

# **Assessment of nutrition information online and the #nutrition social network**

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## **Declaration**

### **Intellectual property and publications**

I confirm that the work submitted is my own, except where work which has formed part of jointly authored publications has been included. My contribution and the other authors to this work has been explicitly indicated below. I confirm that appropriate credit has been given within the thesis where reference has been made to the work of others.

### **Co-authored publications**

#### **Chapter 2**

**Ellis, CH.** and Evans, CEL. (2022) Nutrition Communication in Public Health and the Media. In Evans, CEL. (Ed.) *Transforming food environments* (1<sup>st</sup> ed., pp. 173-186). Boca Raton, CRC Press. [ISBN 9780367488604](https://doi.org/10.1080/9780367488604)

**Author contributions:** CHE researched literature and prepared the first draft. CELE reviewed and edited the initial draft. Both authors reviewed and edited the manuscript and approved the final version.

#### **Chapter 3**

**Ellis CH.,** Moore JB., Ho P., Evans CEL. Development and validation of a quality assessment tool to assess online nutrition information. *DIGITAL HEALTH*. 2023;9. doi:[10.1177/20552076231187249](https://doi.org/10.1177/20552076231187249)

**Author contributions:** CHE researched literature and conceived the study. CELE was involved in study design and protocol development. JBM contributed to the conceptualisation and methodology. PH advised on and contributed to the statistical and data analysis. CHE wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

#### **Chapter 4**

**Ellis CH.,** Moore JB., Ho P., Evans CEL. Content quality versus sharing practices on social media: A cross-sectional analysis of nutrition information on Twitter. Under review. *Public Health Nutrition*. 2025;28(1):e77. [doi:10.1017/S1368980025000461](https://doi.org/10.1017/S1368980025000461)

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## Chapter 5

**Ellis CH.**, Moore JB., Ho P., Ahmed, W., Evans CEL. Social network and linguistic analysis of the #nutrition discourse on the social network platform X, formerly known as Twitter. *Soc. Netw. Anal. Min.* 14, 238 (2024). <https://doi.org/10.1007/s13278-024-01404-9>

**Author contributions:** CHE researched literature and conceived the study. JBM and CELE were involved in study design and protocol development. WA contributed to the statistical and data analysis. CHE wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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This thesis is submitted in accordance with the requirements of the ‘alternative route via publication’ due to the volume of published material produced from the analyses conducted in this thesis.

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## **Abstract**

### **Introduction**

The global rise in non-communicable disease underscores the critical role of nutrition and poor dietary choices in public health, which is exacerbated by misinformation, and an unregulated digital environment. This thesis developed a validated tool to assess the quality of online nutrition information, examined the actors in the online debate, and offers strategies to improve information quality and reduce the propagation of nutrition misinformation.

### **Methods**

Quality assessment criteria were developed and validated through six stages: literature review, framework development, pilot testing, validation against existing tools, reliability testing, and application to nutrition-related URLs shared via X (formerly Twitter). Reposted and non-reposted data were compared for quality differences. Finally, to fully understand the discourse and structure of the online nutrition debate, NodeXL Pro was used for network, semantic, and sentiment analyses of the #nutrition network on X in March 2023.

### **Results**

The final validated Online Quality Assessment Tool included 10 questions, and demonstrated high interrater reliability ( $k = 0.653$ ,  $p < 0.001$ ) and moderate internal consistency ( $\alpha = 0.382$ ). Pilot testing found 3% of articles were poor, 49% satisfactory, and 48% high-quality, with significant differences in quality scores between blogs, news articles, and press releases,  $\chi^2(2) = 23.22$ ,  $p < 0.001$ . Poor-quality information was more prevalent in personal and company blogs, and reposted articles ( $n=267$ , sum of rank, 461.6) showing a significant difference in quality,  $U = 87475$ ,  $p = 0.006$ , compared to non-reposted articles ( $n=738$ , sum of rank, 518.0). Social network analysis revealed a dispersed #nutrition network, where a few influential users, predominantly non-experts, shaped the debate. Semantic analysis highlighted themes of health, lifestyle, and diet.

