fats. Median intakes of fruit, vegetables and fruit and vegetables collectively were investigated according to various demographic, anthropometric and other lifestyle factors (Table 3.3). Vegetarian and vegan subjects within the cohort had higher median intakes of both fruit and vegetables compared to non-vegetarian or non-vegan subjects. This difference amounted to, on average, an additional 1.5 portions of fruit and vegetables per day. Of the women who regularly took nutritional supplements 36% were found in the highest tertile of intake compared to 30% in the lowest ($p<0.01$). Women categorised as being regular supplement users had a median fruit and vegetable intake of 9.93 portions per day compared to a median intake of 8.92 portions per day in non-supplement users.

3.5.2.2 Medical History

There were no significant differences in median intakes of fruit and vegetables, as a combined variable, between women who reported having been diagnosed as having had either a heart attack, angina, stroke, hypertension, hyperlipidaemia, diabetes or cancer, and those who had never had such a diagnosis. However there was a slight but significant difference in fruit intakes, when considered as a separate variable, with women who had been diagnosed with one of the listed illnesses having a slightly higher median fruit intake than those who had not.

Table 3.3 Median number of portions consumed (95% CI) of fruit and vegetables according to various demographic, anthropometric and other lifestyle factors with *p*-values.

	Fruit and vegetables			Fruit			Vegetables		
	No.	CI	*p*	No.	CI	*p*	No.	CI	*p*
Vegetarian status									
Vegetarian/vegan	10.79	(10.66 to 10.92)	<0.01	4.71	(4.62 to 4.78)	<0.01	5.59	(5.52 to 5.65)	<0.01
Non-vegetarian/non-vegan	9.06	(9.00 to 9.12)		4.25	(4.22 to 4.30)		4.40	(4.36 to 4.44)	
Women who									
Regularly use vitamin/mineral supplements	9.93	(9.84 to 10.02)	<0.01	4.58	(4.52 to 4.63)	<0.01	4.87	(4.83 to 4.92)	<0.01
Never use vitamin/mineral supplements	8.92	(8.83 to 9.01)		4.03	(3.98 to 4.09)		4.44	(4.39 to 4.49)	
Illnesses									
Have had any of the defined illnesses*	9.63	(9.50 to 9.74)	0.11	4.49	(4.42 to 4.55)	<0.01	4.65	(4.60 to 4.72)	0.05
Have not had any of the defined illnesses*	9.48	(9.42 to 9.56)		4.33	(4.29 to 4.37)		4.71	(4.67 to 4.75)	
Women who drink alcohol									
> once per week	9.66	(9.53 to 9.75)	<0.01	4.33	(4.29 to 4.39)	<0.01	4.90	(4.85 to 4.94)	<0.01
Once per week	9.55	(9.37 to 9.70)		4.47	(4.38 to 4.55)		4.60	(4.53 to 4.68)	
< once per week	9.26	(9.13 to 9.40)		4.35	(4.29 to 4.43)		4.40	(4.32 to 4.47)	
Never	9.31	(9.14 to 9.51)		4.41	(4.32 to 4.53)		4.37	(4.25 to 4.46)	
Women who									
Smoke daily	7.65	(7.41 to 7.89)	<0.01	3.12	(3.03 to 3.23)	<0.01	4.21	(4.10 to 4.32)	<0.01
Smoke occasionally	9.22	(8.91 to 9.70)		3.98	(3.75 to 4.23)		4.72	(4.55 to 5.01)	
Used to smoke	9.82	(9.72 to 9.93)		4.40	(4.34 to 4.46)		4.91	(4.84 to 4.98)	
Never smoke	9.63	(9.55 to 9.72)		4.54	(4.49 to 4.58)		4.65	(4.62 to 4.70)	
Marital status									
Married	9.62	(9.56 to 9.70)	<0.01	4.41	(4.37 to 4.46)	<0.01	4.79	(4.75 to 4.83)	<0.01
Divorced	9.33	(9.14 to 9.66)		4.18	(4.06 to 4.28)		4.61	(4.51 to 4.73)	
Widowed	9.29	(9.06 to 9.60)		4.51	(4.38 to 4.70)		4.40	(4.28 to 4.53)	
Single	8.92	(8.63 to 9.09)		4.20	(4.07 to 4.35)		4.19	(4.04 to 4.29)	
Separated	9.35	(8.93 to 9.88)		4.23	(3.90 to 4.54)		4.55	(4.39 to 4.84)	

*Defined illnesses were self-reported heart attack, coronary thrombosis, myocardial infarction, angina, stroke, hypertension, hyperlipidaemia, diabetes or cancer.

Table 3.3 continued.

	Fruit and vegetables			Fruit			Vegetables		
	No.	CI	*p*	No.	CI	*p*	No.	CI	*p*
Employment status									
Employed	9.43	(9.34 to 9.53)	<0.01	4.27	(4.23 to 4.32)	<0.01	4.71	(4.66 to 4.76)	<0.01
Housewives	9.59	(9.45 to 9.79)		4.43	(4.32 to 4.53)		4.73	(4.64 to 4.83)	
Retired	9.73	(9.57 to 9.87)		4.70	(4.62 to 4.79)		4.56	(4.49 to 4.64)	
Students	9.78	(9.20 to 10.57)		4.10	(3.63 to 4.47)		4.99	(4.54 to 5.47)	
Unemployed	9.16	(8.50 to 9.93)		3.81	(3.44 to 4.33)		4.69	(4.41 to 5.12)	
Socio-economic group									
Never had a paid job	9.50	(8.67 to 10.15)	<0.01	4.40	(4.12 to 4.80)	<0.01	4.33	(3.83 to 5.01)	<0.01
Managers/administrators	9.39	(9.23 to 9.55)		4.19	(4.10 to 4.28)		4.68	(4.59 to 4.78)	
Professional	10.16	(10.03 to 10.29)		4.82	(4.73 to 4.90)		4.89	(4.82 to 4.95)	
Associate professional	10.08	(9.93 to 10.24)		4.63	(4.55 to 4.73)		5.01	(4.92 to 5.12)	
Clerical & secretarial	9.10	(9.00 to 8.20)		4.17	(4.12 to 4.24)		4.51	(4.45 to 4.57)	
Craft & skilled	9.15	(8.80 to 9.86)		3.97	(3.70 to 4.30)		4.65	(4.35 to 4.94)	
Personal & protective	9.26	(9.07 to 9.56)		4.17	(4.03 to 4.30)		4.64	(4.50 to 4.77)	
Sales	8.70	(8.39 to 9.03)		3.88	(3.70 to 4.03)		4.35	(4.23 to 4.54)	
Plant & machine operatives	8.36	(7.80 to 8.96)		3.69	(3.36 to 4.05)		4.08	(3.73 to 4.43)	
Other	8.25	(7.83 to 8.69)		3.70	(3.53 to 3.94)		4.00	(3.78 to 4.19)	
Women living in									
North East	9.61	(9.15 to 9.86)	<0.01	4.16	(3.99 to 4.40)	<0.01	4.92	(4.72 to 5.12)	<0.01
North West	9.09	(8.96 to 9.26)		4.15	(4.01 to 4.27)		4.54	(4.41 to 4.64)	
Yorkshire and the Humber	9.39	(9.22 to 9.67)		4.31	(4.20 to 4.45)		4.68	(4.59 to 4.79)	
East Midlands	9.50	(9.29 to 9.76)		4.40	(4.25 to 4.55)		4.63	(4.54 to 4.77)	
West Midlands	9.47	(9.19 to 9.68)		4.36	(4.24 to 4.52)		4.57	(4.46 to 4.68)	
East of England	9.71	(9.47 to 9.93)		4.43	(4.33 to 4.57)		4.77	(4.63 to 4.89)	
Greater London	9.60	(9.43 to 9.80)		4.33	(4.24 to 4.41)		4.79	(4.69 to 4.89)	
South East	9.53	(9.42 to 9.66)		4.36	(4.29 to 4.43)		4.71	(4.63 to 4.79)	
South West	9.82	(9.58 to 10.00)		4.54	(4.45 to 4.62)		4.86	(4.79 to 7.95)	
Scotland	9.45	(9.25 to 9.69)		4.51	(4.42 to 4.69)		4.50	(4.38 to 4.60)	
Wales	9.47	(9.20 to 9.79)		4.44	(4.25 to 4.61)		4.71	(4.50 to 4.91)	
Northern Ireland	9.75	(8.64 to 11.26)		4.61	(4.12 to 5.28)		4.60	(3.99 to 5.65)	

Table 3.3 continued.

	Fruit and vegetables			Fruit			Vegetables		
	No.	CI	*p*	No.	CI	*p*	No.	CI	*p*
Educational level									
No qualifications	8.69	(8.55 to 8.87)	<0.01	3.95	(3.86 to 4.07)	<0.01	4.28	(4.20 to 4.36)	<0.01
O-level	9.32	(9.22 to 9.44)		4.20	(4.15 to 4.28)		4.64	(4.58 to 4.70)	
A-level	9.91	(9.80 to 10.03)		4.60	(4.53 to 4.68)		4.86	(4.81 to 4.94)	
Degree	10.01	(9.88 to 10.13)		4.63	(4.57 to 4.70)		4.93	(4.87 to 4.99)	
Women who									
Have children under the age of 16	9.69	(9.27 to 9.55)	0.19	4.17	(4.11 to 4.24)	<0.01	4.82	(4.76 to 4.89)	<0.01
Do NOT have children under the age of 16	9.56	(9.48 to 9.64)		4.43	(4.40 to 4.48)		4.65	(4.62 to 4.69)	

3.5.2.3 Alcohol and Tobacco Consumption

There was a slight but statistically significant difference in portions of fruit and vegetables per day and frequency of alcohol consumption. Those women who drank alcohol more than once per week were more likely to appear in the upper tertile of fruit and vegetable intakes, whereas women who never drank alcohol were more likely to appear in the lowest tertile of intake ($p<0.01$). Translated into median portions per day the differences were slight with women who drank alcohol more than once per week consuming just one third of a portion more of fruit and vegetables, than those women who never drank alcohol. Women who smoked were far more likely to appear in T1 than in T3, with 46.5% of the smokers appearing in the lowest tertile of fruit and vegetable intake ($p<0.01$). When smoking status was categorised ex-smokers had the highest median intakes of fruits and vegetables, consuming on average over 1.5 portions per day more, of total fruit and vegetables, than daily smokers. This difference was more obvious for fruit consumption than for vegetable consumption.

3.5.2.4 Marital Status and Number of Children

Marital status did have an effect on fruit and vegetable consumption with women who were married or living as married being slightly, but significantly, more likely to be found in T3 than in T1. Women who categorised themselves as divorced, widowed, single or separated were all slightly more likely to be found in T1 than in T3, with single women being the most likely (40% of single women appeared in T1). In terms of median intakes, differences were relatively small ranging from 8.9 portions per day in single women up to 9.6 portions per day in women who were married or living as married. Median intakes of fruit and

vegetables were not significantly different between women who did or did not have children under the age of 16 years.

3.5.3 Socio-economic variables

Education level was divided into four categories – no education, O-level, A-level and degree level. Women with no education were more likely to be found in T1 with 41% appearing there ($p<0.01$). In contrast, women with qualifications at degree level were more likely to appear in T3 ($p<0.01$). In terms of median portions of fruit and vegetables per day, women with degree level qualifications consumed an average of just fewer than 1.5 portions more, than those women with no academic qualifications. As with smoking status, this difference in overall fruit and vegetable consumption was attributed to lower fruit consumption in women with no academic qualifications. When employment status was examined, women who categorised themselves as unemployed were more likely to be found in T1, with 40% appearing here ($p<0.01$), compared to 30% in T3 ($p<0.01$). Housewives, retired women and students had the highest median intakes of fruit and vegetables, although actual differences in median portions per day between the categories of employment status were small. Women classed as "professionals" or "technical and associate professionals" were more likely to appear in T3, with 38% of both groups appearing here. At the lower end of fruit and vegetable intake women categorised as working in sales or as plant and machine operatives were far more likely to be appear in T1 ($p<0.01$). In terms of median intakes of fruit and vegetables these ranged from 8.4 portions per day in plant and machine operatives up to 10.2 portions per day in professional women.

3.5.4 Demographic variables

Subjects were assigned to demographic regions based on the government office regions. 37% of those women living in the North West were found to be in the lowest tertile of intake compared to 29% in T3. However the reverse was true for women living in the South West. Women living in all other regions were fairly evenly split between the tertiles of fruit and vegetable intake.

In the univariate analysis all variables were found to be statistically significant, for combined fruit and vegetable intake, with the exception of two factors; whether or not they had children under the age of 16 years and if they had been diagnosed with either heart attack, angina, stroke, hypertension, hyperlipidaemia, diabetes or cancer. For the next step all variables were entered into the multivariate model. The quoted odds ratios and *p*-values refer to the effect of each variable after accounting for all other variables (Table 3.4).

Table 3.4 Results from the logistic regression model describing the relative probabilities of being a high fruit and vegetable consumer (n = 10, 316).

	Odds ratio (95% CI)	*p*-value
Age	1.04 (1.03 to 1.04)	<0.01
PAL	1.26 (1.17 to 1.37)	<0.01
Vegetarian status		
Vegetarian/vegan	2.21 (2.01 to 2.43)	<0.01
Women who		
Take vitamin/mineral supplements	1.52 (1.40 to 1.66)	<0.01
Illnesses		
Women who have had any of the defined illnesses*	0.96 (0.87 to 1.06)	0.40
Women who drink alcohol		
Never	1.00	
< once per week	0.96 (0.82 to 1.14)	<0.01
Once per week	1.14 (0.96 to 1.36)	
> once per week	1.15 (0.99 to 1.34)	
Women who describe smoking habit as		
Never smoke	1.00	
Used to smoke	1.04 (0.95 to 1.14)	<0.01
Smoke occasionally	0.94 (0.74 to 1.18)	
Smoke daily	0.50 (0.42 to 0.59)	
Marital status		
Single	1.00	
Married	1.62 (1.38 to 1.91)	<0.01
Divorced	1.27 (1.04 to 1.56)	
Widowed	1.21 (0.93 to 1.56)	
Separated	1.07 (0.79 to 1.44)	
Employment status		
Employed	1.00	
Housewives	1.12 (1.05 to 1.35)	0.07
Retired	1.01 (0.86 to 1.18)	
Students	0.88 (0.58 to 1.33)	
Unemployed	0.82 (0.56 to 1.22)	
Socio-economic Group		
Never had a paid job	1.00	
Managers/administrators	0.85 (0.39 to 1.88)	<0.01
Professional	1.04 (0.47 to 2.29)	
Technical and associate professional	1.13 (0.51 to 2.50)	
Clerical and secretarial	0.79 (0.36 to 1.72)	
Craft and skilled	0.78 (0.33 to 1.82)	
Personal and protective	0.88 (0.40 to 1.94)	
Sales	0.63 (0.28 to 1.42)	
Plant and machine operatives	0.74 (0.30 to 1.83)	
Other	0.67 (0.29 to 1.53)	

*Defined illnesses were self-reported heart attack, coronary thrombosis, myocardial infarction, angina, stroke, hypertension, hyperlipidaemia, diabetes or cancer.

Table 3.4 continued.

	Odds ratio (95% CI)	*p*-value
Women living in		
North East	1.00	
North West	0.71 (0.55 to 0.93)	0.04
Yorkshire and the Humber	0.84 (0.64 to 1.09)	
East Midlands	0.75 (0.57 to 1.00)	
West Midlands	0.74 (0.57 to 0.97)	
East of England	0.85 (0.65 to 1.10)	
Greater London	0.86 (0.68 to 1.13)	
South East	0.84 (0.66 to 1.08)	
South West	0.99 (0.77 to 1.28)	
Scotland	0.79 (0.60 to 1.04)	
Wales	0.85 (0.62 to 1.17)	
Northern Ireland	2.09 (0.62 to 6.99)	
Education level		
No qualifications	1.00	
O-level	1.43 (1.24 to 1.65)	<0.01
A-level	1.62 (1.38 to 1.89)	
Degree	1.60 (1.35 to 1.89)	
Women with		
Children under the age of 16 years	1.09 (0.98 to 1.21)	0.13

The multivariate analysis was only carried out on 10,316 of the women within the cohort due to problems with missing data. However when the univariate analysis was repeated on these 10,316 participants alone no changes in the patterns of the original results were observed suggesting that these missing data had not affected the original results (Data not shown). The results from the logistic regression analysis showed that, after controlling for all the other factors, the variables employment status and region were no longer statistically significant. The logistic regression analysis picked up the important, most predictive variables for high fruit and vegetable consumption. Vegetarians and vegans were over twice as likely as non-vegetarians or non-vegans to be high fruit and vegetable consumers, and women who took vitamin or mineral supplements were one and a half times more likely to be high consumers compared to women who did not take any supplements. Women who smoked daily were only half as likely to be high consumers compared to women who

had never smoked and married women were one and half times more likely to be high consumers than single women.

3.5.5 Significance of small effects

Due to the large sample size within this study, statistically the study is very highly powered. This means that even small effects are highly statistically significant, even though they may not be clinically relevant. It should be noted then that when we discuss the results it is critical to assess the size of the effect and the associated confidence intervals, as well as the p-value.

3.6 Discussion

This study reports some clear lifestyle, socio-economic and demographic distinctions among three categories of fruit and vegetable consumption. In this cohort of women, the higher fruit and vegetable consumers were more likely to be slightly older, non- or ex-smokers, married or living with someone, with a degree level of education and of higher socio-economic status.

Reported fruit and vegetable intakes within the cohort under study were high, in comparison with previous data on fruit and vegetable intakes within the UK population (Ministry of Agriculture, Fisheries and Food 1999). The mean reported daily intake in this cohort of women was 10.7 portions, over 2.5 times greater than the average found in the National Food Survey. This is partly due to the inherent problem of any self-reported data, coupled with the known problem of over-estimation of fruit and vegetable consumption using FFQ data (Krebs-Smith et al. 1995; Calvert et al. 1997). However, taking these limitations

into account and understanding that the data are not giving us precise intakes, but rather indications of level of intake, we have categorised these women into three levels of fruit and vegetable consumption. The analysis was repeated for quintiles of fruit and vegetable intake in order to be sure the trends were stable. All trends in the repeat analysis remained the same thus strengthening the initial analysis and verifying that the consumers at the top and bottom end of the scale were not disproportionately affecting the results (Data not shown). The high level of fruit and vegetable consumption found within this cohort of women is perhaps not so surprising when we consider that the sample was not a random sample but instead was chosen to include a large number of vegetarians and vegans who consume larger amounts of fruits and vegetables. Indeed this is also a positive point for the cohort study because, by capturing the higher consumers we are able not only to investigate the protective effects of fruit and vegetable consumption but also any potential threshold effects.

What was interesting in this study is that, although these women seem to be particularly high consumers of fruit and vegetables, the results still mirror findings of previous studies on the general UK population. When considering lifestyle and behavioural characteristics smoking status was found to be a major factor in differentiating between higher and lower fruit and vegetable consumers. Female smokers were much more likely to appear in the lowest tertile of intakes. This finding is in line with other studies carried out on UK populations, which have found that smoking is significantly associated with lower fruit and vegetable consumption (Billson, Pryer, & Nichols 1999; Birkett 1999; Thompson et al. 1999). This is also important because studies have

found that not only do smokers tend to consume less of the antioxidant vitamins found in fruit and vegetables, they also absorb less of these nutrients than do non-smokers (Zondervan et al. 1996 ; Albanes et al. 1997). Although current smokers in this cohort consumed less combined fruit and vegetable portions, than non- or ex-smokers, this was more noticeable for portions of fruit. This was also found in the Spanish arm of the European Prospective Investigation into Cancer (EPIC) where current smokers consumed considerably less fruit than former or never smokers (Agudo & Pera 1999).

As in previous studies the nutrient profiles of the higher fruit and vegetable consumers were found to be more favourable than those of the low consumers, and not just for the antioxidant vitamins (Agudo & Pera 1999; Wallstrom et al. 2000). The higher consumers had lower median intakes of total fat and saturated fat and greater median intakes of carbohydrates, fibre and polyunsaturated fats. This pattern of nutrient intake is associated with more healthy eating behaviours and is generally in line with current recommendations, although unexpectedly the higher consumers did have lower median intakes of monounsaturated fats.

Results of the present study on fruit and vegetable consumption amongst nutritional supplement users back up the conclusions of a previous study on diet and lifestyle characteristics associated with dietary supplement use, which was carried out on a sub-set of the UKWCS cohort. The initial study found that the use of dietary supplements was associated with, among other variables, consuming more fruit and vegetables, and concluded that supplement use is

associated with a healthier lifestyle profile and an adequate nutritional intake (Kirk et al. 1999).

In the present study a woman's marital status was significantly associated with her fruit and vegetable intake, with married women consuming more fruit and vegetables. However in a previous study, looking at different dietary patterns in the UK and their associations with health and lifestyle variables, results showed that women living on their own favoured a dietary pattern that included frequent consumption of fruits, salad and vegetables (Whichelow & Prevost 1996). Other studies have found marital status to be associated with fruit and vegetable consumption, but mainly in men, with single men consuming less fruit and vegetables than their married counterparts (Donkin et al. 1998).

Levels of education and socio-economic status have also been found to influence fruit and vegetable consumption in a number of previous studies. One European-wide study, specifically investigating socio-economic status and fruit and vegetable consumption, concluded that a less healthy dietary pattern exists in lower socio-economic levels in Europe. This dietary pattern includes lower consumption levels of fruit and vegetables (De Irala-Estevez et al. 2000).

The National Food Survey (1998) found that in general fruit and vegetable consumption decreases with the increasing number of children within the household (Ministry of Agriculture, Fisheries and Food 1999). The only lifestyle characteristic found, in the present study, where there were no significant differences in fruit and vegetable consumption, as a combined variable, were

with women who did or did not have children under the age of 16-years. However when the two variables were considered individually it could be seen that women with children under the age of 16 years consumed significantly more vegetables than women *without* children under 16 years. Conversely women with no children under the age of 16 years consumed more fruit than those women *with* children under the age of 16 years. When the variables were combined these two differences cancelled each other out and no significant differences were apparent. When studying fruit and vegetable consumption it may be of importance to be able to separate the two variables so that we can be sure that no differences are being hidden. For most variables, where combined fruit and vegetable intake was found to be low (e.g. smokers, employment status and lower socio-economic groups), it was found that these intakes could mainly be attributed to a lower fruit intake than vegetable intake.

Another interesting area illustrated within the current study was that subjects classified within the highest tertile of intake were found to be consuming more varieties of fruit and vegetables than lower consumers, suggesting that this could be a way forward for health promotion strategies. It may be important to encourage new varieties of fruit and vegetables, within the diet, in order to have any optimism over increasing intakes. This will involve having to teach new shopping strategies and cooking methods before any increase is achieved. However it should be recognised that this particular cohort of women is generally motivated, well educated and of a relatively high socio-economic grouping and that some of the strategies suggested may not be applicable to all sub-groups within society.

3.7 Conclusions

These findings are relevant for future health promotion strategies, confirming that interventions to increase consumption should be targeted towards smokers, single persons and those in lower socio-economic groups. However more research is necessary to investigate how best to motivate population change. Previous studies have identified barriers to change in low fruit and vegetable consumers (Thompson et al. 1999). It might now be more useful to change the approach and to try and identify what motivates current high consumers of fruit and vegetables. This will be investigated within the next chapter.

3.8 Summary of Key Findings

The strongest predictors of a high reported level of fruit and vegetable consumption were;

- Being a vegetarian or vegan
- Being a non-smoker
- Taking vitamin or mineral supplements
- Being married
- Educated to A-level or degree level
- Belonging to a higher socio-economic group

Chapter 4

Motivations for fruit and vegetable consumption in the UKWCS

4.1 Summary

Despite recommendations to increase fruit and vegetable (f&v) consumption within the UK, intakes are still too low. In order to stimulate dietary behaviour change the determinants of food choice need to be explored. The aim of the study was to investigate how the priorities of high consumers of f&v differ from those of low consumers, with respect to food choice motivations. A 4-day food diary and a questionnaire, including the Food Choice Questionnaire (FCQ) and a measure of stage of change (SOC) for f&v consumption, were administered to 998 subjects participating in the UKWCS. Motivation scores from the FCQ were compared with f&v intake and SOC data. In a multiple linear regression model, including age, education level and all FCQ motivations, the strongest motivations affecting specifically f&v intake were health and natural content. It was found that for a one point increase (measured on a scale of 0-4) in health and natural content scores, f&v consumption increased by 1.11 portions (95% C.I. 0.5 – 1.7) and 0.84 portions (95% C.I. 0.4 – 1.3) respectively ($p<0.01$). The SOC evaluation showed significant associations with portions of f&v consumed ($p<0.01$). Women whose SOC was classed as maintenance phase were found to score higher on health, natural content, weight control and ethical concern factors ($p<0.01$). These women also scored lower on convenience questions

($p<0.01$).In conclusion, within this particular group of women the most important motivating factors for food choice, within the high fruit and vegetable consumers, were health and natural content of the food.

4.2 Introduction and study rationale

In Chapter 3 it was concluded that the lowest consumers of fruit and vegetables, in terms of their basic demographic data, are smokers, single persons and those in lower socio-economic groups. This is useful information for the targeting of health promotion interventions, however it tells us little about human health behaviour.

Intakes of fruit and vegetables in the UK continue to fall short of the WHO goal, of 400g of fruit and vegetables per person per day, despite health promotion attempts to increase consumption (World Health Organisation 1990; Department Of Health 1999; Thompson et al. 1999). Adapting science and achieving meaningful behaviour change is a serious challenge for any health promotion program. Social marketing is an approach, which may be applied to the promotion of healthy eating, whereby programmes are directed at target groups in the population based on their differing attitudes, beliefs, motivations and behaviour (Lefebvre et al. 1995). Thus in order to change the dietary behaviour of any population it is important to take into consideration the motivations for food choice within that population.

The concept of applying social marketing techniques within dietary health promotion is not a new one, as we learnt from the literature review in Chapter 1. However previous studies have concentrated their efforts on identifying barriers to change in low consumers of fruit and vegetables (Institute of European Food Studies 1996a; Institute of European Food Studies 1996b; Cox et al. 1998). As was concluded in Chapter 3 more research is now needed to investigate how

best to motivate population change. Therefore, in an innovative approach, this study attempts to identify factors that motivate current *high* consumers of fruit and vegetables.

In order to do this The Food Choice Questionnaire (FCQ) was employed. This questionnaire was designed to measure the importance placed, by subjects, on nine different categories of food choice motivations; health, mood, convenience, sensory appeal, natural content, price, weight control, familiarity and ethical concern (Steptoe, Pollard, & Wardle 1995). This method has not been used previously to identify food choice motivations for fruit and vegetable consumption. The study was designed to include the FCQ because it was developed solely to study food choice behaviour, as opposed to more general human health behaviours, and also it measures food choice motivations at a practical level in a similar way to The Food Choice Framework in Chapter 2 (Figure 2.4). In the published literature the FCQ has only been previously used to explain variation in dietary intake in relation to vegetarian diets compared with 'standard' diets or diets that are 'low in red meat' (Pollard, Steptoe & Wardle 1998).

One area where there is currently a lot of research interest is in using the Stages of Change (SOC) model, part of the Transtheoretical Model (TTM), with dietary behaviour change. The TTM was described previously in Chapter 2.3, but as a brief overview the TTM has two elements to it; the stages of change and the process of change. The TTM was originally developed by Prochaska

and DiClemente to describe the process of behavioural change in addictive behaviours (Prochaska & DiClemente 1984; Prochaska & DiClemente 1986).

The SOC model classifies people into five different stages of readiness to change. If people at different stages within the model held similar beliefs, perhaps these classifications could be employed for targeting health promotion interventions. However the SOC model was originally developed to investigate addictive behaviours and may not be appropriate for dietary behaviour changes (Povey et al. 1999). It is thought that one particular problem with using the SOC model in dietary behaviour change is that the difference between a person's perceived and actual intakes could lead to misclassification within the model. If this happened in a health promotion setting then people could potentially receive the wrong information and movement through the model may not happen. A measure of SOC for increasing fruit and vegetable consumption was incorporated into the methodology of this study in order to investigate misclassification of subjects and to identify whether or not people at different stages within the model have similar food choice motivations.

The population for study was again drawn from the UKWCS, because of the dietary variation within the cohort, thus maximising the potential range of intakes of fruit and vegetables. In Chapter 3 it was found that estimated fruit and vegetable consumption was far higher in the UKWCS than we would normally expect to see within the UK population. However because we wish to study the high consumers of fruit and vegetables, within the present study, the UKWCS forms a good basis for this research.

4.3 Aims and objectives

The aim of this study was to develop a greater understanding of the factors affecting the food choice decisions in relation to fruit and vegetable consumption.

Objectives:

- To investigate how the priorities of high consumers differ from those of low consumers with respect to food choice motivations.
- To investigate the relationships between fruit and vegetable intakes, food choice motivations and the process of behaviour change.

4.4 Methods

4.4.1 Sample

The number of women selected from the UKWCS to receive an FCQ, in order to investigate food choice motivations for fruit and vegetable consumption, was decided using a power calculation based on previous studies that had utilised the FCQ (Steptoe, Pollard, & Wardle 1995; Pollard, Steptoe, & Wardle 1998). Assuming a standard deviation of 0.8 the number of subjects required to detect a difference of 0.3, with 90% power, on any of the scales for the nine dimensions within the FCQ was 650. A significance level of 0.01 was used to allow for multiple comparisons. Allowing for a conservatively estimated response rate of 30%, 2200 questionnaires were required to be sent. The UKWCS participants are contacted in waves of 3000 and therefore the current study was based on one wave of the UKWCS mailing that was sent out in August 1999.

4.4.2 Research design and data collection

The 3000 women contacted each received a four-day food diary (see Appendix B) and a questionnaire (see Appendix C for full questionnaire). The questionnaire included The Food Choice Questionnaire, which has been found to be reliable, internally consistent and stable over time (Steptoe, Pollard, & Wardle 1995; Pollard, Steptoe & Wardle 1998). This questionnaire begins with the sentence "It is important to me that the food I eat on a typical day..." and is then followed by a series of 36 statements covering the nine dimensions measured by the FCQ. For example, "It is important to me that the food I eat on a typical day is easy to prepare". This statement is part of the assessment for the dimension of convenience. The participants are asked to tick an appropriate response for each statement ranging from "not at all important" to "very important" on a 4-point scale.

The second part of the questionnaire included an assessment measure for the Stage of Change (SOC) model (Prochaska & DiClemente 1992). Subjects were asked to read seven statements and to tick the box next to the statement that most applied to their diet. The statements related to whether or not the subjects were eating five portions of fruit and vegetables daily and, if so, how long they had been doing this for. Based on the response subjects were classified into one of the five stages; Precontemplation, contemplation, preparation, action or maintenance. Subjects classed in the Precontemplation phase were currently not consuming five portions of fruit and vegetables daily and did not want to start in the next six months. In the Contemplation phase subjects were still not consuming five portions but they stated that they did want to start in the next six

months. In the next phase, Preparation, subjects were again not consuming five portions of fruit and vegetables daily but this time they stated that they would like to start in the next month. In the Action phase subjects were currently consuming five, or more, portions of fruit and vegetables daily, or on most days, and had been for less than six months. Finally, subjects in maintenance were still currently consuming five, or more, portions daily, or on most days, but they had been doing this for more than six months.

4.4.3 Data analysis

Using the four-day food diary data the portions of fruit and vegetables consumed per person were calculated and then averaged over the four day period. This daily figure included fruit and vegetables from composite dishes and allowed for one portion of fruit juice per day but excluded potatoes. Standard portion sizes were employed for calculation of the amounts consumed (Crawley 1994).

All analyses were carried out using the Statistical Package for the Social Sciences (SPSS) version 9.0 (SPSS Inc 1998). FCQ data were scored for each statement on the questionnaire so that scores ranged from 1 for an answer of "not at all important" up to 4 for an answer of "very important". Scores on items contributing to each dimension were then added up and divided by the number of questions relating to that particular dimension, giving an average score on a scale of 1 to 4, per person, for each of the nine dimensions (Steptoe, Pollard, & Wardle 1995; Pollard, Steptoe & Wardle 1998). Non-parametric tests were employed where necessary because of the skewed nature of the FCQ data.

Average scores on the FCQ are presented as medians and correlations between FCQ factors were investigated using Spearman's correlation. The subjects were then split into tertiles of fruit and vegetable intake and median FCQ scores within each tertile were explored and compared using appropriate correlations. A linear regression model was then used to determine which of the FCQ factors were the strongest predictors of fruit and vegetable consumption. This was repeated adjusting for age and education level.