### **Conclusion**

This thesis introduced a novel tool for assessing online nutrition information quality with high validity and reliability. Its use revealed that low-quality articles are more frequently shared. Social network and sentiment analyses illustrated a dispersed, publicly driven #nutrition debate, dominated by health and lifestyle topics primarily propagated via reposting.

## Table of Contents

<b>Declaration.....</b>	<b>II</b>
<b>Acknowledgements.....</b>	<b>IV</b>
<b>Abstract.....</b>	<b>V</b>
<b>Table of Contents .....</b>	<b>VI</b>
<b>List of Figures.....</b>	<b>X</b>
<b>List of Tables .....</b>	<b>XI</b>
<b>Abbreviations .....</b>	<b>XII</b>
<b>Scientific contributions from this PhD.....</b>	<b>XIV</b>
<b>Positionality statement.....</b>	<b>XVI</b>
<b>Thesis outline.....</b>	<b>XVII</b>
<b>Chapter 1 Thesis overview, gaps, aims, and objectives .....</b>	<b>18</b>
1.1 Introduction: Nutrition and global public health .....	18
1.1.1 The food environment .....	17
1.1.2 Public interest in nutrition .....	19
1.2 Nutrition communication .....	19
1.2.1 Assessment of information quality .....	20
1.2.2 Social media.....	21
1.2.3 Social networks.....	22
1.3 Risks to public health .....	23
1.3.1 Misinformation .....	24
1.3.2 Polarisation .....	24
1.3.3 The rise of the ‘Influencer’ .....	25
1.4 Gaps in knowledge and methodology .....	26
1.4.1 Quality criteria and assessment tools.....	26
1.4.2 Information quality .....	27
1.4.3 Network analysis .....	27
1.5 Aims and objectives .....	27
1.5.1 Aims .....	28
1.5.2 Objectives .....	28
1.6 References.....	30
Reflections on developments since the literature review was published .....	39
<b>Chapter 2 Nutrition communication in public health and the media .....</b>	<b>42</b>
2.1 Introduction .....	42

2.2 Health and nutrition communication .....	42
2.2.1 History of health and nutrition communication in the UK .....	43
2.2.2 Social marketing campaigns .....	44
2.2.3 Case study: UK Change4Life social marketing campaign .....	45
2.3 Nutrition in the media.....	46
2.3.1 Newspapers.....	46
2.3.2 Blogs .....	47
2.3.3 Online social media .....	47
2.4 False information and ‘fake news’ .....	49
2.4.1 Misinformation .....	50
2.4.2 Disinformation .....	50
2.4.3 Fake news .....	51
2.4.4 Sharing false information .....	51
2.4.5 Media as a propagandist .....	53
2.5 Conclusions and recommendations .....	54
2.6 References .....	54
<b>Chapter 3 Development and validation of a quality assessment tool to assess online nutrition information .....</b>	<b>58</b>
3.1 Abstract .....	58
3.2 Introduction .....	59
3.2.1 Aims .....	62
3.3 Methods .....	62
3.3.1 Development of a novel online quality assessment tool (OQAT) .....	62
3.3.2 Expert panel evaluation .....	65
3.3.3 Validation of the novel OQAT .....	65
3.3.4 Inter-rater reliability.....	65
3.3.5 Pilot data collection .....	66
3.3.6 Statistical analysis.....	66
3.4 Results .....	67
3.4.1 Development of the Online Quality Assessment Tool (OQAT).....	67
3.4.2 Validation of the Online Quality Assessment Tool (OQAT) .....	70
3.4.3 Reliability testing.....	70
3.4.4 Fit .....	71
3.4.5 Estimation of cut-off points .....	72
3.4.6 Testing the OQAT for quality assessment of online information.....	72
3.5 Discussion .....	76
3.5.1 Conclusions.....	81

3.6 References .....	81
<b>Chapter 4 Content quality versus sharing practices on social media: A cross-sectional analysis of nutrition information on Twitter.....</b>	<b>85</b>
4.1 Abstract .....	85
4.2 Introduction .....	86
4.3 Methods .....	88
4.3.1 Data collection and screening .....	88
4.3.2 Statistical analysis.....	90
4.4 Results .....	91
4.4.1 Data collection .....	91
4.4.2 Fit and inter-rater analysis .....	93
4.4.3 Descriptive analysis .....	95
4.4.4 Retweet and no retweet comparison .....	98
4.4.5 Media source.....	98
4.4.6 Quality by media source .....	99
4.5 Discussion .....	99
4.5.1 Strengths and limitations .....	102
4.5.2 Conclusions.....	105
4.6 References .....	105
<b>Chapter 5 Social network and linguistic analysis of the #nutrition discourse on the social network platform X, formerly known as Twitter .....</b>	<b>108</b>
5.1 Abstract .....	108
5.2 Introduction .....	109
5.2.1 Influencers .....	110
5.2.2 Aims and objectives.....	110
5.3 Methods.....	111
5.3.1 Data retrieval .....	111
5.3.2 Data cleaning .....	113
5.3.3 Data analysis.....	113
5.4 Results .....	114
5.4.1 Social network analysis .....	115
5.4.2 Influencers .....	117
5.4.3 Semantic analysis.....	118
5.4.4 Sentiment analysis .....	120
5.5 Discussion .....	121
5.5.1 Future research.....	125
5.5.2 Conclusions.....	125



5.6 References .....	125
<b>Chapter 6 Critical discussion .....</b>	<b>129</b>
6.1 Summary of findings .....	129
6.2 Contributions to the evidence-base .....	130
6.2.1 Methodology – a mixed methods approach .....	131
6.2.2 Identification of routes to combat online misinformation .....	132
6.2.3 Creation of the novel Online Quality Assessment Tool .....	133
6.2.4 Social networks.....	134
6.3 Ethical considerations.....	134
6.4 Limitations and strengths of the PhD research.....	135
6.4.1 Limitations .....	135
6.4.1.1 Methodology .....	135
6.4.1.2 Social media .....	137
6.4.1.3 The Online Quality Assessment Tool (OQAT) .....	138
6.4.2 Strengths .....	138
6.4.2.1 Methodology .....	138
6.4.2.2 Social media .....	139
6.4.2.3 Online Quality Assessment Tool (OQAT).....	140
6.4.2.4 Social network analysis.....	140
6.5 Implications for public health and recommendations .....	140
6.5.1 Public health implications.....	141
6.5.2 Recommendations.....	142
6.6 Recommendations for further research .....	145
6.7 Conclusions .....	148
6.8 References .....	148
Appendix A Chapter 3 Supplementary material .....	<b>154</b>
Appendix B Chapter 4 Supplementary material .....	<b>160</b>
Appendix C Chapter 5 Supplementary material .....	<b>162</b>
Appendix D Generative AI statement .....	<b>163</b>
Appendix E Intellectual Property and Commercialisation Statement .....	<b>166</b>
Appendix F Data use statement .....	<b>167</b>
Appendix G Statement of data flow and software .....	<b>168</b>
Appendix H Search term decision process.....	<b>169</b>