The SOC model was investigated to see if there were any relationships with median intakes of fruit and vegetables or median FCQ scores. Misclassification of subjects within the SOC was also examined by estimating the sensitivity, specificity, positive predictive value and negative predictive value of the SOC assessment tool within the questionnaire. In the present study misclassification was examined solely between action and non-action phases. The action phases (action and maintenance) were those where subjects had reported that they were currently consuming five or more portions of fruit and vegetables per day, and had been doing so for either more, or less, than six months. The non-action phases (precontemplation, contemplation and preparation) were those where subjects were not currently consuming five portions of fruit and vegetables per day.

4.5 Results

4.5.1 Response rate

Out of the 3000 women contacted 197 (6.6%) had either died or had moved house. 1139 women completed and returned the FCQ and 1103 completed the four-day food diary. Of these women 998 completed and returned both the diary and the questionnaire. Only women who had returned both were included in the analysis, giving an overall response rate of 36%. Since baseline data were available on all subjects contacted the socio-demographic profiles of the responders and the non-responders could be compared and this is presented in Table 4.1. Responders were slightly older, less likely to be smokers and more likely to be vegetarian, married or living as married, with a degree level of education, compared with the non-responders. There was no significant difference between median portions of fruit and vegetables consumed per day, as assessed in the baseline analysis, using a food frequency questionnaire.

Table 4.1 Socio-demographic and health behaviour characteristics of responders v. non-responders.

	Responders (n=998)	**Non-responders (n=2003)**	***p*-Value**
Median age (years)	50.7	49.8	<0.05
Median BMI (kg/m^2)	23.8	23.9	0.32
Median portions of fruit and vegetables consumed at baseline	10.6	10.3	0.19
Smokers:			
Yes (%)	7.1	11.5	<0.01
Vegetarian status:			
Vegetarian (%)	47.5	41.0	<0.01
Marital status:			
Married or living as married (%)	72.9	68.3	<0.05
Divorced (%)	9.0	12.2	
Widowed (%)	7.2	7.9	
Single (%)	9.1	8.8	
Separated (%)	1.8	2.8	
Highest Educational Qualification:			
No education (%)	13.0	18.0	<0.01
'O'-level (%)	28.9	30.5	
'A'-level (%)	26.4	24.5	
Degree (%)	31.7	27.0	

4.5.2. Fruit and vegetable consumption and FCQ factors

Median intakes of fruit and vegetables, as measured by the four-day food diary and the median scores for each of the FCQ factors are presented in Table 4.2. The median intake of fruit and vegetables was 6.7 portions per person per day. This is higher than we would normally expect to see within the UK population. It was found that within these women health, sensory appeal, natural content and weight control were the strongest determinants of general food choice in all subjects.

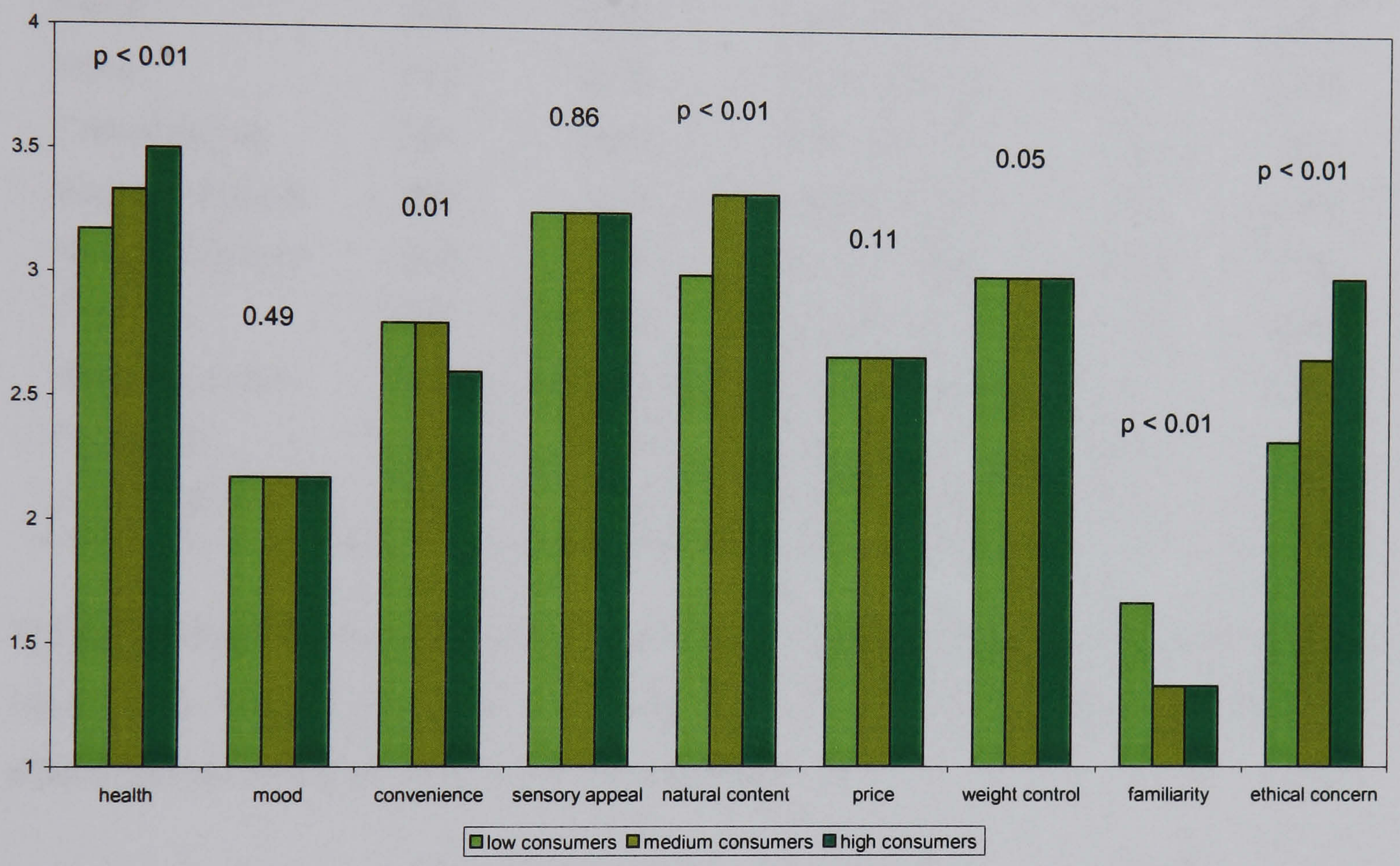
Table 4.2 Median fruit and vegetable intakes and median scores for each FCQ factor

	All Subjects (n = 998)	**Interquartile Range**
Median fruit and vegetable intakes		
Fruit (portions per day)	3.7	2.4 to 5.4
Vegetables (portions per day)	2.8	1.9 to 3.9
Fruit and vegetables (portions per day)	6.7	4.7 to 8.9
Median FCQ scores		
Health	3.33	3.00 to 3.67
Natural Content	3.33	2.67 to 4.00
Sensory Appeal	3.25	2.75 to 3.50
Weight control	3.00	2.33 to 3.33
Convenience	2.80	2.20 to 3.20
Price	2.67	2.00 to 3.00
Ethical Concern	2.67	2.00 to 3.33
Mood	2.17	1.67 to 2.83
Familiarity	1.67	1.00 to 2.00

Median scores on each FCQ scale according to tertile of fruit and vegetable intake can be seen in Figure 4.1. Those in the highest tertile of fruit and vegetable intakes had higher median health, natural content and ethical

concern scores compared with women in the lowest tertile of intakes ($p<0.01$). However women appearing in the lowest tertile of intakes had a higher median score for the familiarity factor compared with the women in the highest tertile ($p<0.01$).

Figure 4.1 Median scores on each FCQ scale according to tertile of fruit and vegetable intake.



A linear regression model was employed to describe the impact of the nine FCQ factors on fruit and vegetable consumption. The unadjusted results may be seen in Table 4.3. The model was then repeated adjusting for age, education level and all of the FCQ factors and these results can be seen in Table 4.4. The R^2 demonstrates the proportion of the total variation that is explained by the model. The results show that the strongest motivations affecting specifically fruit and vegetable consumption were health and natural content. It was found that for a one point increase (measured on a scale of 1-4) in health and natural

content scores, combined fruit and vegetable consumption increased by 1.11 portions (95% CI 0.5 – 1.7) and 0.84 portions (95% CI 0.4 – 1.3) respectively.

Table 4.3 Unadjusted results from the linear regression model describing the impact of the nine FCQ factors on fruit and vegetable consumption

	n	Regression Slope	(95% CI)	*p*-Value	R^2
Health	968	1.29	(0.85 to 1.72)	<0.01	3.4%
Mood	963	0.00	(-0.23 to 0.36)	0.67	0.0%
Convenience	961	-0.26	(-0.57 to 0.05)	0.10	0.3%
Sensory Appeal	969	-0.14	(-0.53 to 0.25)	0.48	0.1%
Natural Content	965	1.17	(0.87 to 1.48)	<0.01	5.7%
Price	972	-0.27	(-0.57 to 0.02)	0.07	0.3%
Weight Control	967	0.23	(-0.05 to 0.50)	0.11	0.3%
Familiarity	968	-0.56	(-0.89 to -0.22)	<0.01	1.1%
Ethical Concern	987	0.36	(0.11 to 0.62)	<0.01	0.8%

Table 4.4 Results from the linear regression model describing the impact of the nine FCQ factors on fruit and vegetable consumption, adjusted for age, education level and all of the FCQ factors (n = 867)

	Regression Slope	(95% CI)	*p*-Value	R^2
Health	1.11	(0.53 to 1.70)	<0.01	9.3%
Mood	-0.10	(-0.47 to 0.26)	0.58	
Convenience	0.01	(-0.42 to 0.31)	0.78	
Sensory Appeal	-0.40	(-0.82 to 0.03)	0.07	
Natural Content	0.84	(0.44 to 1.25)	<0.01	
Price	-0.17	(-0.51 to 0.17)	0.32	
Weight Control	0.15	(-0.16 to 0.46)	0.33	
Familiarity	-0.25	(-0.63 to 0.14)	0.22	
Ethical Concern	-0.01	(-0.40 to 0.23)	0.60	

4.5.3 Fruit and vegetable consumption and number of factors preventing an increase.

One of the additional questions within the postal questionnaire asked about what factors people felt were outside of their own control and prevented them from increasing their fruit and vegetable intakes. The results from this question were analysed qualitatively, using a coding technique. The number of different factors participants wrote down were also added up and compared against estimated fruit and vegetable intakes from the four-day food diary (Table 4.5). Those subjects who felt that they had the highest number of factors, outside of their own control, preventing them from increasing their fruit and vegetable consumption did have the lowest intakes ($p<0.01$).

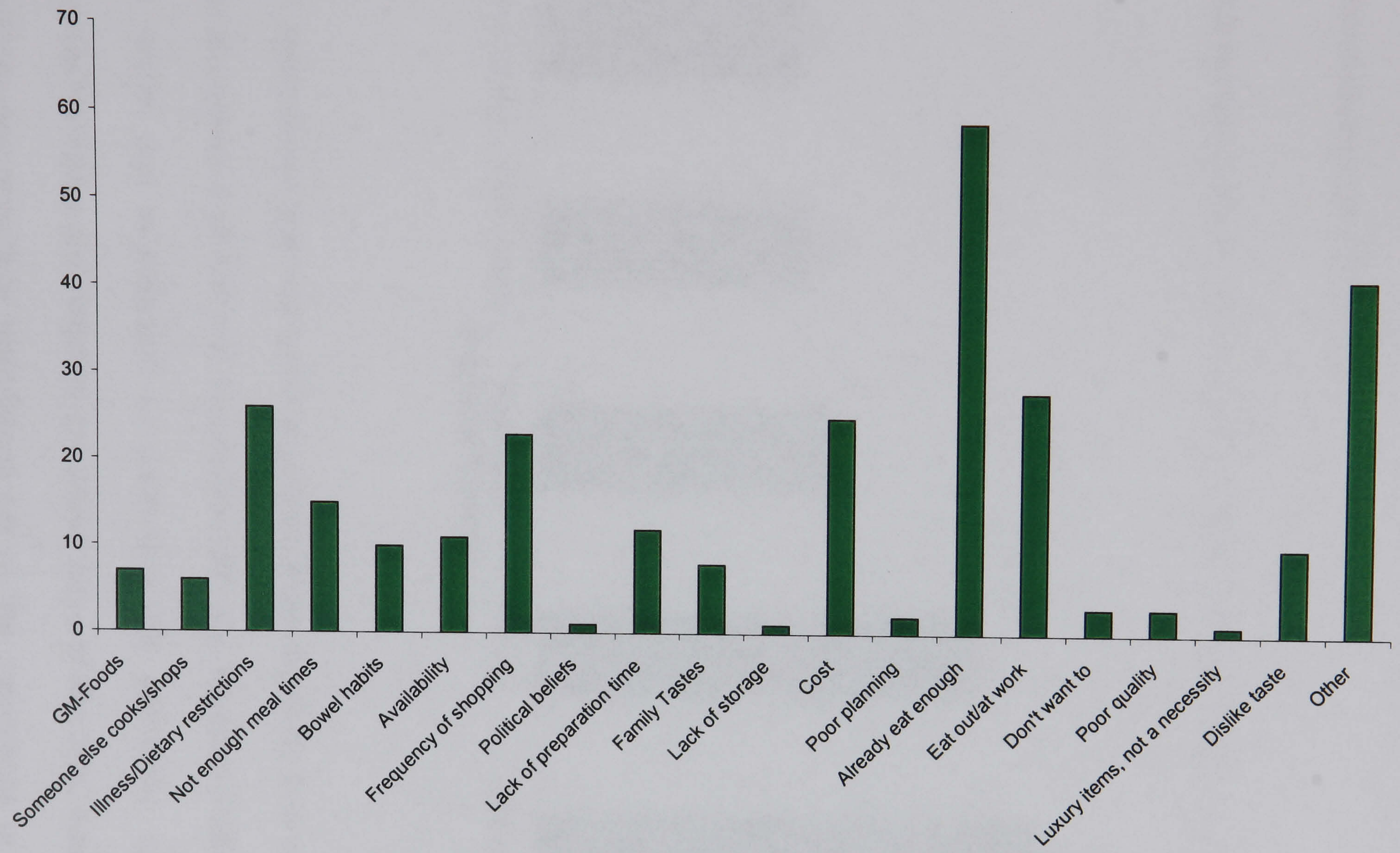
Table 4.5 Median fruit and vegetable intakes with number of factors mentioned that prevented an increase in fruit and vegetable consumption

No. of factors	n	Median intakes	*p*-value
0	792	6.9	<0.01
1	150	6.3	
2	36	5.3	
3	12	5.2	
4	6	5.4	
5	2	4.9	

The coding categories and the number of times each factor was mentioned by different participants can be seen in Figure 4.2. The most mentioned factor was that participants felt that they already ate enough fruit and vegetables. However the minimum intake of fruit and vegetables in women responding that they

already consume adequate quantities was 2.1 portions per day. Other frequently mentioned factors included illness/dietary restrictions, frequency of shopping trips, cost and difficulties of eating out or at work. These factors will be discussed in more details in the discussion.

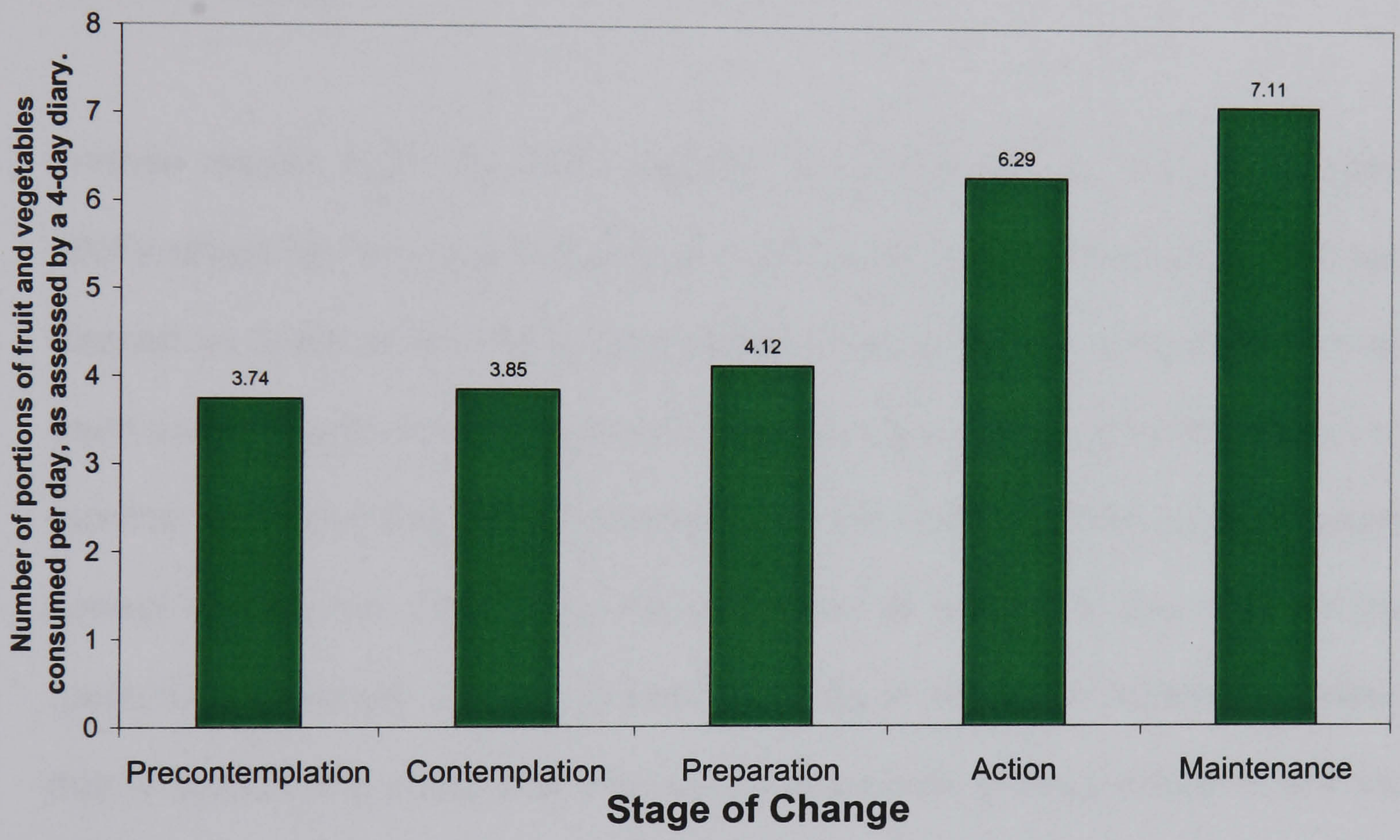
Figure 4.2 Number of times each factor was mentioned when asked, "What are these factors which you feel prevent you from increasing your intake of fruit and vegetables?"



4.5.4. SOC, food choice motivations and fruit and vegetable consumption.

The SOC evaluation showed significant associations with portions of fruit and vegetables consumed (Figure 4.3), so that the number of portions of fruit and vegetables consumed daily increased as SOC moves towards the action and maintenance phases ($p<0.01$).

Figure 4.3 Median portions of fruit and vegetables for each stage of change.



The SOC assessment tool was used to predict those subjects that consumed more than five portions of fruit and vegetables per day. Misclassification within the SOC model was investigated by estimating the sensitivity, specificity, positive predictive value and negative predictive value of the SOC assessment tool. Sensitivity and specificity calculations tell us the proportions of subjects who are correctly identified by the SOC model, whether they consume 5 or

more portions per day, or not. The positive predictive value then tells us the proportion of subjects who consumed more than 5 portions of fruit and vegetables per day, and were correctly identified, compared to the negative predictive value which identifies those consuming less than 5 portions of fruit and vegetables per day. The sensitivity was 96% (CI 94.0% to 97.1%), the specificity was 28% (CI 23.0% to 33.4%), the positive predictive value (ppv) was 76% (CI 73.5% to 79.2%) and the negative predictive value (npv) was 72% (CI 64.0% to 84.6%).

Further results from the SOC analysis are presented in Table 4.6. Clear relationships can be observed between SOC and median FCQ scores. Women classed as being in the maintenance phase, that is women who claim to have been eating five portions of fruit and vegetables on most days for more than six months, were found to score more highly on the health, natural content, weight control and ethical concern factors compared to women in the other stages ($p<0.01$). Conversely women classed as being in the precontemplative phase, that is women who stated that they were not consuming five portions of fruit and vegetables per day and did not intend to start in the next six months, had higher median scores for convenience factors than women in the other stages ($p<0.01$).

Table 4.6 Stage of change relationships with median FCQ scores

	Precontemplation (n=43)	Contemplation (n=27)	Preparation (n=42)	Action (n=18)	Maintenance (n=853)	*p*-Value
Health	3.00	3.00	3.00	3.00	3.33	<0.01
Mood	2.00	2.17	2.17	2.00	2.17	0.03
Convenience	3.20	3.00	2.80	2.80	2.60	<0.01
Sensory Appeal	3.38	2.88	3.25	3.25	3.25	0.45
Natural Content	3.00	2.67	3.00	3.00	3.33	<0.01
Price	2.67	2.67	2.67	3.00	2.67	0.09
Weight Control	2.67	2.67	2.67	2.67	3.00	<0.01
Familiarity	2.00	1.67	1.67	1.33	1.67	0.07
Ethical Concern	2.00	2.33	2.33	2.50	2.67	<0.01

4.6 Discussion

The results of this study provide a unique insight into the food choice motivations and the behavioural change process, in relation to fruit and vegetable consumption, within this group of women.

4.6.1. General food choice motivations

The strongest determinants of general food choice in this sample of women were health and natural content. These two dimensions of the FCQ relate to the importance of food being "nutritious" and "good for you", as well as containing no additives or artificial ingredients. The sensory appeal and weight control dimensions were also strong motivators within this group. Few previous studies have tried to identify determinants of food choice solely in women. One pan-EU survey investigated both male and female attitudes to food, nutrition and health (n = 14,331). The survey found that, both in the overall EU sample and in the UK sample, quality, price, taste, healthy eating and family constraints were the five most frequently mentioned influences on food choice (Institute of European Food Studies 1996a). If we compare these results we can see some quite different characteristics where in the current study health issues, including natural content and weight control, are the top motivating factors, with sensory appeal also being considered important. However in the EU sample sensory appeal is top of the list, including quality and taste, and price is a more highly influencing factor on food choice than is health.

Another study, utilising the FCQ to try to explain variation in dietary intake between meat eaters, low red meat eaters and vegetarians, found that their

samples strongest determinants of food choice were sensory appeal, price, health and convenience (Pollard, Steptoe, & Wardle 1998). This group seems to have similar influences on food choice to the EU sample, both mentioning sensory appeal first, then price, followed by health. In the current study price was not seen as a prime motivating factor on food choice behaviour. This probably reflects the relatively high socio-economic group of women within this study.

4.6.2. Food choice motivations for high fruit and vegetable consumers

Women appearing in the highest tertile of fruit and vegetable intakes were found to score higher on the health, natural content and ethical concern dimensions of the FCQ ($p<0.01$). This is perhaps not surprising as people who score high on the health and natural content dimensions will generally be more health conscious and therefore are more likely to be aware of the health benefits of consuming adequate amounts of fruit and vegetables. Also the women who score high on all three of these dimensions; health, natural content and, especially, ethical concern, are more likely to be vegetarians. The study, referred to previously, that attempted to explain variations in food choice between meat eaters, low red meat eaters and vegetarians found that the group who ate only small amounts of red meat scored highly on health, natural content, weight control and ethical concern factors of the FCQ (Pollard, Steptoe, & Wardle 1998). Whereas vegetarians only differed significantly on the ethical concern factors compared with the standard meat-eating group. Both of these groups, the 'health conscious' and the vegetarians have been found to have

high intakes of fruit and vegetables in previous studies (Kirk et al. 1999; Pollard, Greenwood, & Cade 2001).

What was particularly interesting in this study was that the higher consumers of fruit and vegetables had lower familiarity scores on the FCQ than lower consumers ($p<0.01$). The familiarity dimension of the FCQ seeks to find out if it is important to people that the food they eat "is familiar" or "is what I usually eat" or even "is like the food I ate when I was a child". It seems that the higher consumers of fruit and vegetables were less food neophobic than the lower consumers, that is that they were more likely to try new or novel foods, and they probably ate a wider variety of different foods (Koivisto Hursti & Sjoden 1997). This equates with previous data from chapter 3, where it was found that the higher consumers of fruit and vegetables consumed significantly more different varieties of fruit and vegetables, more than once per week, than did the lower consumers (Pollard, Greenwood, & Cade 2001). It would make sense then that these people are perhaps less food neophobic, and are happy to experiment with new varieties, or cooking / preparation methods, of fruit and vegetables. It may therefore be important to make new varieties more available and certainly encourage new and different varieties of fruit and vegetables within the diet, in order to have any optimism over increasing intakes.

The high consumers of fruit and vegetables considered convenience concerns less of an issue, than the low consumers, although this was not as statistically significant as the other dimensions mentioned ($p<0.05$). Convenience concerns involved time available for preparation of food and shopping, availability of

shops and simplicity of preparation and cooking. Convenience in terms of time constraints is a complex issue. It involves time available to go shopping, and thus the perishable nature of foodstuffs, very applicable to fruit and vegetables. It also includes the time available for preparation and consumption of foods and therefore the convenience of the foodstuff itself. Previous studies show conflicting opinions on all aspects of time constraints and how they affect food choice decisions. An American investigation using focus group interviews found that fruit was viewed as convenient but was considered perishable and expensive when out of season. For vegetables, preparation time was considered to be a barrier to increased consumption (Heimendinger & Van Duyn 1995). However among EU subjects 'lengthy preparation' and 'healthy foods being more perishable' were considered as unimportant barriers to healthy eating. The main perceived barriers were still related to time though, including 'irregular working hours' and 'busy lifestyle' (Kearney & McElhone 1999). This conflicting evidence is probably due to the fact that time constraints will be more important to some groups of the population than others. In the present study the high fruit and vegetable consumers rate issues around foods being able to be cooked very simply or easy to prepare as relatively unimportant. Perhaps the low consumers need to be educated in more quick and easy ways to incorporate fruit and vegetables into the diet.

The linear regression model was used to identify the strongest predictors of high fruit and vegetable consumption. After adjusting for age and education level health and natural content were still the strongest predictors of high fruit and vegetable consumption ($p<0.01$).

4.6.3. Fruit and vegetable consumption and number of factors preventing an increase

Subjects were asked about what factors, that they felt were outside of their own control, prevented them from increasing their fruit and vegetable intakes. The most frequently given answer was that people felt that they were already consuming adequate amounts of fruit and vegetables. This probably reflects the high consumption of fruit and vegetables within this cohort of women, however some of these women felt that they are consuming adequate quantities whilst intakes were still lower than recommended. The minimum intake of fruit and vegetables in women responding that they already consumed adequate quantities was 2.1 portions per day. This identifies a lack of awareness, whether it be a lack of awareness of the recommendations or a lack of awareness of actual intakes.

The second biggest category of factors preventing an increase in consumption was the 'other' category. These answers were relatively random and could not be classified neatly into any of the categories. Some women, particularly older women, talked about how they could not increase their intakes because they could not physically eat that much fruit or vegetables. For example one lady wrote, *"In one's seventies, the thought of 5 servings of anything makes one quail! The sheer bulk of food becomes reduced as years go by"* and another said *"As I grow older, I eat less, to consume five portions per day, I would have room for nothing else".* Other concerns centred on how exactly to incorporate five portions into one day's meals. One subject wrote, *"Find it hard to put veg with most of the dishes we eat e.g. curry and rice, pasta dishes, fish and chips".*

These subjects would benefit from very practical tips about increasing fruit and vegetables in the diet, for example using frozen vegetables in curries and pasta dishes.

Whatever the factors were that prevented an increase in fruit and vegetable consumption, the more factors cited by participants the lower the actual intakes of fruit and vegetables. In most cases, apart from illness and dietary restrictions, factors cited could be tackled in health promotion interventions with very simple tips and advice on increasing consumption.

4.6.4. Stages of Change

A clear relationship was observed between Stages of Change and actual consumption of fruit and vegetables, with women who were categorised as being precontemplators consuming the least amount of fruits and vegetables (3.7 portions per day) and those in the maintenance phase consuming a median of 7.1 portions daily ($p<0.01$). All of the women categorised as being in one of the non-action phases, that is precontemplation, contemplation and preparation, consumed less than five portions per day. Whereas the women in the action and maintenance groups consumed well over the recommended five portions per day, 6.3 portions and 7.1 portions respectively. Previous studies have also reported a strong relationship between SOC for fruit and vegetable consumption and actual intakes (Laforge, Greene, & Prochaska 1994; Brug, Glanz, & Kok 1997).

In discussions concerning the applicability of the SOC model in dietary behaviour change, the reliability of the questionnaire in classifying subjects within the stages correctly is of notable importance. The challenge of correctly measuring dietary exposure and the problems with self-reported dietary assessment were discussed in Chapter 1, and in Chapter 3 the over-estimation of fruit and vegetable intakes using the food frequency questionnaire was observed. So when using a self-reported tool to assess SOC the reliability of that tool must be assessed. The positive and negative predictive values showed the assessment measure to be fair in predicting SOC classification. However these values are highly dependent on the prevalence of the behaviour within the study population, and thus the characteristics of the population under study, and as such are not generalisable (Altman 1991).

However the sensitivity or specificity of the assessment tool are not related to the prevalence of the behaviour within the population (Altman 1991). The sensitivity result for the tool used within the current study was extremely high (96%). This tells us the proportion of subjects out of those who were *actually* consuming five or more portions of fruit and vegetables per day that the questionnaire identified as consuming five or more portions per day. Therefore the assessment tool is good at classifying those people who actually *do* consume more than five portions per day into the one of the Action phases, either action or maintenance. However the specificity of the tool was relatively poor (28%), revealing that the measure is not as good at picking up those people who actually consume less than five portions of fruit and vegetables per day and classifying them correctly. This result is as one would expect because

the subjects who are being misclassified are those who are over-reporting their consumption of fruit and vegetables, so that they are saying that they consume more than five portions of fruit and vegetables per day (action or maintenance phase), however when actual consumption is investigated they are consuming less than five portions per day. When using the SOC model in an intervention situation it is precisely those people that the tool is misclassifying, that is those who claim to be eating five or more portions of fruit and vegetables per day but in actuality are not, that we need to identify correctly. Also the problem of misclassification is likely to be higher if finer divisions than action and non-action are needed, for example between contemplation and preparation stages. Therefore it can be concluded that self-reported intakes of fruit and vegetables should not be used when classifying subjects into the SOC model.

Previous studies have suggested that dietary interventions could benefit from a stage-tailored approach, so that people who are precontemplators need a different approach than do people who may be in the action phase (Laforge, Greene, & Prochaska 1994; Brug, Glanz & Kok 1997). This implication is backed up by the results of the present study, particularly when the FCQ scores within each SOC are considered. When the median FCQ scores were looked at within each stage some obvious relationships could be observed. Women in the maintenance and action phases had significantly higher median health, natural content, weight loss and ethical concern scores than in the other stages ($p<0.01$). Conversely women in the precontemplation phase tended to have the highest median convenience scores and women in the contemplation and preparation phases scored slightly lower on convenience than the

precontemplators, but they were still higher than those who were in action or maintenance ($p<0.01$). This information seems to suggest that if interventions were stage-tailored then those in the non-action phases would benefit from increased information on convenience issues relating to fruit and vegetable consumption, as opposed to being given information on the health benefits of fruit and vegetables. Carlo Diclemente (1991) suggests those individuals in precontemplation about a problem behaviour, in this case not consuming five portions of fruit and vegetables per day, are not even thinking about changing that behaviour and in fact may not even see the behaviour as a problem (DiClemente 1991). Therefore to give advice about exactly how to increase fruit and vegetables in the diet at this stage is going to be inappropriate and is likely to be seen as not relevant to the precontemplator. Instead it might be more appropriate to raise the awareness of the problem itself in order to move these people from the precontemplation phase into the contemplation and action phases. Once into the contemplation and action phases of the SOC model interventions should also include additional information, as previously suggested in this chapter, on more quick and easy ways to incorporate fruit and vegetables into the diet. If interventions are to be targeted towards people in the action phase then more general information around convenience issues should be offered. Practical tips on making it easier to increase fruit and vegetable intakes on a daily basis, perhaps in the form of focus groups to offer support, would be preferential for achievement of the maintenance position.

Although the results of the present study lend support to the use of the SOC model in increasing fruit and vegetable consumption, as a dietary behaviour

change, it is not conclusive and it certainly does not attempt to suggest that the SOC is applicable to all dietary behaviours. Moreover the results show that when classifying subjects within the SOC model self-reports of dietary behaviour should not be relied upon and subjects instead should be classified on the basis of observed behaviour. More research is required, particularly in the form of stage-matched intervention trials, to determine conclusively whether or not the TTM, or more specifically the SOC model, is applicable to eating behaviour (Horwath 1999).

4.6.5. Limitations

Respondents to the study seemed to be a slightly more 'health conscious' group, than the non-responders, being more likely to be non-smokers and vegetarians. However when the median portions of fruit and vegetables consumed per day at baseline were compared, no significant differences were observed. Taking into account that the baseline data were collected between one and four years prior to this study, even if diet had changed dramatically, we are trying to identify factors motivating current high consumers of fruit and vegetables. Therefore a more 'health conscious' group does not pose any real problems. Also due to the large sample size many differences between responders and non-responders are statistically significant despite the actual differences being very small.

Reported fruit and vegetable intakes within the study group were higher than would normally be expected in the UK population. The median intake was 6.7 portions per person per day compared with a UK national average of 310g per

person per day, the equivalent of about 4 portions (Ministry of Agriculture, Fisheries and Food 1999). This may be partly due to the inherent problems of any self-reported data and perhaps, because the sample was chosen to specifically include large numbers of vegetarians and vegans who are likely to consume greater quantities of fruit and vegetables. This was shown to be true in the investigation into lifestyle factors affecting consumption in the UKWCS in Chapter 3.

It is also possible that over-reporting contributed to the high recorded fruit and vegetable intakes. If this is true it may, at least partly, explain some of the relationships with the FCQ measures. For example, women appearing in the highest tertile of fruit and vegetable intakes were found to score higher on the health and natural content dimensions of the FCQ ($p<0.01$). Perhaps these women tended to over-report fruit and vegetable intakes the most because they regarded high intakes as desirable and were more aware of the health benefits of increased fruit and vegetable intakes.

It should be recognised that this particular cohort of women were generally well motivated, well educated and of a relatively high socio-economic status and therefore some of the data may not be applicable to other sub-groups of the population. Nevertheless the data give a useful insight into the food choice motivations of a group of 'health conscious' women with a high fruit and vegetable intake, and leads us to be able to make some suggestions as to what health promotion strategies should be based on.

4.7 Conclusion

In this particular group of women aged between 35 and 69 years the most important motivating factors for food choice, within the high fruit and vegetable consumers, were health and natural content of the food. The findings of the study may help to create effective practical strategies for increasing overall consumption of fruit and vegetables among UK consumers. Any approach should be appropriately targeted towards the intervention population, and this study suggests that the SOC model may be suitable for this behaviour change provided that classification methods are appropriate. Useful strategies would include raising the awareness of the problem in precontemplators, encouraging people at all other stages to experiment more with new varieties of fruit and vegetables, and trying to convince people that fruit and vegetables can be easy to prepare and fun and interesting to cook.

4.1 Summary of Key Findings

- The most important motivating factors for food choice within the high consumers of fruit and vegetables were health and natural content of the food.

- Higher consumers of fruit and vegetables had lower familiarity scores on the FCQ.

- Higher consumers of fruit and vegetables considered convenience less of an issue than did the lower consumers.

- There was a clear relationship between SOC and actual consumption of fruit and vegetables.

- The sensitivity of the SOC assessment tool was very good, however the specificity was poor, leading to misclassification of subjects consuming less than five portions of fruit and vegetables per day.

- Women classified in different stages of change had differing food choice motivations.

- More research is required to conclusively determine whether or not the SOC model is applicable to eating behaviour.

Chapter 5

Blood as a biomarker of fruit and vegetable consumption

5.1 Summary

Due to the inherent problems with dietary assessment methodology, there has been a recent move towards using biomarkers of nutrient intake as the 'Gold Standard'. However there is not necessarily a close relationship between the amount of a nutrient found in the diet and values obtained in biological samples. The aim of the present study was to assess the variability and validity of plasma-based biomarkers of antioxidant vitamin, and fruit and vegetable intake. The subjects were 54 free-living, non-smoking women recruited from participants of the UKWCS, living in Leeds, Wakefield, Huddersfield and Bradford, UK. Two fasting blood samples were taken at two time points, 18 months apart. A 4-day food diary was completed prior to the first blood sample and a 24-hour recall was conducted at the time of the second blood collection. All blood samples were analysed for ascorbic acid and four carotenoids. Associations between antioxidant vitamin intake from all food sources and supplements, as well as fruit and vegetable intake, and plasma levels of the antioxidant vitamins were assessed. Using the 4-day diary positive associations were found between micronutrient intake from *all* food sources and plasma concentrations of ascorbic acid ($p<0.01$) and β-carotene ($p<0.01$). No associations were seen between plasma micronutrient levels and specifically

fruit and vegetable intakes. In general associations between plasma levels and intakes assessed by the 24-hour recall were less marked than those based on the 4-day diary. In conclusion plasma ascorbic acid and β-carotene are good *indicators* of previous vitamin C and β-carotene intake, from all food sources. However caution is required in extrapolating these results to include individual food groups, rich in these vitamins, such as fruit and vegetables. The results imply that the practice of using plasma biomarkers simply as a *proxy* measure of intake of specific dietary components is not valid and emphasise that plasma biomarkers are not simply a reflection of dietary intake but also of a number of physiological processes. Biomarkers in nutrition epidemiological studies are however useful to measure nutrient status at the tissue level.

5.2 Introduction and study rationale

In chapter 1 the health benefits of including fruit and vegetables in the diet were discussed at length. One of the biggest challenges in nutritional epidemiology is correctly measuring dietary intake and yet this is a fundamental part of assessing diet-disease relationships. Throughout this thesis there are examples of the difficulties in accurately measuring fruit and vegetable intakes. In Chapter 3 reported fruit and vegetable intakes were assessed using a food frequency questionnaire, and in Chapter 4 intakes were measured using a 4-day food diary. The measured fruit and vegetable intakes, by both methods, within the study population were far higher than would normally be expected in the UK population, and reasons for this have been discussed within the relevant thesis chapters. However there is no doubt that this will be at least partly due to over-reporting of fruit and vegetable consumption by the subjects.

When studying relationships between diet and disease, reliable and valid methods for dietary assessment are essential. Traditionally methods of assessing dietary exposure have been subjective, employing tools such as the food diary, food frequency questionnaire and 24-hour recall. However these methods are all prone to substantial errors from reporting, portion size estimation and inaccurate recall. In relation to estimation of fruit and vegetable intakes it could easily be assumed that, because they are discrete items, measurement of consumption would be easy. However, studies have shown that food frequency questionnaires have a tendency to overestimate fruit and vegetable consumption. The more questions asked the greater the tendency to overestimate (Krebs-Smith et al. 1995). This overestimation of fruit and

vegetable consumption has also been observed within the UKWCS. Due to the known over-estimation by the FFQ, the questionnaire sent out to UKWCS subjects also included cross-check questions. Cross-check questions were in the form: 'How many servings of fruit and fruit containing dishes do you eat per week?' A similar question was asked for vegetables. Subjects were asked to exclude potatoes in their estimate of vegetable servings per week and to exclude dried fruit and fruit juice in their estimate of fruit servings per week. It was found that when cross checking frequency of fruit consumption, 63% of respondents recorded twice as many fruits using the FFQ compared to the cross-check question (Calvert et al. 1997). It follows then that if the consumption of fruit and vegetables cannot be estimated accurately, nutrient intake estimations are likely to be just as inaccurate, if not more so.

In order to explore further the link between fruit and vegetable consumption and disease risk it is essential that intake is measured as accurately as possible. The measurement errors associated with traditional dietary assessment methods could have a serious effect on disease risk assessment. The nature of this effect will depend on the form the measurement error takes. Given the continuing problems with the accuracy and validity of dietary intake assessment, a reliable biomarker of fruit and vegetable, and antioxidant vitamin, intake would be a useful tool in epidemiological research, as indeed would biomarkers of other dietary factors, offering an alternative, more objective measure, compared to questionnaire-based diet assessment (Wild et al., 2001). Whilst the above approach has considerable promise there may not be a close relationship between the amount of a nutrient found in the diet and levels found

in biological fluid (Bates & Thurnham 1997). This is due to many potentially inter-related factors including homeostatic mechanisms, rates of utilisation and metabolism, storage and mechanisms of mobilisation (Nelson 1998). In addition, although classifying an individual's vitamin intake by using a single plasma measurement would be valuable, high intra-individual, relative to inter-individual, variability may cause misclassification of a number of individuals if a single measure is used (van Kappel et al 2001). A single plasma measure needs to be adequate to characterise an individual's long-term level if it is to be of any use in epidemiological studies. Despite this there has been a recent move towards using biomarkers as the 'Gold Standard' with which other dietary assessment methods are compared. The validity and variability of using biomarkers of dietary intake needs to be assessed to ensure that this practice is valid. Although a number of studies have addressed this point they have tended to focus on feeding studies where the biomarkers are measured before and after supplementation, or manipulation of normal diets (Martini et al. 1995; Hof-KH et al. 1999; McEligot et al. 1999). Fewer studies have investigated the relationships between dietary intake and levels of biomarkers in free-living subjects consuming their habitual diets.

5.3 Aims and objectives

The aim of this study was to investigate the relationship between intake of antioxidant vitamins, from both dietary and supplementary sources, and blood levels of antioxidant vitamins in a community-based sample of women.

Objectives;

- To evaluate the validity of plasma antioxidant levels as biomarkers of intakes of antioxidant vitamins, and fruit and vegetables.
- To explore the variability of plasma antioxidant levels, in particular intra-person seasonal variation.

5.4 Methods

5.4.1. Sample

The population for study was drawn from the UKWCS. In 1997 the UKWCS: Non Starch Polysaccharide (NSP) sub-study (unpublished) was conducted on 264 of the UKWCS participants living in the Yorkshire area. Within this sub-study samples of blood were collected and participants were asked whether they would be willing to give further samples of blood in the event of future research. Those who gave a positive response, and lived in the Leeds, Wakefield, Huddersfield and Bradford areas, were invited to take part in the present study.

Power calculations were based on data available from a previous study of plasma micronutrients (Cade et al. 2001). Using Monte Carlo methods in Stata 7 (Statacorp 2001), adequate power to detect a range of suitably weak

relationships between micronutrient intakes and plasma concentrations can be achieved with 60 subjects. All micronutrient concentrations were log transformed, and relationships are therefore expressed in terms of percentages. 60 subjects would give over 90% power to detect just a 15% increase in plasma ascorbic acid concentrations (e.g. from 10μg/ml to 11.5μg/ml) associated with a 100% increase (a doubling) in vitamin C intake, (e.g. from 80mg to 160mg). Also 60 subjects would give 90% power to detect a 20% increase in plasma β-carotene concentrations (e.g. from 500nmol/l to 600nmol/l) associated with a 100% increase (a doubling) in β-carotene intake (e.g. from 1000μg to 2000μg). Any larger response to change in intake would be detectable with greater power. The associations are presented in terms of a percentage increase in plasma concentration with a doubling (100%) in intake. This would be a moderately large increase in intake, however not unachievable and chosen for clarity of presentation. For smaller increases in intake, the corresponding increase in plasma concentrations would be proportionately reduced, though the statistical significance would be unchanged.

5.4.2. Ethical considerations

Ethical committee approval was gained from all four of the relevant Local Research Ethics Committees (LRECs).

5.4.3. Research design and data collection

As part of the UKWCS: NSP sub-study participants had already completed a four-day food diary (see Appendix C) and one blood sample had been taken on the day immediately following completion of the diary. Subject information

sheets (see Appendix D) and consent forms (see Appendix E) were sent by post to all 143 eligible ladies identified for the present study. Once consent was given the subjects were contacted and an appointment was made for a home visit to be carried out. The home visit was deliberately carried out eighteen months after they had given their first blood sample as part of the UKWCS: NSP sub-study. This was organised to provide two blood samples from each participant taken at two time points, eighteen months apart to maximise seasonal variation. Subjects were sent reminder cards that asked them to fast from midnight the night before the home visit took place (see Appendix F). At the home visit a second consent form was completed (see Appendix G), allowing the second blood sample to be taken. Anthropometric measurements were collected including height and weight, and a 24-hour dietary recall was conducted (see Appendix H). Participants were also asked about their smoking habit, use of prescribed drugs, general health status and nutritional supplement use.

5.4.4. Experimental techniques

Both blood samples were collected from subjects at home after an overnight fast. Samples were collected into lithium heparin (8mls) tubes and placed in a dark cool box for transportation back to the laboratories. Samples were then separated and prepared for storage within 2 hours of collection. All samples were stored at -70°C. All laboratory analyses were carried out by The Molecular Epidemiology Unit, School of Medicine, University of Leeds and details of techniques can be found in Appendix I.

5.4.5. Data analysis

Nutrient intakes were calculated, from both the four-day food diary and the 24-hour recall, using the dietary assessment package COMP-EAT (Carlson Bengston Consultants Ltd. 2001). This package uses standard food tables to calculate nutrient intakes (Royal Society of Chemistry and Ministry of Agriculture 1991). However these food tables are too incomplete to assess intakes of lutein, cryptoxanthin and lycopene due to missing data in the tables. For the purpose of this statistical analysis, values for carotenoid equivalents were used in place of individual carotenoid data for lutein, cryptoxanthin and lycopene.

Using the four-day food diary and the 24-hour recall data the total amount of fruit and vegetables consumed per person were calculated in grams per day at the two different time points. This daily figure included fruit and vegetables from composite dishes but excluded potatoes, which in dietetic terms are classed as a starchy staple rather than a vegetable (Williams 1995). Standard portion sizes were employed for calculation of amounts consumed using Helen Crawley's book of food portion sizes (Crawley 1994). Fruit and vegetable juices were calculated separately. All analyses were carried out using Statistical Package for the Social Sciences (SPSS) version 9.0 (SPSS Inc 1998). All tests were carried out at both time points. The first set of results were compared with the four-day food diary data and the second blood results with the 24-hour recall. All variables were log transformed to ensure statistical assumptions were valid.

The subjects were divided into tertiles (referred to as Tertiles 1-3) according to their fruit and vegetable consumption. Tertile 1 comprised those with the lowest intakes and Tertile 3 represented the consumers with the highest intakes. To test for linear trends of plasma micronutrient levels across tertiles of fruit and vegetable consumption analysis of variance was employed. Linear regression was used to investigate the univariate relationships between blood antioxidant vitamin concentrations and dietary intake of antioxidants from food sources, supplements and fruit and vegetable intakes. Multiple regression was then employed to investigate the same relationships adjusting for age, body mass index (BMI), total calorific intake including alcohol, and dietary and supplementary antioxidant vitamin intake as appropriate. Potential threshold effects were investigated by treating individual antioxidant vitamin intakes as categorical variables in the regression models, and calculating separate effect estimates for each level of antioxidant vitamin intake.

To investigate variability of the plasma antioxidant vitamins Bland-Altman tests were employed to determine the degree of agreement between the two blood measures (Bland & Altman 1986). Changes between quartiles of antioxidant intakes, over 18 months, were investigated using crosstabs. Finally the effect of seasonality on the blood samples was investigated using paired T-tests between two halves of the year.

5.5 Results

5.5.1. Response rate

Out of the 143 eligible women contacted 3 had moved house and 1 had died.105 women consented to taking part in the study and of these 36 could not be found a convenient appointment time in the correct season. 69 home visits were completed and full data were collected on 64 women. This gave a response rate of 62%. However for the purpose of this analysis 9 women were excluded because they were smokers. Smokers were excluded because not only have they been found to consume less fruit and vegetables but they also absorb less of the antioxidant nutrients from foods and would therefore confound the results. One other woman was also excluded because her results excessively skewed the data as a result of an extremely high intake of supplemental beta-carotene. Final analysis was therefore carried out on 54 non-smoking women.

5.5.2. Basic descriptives

The basic characteristics of the sample, at both time points can be seen in Table 5.1. At the first collection (T_1) the mean age was 54.2 years and at the second collection (T_2) the mean age was 55.7 years. Mean daily consumption of all fruits and vegetables, including juices were 479g at T_1 and 451g at T_2. All mean plasma levels of vitamins were within the normal ranges at both time points. Intakes of dietary vitamin C, β-carotene and carotenoid equivalents were all higher at T_1 than at T_2. Overall fruit and vegetable intakes remained fairly stable over time from T1 to T2. However micronutrient intakes varied greatly, particularly β-carotene. This could be partly due to changes in other food

sources of micronutrients, or more likely because of changes in the types and diversity of fruit and vegetables consumed between the two time points.

Table 5.1 Characteristics of the sample assessed at T_1 using the 4-day food dairy and T_2 using the 24-hour recall (n=54)

Variables	T_1 Mean (95% CI)	T_2 Mean (95% CI)	*p*-Value
Age (years)	54.2 (51.8 to 56.7)	55.7 (53.2 to 58.2)	<0.01
Body Mass Index (kg/m^2)	25.9 (24.4 to 27.4)	25.3 (23.9 to 26.6)	0.03
Energy Intake (Kcal)	1874 (1752 to 1997)	1729 (1587 to 1871)	0.03
Vegetable Intake / Day (g)	200 (174 to 226)	173 (144 to 202)	0.12
Fruit Intake / Day (g)	197 (156 to 237)	202 (146 to 258)	0.86
Fruit Juice Intake / Day (g)	82 (58 to 106)	76 (44 to 108)	0.72
Plasma Ascorbic Acid (μg/ml)*	10.8 (9.6 to 12.1)	12.1 (11.2 to 13.0)	0.02
Plasma β-carotene (nmol/l)*	495.3 (420.9 to 582.9)	461.9 (385.3 to 553.6)	<0.01
Plasma Lutein (nmol/l)*	556.6 (501.2 to 618.2)	525.6 (466.8 to 591.8)	0.19
Plasma Cryptoxanthin (nmol/l)*	258.9 (219.1 to 305.9)	295.6 (241.6 to 361.5)	0.11
Plasma Lycopene (nmol/l)*	469.2 (396.9 to 554.8)	404.8 (330.4 to 496.1)	0.02
Dietary Vitamin C / Day (mg)*	100.7 (86.1 to 117.7)	76.7 (61.2 to 96.2)	0.02
Dietary β-carotene / Day (μg)*	1635.0 (1338.0 to 1998.0)	460.8 (221.5 to 958.6)	<0.01
Dietary Carotene Equivs / Day (μg)*	2316.7 (1955.3 to 2744.9)	1281.3 (944.6 to 1738.0)	<0.01

5.5.3. Linear trends analysis

Linear trends in plasma micronutrient levels were investigated over tertiles of fruit and vegetable consumption and the results are presented in Table 5.2. At T_1 using the four-day diary, ascorbic acid plasma levels did increase over the tertiles from Tertile 1 to Tertile 3, however the actual mean differences between the tertiles were not statistically significant. At T_2, using the 24-hour recall method of assessment, plasma ascorbic acid levels again increased over the tertiles of fruit and vegetable consumption and the mean differences between the tertiles were statistically significant ($p<0.01$). All plasma carotenoids, *excluding* β-carotene, showed statistically significant linear trends across the tertiles of fruit and vegetable consumption at T_1, and all plasma carotenoids, *including* β-carotene, showed statistically significant trends at T_2.

Table 5.2 Mean fruit and vegetable intakes and plasma micronutrient levels within each tertile of fruit and vegetable consumption, including fruit juice, as assessed by the 4-day food diary at T_1, and by the 24-hour recall at T_2 (n=54)

	Geometric means (95% C.I.)							
	T_1				T_2			
	Tertile 1	Tertile 2	Tertile 3	*p*	Tertile 1	Tertile 2	Tertile 3	*p*
Mean f&v intake (g)	241	435	743		160	404	786	
Ascorbic Acid (μg/ml)	9.6 (7.5 to 12.3)	10.7 (8.5 to 13.5)	12.1 (10.5 to 14.1)	0.11	10.4 (9.0 to 12.0)	12.0 (10.7 to 13.4)	14.1 (12.9 to 15.4)	<0.01
β-carotene (nmol/l)	394.1 (302.5 to 513.3)	553.4 (392.1 to 781.1)	546.9 (427.6 to 699.2)	0.11	360.3 (245.8 to 528.1)	440.7 (343.4 to 565.6)	620.6 (458.4 to 840.2)	0.01
Lutein (nmol/l)	492.2 (399.3 to 606.7)	532.3 (447.5 to 633.1)	655.4 (550.9 to 779.8)	0.03	441.4 (346.5 to 562.2)	496.4 (411.0 to 599.4)	662.9 (560.0 to 784.7)	<0.01
Cryptoxanthin (nmol/l)	215.2 (149.6 to 309.6)	246.2 (182.8 to 331.5)	325.1 (260.1 to 406.3)	0.05	239.7 (169.5 to 338.8)	270.8 (182.9 to 400.8)	397.9 (285.6 to 554.3)	0.04
Lycopene (nmol/l)	492.2 (399.3 to 606.7)	532.3 (447.5 to 633.1)	655.4 (550.9 to 779.8)	0.03	281.1 (163.9 to 482.3)	457.6 (385.6 to 543.0)	515.7 (410.0 to 648.8)	0.01
Total Carotenoids (nmol/l)	1609.9 (1339.8 to 1934.3)	1993.2 (1607.8 to 2470.8)	2138.8 (1840.3 to 2485.7)	0.03	1452.4 (1113.4 to 1894.7)	1764.6 (1490.5 to 2088.9)	2304.9 (1876.9 to 2830.2)	<0.01

5.5.4. Regression analyses

Linear regression models were employed to describe the impact of micronutrient, and fruit and vegetable intakes, on plasma micronutrient levels and both unadjusted (Tables 5.3 and 5.5) and adjusted (Tables 5.4 and 5.6) results are presented. In this analysis fruit intakes and vegetables intakes were treated as separate variables.

Table 5.3 Unadjusted results from the linear regression model describing the impact of micronutrient, and fruit and vegetable, intakes, as assessed by the 4-day food diary at T_1, on plasma micronutrient levels (n=54)

	% increase in blood nutrient concentrations, and 95% C.I., associated with a doubling of dietary intake unadjusted for other factors.									
	Ascorbic acid	***p*-value**	**β-carotene**	***p*-value**	**Lutein**	***p*-value**	**Cryptoxanthin**	***p*-value**	**Lycopene**	***p*-value**
Intake from food sources	25.4 (10.3 to 67.2)	<0.01	27.3 (10.5 to 46.6)	<0.01	8.5 (-3.5 to 22.0)	0.17	15.8 (-3.8 to 39.4)	0.12	20.8 (0.6 to 45.1)	0.04
Intake from supplements	1.7 (-0.2 to 3.7)	0.08	4.5 (0.5 to 8.7)	0.03	1.5 (-1.1 to 4.2)	0.25	0.3 (-3.8 to 4.8)	0.87	-5.8 (-9.5 to –2.1)	<0.01
Vegetable intake	9.9 (-6.1 to 28.6)	0.24	20.6 (-2.8 to 49.7)	0.09	11.2 (-3.3 to 27.9)	0.14	9.9 (-12.3 to 37.7)	0.41	56.4 (29.1 to 89.3)	<0.01
Fruit intake	8.5 (-0.3 to 18.1)	0.06	5.2 (-6.8 to 18.7)	0.41	8.2 (0.3 to 16.6)	0.04	10.0 (-2.7 to 24.2)	0.12	17.0 (4.0 to 31.5)	0.01
Vegetable juice intake	1.5 (-3.3 to 6.5)	0.54	5.8 (-0.9 to 13.0)	0.09	2.0 (-2.3 to 6.5)	0.36	1.8 (-4.9 to 9.1)	0.60	4.9 (-2.0 to 12.3)	0.16
Fruit juice intake	1.8 (0.0 to 3.7)	0.05	1.6 (-1.0 to 4.3)	0.21	0.6 (-1.0 to 2.3)	0.45	1.2 (-1.4 to 4.0)	0.37	-1.0 (-3.5 to 1.7)	0.47

Table 5.4 Results from the linear regression model describing the impact of micronutrient and fruit and vegetable intakes, as assessed by the 4-day food diary at T_1, on plasma micronutrient levels (n=54)

Adjusted for age, BMI, total calorific intake including alcohol and dietary, and supplementary, antioxidant vitamin intake as appropriate.

	% increase in blood nutrient concentrations, and 95% C.I., associated with a doubling of dietary intake.									
	Ascorbic acid	***p*-value**	**β-carotene**	***p*-value**	**Lutein**	***p*-value**	**Cryptoxanthin**	***p*-value**	**Lycopene**	***p*-value**
Intake from food sources	25.8 (8.3 to 46.1)	<0.01	30.9 (15.3 to 48.6)	<0.01	6.3 (-5.6 to 19.8)	0.30	9.6 (-9.8 to 33.1)	0.35	5.7 (-11.2 to 26.0)	0.53
Intake from supplements	1.8 (-0.1 to 3.4)	0.06	6.5 (3.1 to 10.0)	<0.01	2.1 (-0.5 to 4.8)	0.11	0.9 (-3.3 to 5.3)	0.66	-4.7 (-8.3 to –1.0)	0.01
Vegetable intake	-7.7 (-26.3 to 15.5)	0.47	15.7 (-13.1 to 54.1)	0.31	-2.7 (-20.2 to 18.6)	0.78	-16.2 (-39.8 to 16.6)	0.29	31.0 (-1.2 to 74.0)	0.06
Fruit intake	8.5 (-3.3 to 21.8)	0.16	-0.6 (-14.3 to 15.2)	0.93	8.9 (-1.7 to 20.7)	0.10	8.4 (-8.6 to 28.6)	0.34	-0.3 (-13.9 to 15.4)	0.97
Vegetable juice intake	0.9 (-3.8 to 5.9)	0.70	4.9 (-1.2 to 11.4)	0.11	1.4 (-2.7 to 5.7)	0.49	2.0 (-4.7 to 9.4)	0.56	2.5 (-3.4 to 8.7)	0.41
Fruit juice intake	1.6 (-0.3 to 3.5)	0.10	0.6 (-1.9 to 3.2)	0.62	0.1 (-1.6 to 1.8)	0.95	0.7 (-2.2 to 5.6)	0.63	-1.0 (-3.5 to 1.5)	0.40

Table 5.5 Unadjusted results from the linear regression model describing the impact of micronutrient and fruit and vegetable intakes, as assessed by the 24-hour recall at T_2, on plasma micronutrient levels (n=54)

	% increase in blood nutrient concentrations, and 95% C.I., associated with a doubling of dietary intake unadjusted for other factors.									
	Ascorbic acid	***p*-value**	**β-carotene**	***p*-value**	**Lutein**	***p*-value**	**Cryptoxanthin**	***p*-value**	**Lycopene**	***p*-value**
Intake from food sources	11.7 (5.9 to 17.7)	<0.01	5.5 (0.8 to 10.4)	0.02	10.1 (2.7 to 18.1)	<0.01	0.0 (-12.0 to 13.5)	0.99	7.7 (-5.1 to 22.3)	0.25
Intake from supplements	0.5 (-0.6 to 1.7)	0.38	3.6 (-3.0 to 10.6)	0.29	0.9 (-3.4 to 5.3)	0.69	-1.9 (-8.9 to 5.5)	0.60	-1.0 (-8.0 to 6.7)	0.80
Vegetable intake	1.7 (-0.2 to 3.6)	0.08	3.5 (-1.4 to 8.5)	0.16	3.8 (0.7 to 7.0)	0.02	-0.6 (-5.9 to 4.9)	0.82	5.2 (-0.1 to 11.0)	0.06
Fruit intake	1.8 (0.4 to 3.2)	0.01	4.9 (1.3 to 8.7)	<0.01	1.5 (-0.9 to 4.0)	0.22	2.9 (-1.2 to 7.2)	0.17	4.7 (0.6 to 9.0)	0.03
Fruit juice intake	0.9 (-0.1 to 2.0)	0.07	2.5 (-0.1 to 5.3)	0.06	2.2 (0.6 to 3.9)	0.01	3.3 (0.4 to 6.3)	0.03	1.9 (-1.1 to 5.0)	0.21

Table 5.6 Results from the linear regression model describing the impact of micronutrient and fruit and vegetable intakes, as assessed by the 24-hour recall at T_2, on plasma micronutrient levels (n=54)

Adjusted for age, BMI, total calorific intake including alcohol and dietary, and supplementary, antioxidant vitamin intake as appropriate.

	% increase in blood nutrient concentrations, and 95% C.I., associated with a doubling of dietary intake.									
	Ascorbic acid	***p*-value**	**β-carotene**	***p*-value**	**Lutein**	***p*-value**	**Cryptoxanthin**	***p*-value**	**Lycopene**	***p*-value**
Intake from food sources	10.7 (4.3 to 17.5)	<0.01	6.4 (1.4 to 11.6)	0.01	13.3 (5.0 to 22.3)	<0.01	1.1 (-12.8 to 17.1)	0.89	15.3 (2.0to 31.6)	0.04
Intake from supplements	0.3 (-0.7 to 1.3)	0.53	2.3 (-3.8 to 8.8)	0.46	0.5 (-3.2 to 4.3)	0.80	-2.8 (-9.7 to 4.5)	0.43	-1.8 (-8.0 to 4.8)	0.58
Vegetable intake	1.8 (-0.1 to 3.8)	0.07	3.3 (-2.1 to 9.1)	0.22	4.4 (1.0to 7.8)	0.01	-0.5 (-6.3 to 5.6)	0.87	5.5 (0.1to 11.3)	0.05
Fruit intake	1.3 (0.0to 2.7)	0.05	4.0 (0.3 to 7.8)	0.04	0.6 (-1.6 to 2.8)	0.58	2.9 (-1.1 to 7.1)	0.16	3.7 (0.1to 7.5)	0.05
Fruit juice intake	0.4 (-0.6 to 1.4)	0.40	1.8 (-1.0 to 4.7)	0.20	1.6 (0.0 to 3.4)	0.05	4.0 (0.8 to 7.3)	0.01	2.0 (-0.8 to 4.8)	0.16

Using the four-day diary method of dietary assessment, and after adjustment for age, BMI and total calorific intake including alcohol, few dietary intake parameters produced a change in plasma nutrient levels of greater than 10% (Table 5.4). Of those that did, plasma ascorbic acid concentrations rose 26% when total vitamin C intake, from *all* food sources, was doubled ($p<0.01$), however this association was not mirrored when fruit intakes, or vegetable intakes, were investigated individually. When total β-carotene intake, from *all* food sources, was doubled a corresponding 31% increase in plasma β-carotene was observed ($p<0.01$). This association was also seen with vegetable intakes, so that when vegetable intakes were doubled a 16% rise in plasma β-carotene was observed, although this effect did not reach statistical significance ($p=0.31$).

In general the impact of a doubling of intakes on plasma micronutrient levels, based on the 24-hour recall data (Tables 5.5 and 5.6), were less marked than when based on the 4-day diary data described above. For example, when total vitamin C intake from *all* food sources doubled the corresponding increase in plasma ascorbic acid concentration was only 11% ($p<0.01$). In the analysis on the 24-hour recall data when carotenoid equivalents, from *all* food sources doubled, plasma lutein concentrations rose by 13% ($p<0.01$) and plasma lycopene concentrations rose by 15% ($p=0.04$). Although in the analysis of the 24-hour recall data more statistically significant associations were seen between fruit intakes and vegetable intakes with plasma micronutrient concentrations, than with the 4-day diary, no changes in plasma

micronutrient concentrations greater than 10% were observed in association with a doubling of dietary intake.

These findings are consistent with the results seen in the linear trend analysis, and showed that although some of the trends were statistically significant, for the majority, the actual sizes of the effects were small. In both sets of analyses, at T_1 and T_2, no increases in plasma micronutrients of greater than 10% were observed with a doubling of supplemental intakes.

5.5.5. Threshold effects

Potential threshold effects were investigated by treating individual antioxidant vitamin intakes as categorical variables in the regression models, and calculating separate effect estimates for each level of antioxidant vitamin intake. A threshold effect was observed for ascorbic acid and this effect occurred at intakes of around 60mg/day. No other threshold effects were detected for any of the other vitamins.

5.5.6. Variability of blood measures

Bland-Altman plots were used to assess variability in plasma micronutrient levels between T_1 and T_2 (Figures 5.1 – 5.5). All plasma micronutrient measures showed extremely poor agreement between the two time points. The mean difference (range in parentheses) between the two time points (T_2 – T_1) for ascorbic acid was 10.5% (-45.1 to 122.6%), β-carotene, –9.5% (-63.2% to 122.6%), lutein, –9.5% (-50.3% to 64.9%), cryptoxanthin, 10.5% (-66.7% to 266.9%) and lycopene, –9.5% (-63.2% to 122.6%).