## List of Figures

Figure 1.1 Global prevalence of aspects of the triple burden of malnutrition .....	17
Figure 2.1 Timeline of health communication in the UK .....	43
Figure 2.2 Most popular social networks worldwide as of July 2020, ranked by number of active users (in millions) using data from Data Reportal. ....	48
Figure 2.3 Social diffusion model of information, misinformation and disinformation .....	52
Figure 3.1 Flow diagram of identification and screening of tweets from 19 April 2021 for analysis to test the novel tool for assessing the quality of online nutrition information .....	74
Figure 3.2 Percentage of articles in each category as assessed by the novel Online Quality Assessment Tool (OQAT) .....	75
Figure 3.3 Mean Online Quality Assessment Tool (OQAT) score per criterion by content type .....	76
Figure 4.1 Total number of tweets categorised as nutrition information and URLs collected by month in 2021 .....	92
Figure 4.2 Flow diagram of identification and screening of tweets for analysis to assess the quality of online nutrition information .....	93
Figure 4.3 Wright map illustrating the quality of each article and discriminating quality assessment criteria. ....	94
Figure 4.4 Fourfold display of article quality (High vs Satisfactory) by source. ....	98
Figure 5.1 Overview of research methods in NodeXL Pro .....	113
Figure 5.2 Number of posts by published category .....	115
Figure 5.3 Network visualisation of the #nutrition debate on X .....	117
Figure 5.4 Semantic network map of word pairs .....	120
Appendix A Chapter 3 Supplementary material	
Figure A.1 Wright Maps used to determine cut-offs for poor, satisfactory and high- quality articles, Rater 1 .....	158
Figure A.2 Wright Maps used to determine cut-offs for poor, satisfactory and high- quality articles, Rater 2 .....	159
Appendix B Chapter 4 Supplementary material	
Figure B.1 Wright Map of Rater One scores .....	160
Figure B.2 Wright Map of Rater One scores .....	160

## List of Tables

Table 2.1 Top Five Reasons for Sharing Misinformation on Social Media by Gender .....	53
Table 3.1 Quality Assessment Criteria for the Novel Online Quality Assessment Tool (OQAT).....	68
Table 3.2 Content analysis codebook .....	69
Table 3.3 Tabulation of scores on the Robinson and the Online Quality Assessment Tool (OQAT) by tertile for news articles.....	70
Table 3.4 Interrater reliability by tertile for all data assessed.....	71
Table 3.5 Item fit statistics for the dichotomous Rasch Model.....	73
Table 4.1 Online Quality Assessment Tool ranks by shared status, content type and media source .....	96
Table 5.1 Summary of the #nutrition network debate taking place on X .....	116
Table 5.2 Top 10 influential users in the #nutrition network ranked by their betweenness centrality score .....	118
Table 5.3 Top 10 hashtags, words and word pairs .....	119
Table 5.4 Sentiment analysis of the network .....	121
Table 6.1 Summary of key outcomes from this thesis .....	131
Appendix A Chapter 3 Supplementary material	
Table A.1 Source of the final quality Indicators selected for the novel Online Quality Assessment Tool (OQAT) .....	154
Table A.2 Instructions for using the Online Quality Assessment Tool (OQAT) ...	154
Appendix C Chapter 5 Supplementary material	
Table C.1 Network Theory definitions .....	162

## Abbreviations

### Abbreviation/Acronyms

ACM  
AI  
AMS  
API  
BBC  
BMI  
CI  
CNN  
COMBI  
DALY  
ECDC  
EU  
FAO  
FDA  
GPT  
HONcode  
IQR  
JAMA  
JMLE  
NCD  
NGO  
NodeXL Pro  
  
OFCOM  
OQAT  
OUTFIT  
PCAR  
PHE  
PR  
SARS-CoV-2  
SDG  
SE  
SNA  
SPSS  
SSB  
STEM  
UAE  
UK  
UN  
UNESCO  
UNICEF

### Definitions

Association for Computing Machinery  
Artificial Intelligence  
Academy of Medical Sciences  
Application Programming Interface  
British Broadcasting Corporation  
Body Mass Index  
Confidence Interval  
Cable News Network  
Communication for Behavioural Impact framework  
Disability Adjusted Life Years  
European Centre for Disease Prevention and Control  
European Union  
Food & Agriculture Organization  
U.S. Food and Drug Administration  
Generative Pre-trained Transformers  
Health on the Net Code of Conduct  
Inter Quartile Ranges  
Journal of American Medical Association  
Joint Maximum Likelihood Estimation  
Non-Communicable Disease  
Non-Government Organisation  
Network Overview for Discovery and Exploration in Excel  
Office of Communications  
Online Quality Assessment Tool  
Outlier-sensitive Fit  
Principal Component Analysis of Rasch Residuals  
Public Health England  
Press Release  
Severe Acute Respiratory Syndrome Coronavirus 2  
Sustainable Development Goals  
Standard Error  
Social Network Analysis  
Statistical Package for the Social Sciences  
Sugar Sweetened Beverage  
Science Technology Engineering and Maths  
United Arab Emirates  
United Kingdom  
United Nations  
United Nations Educational, Scientific and Cultural Organization  
United Nations International Children's Emergency Fund