Figure 5.1 Bland-Altman plot to assess variability in plasma ascorbic acid levels between T_1 and T_2

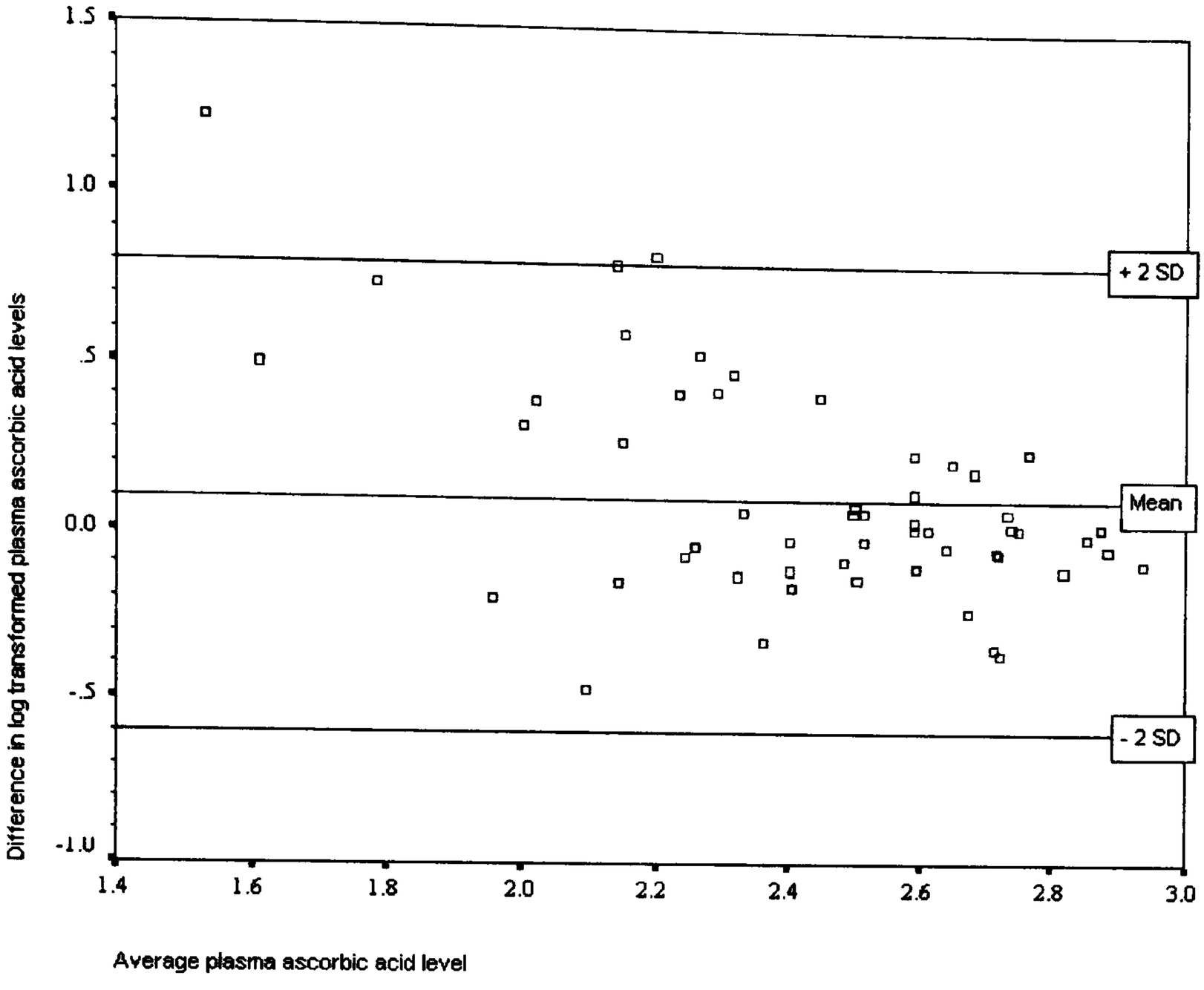


Figure 5.2 Bland-Altman plot to assess variability in plasma beta carotene levels between T_1 and T_2

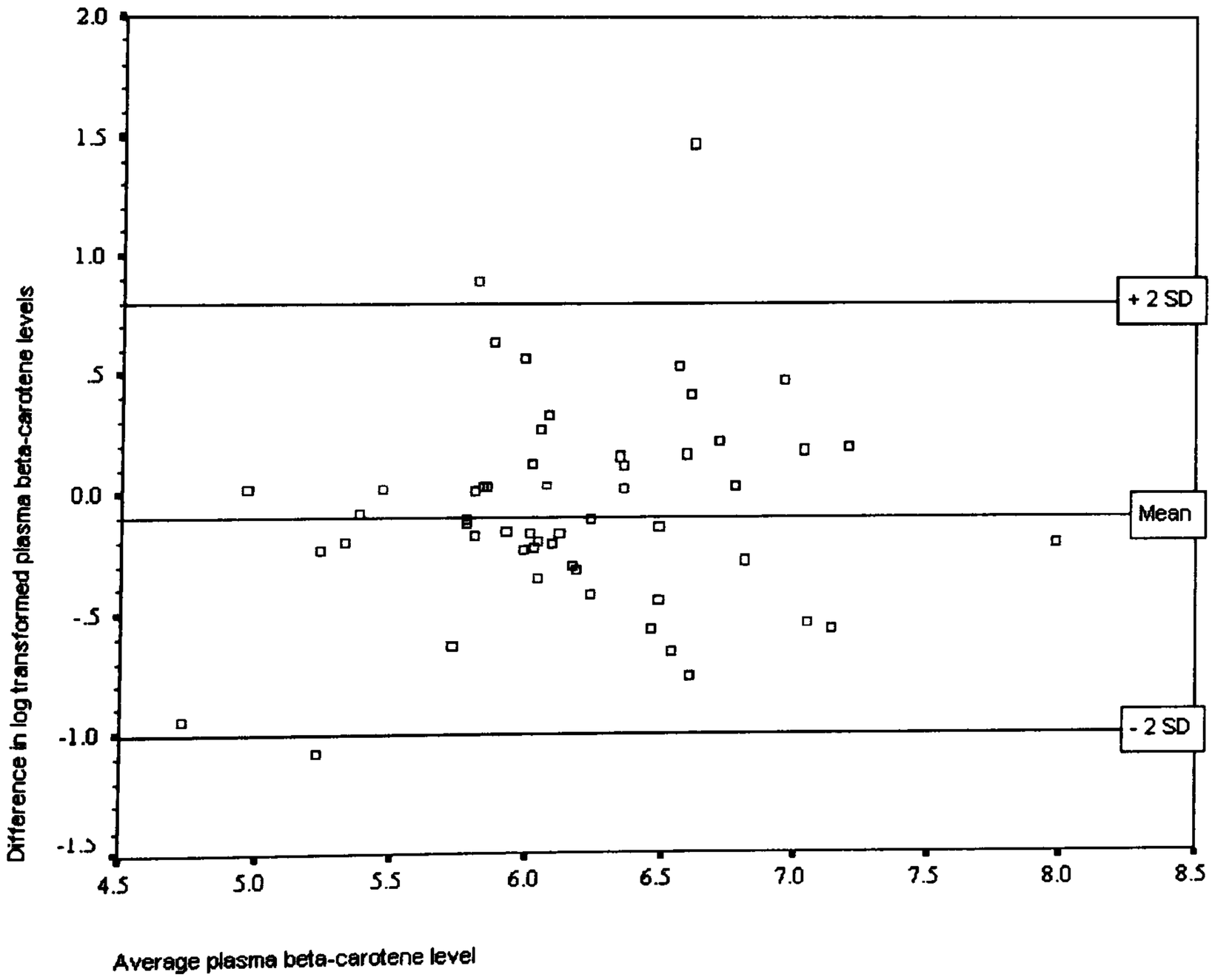


Figure 5.3 Bland-Altman plot to assess variability in plasma lutein levels between T_1 and T_2

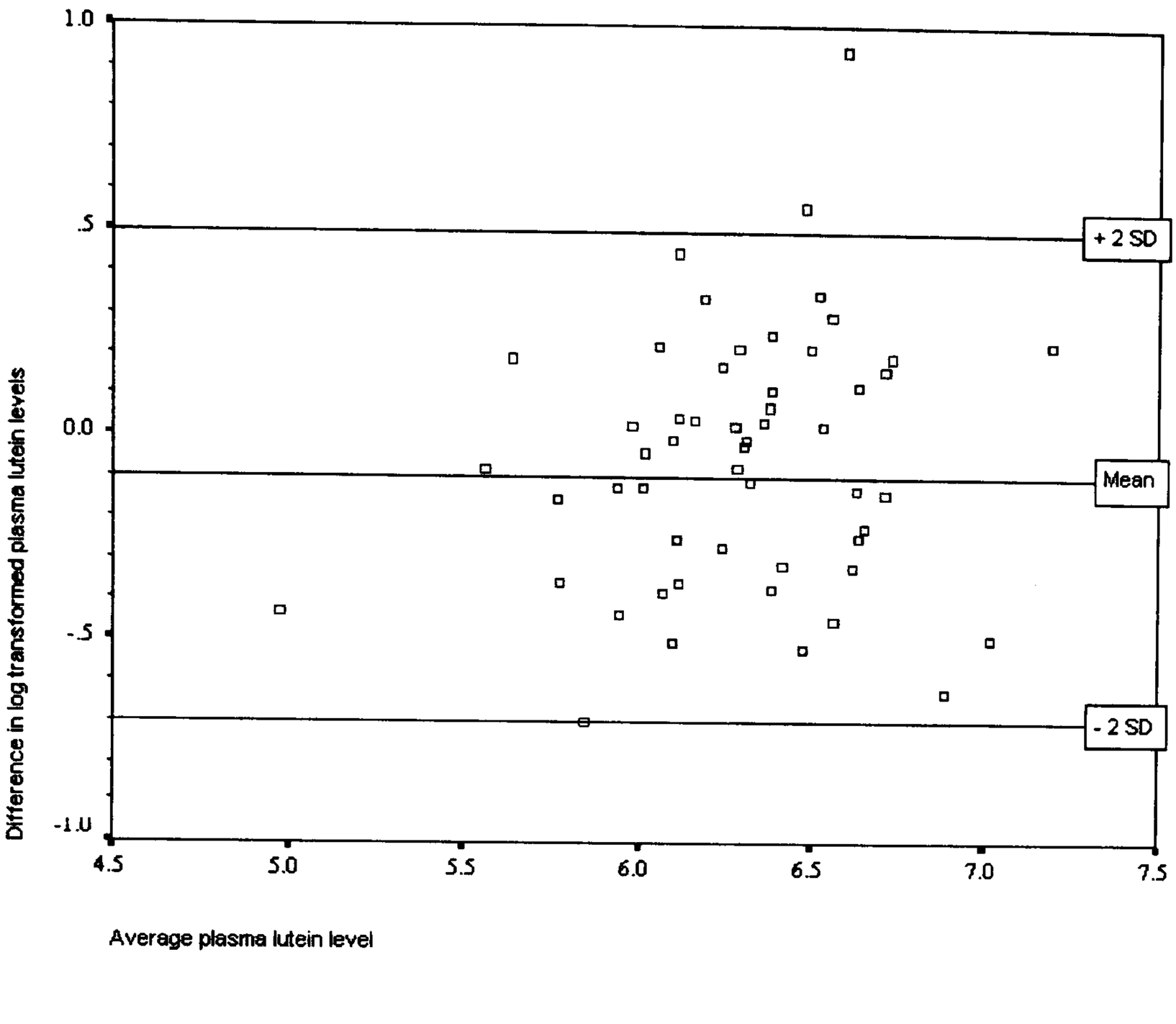


Figure 5.4 Bland-Altman plot to assess variability in plasma cryptoxanthin levels between T_1 and T_2

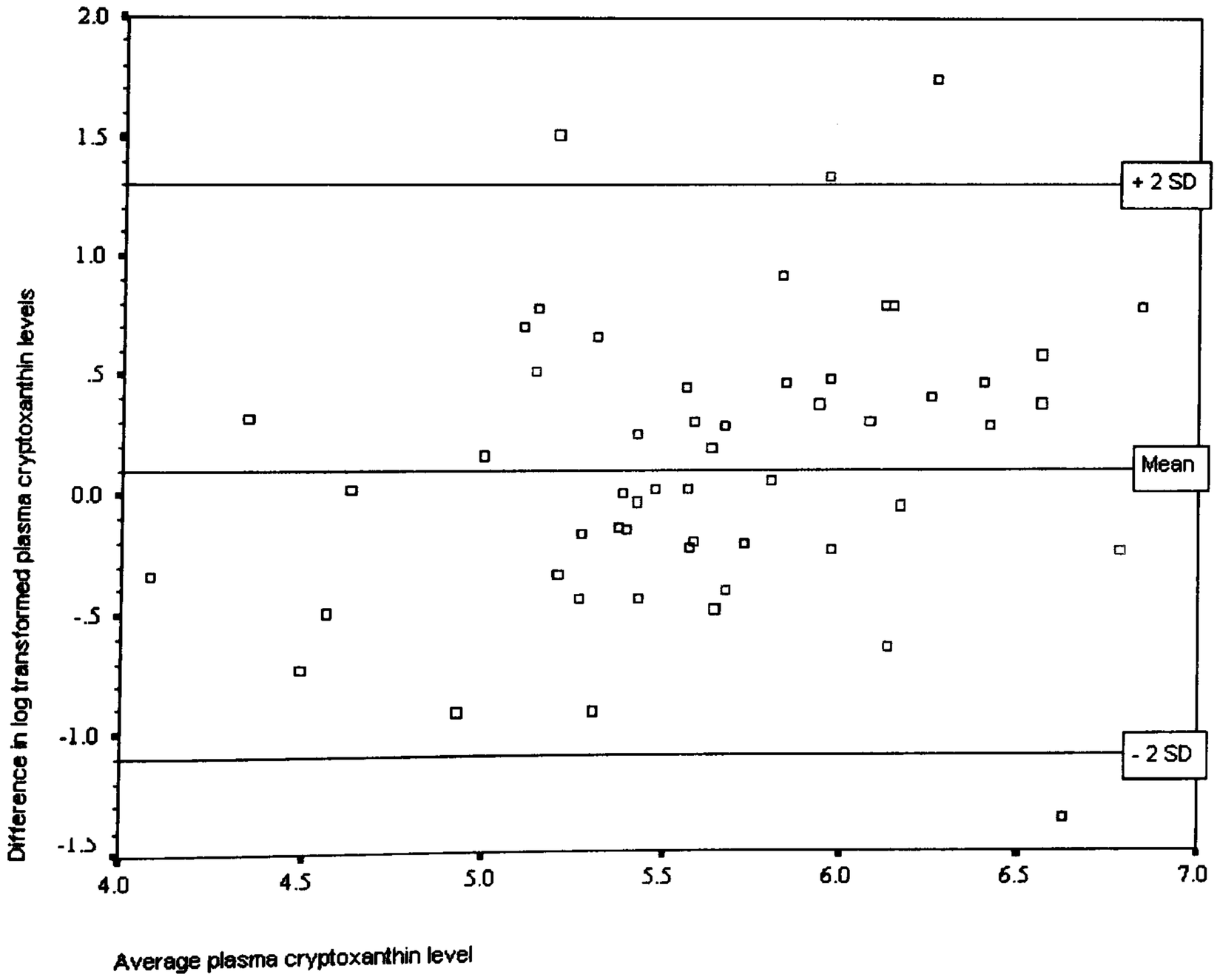
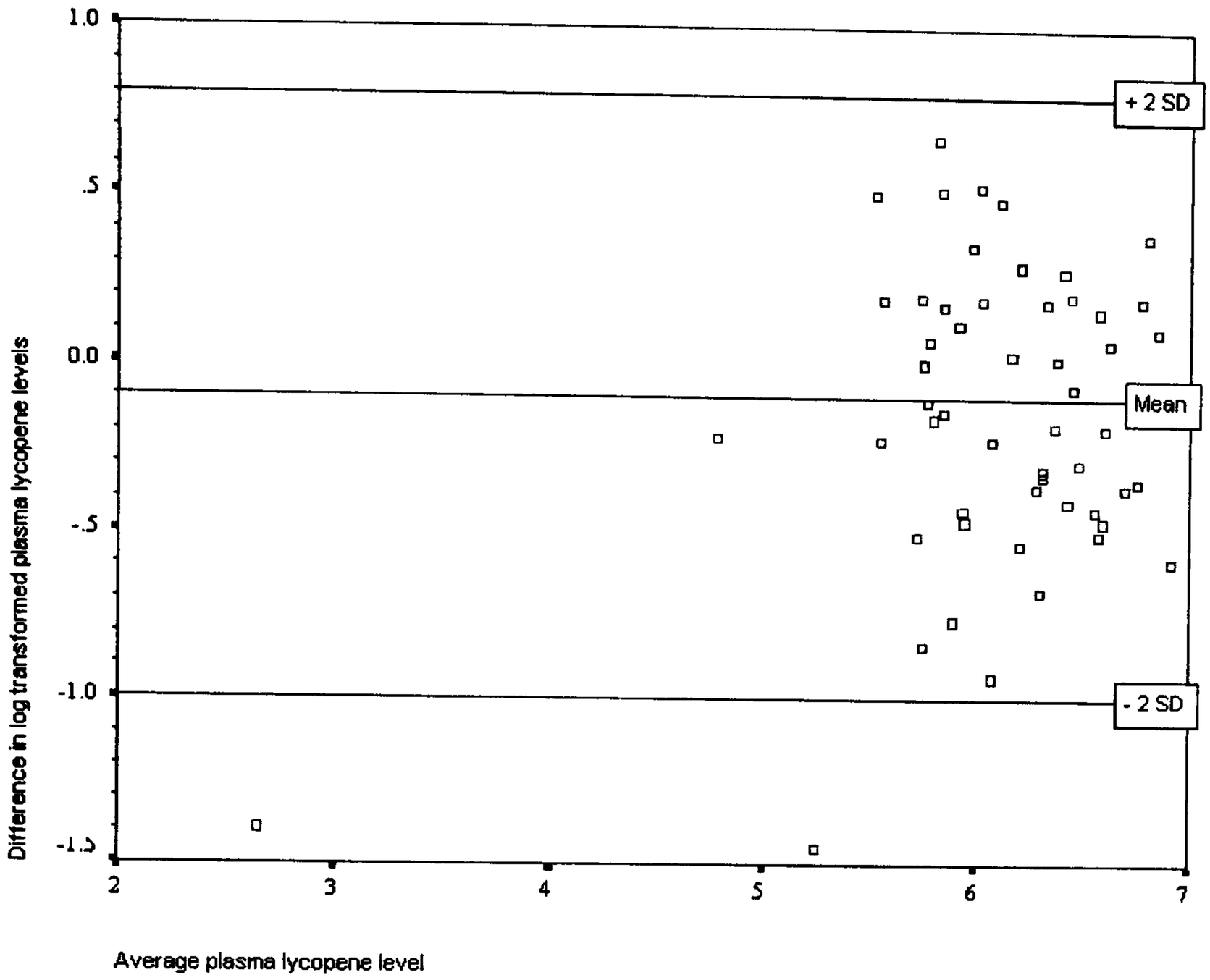


Figure 5.5 Bland-Altman plot to assess variability in plasma lycopene levels between T_1 and T_2



In relation to variability changes in an individual's ranking over quartiles were also investigated between T_1 and T_2 (Table 5.7).

Table 5.7 Percentage of individuals moving between quartiles of antioxidant vitamin intake between T_1 and T_2.

	Percentage of individuals moving between quartiles of intake		
	Decreased	**Stayed the same**	**Increased**
Ascorbic acid	24	52	24
β-carotene	26	56	19
Lutein	31	39	30
Cryptoxanthin	31	43	26
Lycopene	32	35	33

The effect of seasonality on the blood samples was investigated using paired T-tests and these results can be seen in Table 5.8. It should be noted here that T_1 and T_2 do not map directly to summer and winter plasma measures. Plasma measurements taken at T_1, could have been taken either in the summer or the winter months, and therefore T_2 was taken 18 months after T_1, to ensure that the second blood sample was representative of a different seasonal time-point. The only micronutrient to have an observed difference in mean summer and winter plasma levels was lutein. Plasma lutein levels were, on average, 11% higher when collected during the summer months in comparison to collections taken during the winter months ($p<0.01$).

Table 5.8 Plasma micronutrient level comparison by season

	% difference between summer and winter plasma levels (95% C.I.)		**P-Value**
Ascorbic acid (μg/ml)	0.2	(-8.9 to 10.1)	0.97
β-carotene (nmol/l)	4.8	(-7.1 to 18.3)	0.44
Lutein (nmol/l)	11.3	(2.4 to 20.9)	0.01
Cryptoxanthin (nmol/l)	-3.5	(-18.4 to 14.1)	0.67
Lycopene (nmol/l)	-4.4	(-16.0 to 8.8)	0.49

5.6. Discussion

The results of this study provide useful information concerning the relationships between dietary intakes and plasma levels of the antioxidant vitamins, using two different dietary assessment methods, namely the four-day food diary and the 24-hour recall.

As in the previous chapters, mean reported fruit and vegetable intakes were particularly high at both time points within this study, far higher than might be expected in the average UK population. Mean daily consumption of all fruits and vegetables, including juices were 479g per person at T_1 and 451g per person at T_2, compared to a UK national average of 310g per person per day (Ministry of Agriculture, Fisheries and Food 1999). This may be partly due to the inherent problems of any self-reported data, and probably, because the sample was chosen to specifically include large numbers of vegetarians and vegans. However if plasma biomarkers are to be useful then they should reflect dietary intakes across groups with diverse lifestyles and dietary habits, including particularly high and low consumers of the antioxidant vitamins, or fruit and vegetables, such as those used by women in this study.

It has been estimated that 36 days of weighed records are required for an accurate measurement of dietary intake of vitamin C (Bingham 1987). However within a research situation this is not a practical measure and therefore it must be acknowledged that the estimation of actual nutrient intakes will be imprecise.

5.6.1. Comparison of plasma vitamin C with estimated dietary intake.

When using the four-day food diary to assess fruit and vegetable consumption, plasma ascorbic acid concentration did tend to increase over tertiles of consumption, although the increases were not statistically significant. Further analysis demonstrated that there was a strong relationship between dietary intakes of vitamin C, from *all* food sources, and plasma ascorbic acid concentrations even after adjustment for age, BMI and total calorific intake including alcohol. When the study was repeated using the 24-hour dietary recall method again a relationship between dietary intakes of vitamin C, from *all* food sources, and plasma ascorbic acid concentration was observed. These results are consistent with previous studies that have found that plasma ascorbic acid is consistently correlated with ingested vitamin C within the physiologic range of the typical Western diet (Sinha, Block, & Taylor 1992; Drewnowski et al. 1997). The effect seen at T_2 was slightly smaller than at T_1, with an 11% rise in plasma ascorbic acid levels observed with a doubling in vitamin C intake, compared to a 26% rise when using the four-day food diary. It cannot be said whether this is due to the kinetics of the biomarker or to the inaccuracies of the dietary assessment methodologies. However we know that Vitamin C is rapidly absorbed and is transported in the plasma from the site of absorption to the tissues. This means that plasma is the most responsive compartment of the blood to recent intakes and exhibits large fluctuations in response to vitamin C-rich meals (Bates & Thurnham 1997). Thus it is more likely that the difference in the effects seen between T_1 and T_2 are due to inaccuracies in the 24-hour recall method of assessment for

Vitamin C intake. Perhaps the four-day food diary is simply a better method for the assessment of vitamin C intakes than the 24-hour recall.

Consequently, as in the current study, fasting blood samples are usually taken to avoid short-term fluctuations caused by recent intakes. This may partly explain why the plasma levels better reflect the more medium- or longer-term intakes of vitamin C, as assessed by the four-day food diary.

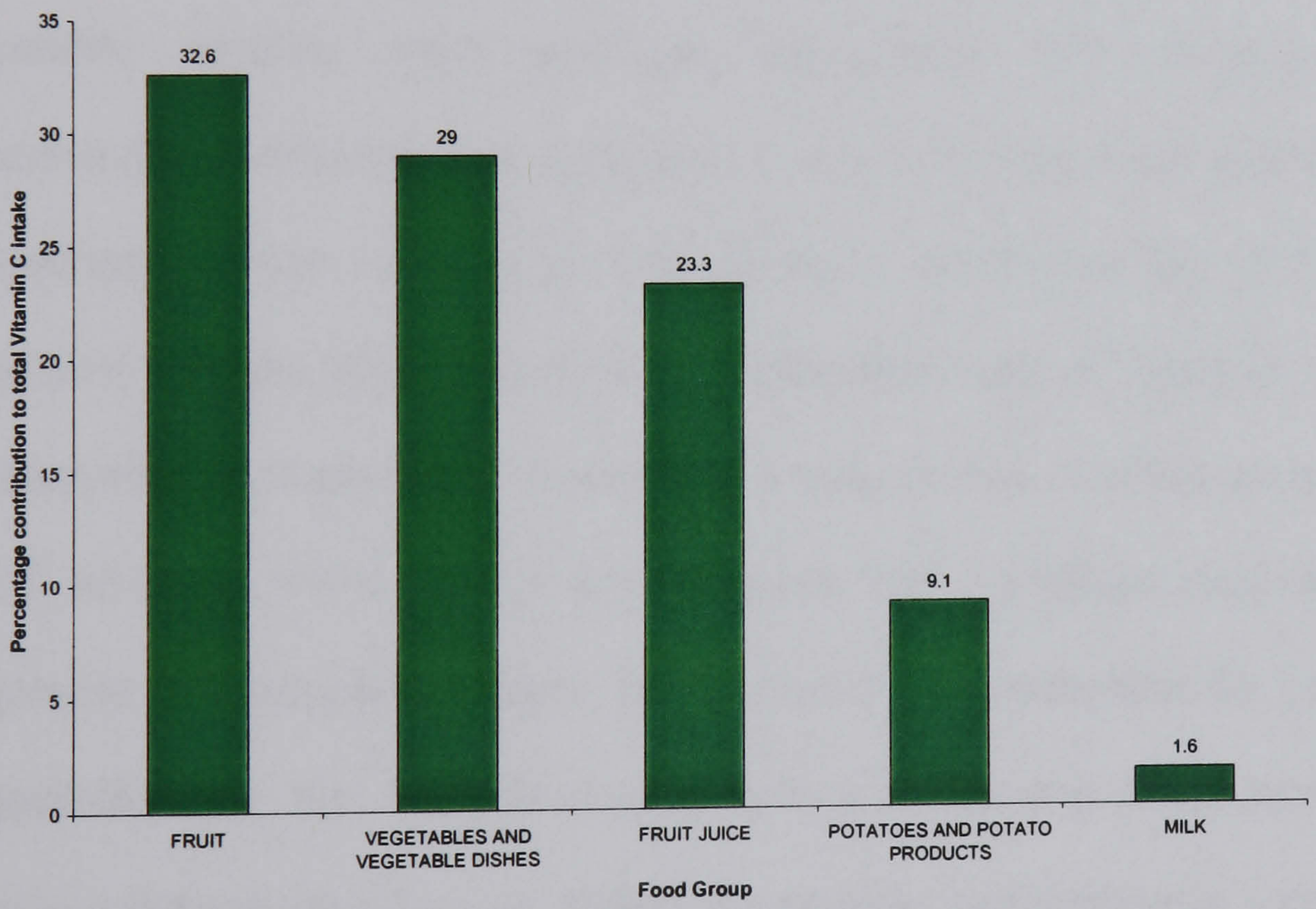
When considering the relationship between plasma ascorbic acid and intakes of specific food items, no associations were observed between plasma ascorbic acid and estimated dietary intake of either fruits or vegetables using the four-day diary, or 24-hour recall method. This contrasts with results of other studies reporting significant relationships between intakes of fruit and vegetables and plasma ascorbic acid concentrations. One study of community-based French adults (n=837) found that, in correlation analyses, serum vitamin C had significant relationships with both fruit and vegetable intakes. Following on from this it was found, in regression analysis, that serum vitamin C was a better predictor of fruit intake than of vegetable intake (Drewnowski et al. 1997). Another study of British adults found that plasma vitamin C is consistently correlated with reported frequency of foods rich in this vitamin, namely, fruit and vegetables (Ness et al. 1999). It is difficult however to compare these previous studies with the present investigation as they assessed dietary intake using methods based on the food frequency questionnaire, as opposed to the 24-hour recall or four-day food diary. Possibly the food frequency questionnaire produces a better estimate of fruit

and vegetable intake because it particularly prompts subjects to estimate their intake of specific food items, although this seems unlikely. However an alternative explanation is that the women involved in the present study are particularly high consumers of fruit and vegetables, and that what is observed is a less marked effect on plasma ascorbic acid of increasing already high intakes of fruit and vegetables due to a threshold effect. It is well documented that at very high levels of intake the linear relationship between vitamin C and plasma ascorbic acid disappears. This is due to a decrease in efficiency of absorption from the gastrointestinal tract and an increase in urinary losses (Sinha, Block, & Taylor 1992; Drewnowski et al. 1997). In the present study potential threshold effects were investigated and indeed it was found that the relationship between intake and plasma levels of ascorbic acid reached plateau at an intake level of around 60mg/day. A threshold has been observed previously at this level (Bates & Thurnham 1997). This threshold effect may also explain why no associations were seen between supplemental vitamin C intake and plasma ascorbic acid.

Aside from the observed threshold effect, there may be other reasons why fruit intakes and vegetable intakes were not associated with larger, or more significant, changes in plasma ascorbic acid concentrations. If increasing total vitamin C intake, from *all* food sources, is associated with an increase in plasma concentration yet fruit and vegetable intakes do not mirror this, then are there significant alternative sources of vitamin C? The foods contributing to total vitamin C intake from the 24-hour recall data were investigated and baked potatoes were found to be the fourth highest contributor to vitamin C

intake in these women. In fact as a food group potatoes and potato products contributed over 10% of total vitamin C intake (Figure 5.6). However potatoes were excluded from our definition of vegetables, as is standard practice (Williams 1995). This could partly explain the discrepancy between vitamin C intake, from *all* food sources, fruit and vegetable intakes and plasma levels. These data suggest that plasma ascorbic acid may be a reliable biomarker for dietary intake of vitamin C from *all* food sources, however care should be taken in extrapolating this result to specific vitamin C-rich foods.

Figure 5.6 Top five food group contributors to vitamin C intake



5.6.2. Comparison of plasma carotenoids with estimated dietary intake.

In a similar manner to the vitamin C data, all plasma carotenoids measured had a tendency to increase with increasing tertile of fruit and vegetable consumption, when assessed using both the four-day diary and the 24-hour recall. However after adjustment in the linear regression model, at T_1 using the four-day diary, only the association between total β-carotene intake from *all* food sources and plasma concentration was maintained, and at T_2 only the associations between total intake of carotenoid equivalents and lutein and lycopene concentrations were significant.

In relation to fruit and vegetable intakes at T_1, using the four-day diary, vegetable intakes were positively associated with plasma lycopene concentration, although this association was not statistically significant after adjustment. When employing the 24-hour recall method (T_2) fruit and vegetable intakes were significantly associated with a number of different plasma micronutrient levels, however the magnitudes of effect were extremely small, all being <10%. Lutein and lycopene had significant associations with vegetable consumption, lutein being found in predominantly green leafy vegetables and the main source of lycopene coming from tomatoes and tomato products (Scott et al. 1996). β-carotene and lycopene were found to be associated with fruit intake. This may be because although β-carotene occurs predominantly in vegetables it has been found that for the same quantity of intake from fruits and vegetables, a four-fold greater increase in serum levels occurs with β-carotene from the former dietary source (Castenmiller & West 1998). Lutein and cryptoxanthin were positively

associated with fruit juice intake. One study found that serum carotenoids were associated with either fruit or vegetable consumption, in a similar pattern to these results. The authors concluded that this underlined the importance of measuring several carotenoids in the blood to evaluate fruit and vegetable consumption (van Kappel et al. 2001).

Previous studies have shown that moderate to large doses of β-carotene, administered orally, produce a marked increase in plasma response which peaks at 6hours, decreases and then rises to a higher concentration at about 24 hours (International Agency for Research on Cancer 1998). A greater number of associations were observed between fruit and vegetable intakes and plasma carotenoid levels, when measuring the intakes using the 24-hour recall compared to the four-day food diary. This most likely reflects the responsiveness of the biomarker to recent intakes and has implications for epidemiological studies where longer-term measures of dietary intakes are usually required.