URL	Uniform Resource Locator
US	United States
USA	United States of America
WEF	World Economic Forum
WHO	World Health Organization

## Scientific contributions from this PhD

### Published peer-reviewed articles

**Ellis, CH.** & Evans, CEL. (2022) Nutrition Communication in Public Health and the Media. In Evans, CEL. (Ed.) *Transforming food environments* (1<sup>st</sup> ed., pp. 173-186). Boca Raton, CRC Press. [ISBN 9780367488604](#)

**Ellis CH.,** Moore JB., Ho P., Evans CEL. (2023) Development and validation of a quality assessment tool to assess online nutrition information. *DIGITAL HEALTH*. 2023;9. <https://doi.org/10.1177/20552076231187249>

**Ellis CH.,** Moore JB., Ho P., Evans CEL. Content quality versus sharing practices on social media: A cross-sectional analysis of nutrition information on Twitter. *Public Health Nutrition*. 2025;28(1):e77. [doi:10.1017/S1368980025000461](https://doi.org/10.1017/S1368980025000461)

**Ellis CH.,** Moore JB., Ho P., Ahmed, W., Evans CEL. (2024) Social network and linguistic analysis of the #nutrition discourse on the social network platform X, formerly known as Twitter. *Soc. Netw. Anal. Min.* 14, 238. <https://doi.org/10.1007/s13278-024-01404-9>

### Conference presentations

**Nutrition Society Live 2020:** Systematic assessment of obesity information on the microblogging platform Twitter. **Ellis, CH.,** Evans, CEL., and Moore, JB. *Proc Nutr Soc.* 2020; 79 (OCE3) E791. Doi:[10.1017/S0029665120007776](https://doi.org/10.1017/S0029665120007776)

**Nutrition Society Winter Conference 2021:** Development and validation of a novel quality assessment tool to measure the quality of nutrition information online. **Ellis, CH.,** Moore, JB and Evans, CEL. *Proc Nutr Soc.* 2022; 81(OCE1) E27. Doi:[10.1017/S0029665122000271](https://doi.org/10.1017/S0029665122000271)

**International Union of Nutrition Sciences, International Congress of Nutrition 2022:** Quality comparison of nutrition information on Twitter with and without a secondary share. **Ellis, CH.,** Coyle, K., Moore, JB., and Evans, CEL. *Ann Nutr Metab.* 2023 79 (Suppl.1): 14–1172. Doi:[10.1159/000530786](https://doi.org/10.1159/000530786)

**14<sup>th</sup> European Nutrition Conference 2023:** Social Network and Sentiment Analysis of the #Nutrition Discourse on Twitter. **Ellis, CH., Evans, CEL., and Moore, JB.** *Proceedings*. 2023, 91, 301. Doi: [10.3390/proceedings2023091301](https://doi.org/10.3390/proceedings2023091301)

## **Positionality statement**

The quality of nutrition information available online is more than an academic concern—it is a public health issue with global implications. As Science Director at the Nutrition Society, and previously a Scientific Writer, I have witnessed first-hand the growing disconnect between evidence-based nutrition science and the content that circulates online. The rapid spread of oversimplified and misleading nutrition content online has made it increasingly difficult for individuals to make healthy dietary choices, and poses a significant threat to public trust in science.