It is perhaps not surprising that, when we study associations between food intake and plasma measures of carotenoids, magnitudes of effects are small when we consider that the bioavailability and metabolism of carotenoids, and thus the plasma measurements, are significantly affected by dietary, physiological and matrix-associated factors. For example carotenoids are found in the matrices of fruit and vegetables. This matrix usually consists of fibre, digestible polysaccharides and proteins. During food preparation this matrix is not always broken down and therefore bioavailability, defined as the

accessibility of a nutrient to participate in unspecified metabolic and/or physiological processes, can vary from as little as 10% up to as much as 50% (Furr & Clark 1997). So we can see that food processing, cooking and storage can affect the bioavailability of carotenoids. Other factors lowering the bioavailability of carotenoids are the presence of fibre, a lack of fat in the diet, presence of undigested lipids, including fat substitutes, inadequate bile flow and various clinical conditions involving lipid malabsorption (International Agency for Research on Cancer 2001).

However, limitations also exist with self-reported dietary assessment methods to estimate carotenoid intakes. Many nutritional studies rely on food composition tables to translate food consumption data into estimates of nutrient intake, relying heavily on the accuracy and completeness of the food composition tables used. For example, in the present study the food tables used were too incomplete to assess intakes of lutein, cryptoxanthin and lycopene due to missing data and so a value for carotene equivalents was used in place of the individual carotenoid data. The carotene equivalent value includes β-carotene, plus half the recorded amounts of α-carotene and β-cryptoxanthin. This is a potential source of error because it is an amalgamation of a number of different carotenoids, which do not include the non-provitamin A carotenoids. Comparisons of databases of carotenoids can prove informative. One study compared two different databases; the first was based on carotenoid estimates, similar to the present study, and the second database was the new US Department of Agriculture – National Cancer Institute (USDA-NCI) Carotenoid Food Composition Database (Chug-Ahuja et

al. 1993; Mangels et al. 1993). The authors of this study concluded that although estimates did differ significantly between the two methods, only minor differences in rankings and diet-serum correlations were found using either data source (Van den Langenberg et al. 1996). This result was backed up by a second study investigating the relationship between FFQ intake estimates and plasma values of carotenoids (Ritenbaugh et al. 1996). However one study concluded that the new carotenoid database provides valuable information on specific carotenoid intake (Michaud et al. 1998). The present study was repeated using both a new European nutrient database, and the US Department of Agriculture – National Cancer Institute (USDA-NCI) Carotenoid Food Composition Database (Mangels et al. 1993), for those foods which we previously did not have full carotenoid information on. The results showed that although associations between intake and plasma levels of lycopene and cryptoxanthin were more statistically significant than from the initial results, actual percentage increases in plasma levels were still low (<10%). Therefore only minor differences are observed between each data source when assessing group means, although perhaps if the focus were shifted to an individual level these differences might be significant.

5.6.3. Variability of plasma antioxidant vitamin levels.

Classifying an individual's vitamin intake by using a single plasma measurement of antioxidant vitamins would be valuable in large-scale epidemiological studies. However, there is no clear evidence that a single measure is adequate to rank subjects correctly. Changes in dietary intake, metabolic changes associated with age, and diurnal and seasonal variations

will all affect the variability of blood measures (Comstock et al. 2001). In the present study all plasma micronutrient measures showed extremely poor agreement between the two time points. This is in contrast to previous studies, particularly looking at β-carotene, which have found that plasma β-carotene is similar over time for a given individual (International Agency for Research on Cancer 1998; Comstock et al. 2001; van Kappel et al. 2001). Earlier studies have tended to use correlation coefficients to investigate whether or not two blood measurements were linearly related, however it can be argued that this is not the best statistical method to use. Correlation coefficients measure the strength of a relationship between two variables. In this case though what we want to know is the level of agreement between the two measurements, thus the Bland-Altman method would be the more appropriate statistical method (Bland & Altman 1986). It has been found that data, which seem to be in poor agreement using the Bland-Altman method can still produce quite high correlations (Bland & Altman 1986).

In epidemiological studies a small degree of intra-individual variability may not be problematic, so long as individuals can be categorised and ranked effectively and accurately. However when an individual's movements between quartiles of antioxidant intakes, between T_1 and T_2, are investigated it can be seen that a single measure of any plasma antioxidant would be insufficient to rank subjects adequately over an eighteen-month period.

Seasonal variation was investigated within the study although only the mean levels of lutein showed a statistically significant seasonal difference. The poor

agreement, using the Bland-Altman technique, between plasma vitamin levels at the two time points in the present study is probably therefore due to intra-individual changes in diet between the two time points, and is not a reflection on the biomarker.

5.6.4. Biomarkers – what are they measuring?

The results of the present study show that there are indeed some positive associations between estimates of dietary intake and plasma concentrations of micronutrients. However these associations are not universal and the relationships are complex. It is important therefore to consider carefully what each approach to dietary assessment is actually measuring. It has already been stated in the introduction to Chapter 5 that traditional dietary assessment methods are all prone to substantial errors from reporting, portion size estimation and inaccurate recall. However what they attempt to do is to assess dietary intake as accurately as possible. So what is the plasma biomarker measuring? The plasma biomarkers measure the amount of a nutrient after it has been digested and absorbed, rates of which will vary depending on a number of factors including varying homeostatic mechanisms, metabolism, concomitant drug use or presence of chronic illnesses. Plasma nutrient levels are also complex because plasma has two different functions in relation to nutrient transportation, i.e. transferring nutrients from the gut lumen to tissue pools, and in turn carrying nutrients away from the tissue pool for utilisation by target tissues. Therefore the nutrient content of plasma represents two different processes, one of which will be sensitive to short-term fluctuations of intake, and the other to longer-term fluctuations when the

nutrient is distributed more slowly to other tissues. Therefore a biomarker may measure the amount of a nutrient present in, or available to, the tissues of the body (Bates & Thurnham 1997). In nutrition epidemiological studies this is an important measure to assess in its own right. However, this is not the same as attempting to obtain accurate measurements of dietary intake of these micronutrients through self-reporting.

5.7. Conclusion

Plasma ascorbic acid and β-carotene are good *indicators* of previous vitamin C and β-carotene intake, from all food sources. However caution is required in extrapolating these results to include individual food groups, rich in these vitamins. The results imply that the practice of using plasma biomarkers simply as a *proxy* measure of dietary intake is not valid and emphasise that plasma biomarkers are not simply a reflection of dietary intake but also of a number of physiological processes. Biomarkers in nutrition epidemiological studies are however useful to measure nutrient status at the tissue level, and may therefore give a more complete picture of micronutrient status when used in partnership with traditional dietary assessment methodologies.

5.8. Summary of Key Findings

- Plasma ascorbic acid may be a reliable biomarker for dietary intake of vitamin C from *all* food sources, however care should be taken in extrapolating this result to specific vitamin-C rich foods.

- The plasma carotenoids performances as biomarkers of dietary intake are variable and unpredictable.

- Only plasma lutein exhibited a statistically significant seasonal difference.

- There are some positive associations between estimates of dietary intake and plasma concentrations of the micronutrients, however these associations are not universal and the relationships are complex.

- Plasma antioxidant vitamin levels are not biochemical markers of *accurate* dietary intakes.

- Plasma antioxidant vitamin levels, as a biomarker, measures the amounts of a nutrient present in, or available to, the tissues of the body. In nutrition epidemiology this is an important measure to assess in its own right.

Chapter 6

Discussion, implications and suggestions for further work

6.1 Discussion

The purpose of this thesis was to study food choice motivations in relation to fruit and vegetable consumption. In particular, the aims were: to review current knowledge in this area; to describe key health and lifestyle characteristics differentiating between high and low fruit and vegetable consumers in the UKWCS; to explore food choice motivations specifically in relation to fruit and vegetable consumption in the UKWCS; and finally to describe the measurement error associated with fruit and vegetable research by exploring plasma antioxidants as biochemical markers of fruit and vegetable consumption.

More analysis was undertaken, during the timespan of completing this thesis, than is actually presented. However in order to produce a clear and concise thesis, only data which was seen to add value, and contribute to the overall theme of the thesis, were included in the final chapters.

6.1.1 Health and lifestyle factors affecting fruit and vegetable consumption in the UK Women's Cohort Study

The results of this study indicated that there are clear lifestyle, socio-economic and demographic distinctions between high and low fruit and vegetable consumers. In particular, in this cohort of women, the higher fruit and vegetable consumers were more likely to be slightly older, non- or ex-smokers, married or living with someone, with a degree level of education and of higher socio-economic status. The study also found that when combined fruit and vegetable intake was low, this could usually be attributed to a lower fruit intake than vegetable intake, suggesting that it is increased fruit intakes that might need promoting in health promotion campaigns. The results also showed that a diversity of intake is important to attain the highest levels of intake, it might also therefore be important to encourage new varieties of fruit and vegetables within the diet in order to increase intakes.

The generalisability of the results to the entire UK population is not possible. This particular cohort of women are generally motivated, well educated and of a relatively high socio-economic grouping. However the results of the study are relevant for future health promotion strategies, confirming that interventions to increase fruit and vegetable consumption should be targeted towards smokers, single persons and those in lower socio-economic groups.

6.1.2 Motivations for fruit and vegetable consumption in the UK Women's Cohort Study

The results of this study provided a unique insight into the food choice motivations and the behavioural change process, in relation to fruit and vegetable consumption within the UKWCS.

It was found that in this particular cohort of women the strongest determinants of food choice were health factors and natural content of the food. In relation to fruit and vegetable intakes, women appearing in the highest tertile of fruit and vegetable consumption scored higher on the health, natural content and ethical concerns dimensions of the FCQ, and significantly lower on the familiarity and convenience scores than lower consumers.

There were some factors identified by participants which they felt were outside of their own control and inhibited them from consuming more fruit and vegetables. There were a wide variety of reasons stated, however the most frequently given answer was that subjects felt that they were already consuming enough fruit and vegetables, even when some were eating just two portions per day.

The SOC evaluation showed significant associations with portions of fruit and vegetables consumed. The results also showed that women classed as being in the maintenance phase scored higher on the health, natural content, weight control and ethical concern factors of the FCQ. This study lends support to the use of the SOC model in interventions to increase fruit and vegetable

consumption because it suggests that women classified in different stages of change have differing food choice motivations.

6.1.3 Blood as a biomarker of fruit and vegetable consumption

The final study in this thesis shifted focus slightly to investigate the use of plasma antioxidants as biochemical markers of fruit and vegetable intakes. The results of this study provide useful information concerning the relationships between dietary intakes and plasma levels of the antioxidant vitamins, using two different dietary assessment methods, namely the 4-day food diary and the 24-hour recall.

It was found that there was a strong relationship between plasma vitamin C and dietary intakes from all food sources, with both dietary assessment methods. The effect was stronger for the 4-day food diary, probably reflecting the more medium- or long-term assessment of intake by the marker. No relationships were observed between dietary intakes of fruit and vegetables, and plasma levels of antioxidant vitamins by either dietary assessment method. It was therefore concluded that plasma ascorbic acid may be a reliable biomarker for dietary vitamin C from all food sources, however care should be taken in extrapolating this result to specific vitamin C-rich foods.

Plasma carotenoid levels were found to be poor markers of carotenoid intakes. Where relationships were observed between intake and plasma levels the magnitude of the relationships were generally small (<10%) and variable results were observed between the two different dietary assessment

methods. This was also observed when studying fruit and vegetable intakes compared with plasma carotenoid levels. Although the sizes of effect were still small, a greater number of associations were observed between fruit and vegetable intakes and plasma carotenoid levels, when intakes were measured using the 24-hour recall. This most likely reflects the more short-term nature of the biomarker.

There was large intra-individual variability in antioxidant vitamin intake between the two different time-points, however this was found not to be due to seasonality for all nutrients studied except for lutein. Mean levels of lutein did exhibit a statistically significant seasonal difference with mean plasma levels being 11.3% higher when collected during the summer months compared to the winter months.

This study concluded that plasma antioxidant concentrations are not accurate enough to be used as biomarkers of measurement of dietary intake. What they are *actually* measuring is however still an important assessment to make in nutrition epidemiological studies, and when used in partnership with traditional dietary assessment methodology, may give us a more complete picture.

6.2 Summary of Key Findings

The key findings of this thesis can therefore be summarised as follows:

- In the UKWCS the higher fruit and vegetable consumers were more likely to be slightly older, non- or ex-smokers, married or living with someone, with a degree level of education and of higher socio-economic status.

- In the UKWCS, the highest consumers of fruit and vegetables are motivated in their food choice by health concerns, the natural content of the food and by ethical concerns. They are not as motivated by convenience issues or as worried about their foods being familiar to them as are the lower fruit and vegetable consumers.

- There was a clear relationship between SOC and actual consumption of fruit and vegetables. This study finds support for the use of the SOC model in interventions to increase fruit and vegetable consumption because it suggests that women classified in different stages of change have differing food choice motivations. However more research in the area is still required.

- Plasma ascorbic acid may be a reliable biomarker for dietary vitamin C from all food sources, however care should be taken in extrapolating this result to specific vitamin C-rich foods.

- The plasma carotenoids performance as biomarkers of dietary intake are variable and unpredictable.

- Plasma antioxidants are not biochemical markers of accurate dietary intakes, at either the nutrient or food level. Plasma antioxidant vitamin levels, as biomarkers, measure the amount of a nutrient available to the tissues of the body.

6.3 Appraisal of methods

The search strategy for the literature review conducted in Chapter 2 was completed using a systematic approach. However the review was conducted by only one researcher and the assessment approach for inclusion and quality of studies was not structured but instead relied on one researcher's opinion on quality and relevance. The reasons for this were necessity and practicality, due to time and monetary constraints. Nevertheless from the structured searches for published and unpublished studies it is possible to be reasonably certain that the review provides a fair representation of the information available.

The limitations of the individual studies presented have been discussed throughout the thesis. The main limitation within each study was that the population for study, that is the UKWCS, tended to be women who were motivated, well-educated and of a relatively high socio-economic group, and this had a knock-on effect on the generalisability of the results to the remaining UK population. However the results give us an interesting, and indeed valuable, insight into lifestyle behaviours and food choice motivations within a population consisting of some extremely high fruit and vegetable consumers. This population is in itself novel because of the large numbers of high fruit and vegetable consumers. However because of the large sample sizes used within the three studies comprising this thesis, a range of fruit and vegetable intakes could be observed, so that the lowest consumers of fruit and vegetables were still represented within the study population. Indeed

although the sample may in itself be a limitation, the sample was specifically chosen for this thesis because of the diversity of intakes observed.

A further limitation is an obvious problem having completed the study presented in chapter 5, and that is that there is no 'Gold Standard' dietary assessment method. The methodologies in the studies presented within this thesis differ, from the FFQ to the 4-day food diary. However it has been estimated that 36 days of weighed food records are required in order to correctly classify subjects' vitamin C intake, and for the precision to be within 10% (Bingham 1987). Within a research situation this is certainly not practical and the 4-day food diary is as much as we can expect from our subjects, but then it must be acknowledged that the estimation of actual nutrient intakes will be imprecise.

6.4 Implications for health promotion

The results from the first study of the thesis indicate that health promotion techniques should be targeted at younger people, who live alone, smoke and have a low education level and socio-economic grouping.

The phenomenon of 'optimistic bias', where people believe they are less at risk than a comparable member of society was described briefly in the literature review in Chapter 2 (Weinstein 2000). A number of studies have found that participants believed that they were consuming adequate amounts of fruit and vegetables when, in actuality, they were consuming far less than the recommended intakes (Cotugna et al. 1992; Kearney et al. 1997; Cox et

al. 1998). This was also recorded by some of the women in the UKWCS when investigating their food choice motivations. The most frequently given answer to the question, "What are these factors which you feel prevent you from increasing your intake of fruit and vegetables?" was that people felt that they were already consuming adequate amounts. The minimum intake of fruit and vegetables in women responding that they already consumed adequate quantities was 2.1 portions per day. This finding indicates a lack of awareness, although it could be a lack of awareness of two different things. Firstly this could be due to a lack of awareness of what an adequate amount of fruit and vegetables is, and secondly of what they are actually consuming. In terms of implications for health promotion it is obvious that individuals need to know more about the recommendations, and they also need to be made more aware of their own intakes.

The findings of the study investigating food choice motivations in high fruit and vegetable consumers suggest that higher consumers are more motivated by health and natural content of food than are the lower consumers. Coupled with the finding of a lack of awareness of the recommendations for fruit and vegetable consumption it would seem that promotion of the health benefits of increasing fruit and vegetables in the diet is still warranted. In the UK people are exposed to a wide range of messages concerning food, and sometimes nutrition, however these may be contradictory. These messages may also come from a wide range of sources. According to a pan-EU survey when people in the UK look for healthy eating information they go first to magazines, then to TV and radio, followed by newspapers, food packaging,

health professional, advertising and finally government agencies (Institute of European Food Studies 1996b). It is important then that health promotion interventions to increase consumption access these media sources to communicate the message effectively and widely. In the literature review in Chapter 2 it was found that the promotion of fruit and vegetables was low and the money spent on advertising minimal. Although, perhaps an expensive technique, advertising in this manner is essential to capture the numbers of people who are still unaware of the health benefits of fruit and vegetables.

Innovative marketing strategies to promote fruit and vegetables are much needed to help efforts to increase consumption levels. The image of fruit and vegetables needs to be redesigned using sophisticated marketing techniques to make them more attractive to the consumer. However this is far removed from the limited role of the health promotion worker, and strategies would need to be subsidised by government or by the fruit and vegetable producers. The '5 a day—for better health!' campaign, run by the California Department of Health Services, claim to have "raised public awareness that fruits and vegetables help reduce cancer risk, increased fruit and vegetable consumption in major population segments, and created an ongoing partnership between public health and agribusiness that has allowed extension of the campaign to other population segments.." The campaign claims to have fulfilled this through the use of mass media and through its partnerships between the state health department and the produce and supermarket industries, as well as via point-of-purchase type interventions (Foerster et al 1995).

By making fruit and vegetables more attractive, fun and interesting to the consumers, and by increasing awareness of fruit and vegetables through accessing relevant media sources, it may increase social pressure to consume more fruit and vegetables. Previous studies have found social pressure to increase consumption to be low, although when social pressure was felt it was positive towards increasing fruit and vegetable intakes (Cox et al. 1998). By positively increasing levels of awareness it may be possible to increase social pressure to comply with the dietary recommendations.

One of the interesting findings of the lifestyle and behaviour study was that the highest consumers of fruit and vegetables tended to eat a more diverse range of fruit and vegetables than the lower consumers. This suggests that it may be important to encourage new varieties of fruit and vegetables, within the diet, in order to have any optimism over increasing intakes. This will involve having to teach new shopping strategies and cooking methods before an increase is likely to be achieved. Following on from this it was also found in the second study, on food choice motivations, that higher consumers of fruit and vegetables considered the familiarity of food to be less of an issue than did the lower consumers. This equates with the finding above in that higher consumers may be less food neophobic than lower consumers and therefore happy to experiment with new varieties in the diet. It was found in the literature review that, unlike taste genetics, the initial rejection of food caused by food neophobia may be reversed by repeated exposure to and consumption of the novel food item (Koivisto Hursti & Sjoden 1997).

Supermarket taste sessions would be an excellent health promotion technique to introduce new varieties of fruit and vegetables to the consumer, whilst at the same time not forcing the consumer to have to pay for the item, prepare it themselves and, perhaps ultimately throw it away if they then do not like it. The results of a previous study discovered that subjects thought that opportunities to try unfamiliar fruits and vegetables in supermarket taste sessions could be a good way to help increase consumption (Anderson et al. 1994b).

Health promotion interventions may benefit from using a stage-tailored approach, such as the SOC model, in order to classify individuals into groups of fruit and vegetable consumers, all holding similar sets of motivational inputs into their food choice behaviour. The present study suggests that women classified in different stages of change have differing food choice motivations, and therefore lends support to the use of the SOC model in interventions. However this is not conclusive and more research is required.

As discussed previously in the literature review, presented in chapter 2, health promotion strategies tend to be poorly evaluated. There is little available literature, particularly evaluating interventions aimed at increasing fruit and vegetable consumption, and this is certainly an area that needs attention in the future. The Health Education Authority did commission a systematic review of effectiveness of published, and unpublished, interventions completed between 1985 and 1996 that aimed to promote healthy eating in the general population. The results of this review showed that interventions in

supermarket settings exhibited a short-term influence on food purchasing behaviours, increasing the total market share of promoted food items by between 1 and 4%. The most effective interventions in this setting involved simple signs identifying healthier choices, which were either reinforced or accompanied by more detailed leaflets. Short-term changes in meal choices were seen however no longer-term evaluations were reported (Health Education Authority 1997). This information lends support to the ideas of supermarket, or point-of-purchase type interventions as being successful and worthwhile. However health promotion strategies desperately need to be more fully evaluated, both for short- and long-term influences on eating habits.

6.4 Implications for future research

Previous research in the area of food choice and fruit and vegetable consumption has primarily focused on barriers to increasing intakes in low consumers, however this thesis takes a novel approach by looking at the problem from a different angle, and asking what motivates the high consumers of fruit and vegetables. Future research could benefit from this approach.

Although the results of the present study lend support to the use of the SOC model in health promotion interventions, it is not conclusive and does not attempt to suggest that the SOC is applicable to all dietary behaviours. More research is required, particularly in the form of stage-matched intervention trials, to determine conclusively whether or not the TTM, or more specifically the SOC model, is applicable to eating behaviour (Horwath 1999).

When investigating blood as a biomarker of fruit and vegetable intakes, the findings show that the practice of using plasma biomarkers as a *proxy* measure of dietary intake is not valid, emphasising that plasma biomarkers are not simply a reflection of dietary intake but also of a number of physiological processes. This finding should influence future research, indicating that good practice in nutritional epidemiological studies would be to assess dietary intakes using traditional dietary assessment methodology, coupled with an assessment of nutrient status at the tissue level using biomarkers, in order to complete a more thorough assessment of disease risk.

Chapter 7

References

Agudo, A. & Pera, G. 1999, "Vegetable and fruit consumption associated with anthropometric, dietary and lifestyle factors in Spain.", *Public Health Nutrition*, vol. 2,no. 3, pp. 263-271.

Ajzen, I. 1991, "The Theory of Planned Behaviour", *Organizational Behavior and Human Decision Processes*, vol. 50, pp. 179-211.

Altman, D. G. 1991, *Statistics for Medical Research* Chapman & Hall, London.

Anderson, A. S. & Cox, D. 2000, "Five a day - challenges and achievements", *Nutrition and Food Science*, vol. 30,no. 1, pp. 30-34.

Anderson, A. S., Cox, D. N., McKellar, S., Reynolds, J., Lean, M. E. J., & Mela, D. J. 1998, "Take Five, a nutrition education intervention to increase fruit and vegetable intakes: Impact on attitudes towards dietary change", *British Journal of Nutrition*, vol. 80,no. 2, pp. 133-140.

Anderson, A. S., Lean, M. E. J., Foster, A., & Marshall.D. 1994a, "The Chief Scientist Reports... Ripe for Change: Fruit and vegetables in Scotland - current patterns and potential for change.", *Health Bulletin*, vol. 52,no. 1, pp. 51-64.

Anderson, A. S., Marshall.D., Lean, M. E., & Foster, A. 1994b, "Five a Day? factors Affecting Fruit and Vegetable Consumption in Scotland", *Nutrition and Food Science*, vol. 5, pp. 14-16.

Anderson, A. S. & Morris, S. E. 2000, "Changing Fortunes: changing food choices", *Nutrition and Food Science*, vol. 30,no. 1, pp. 12-15.

Baranowski, T., Weber Cullen, K. & Baranowski, J. 1999, "Psychosocial Correlates of Dietary Intake: Advancing Dietary Intervention", *Nutrition Research Reviews*, vol. 19, pp. 17-40.

Barker, M., Thompson, K., & McClean, S. 1995, "Attitudinal dimensions of food choice and nutrient intake", *British Journal of Nutrition*, vol. 74, pp. 649-659.

Bates, C. J. & Thurnham, D. I. 1997, "Biochemical markers of nutrient intake," in *Design Concepts in Nutritional Epidemiology*, 2nd edn, B. M. Margetts & M. Nelson, eds., Oxford University Press, Oxford, pp. 170-240.

Billson, H., Pryer, JA., & Nichols, R. 1999, "Variation in fruit and vegetable consumption among adults in Britain. An analysis from the dietary and nutritional survey of British adults.", *European Journal of Clinical Nutrition*, vol. 53, pp. 946-952.

Bingham, S. A. 1987, "The dietary assessment of individuals; methods, accuracy, new techniques and recommendations", *Nutrition Abstracts and Reviews (Series A)*, vol. 57,no. 10, pp. 705-742.

Birkett, N. J. 1999, "Intake of fruits and vegetables in smokers", *Public Health Nutrition*, vol. 2,no. 2, pp. 217-222.

Bland, J. M. & Altman, D. G. 1986, "Statistical methods for assessing agreement between two methods of clinical measurement", *Lancet*, vol. 1,no. 8476, pp. 307-310.

Block, G., Patterson, B., & Subar, A. 1992, "Fruit, vegetables, and cancer prevention: a review of the epidemiological evidence. [Review] [246 refs]", *Nutrition & Cancer*, vol. 18,no. 1, pp. 1-29.

Brouwer, I. A., van Dusseldorp, M., West, C. E., Meyboom, S., Thomas, C. M. G., Duran, M., van het Hof, K. H., Eskes, T. K. A. B., Hautvast, J. G. A. J., & Steegers-Theunissen, R. P. M. 1999, "Dietary Folate from Vegetables and Citrus Fruit Decreases Plasma Homocysteine Concentrations in Humans in a Dietary Controlled Trial", *Journal of Nutrition*, vol. 129, pp. 1135-1139.

Brug, J., Debie, S., van Assema, P., & Weijts, W. 1995, "Psychosocial Determinants of Fruit and Vegetable Consumption Among Adults: Results of Focus Group Interviews", *Food Quality and Preference*, vol. 6, pp. 99-107.

Brug, J., Glanz, K., & Kok, G. 1997, "The Relationship between Self-Efficacy, Attitudes, Intake Compared to Others, Consumption and Stages of Change Related to Fruit and Vegetables.", *American Journal of Health Promotion*, vol. 12,no. 1, pp. 25-30.

Burger, I. 1997, "Some Aspects of Food Choice and Availability Today", *Nutrition and Health*, vol. 11, pp. 233-238.

Cade, J., Greenwood, D., Neenan, T., Calvert, C., White, K., & Schorah, C. 2001, "How does dietary non-starch polysaccharide intake effect plasma micronutrient levels? Results from the UK Women's Cohort Study.", *Proceedings of the Nutrition Society*, vol. 60, p. 59A.

Cade, J., Upmeier, H., Calvert, C., & Greenwood, D. 1999, "Costs of a healthy diet: analysis from the UK Women's Cohort Study.", *Public Health Nutrition*, vol. 2,no. 4, pp. 505-512.

Calvert, C., Cade, J., Barrett, J. H., Woodhouse, A., & UKWCS Steering Group. Using cross-check questions to address the problem of mis-reporting of specific food groups on Food Frequency Questionnaires. European Journal of Clinical Nutrition 51, 708-712. 1997.

Carlson Bengston Consultants Ltd. COMP-EAT. [5.7]. 2001. London, Carlson Bengston Consultants Ltd.

Castenmiller, J. J. & West, C. E. Bioavailability and Bioconversion of Carotenoids. Annual Review of Nutrition 18, 19-38. 1998.

Center for Reviews and Dissemination Reviewers 2001b, "Is there a role for antioxidant vitamins in the prevention of cardiovascular diseases: an update on epidemiological and clinical trials data", *Database of Abstracts of Reviews of Effectiveness*, vol. Issue 1, October 2001..

Center for Reviews and Dissemination Reviewers 2001a, "The antioxidant vitamins and cardiovascular disease: a critical review of epidemiologic and clinical trial data", *Database of Abstracts of Reviews of Effectiveness*, vol. Issue 1, October 2001..

Charles, N. & Kerr, M. 1988, *Women, food and families* Manchester University Press, Manchester and New York.

Chug-Ahuja, J. K., Holden, J. M., Forman, M. R., Mangels, A. R., Beecher, G. R., & Lanza, E. 1993, "The development and application of a carotenoid database for fruits, vegetables, and selected multicomponent foods.", *Journal of the American Dietetic Association*, vol. 93, pp. 318-323.

Clark.J.E. 1998, "Taste and flavour: their importance in food choice and acceptance", *Proceedings of the Nutrition Society*, vol. 57, pp. 639-643.

Committee on Medical Aspects of Food and Nutrition Policy 1994, *Nutritional Aspects of cardiovascular Disease*, HMSO, London, 46.

Committee on Medical Aspects of Food and Nutrition Policy 1998, *Nutritional Aspects of the Development of Cancer*, HMSO, London, 48.

Comstock, G. W., Burke, A. E., Hoffman, S. C., Norkus, E. P., Gross, M., & Helzlsouer, K. J. 2001, "The repeatability of serum carotenoid, retinoid, and tocopherol concentrations in specimens of blood collected 15 years apart", *Cancer Epidemiology, Biomarkers & Prevention*, vol. 10,no. 1, pp. 65-68.

Cotugna, N., Subar, A. F., Heimendinger, J., & Kahle, L. 1992, "Nutrition and cancer prevention knowledge, beliefs, attitudes, and practices: the 1987 National Health Interview Survey", *Journal of the American Dietetic Association*, vol. 92,no. 8, pp. 963-968.

Cox, D. N., Anderson, A. S., Lean, M. E. J., & Mela, D. J. 1998, "UK consumer attitudes, beliefs and barriers to increasing fruit and vegetable consumption", *Public Health Nutrition*, vol. 1,no. 1, pp. 61-68.

Cox, D. N., Anderson, A. S., McKellar, S., Reynolds, J., Lean, M. E. J., & Mela, D. J. 1996, "Vegetables and fruits: barriers and opportunities for greater consumption", *Nutrition and Food Science*, vol. 5, pp. 44-47.

Cox, D. N., Anderson, A. S., Reynolds, J., McKellar, S., Mela, D. J., & Lean, M. E. J. 1997, "Measuring fruit and vegetable intake: is five-a-day enough?", *European Journal of Clinical Nutrition*, vol. 51, pp. 177-180.

Crawley, H. 1994, *Food Portion Sizes* HMSO, London.

De Irala-Estevez, J., Groth, M., Johansson, L., Oltersdorf, U., Prattala, R., & Martinez-Gonzalez, M. A. 2000, "A systematic review of socio-economic differences in food habits in Europe: consumption of fruit and vegetables.", *European Journal of Clinical Nutrition*, vol. 54, pp. 706-714.

DiClemente, C. C. 1991, "Motivational Interviewing and the Stages of Change.," in *Motivational Interviewing. Preparing People to Change Addictive*

Behavior., W. R. Miller & S. Rollnick, eds., The Guilford Press, New York, pp. 191-202.

Dittus, K., Hillers, V. N., & Beerman, K. A. 1995, "Benefits and Barriers to fruit and Vegetable Intake: Relationship between Attitudes and Consumption", *Journal of Nutrition Education*, vol. 27,no. 3, pp. 120-126.

DOH 1999, *Saving Lives: Our Healthier Nation* , HMSO, London.

DOH 2000, *National Service Framework for Cornoary Heart Disease*, Department of Health, London.

Donkin, A. J. M., Johnson, A. E., Lilley, J. M., Morgan, K., Neale, R. J., Page, R. M., & Silburn, R. L. 1998, "Gender and Living Alone as Determinants of Fruit and Vegetable Consumption among the Elderly living at Home in Urban Nottingham", *Appetite*, vol. 30, pp. 39-51.

Draper, A. K. 1992, *Vegetarianism in the UK*, Ph.D., London School of Hygiene and Tropical Medicine.

Drewnowski, A. 1997, "Taste preferences and food intake", *Annu.Rev.Nutr.*, vol. 17, pp. 237-253.

Drewnowski, A., Rock, C. L., Henderson, S. A., Shore, A. B., Fischler, C., Galan, P., Preziosi, P., & Hercberg, S. 1997, "Serum beta-carotene and vitamin C as biomarkers of vegetable and fruit intakes in a community-based sample of French adults. [see comments]", *American Journal of Clinical Nutrition*, vol. 65,no. 6, pp. 1796-1802.

Eastwood, M. A. 1999, "Interaction of dietary antoxidants *in vivo*: how fruit and vegetables prevent disease?", *Quarterly Journal of Medicine*, vol. 92, pp. 527-530.

Fallon, A. & Rozin, P. 1983, "The Psychological Bases of Food Rejections by Humans", *Ecology of Food and Nutrition*, vol. 13, pp. 15-26.

Fischer, R., Griffin, F., England, S., & Garn, S. M. 1961, "Taste Thresholds and Food Dislikes", *Nature*, vol. 191, p. 1328.

Fishbein, M. & Ajzen, I. 1975, *Belief, attitude, intention and behavior.* Wiley, New York.

Foerster, S.B., Kizer, K.W., Disogra, L.K., Bal, D.G., Krieg, B.F. & Bunch, K.L. 1995, "California's "5 a day—for better health!" campaign: an innovative population-based effort to effect large-scale dietary change", *American Journal of Preventive Medicine*, vol. 11, pp. 124-131.

Frewer, L. J., Howard, C., Hedderley, D., & Shepherd, R. 1998, "Methodological Approaches to Assessing Risk Perceptions Associated with Food-Related Hazards", *Risk Analysis*, vol. 18,no. 1, pp. 95-102.

Furr, H.C. & Clark, R.M. 1997, "Intestinal absorption and tissue distribution of carotenoids", *Nutritional Biochemistry*, vol. 8, pp. 364-377.

Germov, J. & Williams, L. 1999, *A sociology of food and nutrition: the social appetite* Oxford University Press, Oxford.

Glanville, E. V. & Kaplan, A. R. 1965, "Food Preference and Sensitivity of Taste For Bitter Compounds", *Nature*, vol. 205,no. 4974, pp. 851-853.

Gregory, J., Foster, K., Tyler, H., & Wiseman, M. 1990, *The Dietary and Nutritional Survey of British Adults*, HMSO, London.

Halliday, A. & Ashwell, M. 1993, *Coronary Heart Disease - 4. The integrated role of the whole diet.*, The British Nutrition Foundation, London, 30.

Health Education Authroity 1997, *Health promotion interventions to promote healthy eating in the general population - a review*, Health Development Agency, London, Summary Bulletin 6.

Heimendinger, J. & Van Duyn, M. A. 1995, "Dietary behavior change: the challenge of recasting the role of fruit and vegetables in the American diet. [Review] [35 refs]", *American Journal of Clinical Nutrition*, vol. 61,no. 6 Suppl, pp. 1397S-1401S.

Hochbaum, G. 1958, "Public Participation in Medical Screening Programs: A Sociological Psychological Study", *Public Health Service Publication*, vol. 12, pp. 572-577.

Hof-KH, v. h., Brouwer, I. A., West, C. E., Haddeman, E., Steegers-Theunissen, R. P. M., Dusseldorp, M. v., Weststrate, J. A., Eskes, T. K. A. B., & Hautvast, J. G. A. J. 1999, "Bioavailability of lutein from vegetables is 5 times higher than that of beta-carotene", *American Journal of Clinical Nutrition*, vol. 70, pp. 261-268.

Holt, G. C. 1993, *Ecological eating, food ideology and food choice.*, Ph.D., Bradford.

Horwath, C. C. 1999, "Applying the transtheoretical model to eating behaviour change: challenges and opportunities", *Nutrition Research Reviews*, vol. 12, pp. 281-317.

http://www.macrobiotic.co.uk/diet.htm 19/03/2001

http://www.vegsoc.org 15/01/2002

Institute of European Food Studies 1996b, *A pan-EU survey of Consumer Attitudes to Food, Nutrition and Health*, Institute of European Food Studies, Ireland, 1.

Institute of European Food Studies 1996a, *A pan-EU survey of Consumer Attitudes to Food, Nutrition and Health*, Institute of European Food Studies, Ireland, 2.

International Agency for Research on Cancer & World Health Organisation 1998, *IARC Handbooks of Cancer Prevention. Volume 2. Carotenoids*, International Agency for Research on Cancer, France.

Jenkins, D. J. A., Reynolds, D., Leeds, A. R., Waller, A. L., & Cummings, J. H. 1979, "Hypocholesterolemic action of dietary fiber unrelated to fecal bulking effect", *American Journal of Clinical Nutrition*, vol. 32, pp. 2430-2435.

Johansson, L. & Andersen, L. F. 1998, "Who eats 5 A Day?: Intake of fruits and vegetables among Norwegians in relation to gender and lifestyle", *Journal of the American Dietetic Association*, vol. 98,no. 6, pp. 689-691.

Kaminski, L. C., Henderson, S. A., & Drewnowski, A. 2000, "Young women's food preferences and taste responsiveness to 6-n-propylthiouracil (PROP)", *Physiology & Behavior*, vol. 68,no. 5, pp. 691-697.

Kearney, K. M. & McElhone, S. 1999, "Perceived barriers in trying to eat healthier - results of a pan-EU consumer attitudinal survey", *British Journal of Nutrition*, vol. 81,no. 2.

Kearney, M., Gibney, M. J., Martinez, J. A., de Almeida, M. D., Friebe, D., Zunft, H. J., Widhalm, K., & Kearney, J. M. 1997, "Perceived need to alter eating habits among representative samples of adults from all member states of the European Union", *European Journal of Clinical Nutrition*, vol. 51 Suppl 2, p. S30-S35.

Khan, M. A. 1981, "Evaluation of Food Selection Patterns and Preferences", *CRC Critical Reviews in Food Science and Nutrition*, vol. 15, pp. 129-153.

Kilcast, D., Cathro, J., & Morris, L. 1996, "Practical approaches to increasing vegetable consumption", *Nutrition and Food Science*, vol. 5, pp. 48-51.

Kirk, M. & Gillespie, A. H. 1990, "Factors Affecting Food Choices of Working Mothers With Young Families", *Journal of Nutrition Education*, vol. 22,no. 4, pp. 161-168.

Kirk, S. F., Cade, J. E., Barrett, J. H., & Conner, M. 1999, "Diet and lifestyle characteristics associated with dietary supplement use in women", *Public Health Nutrition*, vol. 2,no. 1, pp. 69-73.

Koivisto Hursti, U. & Sjoden, P. 1997, "Food and General Neophobia and their Relationship with Seld-Reported Food Choice: Familial Resemblance in Swedish Families with Children of Ages 7-17 Years", *Appetite*, vol. 29, pp. 89-103.

Krebs-Smith, S., Heimendinger, J., Subar, A., Patterson, B., & Pivonka, E. Using Food Frequency Questionnaires to Estimate Fruit and Vegetable Intake: Association between the Number of Questions nad Total Intakes. Journal of Nutrition Education 27[2], 80-85. 1995.

Laforge, R. G., Greene, G. W., & Prochaska, J. O. 1994, "Psychsocial Factors Influencing Low Fruit and Vegetable Consumption", *Journal of Behavioural Medicine*, vol. 17,no. 4, pp. 361-374.

Lampe.J.W. 1999, "Health effects of vegetables and fruit: assessing mechanisms of action in human experimental studies", *American Journal of Clinical Nutrition*, vol. 70, pp. 475S-490S.

Lappalainen, R., Saba, A., Holm, L., Mykkanen, H., Gibney, M. J., & Moles, A. 1997, "Difficulties in trying to eat healthier: descriptive analysis of perceived barriers for healthy eating [published erratum appears in Eur J Clin Nutr 1997 Sep;51(9):641]", *European Journal of Clinical Nutrition*, vol. 51 Suppl 2, p. S36-S40.

Leather, S. 1995, "Fruit and vegetables: consumption patterns and health consequences", *British Food Journal*, vol. 97,no. 7, pp. 10-17.

Lechner, L., Brug, J., Vries, H. d., & De Vries, H. 1997, "Misconceptions of fruit and vegetable consumption: differences between objective and subjective estimation of intake", *Journal of Nutrition Education*, vol. 29,no. 6, pp. 313-320.

Lefebvre, R. C., Lurie, D., Goodman, L. S., Weinberg, L., & Loughrey, K. Social Marketing and Nutrition Education: Inappropriate or Misunderstood? Journal of Nutrition Education 27, 146-150. 1995.

Lennernas, M., Fjellstrom, C., Becker, W., Giachetti, I., Schmitt, A., Remaut de Winter, A. M., & Kearney, M. 1997, "Influences on food choice perceived to be important by nationally-representative samples of adults in the European Union", *European Journal of Clinical Nutrition*, vol. 51,no. Suppl 2, p. S8-S15.

Lindstrom, M., Hanson, B. S., Wirfalt, E., & Ostergren, P. O. 2001, "Socioeconomic differences in the consumption of vegetables, fruit and fruit juices. The influence of psychosocial factors", *European Journal of Public Health*, vol. 11,no. 1, pp. 51-59.

MAFF 1999, *National Food Survey 1998* The Stationery Office, London.

Mangels, A. R., Holden, J. M., Beecher, G. R., Forman, M. R., & Lanza, E. 1993, "The carotenoid content of fruits and vegetables: an evaluation of

analytical data", *Journal of the American Dietetic Association*, vol. 93, pp. 284-296.

Margetts, B. M., Cade, J. E., & Osmond, C. 1989, "Comparison of a food frequency questionnaire with a diet record", *International Journal of Epidemiology*, vol. 18,no. 4, pp. 868-873.

Martini, M. C., Campbell, D. R., Gross, M. D., Grandits, G. A., Potter, J. D., & Slavin, J. L. 1995, "Plasma carotenoids as biomarkers of vegetable intake: the University of Minnesota Cancer Prevention Research Unit Feeding Studies", *Cancer Epidemiology, Biomarkers & Prevention*, vol. 4,no. 5, pp. 491-496.

McClelland, J. W., Demark-Wahnefried, W., Mustian, R. D., Cowan, A. T., & Campbell, M. K. 1998, "Fruit and Vegetable Consumption of Rural African Americans: Baseline Survey Results of the Black Churches United for Better Health 5 A Day Project", *Nutrition and Cancer*, vol. 30,no. 2, pp. 148-157.

McEligot, A. J., Rock, C. L., Flatt, S. W., Newman, V., Faerber, S., & Pierce, J. P. 1999, "Plasma carotenoids are biomarkers of long-term high vegetable intake in women with breast cancer", *Journal of Nutrition*, vol. 129,no. 12, pp. 2258-2263.

McKee, F. 1995, "East of Eden: a brief history of fruit and vegetable consumption", *British Food Journal*, vol. 97,no. 7, pp. 5-9.

Michaud, D. S., Giovannucci, E. L., Ascherio, A., Rimm, E. B., Forman, MR, Sampson, L., & Willett, W. C. 1998, "Associations of plasma carotenoid

concentrations and dietary intake of specific carotenoids in samples of two prospective cohort studies using a new carotenoid database", *Cancer Epidemiology, Biomarkers & Prevention*, vol. 7,no. 4, pp. 283-290.

Mintel 2001c, *Crisps and Snacks*, Mintel International Group Limited, London.

Mintel 2001a, *Fresh fruit and vegetables*, Mintel International Group Limited, London.

Mintel 2001b, *Vitamins and Mineral Supplements*, Mintel International Group Limited, London.

Montano, D. E., Kasprzyk, D., & Taplin, S. H. 1997, "The Theory of Reasoned Action and the Theory of Planned Behaviour," in *Health behavior and health education: theory, research and practice.*, 2nd edn, K. Glanz, F. M. Lewis, & B. K. Rimer, eds., Jossey-Bass, San Francisco, pp. 85-112.

Mooney, C. 1990, "Cost and availability of healthy food choices in a London health district.", *Journal of Human Nutrition and Dietetics*, vol. 3, pp. 111-120.

National Consumer Council 1998, *Farm Policies and Our Food: The Need for Change.*, National Consumer Council, London.

Nelson, M. 1998, "Biomarkers in the study of diet and disease", *Public Health Reviews*, vol. 26,no. 1, pp. 11-12.

Ness, A. R., Khaw, K. T., Bingham, S., & Day, N. E. 1999, "Plasma vitamin C: what does it measure?", *Public Health Nutrition* , vol. 2,no. 1, pp. 51-54.

Ness, A. R. & Powles, J. W. 1997, "Fruit and vegetables, and Cardiovascular Disease: A Review", *International Journal of Epidemiology*, vol. 26,no. 1, pp. 1-13.

Nestle, M. 2000, "Ethical dilemmas in choosing a healthful diet: vote with your fork!", *Proceedings of the Nutrition Society, 59(4):619-29, 2000 Nov*, vol. 59,no. 89 ref, pp. 619-629.

O'Doherty, J. K. & Holm, L. 1999, "Preferences, quantities and concerns: socio-cultural perspectives on the gendered consumption of foods. [Review] [66 refs]", *European Journal of Clinical Nutrition*, vol. 53,no. 5, pp. 351-359.

Perri, M. G., Sears, S. F., & Clark, J. E. 1993, "Strategies for improving maintenance of weight loss: Toward a continous care model of obesity management", *Diabetes Care*, vol. 16, pp. 200-209.

Pitts, M. 1993, "An introduction to health psychology," in *The Psychology of Health: an introduction*, M. Pitts & K. Phillips, eds., Routledge, London, pp. 3-14.

Pollard, J., Greenwood, D., & Cade, J. 2001, "Lifestyle factors affecting fruit and vegetable consumption in the UK Women's Cohort Study.", *Appetite*.

Pollard, T. M., Steptoe, A., & Wardle, J. 1998, "Motives Underlying Healthy Eating: Using the Food Choice Questionnaire to Explain Variation in Dietary Intake", *J.biosoc.Sci.*, vol. 30, pp. 165-179.

Povey, R., Conner, M., Sparks, P., James, R., & Shepherd, R. 1999, "A critical examination of the application of the Transtheoretical Model's stages of change to dietary behaviours", *Health Education Research*, vol. 14,no. 5, pp. 641-651.

Povey, R., Conner, M., Sparks, P., James, R., & Shepherd, R. 2000, "Application of the Theory of Planned Behaviour to two dietary behaviours: Roles of perceived control and self-efficacy", *British Journal of Health Psychology*, vol. 5,no. 2, pp. 121-139.

Prochaska, J. O. & DiClemente, C. C. 1984, *The Transtheoretical Approach: Crossing Traditional Boundaries of Therapy* Dow Jones Irwin, Homewood, IL.

Prochaska, J. O. & DiClemente, C. C. 1986, *Treating Addictive Behaviours: Processes of Change* Plenum Press, New York.

Prochaska, J. O. & DiClemente, C. C. 1992, "Stages of change in the modification of problem behaviors. [Review] [75 refs]", *Progress in Behavior Modification*, vol. 28, pp. 183-218.

Rautalahati, M. & Huttunen, J. 1993, "Antioxidants and Carcinogenesis", *Annals of Medicine*, vol. 25, pp. 435-441.

Rayner, M. 1998, "Vegetables and fruit are good for us so why don't we eat more? [comment]", *British Journal of Nutrition*, vol. 80,no. 2, pp. 119-120.

Reicks, M., Randall, J. L., & Haynes, B. J. 1994, "Factors affecting consumption of fruits and vegetables by low-income families", *Journal of the American Dietetic Association*, vol. 94,no. 11, pp. 1309-1311.

Reid, M. 1995, "A Workshop of the Scottish Colloqium on Food and Feeding (SCOFF) and the BSA Sociology of Food Group Research and Practice Issues in the Study of Fruit and Vegetable Consumption, Food Choice and Eating Habits", *Appetite*, vol. 24, pp. 263-264.

Riboli, E. 1992, "Nutrition and cancer: background and rationale of the European Prospective Investigation into Cancer and Nutrition (EPIC). [Review] [30 refs]", *Annals of Oncology*, vol. 3,no. 10, pp. 783-791.

Ritenbaugh, C., Peng, Y. M., Aickin, M., Graver, E., Branch, M., & Alberts, D. S. 1996, "New carotenoid values for foods improve relationship of food frequency questionnaire intake estimates to plasma values", *Cancer Epidemiology, Biomarkers & Prevention*, vol. 5,no. 11, pp. 907-912.

Royal Society of Chemistry and Ministry of Agriculture, F. a. F. 1991, *McCance and Widdowson's the Composition of Foods*, 5th ed edn, Royal Society of Chemistry, Cambridge.

Rozin, P. & Vollmecke, T. A. 1986, "Food Likes and Dislikes", *Annual Review of Nutrition*, vol. 6, pp. 433-456.

Santos, M. L. & Booth, D. A. 1996, "Influences on meat avoidance among British students", *Appetite*, vol. 27,no. 3, pp. 197-205.

Scott, K. J., Thurnham, D. I., Hart, D. J., Bingham, S. A., & Day, K. 1996, "The correlation between the intake of lutein, lycopene and beta-carotene from vegetables and fruits, and blood plasma concentrations in a group of women aged 50-65 years in the UK", *British Journal of Nutrition*, vol. 75,no. 3, pp. 409-418.

Sigman-Grant, M. 1996, "Stages of Change: A Framework for Nutrition Interventions", *Nutrition Today*, vol. 31,no. 4, pp. 162-170.

Sinha, R., Block, G., & Taylor, P. R. 1992, "Determinants of Plasma Ascorbic Acid in a Healthy Male Population", *Cancer Epidemiology, Biomarkers & Prevention*, vol. 1, pp. 297-302.

Sobala, G. M., Pignatelli, B., Schorah, C. J., Bartsch, H., Sanderson, M., Dixon, M. F., Shires, S., King, R. F., & Axon, A. T. 1991, "Levels of nitrite, nitrate, N-nitroso compounds, ascorbic acid and total bile acids in gastric juice of patients with and without precancerous conditions of the stomach", *Carcinogenesis*, vol. 12,no. 2, pp. 193-198.

SPSS Inc. SPSS for Windows: Release 9.0. [9.0]. 1998. Chicago, SPSS Inc.

Statacorp. Stata Statistical Software. [6.0]. 2001. College Station, TX, Stata Corporation.

Steptoe, A., Pollard, T. M., & Wardle, J. 1995, "Development of a Measure of the Motives Underlying the Selection of Food: the Food Choice Questionnaire", *Appetite*, vol. 25, pp. 267-284.

Stewart, B. & Tinsley, A. 1995, "Importance of food choice influences for working young adults", *Journal of the American Dietetic Association*, vol. 95,no. 2, pp. 227-230.

Strecher, V. J. & Rosenstock, I. M. 1997, "The Health Belief Model," in *Health Behavior and Health Education: theory research and practice.*, 2nd edn, K. Glanz, F. M. Lewis, & B. K. Rimer, eds., Jossey-Bass, San Francisco, pp. 41-59.

The Soil Association 1999, *The Organic Food and Farming Report 1999.*, The Soil Association, Bristol.

Thompson, R. L., Margetts, B. M., Speller, V. M., & McVey, D. 1999, "The health education authority's health and lifestyle survey 1993: who are the low fruit and vegetable consumers?", *Journal of Epidemiology and Community Health*, vol. 53,no. 5, pp. 294-299.

Thurnham, D. I., Smith, E., & Flora, P. S. 1988, "Concurrent liquid-chromatographic assay of retinol, alpha-tocopherol, beta-carotene, alpha-carotene, lycopene, and beta-cryptoxanthin in plasma, with tocopherol acetate as internal standard", *Clinical Chemistry*, vol. 34,no. 2, pp. 377-381.

Tinker, L. F., Schneeman, B. O., Davis, P. A., Gallaher, D. D., & Waggoner, C. R. 1991, "Consumption of prunes as a source of dietary fiber in men with mild hypercholesterolemia", *American Journal of Clinical Nutrition*, vol. 53, pp. 1259-1265.

Treiman, K., Freimuth, V., Damron, D., Lasswell, A., Anliker, J., Havas, S., Langenberg, P., & Feldman, R. 1996, "Attitudes and behaviors related to fruits and vegetables among low-income women in the WIC program", *Journal of Nutrition Education*, vol. 28,no. 3, pp. 149-156.

van Kappel, A. L., Steghens, J., Zeleniuch-Jacquotte, A., Chajes, V., Toniolo, P., & Riboli, E. Serum carotenoids as biomarkers of fruit and vegetable consumption in the New York Women's Health Study. Public Health Nutrition 4[3], 829-835. 2001.

VandenLangenberg, G. M., Brady, W. E., Nebeling, L. C., Block, G., Forman, M., Bowen, P. E., Stacewicz-Sapuntzakis, M., & Mares-Perlman, J. A. 1996, "Influence of using different sources of carotenoid data in epidemiologic studies", *Journal of the American Dietetic Association*, vol. 96,no. 12, pp. 1271-1275.

Wallstrom, P., Wirfalt, E., Janzon, L., Mattisson, I., Elmstahl, S., Johansson, U., & Berglund, G. Fruit and vegetable consumption in relation to risk factors for cancer: a report from the Malmo Diet and Cancer Study. Public Health Nutrition 3[3], 263-271. 2000.

Weinstein, N. D. 2000, "Mindset, optimistic bias about personal risk and health-protective behaviour", *British Journal of Health Psychology*, vol. 4,no. Part 4, p. Nov-300.

Westenhoefer, J. & Pudel, V. 1993, "Pleasure from Food: Importance for Food Choice and Consequences of Deliberate Restriction", *Appetite*, vol. 20, pp. 246-249.

Whichelow, M. J. & Prevost, A. T. 1996, "Dietary patterns and their associations with demographic, lifestyle and health variables in a random sample of British adults", *British Journal of Nutrition*, vol. 76,no. 1, pp. 17-30.

WHO 1990, *Diet, Nutrition and the Prevention of Chronic Diseases*, WHO, Geneva, WHO Tech Rep Ser No 797.

Wild, C.P., Andersson, C., O'Brien, N.M., Wilson, L. & Woods, J.A. 2001, "A critical evaluation of the application of biomarkers in epidemiological studies on diet and health", *British Journal of Nutrition*, vol. 86, pp. S37-S53.

Williams, C. 1995, "Healthy eating: clarifying advice about fruit and vegetables.", *BMJ*, vol. 310, pp. 1453-1455.

World Cancer Research Fund & American Institute for Cancer Research 1997, *Food, Nutrition and the Prevention of Cancer: a global perspective* American Institure for Cancer Research, Washington.

Worsley, A. & Skrzypiec, G. 1998, "Teenage vegetarianism: prevalence, social and cognitive contexts", *Appetite*, vol. 30,no. 2, pp. 151-170.

Appendix A

THE BASELINE QUESTIONNAIRE

CONFIDENTIAL

ID: ☐☐☐☐☐☐

UK Women's Cohort Study

The UK Women's Nutrition & Lifestyle Survey

We want to find out about the relationship of nutrition with the occurrence of certain diseases. This questionnaire is mostly about your usual food intake over the last year. It is designed for both vegetarians and non-vegetarians, so some questions may not seem relevant to you. There are also some questions about other topics such as smoking and exercise.

Please answer every question. If you are uncertain about how to answer a question then do the best you can, but please do not leave a question blank. Don't be put off once you've started! It may be quite lengthy but it is straightforward and quick to work your way through.

Please complete this questionnaire and return it in the pre-paid envelope as soon as possible. Your answers will be treated as strictly confidential and will be used only for medical research.

OOD INTAKE:

sted below are food items divided into sections according to food type. Please put a tick (✓) the box to indicate how often, on average, you have eaten the specified amount of each ood during the last 12 months.

xample: White bread - if you eat 4 or 5 slices a day, you should put a tick in the column eaded "4-5 day".

FOODS AND AMOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6+ per day
BREAD										
White Slices or Rolls	0	1	2	3	4	5	6	7	8 ✓	9

ample: For seasonal fruit such as strawberries, if you eat strawberries about once a week hen in season you should put a tick in the column headed "once a week".

OODS AND MOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS WHEN IN SEASON?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6+ per day
RUIT										
rawberries	0	1	2	3 ✓	4	5	6	7	8	9

ou make a mistake and put a tick in the wrong box just cross through the tick as shown ow, and put another tick in the correct box.

mple: If you eat apples twice a week, but ticked the "2-3 times daily" box instead, just ss this through as shown, and tick in the "2-4 per week" box instead.

ODS AND MOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6+ per day
UIT										
les	0	1	2	3	4 ✓	5	6	7 ✗	8	9

ease estimate how often you eat the following foods, and please answer every question.

LEASE PUT A TICK (✓) ON EVERY LINE

FOODS AND AMOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6+ per day
BREAD/SAVOURY BISCUITS										
White Bread & Rolls	0	1	2	3	4	5	6	7	8	9
Brown Bread & Rolls	0	1	2	3	4	5	6	7	8	9
Wholemeal Bread & Rolls	0	1	2	3	4	5	6	7	8	9
Chapatis, Nan, Paratha	0	1	2	3	4	5	6	7	8	9
Papadums	0	1	2	3	4	5	6	7	8	9
Tortillas	0	1	2	3	4	5	6	7	8	9
Pitta Bread	0	1	2	3	4	5	6	7	8	9
Crispbread e.g. Ryvita	0	1	2	3	4	5	6	7	8	9
Cream Crackers, Cheese Biscuits	0	1	2	3	4	5	6	7	8	9
BREAKFAST CEREALS										
Porridge, Readybrek	0	1	2	3	4	5	6	7	8	9
Sugar Coated Cereals e.g. Sugar Puffs	0	1	2	3	4	5	6	7	8	9
Non-Sugar Coated Cereals e.g. Cornflakes, Rice Krispies	0	1	2	3	4	5	6	7	8	9
Muesli	0	1	2	3	4	5	6	7	8	9
All Bran, Bran Flakes	0	1	2	3	4	5	6	7	8	9
Weetabix, Shredded Wheat	0	1	2	3	4	5	6	7	8	9
POTATOES, RICE & PASTA										
Potatoes e.g. Boiled, Mashed	0	1	2	3	4	5	6	7	8	9
Chips	0	1	2	3	4	5	6	7	8	9
Jacket Potato	0	1	2	3	4	5	6	7	8	9
Roast Potatoes	0	1	2	3	4	5	6	7	8	9
Potato Salad	0	1	2	3	4	5	6	7	8	9
White Pasta e.g. Spaghetti, Green Pasta, Red Pasta, Noodles	0	1	2	3	4	5	6	7	8	9
Wholemeal Pasta, Brown Spaghetti	0	1	2	3	4	5	6	7	8	9
White Rice	0	1	2	3	4	5	6	7	8	9
Brown Rice	0	1	2	3	4	5	6	7	8	9
Wild Rice	0	1	2	3	4	5	6	7	8	9
Macaroni Cheese	0	1	2	3	4	5	6	7	8	9

ease estimate how often you eat the following foods, and please answer every question.

LEASE PUT A TICK (✓) ON EVERY LINE

FOODS AND AMOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6+ per day
DAIRY AND NON-DAIRY PRODUCTS										
Thick & Creamy Yoghurt (125g carton)	0	1	2	3	4	5	6	7	8	9
Low Fat Yoghurt (125g carton)	0	1	2	3	4	5	6	7	8	9
Diet Yoghurt (125g carton)	0	1	2	3	4	5	6	7	8	9
Greek Yoghurt (125g carton)	0	1	2	3	4	5	6	7	8	9
Fromage Frais / Crème Fraiche (125g carton)	0	1	2	3	4	5	6	7	8	9
Dairy Desserts (125 g carton)	0	1	2	3	4	5	6	7	8	9
Single / Sour cream (tablespoon)	0	1	2	3	4	5	6	7	8	9
Double / Clotted Cream (tablespoon)	0	1	2	3	4	5	6	7	8	9
Ice Cream	0	1	2	3	4	5	6	7	8	9
Milk Puddings	0	1	2	3	4	5	6	7	8	9
Low-Fat Cheese	0	1	2	3	4	5	6	7	8	9
Cheese e.g. Cheddar, Brie, Edam	0	1	2	3	4	5	6	7	8	9
Cottage Cheese	0	1	2	3	4	5	6	7	8	9
Cheese and Onion Pastie	0	1	2	3	4	5	6	7	8	9
Soya Cheese	0	1	2	3	4	5	6	7	8	9
Soya Yoghurt	0	1	2	3	4	5	6	7	8	9
MARGARINES / BUTTERS AND SPREADS										
Butter (enough for one slice of bread)	0	1	2	3	4	5	6	7	8	9
Block Margarine, NOT in tub e.g. Stork, Krona (enough for one slice of bread)	0	1	2	3	4	5	6	7	8	9
Polyunsaturated Margarine, in tub e.g. Flora, Sunflower, Granose (enough for one slice of bread)	0	1	2	3	4	5	6	7	8	9
Other Soft Margarine, Dairy Spreads, in tub e.g. Blue Band, Clover (enough for one slice of bread)	0	1	2	3	4	5	6	7	8	9
Low Fat Spread, in tub e.g. Outline, Gold, Flora Lite (enough for one slice of bread)	0	1	2	3	4	5	6	7	8	9
Very Low Fat Spread, in tub e.g. St ivel Lowest Fat Spread (enough for one slice of bread)	0	1	2	3	4	5	6	7	8	9
Monounsaturated Margarine, in tub e.g. Mono, Olivio (enough for one slice of bread)	0	1	2	3	4	5	6	7	8	9

ease estimate how often you eat the following foods, and please answer every question.

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FOODS AND AMOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6 + per day
SPREADS										
Marmite / Bovril / Vegemite	0	1	2	3	4	5	6	7	8	9
Peanut Butter	0	1	2	3	4	5	6	7	8	9
Chocolate / Chocolate & Nut Spread	0	1	2	3	4	5	6	7	8	9
Jam / Marmalade	0	1	2	3	4	5	6	7	8	9
Honey	0	1	2	3	4	5	6	7	8	9
Vegetable Pâté	0	1	2	3	4	5	6	7	8	9
Nut Pâté	0	1	2	3	4	5	6	7	8	9
SAUCES & SOUPS										
Low Calorie Salad Cream (tablespoon)	0	1	2	3	4	5	6	7	8	9
Mayonnaise, Salad Cream Type Dressing (tablespoon)	0	1	2	3	4	5	6	7	8	9
French Type Dressing (tablespoon)	0	1	2	3	4	5	6	7	8	9
Sauces e.g. White / Cheese / 'Cook In' / Curry	0	1	2	3	4	5	6	7	8	9
Tomato Ketchup (tablespoon)	0	1	2	3	4	5	6	7	8	9
Pickles / Chutney / Pesto Sauce	0	1	2	3	4	5	6	7	8	9
Packet Soups - Meat & Veg (Bowl)	0	1	2	3	4	5	6	7	8	9
Other – Vegetable Soups (Bowl)	0	1	2	3	4	5	6	7	8	9
Other – Meat Soups (Bowl)	0	1	2	3	4	5	6	7	8	9
Low Calorie Soups (Bowl)	0	1	2	3	4	5	6	7	8	9
GRAINS (Medium serving)										
Barley	0	1	2	3	4	5	6	7	8	9
Oats	0	1	2	3	4	5	6	7	8	9
Bulgar Wheat	0	1	2	3	4	5	6	7	8	9
Wheat Germ (tablespoon)	0	1	2	3	4	5	6	7	8	9
Cous-cous	0	1	2	3	4	5	6	7	8	9
White Rice	0	1	2	3	4	5	6	7	8	9
Brown Rice	0	1	2	3	4	5	6	7	8	9

lease estimate how often you eat the following foods, and please answer every question.

LEASE PUT A TICK (✓) ON EVERY LINE

FOODS AND AMOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6+ per day
NUTS AND SEEDS										
Peanuts / Pistachio Nuts	0	1	2	3	4	5	6	7	8	9
Cashew Nuts / Almonds	0	1	2	3	4	5	6	7	8	9
Pecan Nuts / Walnuts	0	1	2	3	4	5	6	7	8	9
Sunflower Seeds / Sesame Seeds	0	1	2	3	4	5	6	7	8	9
PULSES (Include when used in recipes)										
Lentils, Dals	0	1	2	3	4	5	6	7	8	9
Chick Peas, Chanas	0	1	2	3	4	5	6	7	8	9
Hummus	0	1	2	3	4	5	6	7	8	9
Baked Beans	0	1	2	3	4	5	6	7	8	9
Mung Beans / Red Kidney Beans	0	1	2	3	4	5	6	7	8	9
Bean Sprouts	0	1	2	3	4	5	6	7	8	9
Black Eyed Beans	0	1	2	3	4	5	6	7	8	9
Butter Beans / Broad Beans	0	1	2	3	4	5	6	7	8	9
EGGS / EGG DISHES										
Boiled / Poached Egg	0	1	2	3	4	5	6	7	8	9
Omelette, Scrambled Egg	0	1	2	3	4	5	6	7	8	9
Fried Egg	0	1	2	3	4	5	6	7	8	9
Quiche	0	1	2	3	4	5	6	7	8	9
VEGETABLE DISHES										
Quorn	0	1	2	3	4	5	6	7	8	9
Textured Vegetable Protein / Sosmix / Burger Mix / Soya Sausages / Soya Mince	0	1	2	3	4	5	6	7	8	9
Vegetarian Chilli / Vegetable Curry	0	1	2	3	4	5	6	7	8	9
Mixed Bean Casserole / Ratatouille	0	1	2	3	4	5	6	7	8	9
Stir-fry Vegetables	0	1	2	3	4	5	6	7	8	9
Vegetable – Lasagne / Moussaka / Ravioli / Filled Pasta with Sauce	0	1	2	3	4	5	6	7	8	9
Vegetable Pizza	0	1	2	3	4	5	6	7	8	9

ease estimate how often you eat the following foods, and please answer every question.