This PhD project offered the opportunity to systematically assess the credibility, dissemination, and impact of online nutrition content, particularly through the lens of social networks and digital health communication. With my background in scientific publishing, policy engagement, and strategic leadership in nutritional science, I was uniquely positioned to contribute meaningful insight into the quality control challenges posed online.

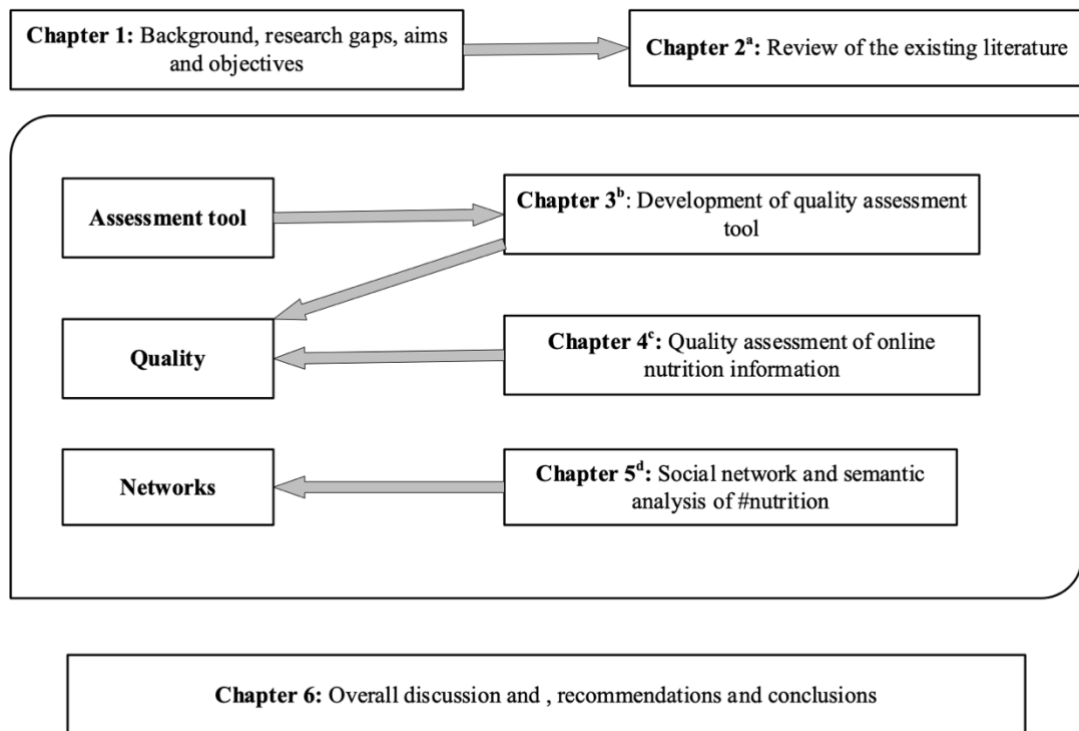
I was motivated by the potential to develop evidence-based frameworks that could help distinguish credible from misleading content. I was particularly interested in identifying indicators of credibility and developing tools to help both professionals to create accurate, accessible dietary guidance, and the public navigate nutrition information online more effectively.

This PhD has allowed me to build on my background in science communication while contributing to a growing field at the intersection of digital health, public nutrition, and misinformation. My findings have been able to deliver impactful, policy-relevant findings that advance both research and practice.



## Thesis outline

This PhD thesis was constructed around a series of interconnected studies, each providing unique insights into the research question. This format not only allows for a more direct presentation of each study but also provides a clearer path for understanding the overall narrative of the research. The thesis itself comprises six chapters, each serving a distinct objective of improving the quality of nutrition information online.



<sup>a</sup>Ellis, CH, & Evans, CEL. 2022. Nutrition Communication in Public Health and the Media, published in: Evans, C.E.L. (Charlotte E.L.) (ed.). 2022. *Transforming Food Environments*. Boca Raton: CRC Press.