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FOODS AND AMOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6 + per day
MEAT										
Beef e.g. Roast, Steak	0	1	2	3	4	5	6	7	8	9
Beef Stew / Casserole / Mince / Curry	0	1	2	3	4	5	6	7	8	9
Beefburger / Hamburger	0	1	2	3	4	5	6	7	8	9
Pork e.g. Roast, Chops, Slices	0	1	2	3	4	5	6	7	8	9
Pork Stew / Casserole	0	1	2	3	4	5	6	7	8	9
Lamb e.g. Roast, Chops	0	1	2	3	4	5	6	7	8	9
Lamb Stew / Casserole	0	1	2	3	4	5	6	7	8	9
OTHER MEATS										
Chicken / Turkey Roast, Slices	0	1	2	3	4	5	6	7	8	9
Breadcrumbed e.g. Chicken Nuggets / Kievs	0	1	2	3	4	5	6	7	8	9
Chicken / Turkey in Creamy Sauce, Curry	0	1	2	3	4	5	6	7	8	9
Bacon	0	1	2	3	4	5	6	7	8	9
Ham	0	1	2	3	4	5	6	7	8	9
Corned Beef, Spam, Luncheon Meats	0	1	2	3	4	5	6	7	8	9
Sausages e.g. Beef Pork	0	1	2	3	4	5	6	7	8	9
Pies / Pasties / Sausage Rolls	0	1	2	3	4	5	6	7	8	9
Offal e.g. Liver, Kidney	0	1	2	3	4	5	6	7	8	9
Liver Pâté / Sausage, Salami	0	1	2	3	4	5	6	7	8	9
Meat – Lasagne / Moussaka / Ravioli / Filled Pasta with Sauce	0	1	2	3	4	5	6	7	8	9
Meat Pizza	0	1	2	3	4	5	6	7	8	9
FISH										
Fish Fingers / Cakes	0	1	2	3	4	5	6	7	8	9
Fried Fish in Batter (as in fish and chips)	0	1	2	3	4	5	6	7	8	9
White Fish e.g. Cod, Haddock, Plaice, Sole, Halibut (fresh or frozen)	0	1	2	3	4	5	6	7	8	9
Oily Fish e.g. Mackerel, Kippers, Tuna, Salmon, Sardines, Herring	0	1	2	3	4	5	6	7	8	9
Shellfish e.g. Crab, Prawns, Mussels	0	1	2	3	4	5	6	7	8	9
Fish Roe / Taramasalata	0	1	2	3	4	5	6	7	8	9
Fish Pie / Fish Lasagne	0	1	2	3	4	5	6	7	8	9

lease estimate how often you eat the following foods, and please answer every question.

LEASE PUT A TICK (✓) ON EVERY LINE

FOODS AND AMOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6 + per day
VEGETABLES										
Beetroot	0	1	2	3	4	5	6	7	8	9
Broccoli, Spring Greens, Kale	0	1	2	3	4	5	6	7	8	9
Brussel Sprouts	0	1	2	3	4	5	6	7	8	9
Cabbage	0	1	2	3	4	5	6	7	8	9
Carrots	0	1	2	3	4	5	6	7	8	9
Cauliflower	0	1	2	3	4	5	6	7	8	9
Celery	0	1	2	3	4	5	6	7	8	9
Coleslaw	0	1	2	3	4	5	6	7	8	9
Low-Calorie Coleslaw	0	1	2	3	4	5	6	7	8	9
Courgettes, Marrow, Squash	0	1	2	3	4	5	6	7	8	9
Cucumber	0	1	2	3	4	5	6	7	8	9
Garlic	0	1	2	3	4	5	6	7	8	9
Green Beans, Runner Beans	0	1	2	3	4	5	6	7	8	9
Leeks	0	1	2	3	4	5	6	7	8	9
Lettuce	0	1	2	3	4	5	6	7	8	9
Mushrooms	0	1	2	3	4	5	6	7	8	9
Aubergine, Okra / Ladies Finger	0	1	2	3	4	5	6	7	8	9
Olives	0	1	2	3	4	5	6	7	8	9
Parsnips	0	1	2	3	4	5	6	7	8	9
Peas, Mushy Peas, Mange-tout	0	1	2	3	4	5	6	7	8	9
Peppers - Red, Green, Yellow, Black etc	0	1	2	3	4	5	6	7	8	9
Swedes	0	1	2	3	4	5	6	7	8	9
Sweetcorn	0	1	2	3	4	5	6	7	8	9
Tomatoes – raw / canned / sauce	0	1	2	3	4	5	6	7	8	9
Turnip	0	1	2	3	4	5	6	7	8	9
Watercress, Mustard & Cress	0	1	2	3	4	5	6	7	8	9

ease estimate how often you eat the following foods, and please answer every question.

LEASE PUT A TICK (✓) ON EVERY LINE

FOODS AND AMOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6 + per day
FRUIT										
Apples	0	1	2	3	4	5	6	7	8	9
Avocado	0	1	2	3	4	5	6	7	8	9
Bananas	0	1	2	3	4	5	6	7	8	9
Grapes	0	1	2	3	4	5	6	7	8	9
Kiwi Fruit	0	1	2	3	4	5	6	7	8	9
Mangoes	0	1	2	3	4	5	6	7	8	9
Oranges, Satsumas, Grapefruit, etc	0	1	2	3	4	5	6	7	8	9
Papaya	0	1	2	3	4	5	6	7	8	9
Pears	0	1	2	3	4	5	6	7	8	9
Pineapple	0	1	2	3	4	5	6	7	8	9
SEASONAL FRUIT (How often have you eaten these fruits, when they are in season?										
Apricots	0	1	2	3	4	5	6	7	8	9
Melon	0	1	2	3	4	5	6	7	8	9
Nectarines	0	1	2	3	4	5	6	7	8	9
Peaches	0	1	2	3	4	5	6	7	8	9
Plums	0	1	2	3	4	5	6	7	8	9
Raspberries	0	1	2	3	4	5	6	7	8	9
Red Currants / Black Currants	0	1	2	3	4	5	6	7	8	9
Rhubarb	0	1	2	3	4	5	6	7	8	9
Strawberries	0	1	2	3	4	5	6	7	8	9
DRIED FRUIT										
Dates	0	1	2	3	4	5	6	7	8	9
Figs	0	1	2	3	4	5	6	7	8	9
Prunes	0	1	2	3	4	5	6	7	8	9
Mixed Dried Fruit e.g. Apricots, Apples, Pears, Mangoes	0	1	2	3	4	5	6	7	8	9
Currants, Raisins, Sultanas	0	1	2	3	4	5	6	7	8	9

lease estimate how often you eat the following foods, and please answer every question.

LEASE PUT A TICK (✓) ON EVERY LINE

FOODS AND AMOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6+ per day
SWEET SNACKS										
Cereal Bars / Flapjacks (one)	0	1	2	3	4	5	6	7	8	9
Fruit Bars (one) e.g. Apricot, Date	0	1	2	3	4	5	6	7	8	9
Chocolate Snack Bars e.g. Mars, Crunchie (one bar)	0	1	2	3	4	5	6	7	8	9
Mini Chocolate Snack Bars, Chocolates – singles or squares (one)	0	1	2	3	4	5	6	7	8	9
Boiled Sweets, Toffees, Mints	0	1	2	3	4	5	6	7	8	9
AVOURY SNACKS										
Crisps (one bag)	0	1	2	3	4	5	6	7	8	9
Other Fried Snacks e.g. Wotsits (one bag)	0	1	2	3	4	5	6	7	8	9
Low Fat or Baked Snacks e.g. Low-Fat Crisps (one bag)	0	1	2	3	4	5	6	7	8	9
Bombay Mix (small handful)	0	1	2	3	4	5	6	7	8	9
Peanuts / Pistachio Nuts (small handful)	0	1	2	3	4	5	6	7	8	9
Mixed Nuts and Raisins (small handful)	0	1	2	3	4	5	6	7	8	9
BEVERAGES										
Tea (cup)	0	1	2	3	4	5	6	7	8	9
Herbal Tea (cup)	0	1	2	3	4	5	6	7	8	9
Coffee – Instant / Ground (cup)	0	1	2	3	4	5	6	7	8	9
offee – Decaffeinated (cup)	0	1	2	3	4	5	6	7	8	9
Coffee Substitute e.g. Caro / Bambu (cup)	0	1	2	3	4	5	6	7	8	9
offee Whitener (teaspoon)	0	1	2	3	4	5	6	7	8	9
ocoa, Hot Chocolate (cup)	0	1	2	3	4	5	6	7	8	9
orlicks, Ovaltine (cup)	0	1	2	3	4	5	6	7	8	9
ow Calorie / Low-Fat Horlicks, valtine, Hot Chocolate (cup)	0	1	2	3	4	5	6	7	8	9
range Juice (Pure Fruit) (glass)	0	1	2	3	4	5	6	7	8	9
ther -(100%) Pure Fruit Juices (glass)	0	1	2	3	4	5	6	7	8	9
uit Squash / Cordial – Diluted (glass)	0	1	2	3	4	5	6	7	8	9
izzy Soft Drinks e.g. Coke, Lemonade lass / can)	0	1	2	3	4	5	6	7	8	9
ow Calorie / Diet Soft Drinks (glass / an)	0	1	2	3	4	5	6	7	8	9

lease estimate how often you eat the following foods, and please answer every question.

LEASE PUT A TICK (✓) ON EVERY LINE

FOODS AND AMOUNTS	HOW OFTEN HAVE YOU EATEN THESE FOODS IN THE LAST 12 MONTHS?									
	NEVER	Less than once a month	1-3 per month	once a week	2-4 per week	5-6 per week	once per day	2-3 per day	4-5 per day	6+ per day
ALCOHOLIC BEVERAGES										
Wines (wineglassful)	0	1	2	3	4	5	6	7	8	9
Beer, Lager (half pint)	0	1	2	3	4	5	6	7	8	9
Cider (half pint)	0	1	2	3	4	5	6	7	8	9
Port, Sherry, Liqueurs (glass)	0	1	2	3	4	5	6	7	8	9
Spirits e.g. Whisky, Gin, Vodka, Brandy (single / one measure)	0	1	2	3	4	5	6	7	8	9
BISCUITS, SWEETS & PUDDINGS										
Plain Biscuits e.g. Marie, Nice, Digestive (one)	0	1	2	3	4	5	6	7	8	9
Chocolate Biscuits (one)	0	1	2	3	4	5	6	7	8	9
Sandwich / Cream Biscuits (one)	0	1	2	3	4	5	6	7	8	9
Fruitcake (one slice)	0	1	2	3	4	5	6	7	8	9
Sponge Cakes (one slice)	0	1	2	3	4	5	6	7	8	9
Buns / Pastries e.g. Croissants, Doughnuts, Tray Bakes, (one)	0	1	2	3	4	5	6	7	8	9
Scones / Pancakes / Muffins / Crumpets (one)	0	1	2	3	4	5	6	7	8	9
Fruit Pies, Tarts, Crumbles, (one slice)	0	1	2	3	4	5	6	7	8	9
Sponge Puddings (one serving)	0	1	2	3	4	5	6	7	8	9

1. Other Foods

Are there any other foods which you eat more than once a week? Yes ☐1 No ☐2

If yes, please list below

Food	Usual serving size	Number of times eaten each week

2. Would you describe yourself as a vegetarian? Yes ☐1 No ☐2

If yes, how long have you been vegetarian? ☐☐ years.

Would you describe yourself as a vegan? Yes ☐1 No ☐2

If yes, how long have you been vegan? ☐☐ years.

3. Do you use herbs and spices at least once per week when cooking food? Yes ☐1 No ☐2

Which fresh herbs and spices would you use at least once a week? Please list here

Which dried herbs and spices would you use at least once a week? Please list here

PORTION SIZE:

4. Compared to other people would you describe your typical average portion size of foods as

Small? ☐1 Medium? ☐2 Large? ☐3

PULSES:

5. Do you eat pulses e.g. beans, peas, lentils etc. Yes ☐1 No ☐2

If no, please go to question 7.

6. Can you please indicate how much of the pulses you eat are fresh, frozen, dried or canned.
Please tick the appropriate boxes, e.g. ¼ Dried, ¾ Frozen.

	Proportion				
	Never	¼	½	¾	All
Fresh	1	2	3	4	5
Frozen	1	2	3	4	5
Dried	1	2	3	4	5
Canned	1	2	3	4	5

How do you usually cook pulses? Tick all applicable.

Steaming / Boiling / Pressure Cooking ☐ 1

Microwaving ☐ 2

Roasting ☐ 3

Stewing / Casseroling / Baking ☐ 4

Stir Frying / Frying ☐ 5

Raw / Soaked / Raw – sprouted ☐ 6

VEGETABLES:

7. How many servings of vegetables or vegetable containing dishes, (excluding potatoes) do you usually eat each week? ☐☐

8. Can you please indicate how much of the vegetables you eat are fresh, frozen, dried or canned. Please tick the appropriate boxes, e.g. ¼ Dried, ¾ Frozen.

	Proportion				
	Never	¼	½	¾	All
Fresh	1	2	3	4	5
Frozen	1	2	3	4	5
Dried	1	2	3	4	5
Canned	1	2	3	4	5

9. Do you ever eat raw vegetables apart from salad vegetables? Yes ☐ 1 No ☐ 2

10. How do you usually cook your vegetables? (excluding potatoes). Tick more than one box if necessary.

Boiling ☐ 1

Steaming ☐ 2

Grilling / Barbecuing / Baking / Roasting (Cooked dry or using a small amount of oil) ☐ 3

Stir Frying / Frying / Saute ☐ 4

Microwaving ☐ 5

Deep Frying – including in batter ☐ 6

Casseroling / Baking in sauce ☐ 7

Other ☐ 8

f other please describe ☐

FRUIT:

11. How many servings of fruit or fruit containing dishes do you usually eat each week ? ☐☐
Can you please indicate how much of the fruit you eat is fresh, stewed, dried or canned.
Please tick the appropriate boxes, e.g. ¼ Fresh, ¾ Canned.

	Proportion				
	Never	¼	½	¾	All
Fresh	1	2	3	4	5
Stewed	1	2	3	4	5
Dried	1	2	3	4	5
Canned	1	2	3	4	5

12. Do you ever cook the fruit you eat? Yes ☐1 No ☐2

13. If so, how do you usually cook your fruit?

Stewing ☐1 Poaching / Steaming ☐2

Baking ☐3 Microwaving ☐4

Other ☐5

If other please describe _____

MEAT: (If you **NEVER** eat meat please go to question 16)

14. How many servings of meat or meat containing dishes do you usually eat each week? ☐☐
What do you do with the visible fat on your meat?

Eat all / most of the fat ☐1

Eat some of the fat ☐2

Eat as little as possible / none ☐3

15. How do you usually cook meat? Tick more than one box if necessary.

Grilling / Barbecuing / Baking / Roasting (Cooked dry or using a small amount of oil) ☐1

Stir Frying / Frying ☐2

Microwaving ☐3

Deep Frying – including in batter ☐4

Casseroling / Baking in sauce ☐5

Other ☐6

If other please describe _____

16. How many servings of fish or fish containing dishes do you usually eat each week? ☐☐
How do you usually cook fish? Tick more than one box if necessary.

Boiling ☐1
Steaming ☐2
Grilling / Barbecuing / Baking / Roasting (Cooked dry or using a small amount of oil) ☐3
Stir Frying / Frying ☐4
Microwaving ☐5
Deep Frying – including in batter ☐6
Casseroling / Baking in sauce ☐7
Other ☐8

f other please describe ☐

MILK:

17. What type of milk do you use most often? Select one only

Full Cream (Silver Top) ☐1
Semi – Skimmed (Red / White Top) ☐2
Skimmed / Fat Free (Blue / White Top) ☐3
Channel Islands (Gold Top) ☐4
Dried Milk ☐5
Soya ☐6
Sterilised ☐7
None ☐8
Other ☐9

If other please specify ☐

If you use soya milk, please describe brand and type.

☐

18. How much milk do you drink each day, including milk with tea, coffee, milky drinks, cereals etc?

None ☐1
¼ Pint ☐2
½ Pint ☐3
¾ Pint ☐4
1 Pint ☐5
More than 1 Pint ☐6

BREAKFAST:

19. Are there any breakfast cereals that you normally eat that were not mentioned earlier? Yes ☐1 No ☐2
If yes, which brand and type of breakfast cereal, do you usually eat?
List the types most often used

Brand	Type

20. Do you usually take sugar on your breakfast cereal? Yes ☐1 No ☐2
If yes, how many teaspoons? ☐☐ teaspoons.

21. Do you usually take sugar / honey in tea, herbal tea, coffee or coffee substitute? Yes ☐1 No ☐2
If yes, please write the number of teaspoons per cup.

Sugar / Honey in tea ☐☐ teaspoons
Sugar / Honey in Herbal Tea ☐☐ teaspoons
Sugar / Honey in Coffee ☐☐ teaspoons
Sugar / Honey in Coffee Substitute ☐☐ teaspoons

Do you use sweeteners instead of sugar or honey? Yes ☐1 No ☐2

If yes, which brand of sweetener do you use? Please specify

If yes, how many tablets per day, or how many teaspoons of powder per day? ☐☐

22. On days when you eat bread, how many slices of bread or rolls do you eat? ☐☐ slices/rolls per day.

USE OF FATS:

23. Do you usually spread butter / margarine on your bread? Yes ☐1 No ☐2 Sometimes ☐3

How many slices of bread / rolls / crackers do you have with spread each day? ☐☐

How much spread do you use?

Just a scrape / thinly spread ☐1
Medium ☐2
Thickly Spread ☐3

24. What kind of fat do you most often use for frying, roasting, grilling etc? Tick more than one if applicable.

Butter ☐ 1
Lard / Dripping ☐ 2
Vegetable Oil ☐ 3
Solid White Vegetable Fat ☐ 4
Margarine ☐ 5
None ☐ 6

If you use vegetable oil, or margarine, please give type e.g. corn, sunflower ☐

25. What kind of fat do you most often use for baking cakes etc.? Tick more than one if applicable.

Butter ☐ 1
Solid White Vegetable Fat ☐ 2
Lard / Dripping ☐ 3
Margarine ☐ 4
Vegetable Oil ☐ 5
None ☐ 6

If you use margarine, please give brand e.g. Flora, Stork ☐

USE OF SALT:

26. How often do you add salt to food while cooking?

Always ☐ 1
Usually ☐ 2
Sometimes ☐ 3
Rarely ☐ 4
Never ☐ 5

27. How often do you add salt to any food at the table?

Always ☐ 1
Usually ☐ 2
Sometimes ☐ 3
Rarely ☐ 4
Never ☐ 5

28. Do you regularly use a salt substitute (e.g. Losalt)? Yes ☐ 1 No ☐ 2

If yes, which brand? ☐

USE OF SUPPLEMENTS:

29. Do you take any vitamins, minerals, fish oils, fibre or other food supplements? Yes ☐ 1 No ☐ 2
If yes, please fill in details below.

Name and Brand of Supplements	How much do you take at a time	How often do you take these?			
		Daily	Weekly	Monthly	Less Often
		1	2	3	4
		1	2	3	4
		1	2	3	4
		1	2	3	4
		1	2	3	4
		1	2	3	4

SPECIAL DIETS:

30. i) Have you changed your diet over the last 12 months? Yes ☐ 1 No ☐ 2
If yes, please indicate if the change was for any of the reasons listed below?
Tick more than one box if applicable

High Blood Pressure ☐ 0
Stomach problems (e.g. ulcer or gastritis) ☐ 1
Bowel Problems (e.g. irritable bowel or diverticulitis) ☐ 2
Concern over eating a healthy diet ☐ 3
Concern over a family history of illness ☐ 4
High Blood Cholesterol / Lipids ☐ 5
Overweight / Obesity ☐ 6
Diabetes ☐ 7
Allergies (e.g. skin rash) ☐ 8
Other ☐ 9

If other please specify

ii) If yes, please describe below specifying how your diet has changed

Do you currently follow any of these diets? Tick more than one box if necessary.

Low Fat ☐ 1
Low Salt ☐ 2
Diabetic ☐ 3
Slimming ☐ 4
Gluten Free ☐ 5
High Fibre ☐ 6
Other ☐ 7

If other please give details

CONSUMPTION OF ALCOHOL:

31. How often, if ever do you drink alcohol?

More than once a week ☐ 1 Once a week ☐ 2

Less than once a week ☐ 3 Never drink alcohol ☐ 4

32. In a typical week, how much do you drink?

Beer or cider ☐☐ pints each week

Wine ☐☐ glasses each week

Sherry / Fortified Wines ☐☐ glasses each week

Spirits ☐☐ glasses (singles) each week

33. Five years ago, how many alcoholic drinks did you have each week?

Beer or cider ☐☐ pints each week

Wine ☐☐ glasses each week

Sherry / Fortified Wines ☐☐ glasses each week

Spirits ☐☐ glasses (singles) each week

SMOKING:

34. Which one of the following best describes you?

I smoke every day ☐ 1

I smoke occasionally, but not every day ☐ 2

I used to smoke every day, but do not smoke at all now ☐ 3

I have never smoked ☐ 4

If you have never smoked, please go to question 37.

35. Do / Did you smoke?

Cigarettes ☐ 1

Cigars ☐ 2

A combination of the above ☐ 3

If you currently smoke or used to smoke cigarettes how many do / did you smoke each day? ☐☐ cigarettes

If you currently smoke or used to smoke cigarettes which brand of cigarettes do / did you usually smoke?

36. If you have stopped smoking for what period of time have you been a non-smoker?

1 year or less ☐ 1 2-5 years ☐ 2

6-10 years ☐ 3 Over 10 years ☐ 4

SIZE:

37. Approximately how much did you weigh when you were born?

☐☐ lbs or ☐☐ Kg or Don't Know ☐

38. Approximately how much did you weigh when you were 20 years old?

☐☐ stones ☐☐ pounds or ☐☐☐ Kg or Don't Know ☐

39. Approximately how much do you weigh at present?

☐☐ stones ☐☐ pounds or ☐☐☐ Kg or Don't Know ☐

40. Have you lost more than half a stone in the last year? Yes ☐1 No ☐2

Have you gained more than half a stone in the last year? Yes ☐1 No ☐2
(Please ignore weight gained during pregnancy.)

1. What is your present waist size?

☐☐ inches or ☐☐☐ centimetres or Don't Know ☐1

42. What is your present hip size?

☐☐ inches or ☐☐☐ centimetres or Don't Know ☐1

43. What is your present height?

☐ ft ☐☐ inches or ☐☐☐ centimetres or Don't Know ☐1

44. What size of blouse do you wear? Size ☐☐

45. What size of skirt do you wear? Size ☐☐

PHYSICAL ACTIVITY:

5. In a typical week during the last 12 months, how many hours did you spend on each of the following activities? Put "0" if none.

Housework, such as cleaning, washing, cooking, child care		☐☐ hours	☐☐ minutes per week
Do-It-Yourself		☐☐ hours	☐☐ minutes per week
Gardening	In Summer	☐☐ hours	☐☐ minutes per week
	In Winter	☐☐ hours	☐☐ minutes per week
Walking, including to work, shopping & leisure	In Summer	☐☐ hours	☐☐ minutes per week
	In Winter	☐☐ hours	☐☐ minutes per week
Cycling, including to work & leisure	In Summer	☐☐ hours	☐☐ minutes per week
	In Winter	☐☐ hours	☐☐ minutes per week
Other physical exercise, such as keep-fit,			
Aerobics, jogging, tennis, swimming	In Summer	☐☐ hours	☐☐ minutes per week
	In Winter	☐☐ hours	☐☐ minutes per week

47. In a normal week, do you do any of these activities vigorously enough to cause sweating or a faster heartbeat?

Yes ☐[1] No ☐[2]

If yes, for how long each week do you do such vigorous physical activity?

☐☐ hours ☐☐ minutes per week

ILLNESS:

48. Have you ever been told by a doctor that you have, or had, any of the following conditions?
Please tick all which apply and give the age at which each condition was first diagnosed.

Heart attack, coronary thrombosis, myocardial infarction	Yes ☐[1]	No ☐[2]	at age ☐☐ yrs old.
Angina	Yes ☐[1]	No ☐[2]	at age ☐☐ yrs old.
Stroke	Yes ☐[1]	No ☐[2]	at age ☐☐ yrs old.
High Blood Pressure (Hypertension)	Yes ☐[1]	No ☐[2]	at age ☐☐ yrs old.
High Blood Cholesterol, Hyperlipidaemia	Yes ☐[1]	No ☐[2]	at age ☐☐ yrs old.
Diabetes	Yes ☐[1]	No ☐[2]	at age ☐☐ yrs old.
Gallstones	Yes ☐[1]	No ☐[2]	at age ☐☐ yrs old.
Polyps in the large intestine	Yes ☐[1]	No ☐[2]	at age ☐☐ yrs old.
Cancer	Yes ☐[1]	No ☐[2]	at age ☐☐ yrs old.

If yes to cancer, what type of cancer was it ?

Any other illnesses or operations?
Do not include hysterectomy or breast surgery. These are covered later in the questionnaire.

Condition / operation / disease	Age first diagnosed
	☐☐ yrs old.
	☐☐ yrs old.
	☐☐ yrs old.
	☐☐ yrs old.

49. Are you currently receiving long-term treatment for any illness or condition? Yes ☐ 1 No ☐ 2
If yes, please give details of treatment. If no please go to question 50:

Illness or Condition	Treatment	Dose	Frequency

50. Have your mother and / or father ever suffered from cancer or a heart attack / heart disease?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3

If yes, please give details

51. If you have brothers and / or sisters, have they ever suffered from cancer or a heart attack / heart disease?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3

If yes, please describe details

EDUCATION:

52. How old were you when you finished your full time education? ☐☐ yrs old.

53. Do you have any of the following qualifications? Tick all applicable

CSE ☐ 1
GCE "O" Level ☐ 2
City & Guilds ☐ 3
"A" Level, Highers ☐ 4
Teaching Diploma, HNC ☐ 5
Degree ☐ 6
Other ☐ 7 Please describe
None of these ☐ 8

EMPLOYMENT:

54. Have you ever had a paid job? Yes ☐ 1 No ☐ 2
If yes, please answer for your current or most recent job

What is / was your job title?
What do / did you do in your job?
What does / did the organisation you work for make or do?

Are / were you a Manager? ☐1 Foreman / woman? ☐2

Supervisor? ☐3 None of these? ☐4

Are / were you self-employed? Yes ☐1 No ☐2

Do you have a paid job at present? Yes ☐1 No ☐2

If no, how would you describe yourself?

Housewife ☐1 Unemployed ☐2

Retired ☐3 Student ☐4

Other ☐5 Please describe ____

When did you last have paid employment ☐☐☐☐ (year) or Never ☐1

55. What is your marital status?

Married or living as married ☐1 Divorced ☐2

Widowed ☐3 Single ☐4

Separated ☐5

If you are not married or living as married, please go to question 57.

PARTNER'S EMPLOYMENT:

56. If married or living as married, has your partner ever had a paid job? Yes ☐1 No ☐2
If yes, please answer for your partner's current or most recent job.

What is / was your partner's job title? ____

What does / did the organisation your partner works for make or do? ____

Is / was your partner a Manager? ☐1 Foreman / woman? ☐2

Supervisor? ☐3 None of these? ☐4

Is / was your partner self-employed? Yes ☐1 No ☐2

Does your partner have a paid job at present? Yes ☐1 No ☐2

If no, how would you describe your partner?

House-husband ☐1 Student ☐2

Unemployed ☐3 Retired ☐4

Other ☐5 Please describe ____

57. Which of these ethnic groups would you consider you belong to?

White ☐ 1 Bangladeshi ☐ 2

Indian ☐ 3 Chinese ☐ 4

Pakistani ☐ 5 Black – Caribbean ☐ 6

Black – other ☐ 7 _____

Other ☐ 8 _____

MENSTRUAL & OBSTETRIC HISTORY:

58. How old were you when you had your first menstrual period? ☐☐ years old

59. What is the usual length of your menstrual cycle?

(i.e. from the first day of one period to the first day of the next period e.g. 26 days)? ☐☐ days.

60. Have you ever been pregnant? Yes ☐ 1 No ☐ 2

Are you pregnant at the moment? Yes ☐ 1 No ☐ 2

How many times have you been pregnant? ☐☐

Have you ever had a miscarriage / still birth? Yes ☐ 1 No ☐ 2

If you have had children, please go to question 61. If not please go to question 63.

61. Have you had any children? Yes ☐ 1 No ☐ 2

If yes, how old were you when your first child was born? ☐☐ years

If yes, how many children have you had? ☐☐ children

If none please go to question 63.

Please can you write in each child's sex and approximate birthweight.

Child	Sex of Child	Approximate Birthweight	Child's D.O.B
CHILD 1:			☐☐☐☐
CHILD 2:			☐☐☐☐
CHILD 3:			☐☐☐☐
CHILD 4:			☐☐☐☐
CHILD 5:			☐☐☐☐

62. Did you ever breast feed any of your children? Yes ☐1 No ☐2

If yes, for those children you breast-fed, please describe how long you continued breast-feeding after each birth, (even only occasional breast-feeding). Tick the appropriate box.

	1-6 days	1-4 weeks	1-3 months	4-6 months	6+ months	12+ months
CHILD 1:	☐1	☐2	☐3	☐4	☐5	☐6
CHILD 2:	☐1	☐2	☐3	☐4	☐5	☐6
CHILD 3:	☐1	☐2	☐3	☐4	☐5	☐6
CHILD 4:	☐1	☐2	☐3	☐4	☐5	☐6
CHILD 5:	☐1	☐2	☐3	☐4	☐5	☐6

63. Have you ever seen a doctor because of fertility problems? Yes ☐1 No ☐2

If yes, has a doctor ever told you that you were infertile? Yes ☐1 No ☐2

64. Have you ever used oral contraceptives (the pill)? Yes ☐1 No ☐2

If yes, how old were you when you first started to use the pill? ☐☐ years old

For how long altogether did you use the pill? ☐☐ years

Are you currently using the pill? Yes ☐1 No ☐2

If no, how old were you when you last used it? ☐☐ years old

65. Have you ever used a coil or intra-uterine device (IUD)? Yes ☐1 No ☐2

If yes, do you have a coil or IUD at present? Yes ☐1 No ☐2

66. How many "natural" menstrual periods have you had in the last 12 months?
Do not count bleeding while using the pill or HRT (Hormone Replacement Therapy)

None ☐1
1 to 3 ☐2
4 to 5 ☐3
6 to 9 ☐4
10 or more ☐5
Not applicable because using the Pill or HRT or currently pregnant ☐6

67. When did you last have a "natural" menstrual period? Do not count bleeding while using the pill or HRT (Hormone Replacement Therapy). Record as fully as possible

Date: _____ or age ☐☐ years old Don't Know ☐

68. Have you ever used HRT (Hormone Replacement Therapy) for menopause? Yes ☐1 No ☐2

If yes, how old were you when you first used HRT? ☐☐ years old

For how long altogether have you used HRT? years ☐☐ and months ☐☐

Are you currently using HRT? Yes ☐1 No ☐2

If no, how old were you when you last used HRT? ☐☐ years old

69. Have you had a hysterectomy?

Yes ☐1 Age at time of operation ☐☐ years old No ☐2 Don't Know ☐3

70. Have you had an operation to remove one or both your ovaries?

Yes ☐1 No ☐2 Don't Know ☐3

If yes, how old were you? ☐☐ years old

Were one or both ovaries removed? One ☐1 Both ☐2 Don't Know ☐3

71. Have you ever had a breast biopsy (minor surgery to remove tissue from your breast for diagnostic purposes)?

Yes ☐1 No ☐2 Don't Know ☐3

If yes, how old were you (first occurrence)? ☐☐ years old.

As soon as we receive this questionnaire we will remove this sheet and keep it securely separately from the rest of the questionnaire so that the information you have given is kept anonymously.

Can you please give us these other details: DATE OF BIRTH

FIRST NAME

OTHER NAME (s)

SURNAME AT BIRTH / (MAIDEN NAME)

CURRENT SURNAME / LAST NAME

Thank you for your help filling out this questionnaire and helping us with our research.

Please send your completed questionnaire in the FREEPOST envelope provided.

Please phone 0113 233 4862 if you have any queries about this questionnaire.

Please write any changes to the details on the label in the spaces below

First Name

Surname

Address

Postcode

Appendix B

THE FOOD CHOICE QUESTIONNAIRE

CONFIDENTIAL

UK Women's Cohort Study

MOTIVATIONS FOR CONSUMING A HEALTHY DIET

This sub-study of the Women's Cohort Study is being carried out in order that more effective dietary advice may be employed in the future. We would like to invite you to take part in this study. This would simply involve you filling out this questionnaire.

This questionnaire is designed to look at personal motivations for a healthy diet. Please answer every question. If you are uncertain how to answer a question then do the best you can, but please do not leave a question blank. Although the questionnaire may look lengthy it is quick and easy to fill out.

Please complete this questionnaire and return it along with the others in the pre-paid envelope provided. Your answers will be treated as strictly confidential and will be used only for medical research.

In question numbers 1-36 we are interested in finding out what factors are the most important for you, when you make a choice about what foods to eat.

Listed below are 36 statements all beginning with "It is important to me that the food I eat on a typical day...". Please complete the questionnaire by ticking the appropriate response for each statement.

It is important to me that the food I eat on a typical day:

	Not at all important	A little important	Moderately important	Very important
1) Is easy to prepare	☐	☐	☐	☐
2) Contains no additives	☐	☐	☐	☐
3) Is low in calories	☐	☐	☐	☐
4) Tastes good	☐	☐	☐	☐
5) Contains natural ingredients	☐	☐	☐	☐
6) Is not expensive	☐	☐	☐	☐
7) Is low in fat	☐	☐	☐	☐
8) Is familiar	☐	☐	☐	☐
9) Is high in fibre and roughage	☐	☐	☐	☐
10) Is nutritious	☐	☐	☐	☐
11) Is easily available in shops and supermarkets	☐	☐	☐	☐
12) Is good value for money	☐	☐	☐	☐
13) Cheers me up	☐	☐	☐	☐

It is important to me that the food I eat on a typical day:

	Not at all important	A little important	Moderately important	Very important
14) Smells nice	☐	☐	☐	☐
15) Can be cooked very simply	☐	☐	☐	☐
16) Helps me cope with stress	☐	☐	☐	☐
17) Helps me control my weight	☐	☐	☐	☐
18) Has a pleasant texture	☐	☐	☐	☐
19) Is packaged in an environmentally friendly way	☐	☐	☐	☐
20) Comes from countries I approve of politically	☐	☐	☐	☐
21) Is like the food I ate when I was a child	☐	☐	☐	☐
22) Contains a lot of vitamins and minerals	☐	☐	☐	☐
23) Contains no artificial ingredients	☐	☐	☐	☐
24) Keeps me awake/alert	☐	☐	☐	☐
25) Looks nice	☐	☐	☐	☐
26) Helps me relax	☐	☐	☐	☐
27) Is high in protein	☐	☐	☐	☐
28) Takes no time to prepare	☐	☐	☐	☐

It is important to me that the food I eat on a typical day:

	Not at all important	A little important	Moderately important	Very important
29) Keeps me healthy	☐	☐	☐	☐
30) Is good for my skin/teeth/hair/nails etc...	☐	☐	☐	☐
31) Makes me feel good	☐	☐	☐	☐
32) Has the country of origin clearly marked	☐	☐	☐	☐
33) Is what I usually eat	☐	☐	☐	☐
34) Helps me cope with life	☐	☐	☐	☐
35) Can be bought in shops close to where I live or work	☐	☐	☐	☐
36) Is cheap	☐	☐	☐	☐

For the next question we would like to know how many fruit and vegetables you eat, and for how long you have been following this dietary pattern. When counting up the number of servings of fruit and vegetables please exclude potatoes and remember to include any fruit and vegetables that may be incorporated into recipes.

37) Please read the following seven statements, and then tick the box next to the statement which you feel most applies to your diet. Please only tick ONE box.

i) I am not eating five servings of fruit and vegetables daily, and I do not want to start in the next six months. ☐

ii) I am not eating five servings of fruit and vegetables daily, but I would like to start in the next six months. ☐

iii) I am not eating five servings of fruit and vegetables daily, but I would like to start in the next month. ☐

iv) I have been eating five servings of fruit and vegetables daily, for less than six months. ☐

v) I have been eating five servings of fruit and vegetables on some days, for less than six months ☐

vi) I have been eating five servings of fruit and vegetables daily, for more than six months. ☐

vii) I have been eating five servings of fruit and vegetables on some days, for more than six months. ☐

In questions numbered 38-42, we would like to know about your beliefs and opinions of your own diet. For the next five questions please tick the box that most closely matches your feelings.

38) Compared to the average person of my age and sex in the UK I think my diet is....

☐	☐	☐	☐	☐
much more healthy	more healthy	about as healthy	less healthy	much less healthy

39) I believe my current diet to be...

☐	☐	☐	☐	☐
extremely healthy	quite healthy	neither healthy nor unhealthy	quite unhealthy	extremely unhealthy

40) For me to increase my intake of fruit and vegetables to five portions per day is....

☐	☐	☐	☐	☐
very easy	easy	neither easy nor difficult	difficult	very difficult

41) There are factors outside my control that could prevent me from increasing my intake of fruit and vegetables to five portions per day.

☐	☐	☐	☐	☐
strongly agree	agree	neither agree nor disagree	disagree	strongly disagree

41a) If you agree or strongly agree with this statement, what are these factors which you feel prevent you from increasing your intake of fruit and vegetables?

_____

_____

_____

_____

_____

42) What is the likelihood that, if you tried, you would be able to increase your intake of fruit and vegetables to five portions per day, from now on?

☐	☐	☐	☐	☐
very likely	likely	neither likely nor unlikely	unlikely	very unlikely

For questions 43 and 44, we would like your opinions on diet in general. For the next two questions please tick the box that most closely matches your feelings.

43) It is difficult to see any benefit in increasing the amounts of fruit and vegetables in the diet.

☐	☐	☐	☐	☐
strongly agree	agree	neither agree nor disagree	disagree	strongly disagree

44) Overall, I think that increasing fruit and vegetable intake, from two portions per day to five portions per day, would be...

a)

☐	☐	☐	☐	☐
very good	good	neither good nor bad	bad	very bad

b)

☐	☐	☐	☐	☐
very enjoyable	enjoyable	neither enjoyable nor unenjoyable	unenjoyable	very unenjoyable

c)

☐	☐	☐	☐	☐
very positive	positive	neither positive nor negative	negative	very negative

d)

☐	☐	☐	☐	☐
very beneficial	beneficial	neither beneficial nor harmful	harmful	very harmful

e)

☐	☐	☐	☐	☐
very pleasant	pleasant	neither pleasant nor unpleasant	unpleasant	very unpleasant

f)

☐	☐	☐	☐	☐
very favourable	favourable	neither favourable nor unfavourable	unfavourable	very unfavourable

Please use this space to record any comments you may have about this questionnaire. We would be very interested in your opinions.

Thank you very much for completing this questionnaire. If you have any queries concerning this project please contact **Jennie Pollard** on **0113 233 4862**. You can call this number at all times and if I am unavailable please leave a message and I will get back to you as soon as possible

THANK YOU FOR YOUR TIME

Appendix C

FOOD & ACTIVITY DIARY

UK Women's Cohort Study

FOOD & ACTIVITY DIARY

We would be grateful if you could record your food and drink for 4 consecutive days starting on a **FRIDAY**. On day three i.e. on **SUNDAY** we would also like you to keep a diary of all your physical activities for the day.

To give us an accurate picture, please fill out the diary in as much detail as possible.

It is very important that you do not change what you eat and drink, or the physical activities that you carry out just because you are keeping a record.

We appreciate that completing this diary will take some time and we wish to take this opportunity to thank you for your co-operation.

If you have any queries, please contact a member of the team on 0113 233 4866 or email cohorteam@leeds.ac.uk.

Thank you very much for your help.

Please complete and return this diary at your convenience, but preferably within the next two months.

INSTRUCTIONS ON HOW TO COMPLETE THIS DIARY

This diary is designed for you to record everything you eat and drink for four days, including one day for physical activity.

- Please record the time you had something to eat or drink in the left-hand column marked **"Time of food/drink"**.

- In the column marked **"Food and drink consumed, along with a description"**, please give a full record of the food/drink and how it was prepared. If possible, please record each individual food and drink item separately **(see example on page 3)**.

- In the last column, please record the **amount of food or drink you consumed** by giving the weight if on the packet or carton e.g. 150g pot of yoghurt, 56g bar of milk chocolate. For other foods we would like you to weigh the foods you consume. If you do not have scales at home, or if you are eating food away from the home, then describe the food you eat using household measures, e.g. tablespoons, cups, large glass, etc. Please document what you ate and drank in as much detail as possible.

- To establish that your weighing scales are accurate, please weigh **at least** one of the following foods in (grammes) and record your results in the boxes below :

1 raw egg (still in the shell) ☐☐g

1 large tin of baked beans (420g) ☐☐☐g

1 full bag of sugar ☐☐☐☐g

- At the end of the third page, there is space to write down all recipes and if more than one serving, how much was consumed by you. Also use this space to record details of any foods/drinks eaten away from home and to record the brand of any manufactured products.

- If you eat ready made foods that have the nutritional information on the packet, then please could you write down this information in the space provided on the fourth page. It is important to state if the information is for either per serving, or per 100 grammes. If it is for a serving, then please write down the serving size from the packet.

- If you took any **dietary supplements** that day, please make a note of them in the section at the end of the fourth page for each day. **If you have the packets of the supplements handy, please could you enclose an empty packet with the diary when you send it back to us. This way we can calculate your nutrient intake more accurately.**

- At the end of the diary section are a few questions about your diet in general over the four days you have recorded. Please remember to complete these before returning your food diary.

hysical Activity Diary

e would like to find out about your physical activity for one full day. **e would like you to fill in the physical activity diary on day ree.**

ease refer to the specific instructions, which are situated just fore the physical activity section in this diary on page 22.

EXAMPLE DAY - UP TO LUNCH

Date: 14 October 1998 Day of the week Friday		
Time of food or drink	**Description of food or drink consumed (include brandname where possible)**	**amount**
7.15 am	Filter Coffee	1 cup (200ml)
	semi-skimmed milk	3 tablespoons
7.30 am	Sainsbury's orange juice, un-sweetened	1 glass (150ml)
	Sainsbury's Bran flakes	40g
	semi-skimmed milk	180ml
10.30am	Plain chocolate digestives (large biscuits)	2
	Earl Grey tea (weak) no milk	1 cup
11 am	banana (medium sized)	95g
11.30 am	London herb company Lemon Zester tea	1
12.10 pm	Local bakery's wholemeal bread un-sliced loaf (cut thickly)	1 slice 47g
	Tesco sunflower margarine	thinly spread
	home-made mushroom risotto (see recipe)	About 1/3 of recipe
	green seedless grapes	32g
	Cox's Orange Pippin apple (medium)	82g
	Sainsbury's wholemilk fruit yoghurt (150g)	1 pot
	London herb company sweet berry tea	1
2pm	Warburton's Carrot cake - with cream cheese topping (see nutritional information)	1 slice - 75g (on packet)

Recipes/description of foods eaten away from home/any other comments

Home-made mushroom risotto
2 Tablespoons of olive oil
3 oz Butter
1 Clove of garlic
1lb Button Mushrooms
10oz Rice (long grain rice)
1 large onion
1½ Pints of vegetable stock
Pinch of salt & pepper
Pinch of rosemary, thyme & chilli powder.

Fry onion & garlic in butter & olive oil until soft. Add chilli & mushrooms. Cook gently for approx 5 mins. Add all of the rice, then add stock ladle by ladle until completely absorbed, this should take around 20 mins.

Usually approx 3 servings from this of equal proportion

Supplements

Please list any vitamins, minerals or other food supplements taken today, giving as much information as possible.
Please enclose the packaging of the supplements when you return this diary back to us.

Brand	Name	Amount and form of supplement	Strength or tick if empty packet is enclosed
1. Healthcrafts	Multivitamin with iron and calcium	(see empty container enclosed) 1 tablet	✓
2. Boots	Evening Primrose	1 capsule	1000mg per capsule
3.			
4.			
5.			
6.			

Example Continued:

Nutritional Information for Ready Made / Packaged foods

Please state, if the information is for a serving or for per 100g

Food	Serving size	per 100g	Energy kcal	Protein	Carbohydrate	Fat	Fibre
Carrot cake		✓	490	4.5	52.4	30.6	0.7

Any extras not already recorded, e.g. sweets/snacks/drinks?

2 polo mints during morning at work, & packet of Salt & Vinegar crisps (Walkers 28g) on the way home

END OF EXAMPLE

DAY ONE

(remember to record portion sizes for all foods)

Date:		
Time of food or drink	Description of food or drink consumed	amount

DAY ONE continued
(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

DAY ONE continued
(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

Recipes/description of foods eaten away from home/ any other comments (If additional space is needed then please use the blank pages at the end of the diary)

Please list any vitamins, minerals or other food supplements taken today, giving as much information as possible.

	Brand	Name	Amount and form taken (tablets, capsules)	Strength or tick if empty packet is enclosed
1.				
2.				
3.				
4.				
5.				
6.				

Nutritional Information for Ready Made / Packaged foods
Please state, if the information is for a serving or for per 100g

Food	Serving size	per 100g	Energy kcal	Protein	Carbohydrate	Fat	Fibre

Any extras not already recorded, e.g. sweets/snacks/drinks?

END OF DAY ONE

DAY TWO
(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

DAY TWO continued
(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

DAY TWO continued
(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

Recipes/description of foods eaten away from home/ any other comments **(if additional space is needed then please use the blank pages at the end of the diary)**

Please list any vitamins, minerals or other food supplements taken today, giving as much information as possible.

Brand	**Name**	**Amount and form taken (tablets, capsules)**	**Strength or tick if empty packet is enclosed**
1.			
2.			
3.			
4.			
5.			
6.			

Nutritional Information for Ready Made / Packaged foods
Please state, if the information is for a serving or for per 100g

Food	Serving size	per 100g	Energy kcal	Protein	Carbohydrate	Fat	Fibre

Any extras not already recorded, e.g. sweets/snacks/drinks?

END OF DAY TWO

DAY THREE
(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

DAY THREE continued
(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

DAY THREE continued
(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

Recipes/description of foods eaten away from home/ any other comments (if additional space is needed then please use the blank pages at the end of the diary)

Please list any vitamins, minerals or other food supplements taken today, giving as much information as possible.

	Brand	Name	Amount and form taken (tablets, capsules)	Strength or tick if empty packet is enclosed
1.				
2.				
3.				
4.				
5.				
6.				

Nutritional Information for Ready Made / Packaged foods
Please state, if the information is for a serving or for per 100g

Food	Serving size	per 100g	Energy kcal	Protein	Carbohydrate	Fat	Fibre

Any extras not already recorded, e.g. sweets/snacks/drinks?

END OF DAY THREE

DAY 3 Twenty-Four Hour Activity Diary

We would like to find out about your physical activity for one day. **Please complete this section on day three.** Please do not wait until the end of the day; fill in the diary continuously throughout the day, starting from when you get out of bed in the morning.

The diary is split into hours of the day, and then four fifteen-minute periods for that hour. In each box, write the number which corresponds to the activity which you have carried out during this fifteen minute period. Please fill in **all** the boxes, following the example diary on page 24.

Code	Activity
1	Sleeping, resting in bed, or lying down.
2	Sitting: eating, watching TV, computing, reading, listening, writing, sewing, talking on telephone, washing dishes etc.
3	Light activity standing: teaching, washing, combing, cooking, ironing, vacuuming, applying make-up, playing a musical instrument etc.
4	Slow walk, driving, to dress, to shower, yoga, food shopping, playing with children etc.
5	Light manual work: floor sweeping, window washing, painting, nursing chores, fast walk, mowing the lawn etc.
6	Leisure & sports in a recreational environment: golf, bowling, cycling, table tennis, gardening etc.
7	Manual work at a moderate pace: snow shovelling, loading goods, wood cutting etc.
8	Leisure & recreational sports at a higher intensity: swimming, horse riding, tennis, badminton, circuit training, skiing etc.
9	Intense manual work, high intensity sports: jogging & running, hiking, mountain climbing etc.

DAY 3 TWENTY-FOUR HOUR ACTIVITY DIARY

Date: ☐☐ ☐☐ ☐☐

Hour mins	0-15 mins	16-30 mins	31-45mins	46-60mins
0 (midnight)				
1 a.m.				
2 a.m.				
3 a.m.				
4 a.m.				
5 a.m.				
6 a.m.				
7 a.m.				
8 a.m.				
9 a.m.				
10 a.m.				
11 a.m.				
12 (midday)				
1 p.m.				
2 p.m.				
3 p.m.				
4 p.m.				
5 p.m.				
6 p.m.				
7 p.m.				
8 p.m.				
9 p.m.				
10 p.m.				
11 p.m.				

An Example of 24-Hour Activity Diary

Please refer to the example form filled in below. This person read in bed until 12.45am. Slept until 9am. Had breakfast until 9.15am, showered and got dressed. From 10am-12.45am they performed various activities around the home such as mowing the lawn & washing the windows. Lunch was at 12.45pm until 1.30pm. Followed by food shopping until 3.30p.m, and reading from 3.30pm until 5.30pm. At 5.30pm this person then cooked and ate dinner, watched TV until 7.30pm, then washed and cleaned the kitchen this took around three quarters of an hour. At 8.15pm they then drove to an aerobics class which started at 8.30pm and lasted for an hour. They then drove back home, washed and then went to bed at 10.30pm.

Hour mins	0-15 mins	16-30 mins	31-45 mins	46-60mins
0 (midnight)	2	2	2	1
1 a.m.	1	1	1	1
2 a.m.	1	1	1	1
3 a.m.	1	1	1	1
4 a.m.	1	1	1	1
5 a.m.	1	1	1	1
6 a.m.	1	1	1	1
7 a.m.	1	1	1	1
8 a.m.	1	1	1	1
9 a.m.	3	4	3	4
10 a.m.	5	5	5	5
11 a.m.	5	5	5	5
12 (midday)	5	5	5	2
1 p.m.	2	2	4	4
2 p.m.	4	4	4	4
3 p.m.	4	4	2	2
4 p.m.	2	2	2	2
5 p.m.	2	2	3	3
6 p.m.	3	2	2	2
7 p.m.	2	2	3	3
8 p.m.	3	4	8	8
9 p.m.	8	8	4	3
10 p.m.	3	3	1	1
11 p.m.	1	1	1	1

QUESTIONS ON PHYSICAL ACTIVITY.

(please tick one box ✓)

Was the day that you filled in :

1) A typical weekend or leisure day ☐
2) A typical week or work day ☐
3) Much less active than usual ☐
4) Much more active than usual ☐

If this day was very unusual, please describe why in the space below. For example, "usually on a Monday, I go swimming for half an hour, in addition to a fifteen minute brisk walk to pick up the children from school, but today I didn't do either of these activities."

DAY FOUR

(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

DAY FOUR continued

(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

DAY FOUR continued
(remember to record portion sizes for all foods)

Date:		
Time of food or drink	**Description of food or drink consumed**	**amount**

Recipes/description of foods eaten away from home/ any other comments **(if additional space is needed then please use the blank pages at the end of the diary)**

Please list any vitamins, minerals or other food supplements taken today, giving as much information as possible.

Brand	**Name**	**Amount and form taken (tablets, capsules)**	**Strength or tick if empty packet is enclosed**
1.			
2.			
3.			
4.			
5.			
6.			

Nutritional Information for Ready Made / Packaged foods
Please state, if the information is for a serving or for per 100g

Food	Serving size	per 100g	Energy kcal	Protein	Carbohydrate	Fat	Fibre

Any extras not already recorded, e.g. sweets/snacks/drinks?

END OF DAY FOUR

Some questions about your diet over the last four days

Even though you have documented your diet over the last four days in detail, we would like to confirm a few facts about your food intake.

1. Are you currently on a weight reducing diet?
   yes[1] ☐ no[2] ☐

2. Were you ill during the period of recording your food intake?
   yes[1] ☐ no[2] ☐

3. Did you change what you normally ate because you were recording your food intake?
   yes[1] ☐ no[2] ☐ don't know[3] ☐

   If Yes, how did your diet change?
   ate more[1] ☐ ate less[2] ☐ ate different foods[3] ☐

   Please specify _____

   _____

   _____

4. Which type of milk did you use most? Select one only

Full cream, silver	☐	Semi-skimmed, red/white	☐
Skimmed / fat free	☐	Channel islands, gold	☐
Sterilized	☐	Dried Milk	☐
Soya	☐	Homogenized	☐
State type _____			
Other	☐		
State type _____			
None	☐		

5. *How much milk did you usually have in your tea?*

A lot ☐ Average ☐ I did not drink tea ☐

Hardly any ☐ None ☐

6. How much milk did you usually have in your coffee?

A lot ☐ Average ☐ I did not drink coffee ☐

Hardly any ☐ None ☐

7. What type of coffee did you mostly drink?

Instant ☐ Instant decaffeinated ☐

Filtered/caffetière ☐ Filtered/caffetière decaffeinated ☐

I did not drink coffee ☐

8. Did you drink decaffeinated tea?

Always ☐ Sometimes ☐ Never ☐

9. Which type of bread did you eat most often in the four days that you filled in the diary? Select one only.

White ☐ Wholemeal ☐ Granary ☐

Brown ☐ Softgrain e.g.(mighty-white) ☐

Other. ☐ please specify _____

10. If you ate butter, margarine or spread. Please indicate (tick ✓) if you ate it on the following foods during the four days that you filled in your diary.

	Always	Sometimes	Never	Don't know	Didn't eat the food
Toast					
Bread					
sandwiches					

11. How thickly did you spread your butter, margarine or spread on bread, crackers etc?

Thick ☐ Medium ☐ Thin ☐ None ☐

12. Which types of fats did you use when you filled in your food diary?

	Brand used & type used	What did you use it for?			
		Baking	Frying	Spreading	Salads
Butter					
Low fat spread					
Very low fat spread					
Polyunsaturated margarine					
Other soft margarine					
Monounsaturated spread e.g. Olivio					
Half-Fat Butter					
Hard margarine					
Olive oil					
Vegetable oils					
White vegetable fat					
Lard					
Dripping					
Other					

13. If you ate meat, what did you do with the visible fat?

Ate all of the fat ☐ Ate most of the fat ☐

Ate some of the fat ☐ Ate as little as possible ☐

14. *If you ate poultry last week, did you eat the skin?*

Yes ☐ No ☐ Sometimes ☐ Don't know ☐

15. Did you add salt to your food during cooking?

Yes ☐ No ☐ Don't know ☐

16. Did you add salt to your food at the table?

Yes ☐ No ☐ Don't know ☐

This space has been left for you to tell us about anything else which you feel is important about your food/drink intake last week.

Thank you for filling in the food and activity diaries.

It may help us if you could put your telephone number here in case we need to clarify any of your responses.

Daytime telephone number: _____

Evening telephone number: _____

Please confirm your personal details

Name _____

Date of Birth ☐☐ ☐☐ ☐☐

Appendix D

SUBJECT INFORMATION SHEET

SUBJECT INFORMATION SHEET

Dear ,

RESEARCH PROJECT TO STUDY MOTIVATIONS FOR CONSUMING A HEALTHY DIET.

Thank you for your participation in the UK Women's Cohort Study: Dietary Fibre Sub-study, and for allowing a blood sample to be taken. Following on from this study we would like to look in more detail at the data collected. Therefore we would like to invite you to take part in a further study which is going to look at personal motivations for a healthy diet and blood levels of certain vitamins.

Taking part in this research study will firstly involve completing a postal questionnaire, called The UK Women's Cohort Study: Motivations for a Healthy Diet. This questionnaire is quick and easy to fill out and involves simply ticking an appropriate response for a number of statements about the food that you eat. Six months later you will be visited by a researcher, at a convenient time in your own home, in order to take a single 5ml blood test (this is the equivalent of about one teaspoon of blood). In the same visit you will be asked to fill out the questionnaire for a second time. We ask you to repeat this in order that we are able to study seasonal changes in food choice.

The results of this study will be of great help in research and also for use in future health promotion campaigns. If you agree to take part in this study we will contact you to arrange an appointment. Taking part in this study is completely voluntary and you may decide at any time not to take part.

Although this study will not be of direct benefit to you it is part of the on-going work of the largest study of women's dietary patterns in the UK - the UK Women's Cohort Study. It is also being carried out to fulfill the requirements of a research degree.

If you have any questions about this research project please do not hesitate to contact Jennie Pollard on 0113 233 4862. We will ensure that anything you tell us will remain completely confidential and will only be used for the purposes of this research.

If you are willing to take part in the project please sign your name on the consent form enclosed, complete the questionnaire and return them both to us in the freepost envelope provided.

Thank you for your time.
Yours sincerely

J E Pollard.

Jennie Pollard
(Researcher)

Appendix E

CONSENT FORM 1

CONSENT FORM

Research project to study motivations for consuming a healthy diet.

Please delete
As applicable.

1. I have read the Subject Information Sheet. Yes / No

2. I have had the opportunity to ask questions and discuss the research study. Yes / No

3. I have received enough information about the study. Yes / No

4. I understand that I am free to withdraw from the study at any time without giving a reason. Yes / No

5. I agree to take part in the research study. Yes / No

Signature.....

Name (block capitals).....

Date.....

Please return this form to us in the enclosed envelope. Thank you for your time.

Appendix F

APPOINTMENT REMINDERS

MOTIVATIONS FOR A HEALTHY DIET:

REMINDER OF APPOINTMENT FOR A BLOOD TEST

DATE: TIME:

PLEASE REMEMBER THIS NEEDS TO BE A FASTING BLOOD SAMPLE.
PLEASE DO NOT EAT OR DRINK ANYTHING FROM MIDNIGHT, THE NIGHT BEFORE, UNTIL AFTER YOUR SAMPLE HAS BEEN TAKEN.

IF YOU NEED TO CANCEL THE ABOVE APPOINTMENT PLEASE CONTACT **JENNIE POLLARD** ON **0113 233 4862**, OR IF YOU NEED TO CANCEL ON THE MORNING OF THE APPOINTMENT PLEASE CALL **07775 788158**

THANK YOU

Appendix G

CONSENT FORM 2

RESEARCH PROJECT TO STUDY MOTIVATIONS FOR CONSUMING A HEALTHY DIET.

I, ... consent to a sample of my blood being taken by JENNIE POLLARD (BSc(Hons) Applied Human Nutrition).

I agree to:

- The sample undergoing investigations as part of the research project to study factors affecting the consumption of a healthy diet.

YES / NO

- Any unused blood being retained for possible inclusion in further studies.

(If the remaining blood were to be used for future research we would contact you again in order to obtain further written consent).

YES / NO

Signature..... ..... (Research Assistant)

Date..... Date .....

I would / would not* be willing to provide further samples of my blood in the event of research arising from this study in the future. (* Delete as applicable).

Appendix H

24-HOUR RECALL DATA SHEET

24-HOUR RECALL

DATE OF VISIT:
DATE OF RECALL:
DAY OF RECALL:

ID NO:
SURNAME:

Before Breakfast

Food/drink	Description and Preparation	Amount

Breakfast

Food/drink	Description and Preparation	Amount

Mid Morning

Food/drink	Description and Preparation	Amount

Lunch

Food/drink	Description and Preparation	Amount

Mid Afternoon

Food/drink	Description and Preparation	Amount

Evening Meal

Food/drink	Description and Preparation	Amount

Later Evening

Food/drink	Description and Preparation	Amount

Dietary Supplements

Appendix I

EXPERIMENTAL TECHNIQUES

Experimental techniques for determining plasma ascorbic acid levels

The samples were analysed for ascorbic acid using modified methods from Sobala *et al.*(Sobala et al. 1991). Quality control (QC) material was prepared from Li-heparin plasma from normal subjects pooled to give a volume of 25-30ml. The plasma was then distributed in 0.5ml aliquots into Lp3 tubes and 1.0ml 25 MPA was added to each tube. The tubes were mixed, capped and stored at -70°c. Samples and QC's were removed from the freezer, thawed and mixed gently. They were then centrifuged at 3500rpm at 4°c for 15 minutes.

Stock standard solutions were prepared by adding 20mg ascorbic acid to 0.5ml Dithiothreitol (DTT) solution (7mg/ml) and making the volume up to 100ml. Working standards of 4µg/ml were prepared by taking aliquots of the stock standard solution (100µl) adding them to 2.5ml 2% metaphosphoric acid (MPA) and 2.4ml UHW deionised water. These standards were prepared daily. Ascorbic acid was measured using reverse phase, ion-pair chromatography on a Waters 4µ Nova-Pak C_{18} cartridge (8 x 100mm) in a Waters Z-Module and protected by a guard column (2cm x 4.6mm) packed with C_{18} corasil. The mobile phase consisted of 0.2M sodium acetate/acetonitrile (95:5 v/v) containing 1.6ml/L octylamine (approximately 10mM). The final pH was 4.3. The flow rate was 2ml/minute and the retention time of ascorbic acid was 4.5 minutes.

Experimental techniques for determining plasma carotenoid levels

The plasma carotenoids; β-carotene, lutein, cryptoxanthin and lycopene, were analysed by reversed phase High Performance Liquid Chromatography using modified methods from Thurnham *et al.* (Thurnham, Smith, & Flora 1988). QC material was prepared from 100ml pooled plasma, mixed for at least one hour on a magnetic stirrer, followed by storage in universals at -40°c overnight. The next morning the universals were thawed, mixed and centrifuged at 3500rpm. The supernatant plasma was then removed and stirred vigorously for 1 hour prior to aliquoting into 1ml portions in LP4 tubes.

Samples and QC's were prepared by mixing 200µl ethanol, containing tocopherol acetate and retinyl acetate, whirly-mixing for 6 seconds and allowing to stand for 2 minutes. 0.7ml of hexane was added to each tube and multivortexed on 4.0 for 2 minutes and then centrifuged at 1000rpm for 3 minutes at room temperature. The hexane layer was then transferred and evaporated under nitrogen at 40°c. To this 200µl ethanol was added and whirly-mixed briefly before leaving to stand in the dark for 15 minutes. The samples were then transferred to 0.3ml autosampler tubes and covered with PVC cling film.

Stock standard solutions of all carotenoids were prepared by dissolving the specific carotenoid in a small amount of dichlormethane and make up to the mark with hexane. Working standards were made by aliquoting 50µl of each carotenoid stock solution into 2 x 20ml volumetric flasks and

makin gup the volume with ethanol. The dilution factor is 400 and 200µl of tocopherol acetate stock was included in this standard. The working standard was stored at -20°c. Carotenoids were measured using reverse phase, ion-pair chromatography. As the method was also measuring tocopherols (data not shown) three detectors were connected in series, the first (ABI 785A) was set at 450nm, the second (ABI 785A) was set at 292nm, and the third (Waters 440) had a filter at 313nm. The peaks were monitored with two pen recorders and the data was recorded on three channels of the 715 HPLC software. The mobile phase consisted of methanol: acetonitrile: dichloromethane (50: 40: 10) containing 20mg BHT/L, ammonium acetate (1g/L) and triethylamine (500µL/l). The flow rate was 1ml/minute and the retention time of β-carotene was 21 minutes. The HPLC was run overnight.

Appendix J

PRESENTATIONS AND PUBLICATIONS BASED ON WORK REPORTED IN THIS THESIS, OR RELATED

Chapter 2

Pollard,J., Kirk,S.F.L. & Cade,J.E. Factors Affecting Food Choice in Relation to Fruit and Vegetable Intake: A Review. Nutrition Research Reviews *(in print)*

Chapter 3

Pollard,J., Greenwood,D., Kirk,S. & Cade,J. (2001) Lifestyle factors affecting fruit and vegetable consumption in the UK Women's Cohort Study. Appetite **37**, 71-79.

Pollard,J., Cade,J., Kirk,S., Greenhalgh,A. & Greenwood,D. Factors affecting fruit and vegetable consumption: baseline analysis of women participating in the UK Women's Cohort Study. Poster presented at the Food Choice 2000 Conference, Dublin, June 2000. Abstract published in conference proceedings.

Chapter 4

Pollard,J., Greenwood,D., Kirk,S. & Cade,J. Motivations for fruit and vegetable consumption in the UK Women's Cohort Study. Public Health Nutrition **5** : 3, 479-486.

Pollard,J., Greenwood,D. & Kirk,S. Motivations for fruit and vegetable consumption in the UK Women's Cohort Study. Presented at the joint Food Choice and Society for the Study of Ingestive Behaviour (SSIB) 2001 Conference, Philadelphia USA, July 2001. Abstract published in conference proceedings.

Chapter 5

Pollard,J., Wild,C.P., White,K., Greenwood,D., Cade,J. & Kirk,S. Comparison of plasma biomarkers with dietary assessment methods for fruit and vegetable intake. Submitted to European Journal of Clinical Nutrition.

Pollard,J.E., Greenwood,D.G. & Cade,J.E. Blood as a biomarker: the antioxidant vitamins. Presented at the British Nutrition Society Summer Meeting, Sheffield, June 2001. Abstract published in conference proceedings.

Pollard,J., Cade,J., Greenwood,D., Kirk,S.F.L., White,K.L.M. & Wild,C.P. Blood as a biomarker of fruit and vegetable consumption. Poster presented at the UK Molecular Epidemiology Group Meeting, London, December 2001.