<sup>b</sup>Ellis, C.H., Moore, J.B., Ho, P. and Evans, C.E.L. 2023. Development and validation of a quality assessment tool to assess online nutrition information. *DIGITAL HEALTH*. **9**.

<sup>c</sup>Ellis, C.H., Moore, J.B., Ho, P. and Evans, C.E.L 2024. Content quality versus sharing practices on social media: A cross-sectional analysis of nutrition information on Twitter. Under review.

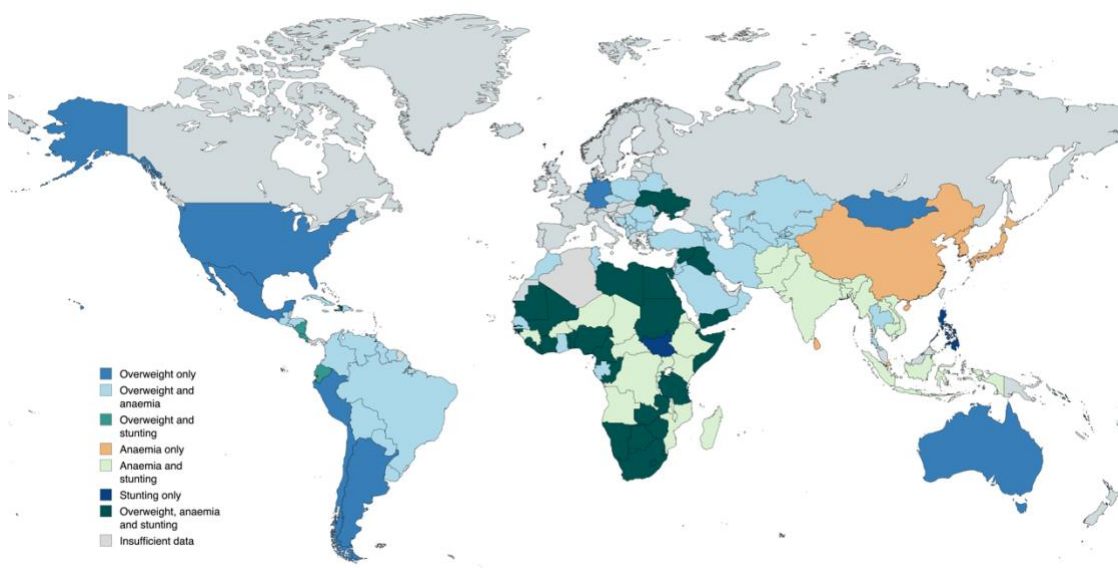
<sup>d</sup>Ellis, C.H., Moore, J.B., Ho, P. Ahmed, W., and Evans, C.E.L. 2024 Social network and linguistic analysis of the #nutrition discourse on the social network platform X, formerly known as Twitter. *Soc. Netw. Anal. Min.* **14**, 238.

## **Chapter 1 Thesis overview, gaps, aims, and objectives**

### **1.1 Introduction: Nutrition and global public health**

Non-communicable diseases (NCDs) continue to rise globally and account for 75% of all deaths (World Health Organization, 2024). The most important modifiable NCD risk factors are diet, smoking, alcohol consumption, and physical activity (Sun et al., 2024) with nutrition and diet a leading risk factor for death. Beyond mortality, disability-adjusted life years (DALY) are a measure of disease burden, expressed as the number of years lost due to ill-health, disability, or early death (Murray et al., 1994). After tobacco use, diets low in fruit is the largest modifiable risk fact accounting for 4.2% of disease burden, while high BMI accounts for 3.8% of global DALYs (May et al., 2015).

Reducing undernutrition continues to be a priority in some regions, as stunting and wasting have both severe consequences for individual's health and impact the economic growth of countries (Hoddinott et al., 2013). At the other end of the scale, overnutrition continues to be problematic with overweight and obesity continuing to rise; the global economic impact of which is estimated to reach \$4.32tn per year by 2035 (World Obesity Federation, 2023). In the UK, the cost of obesity and associated comorbidities was £6.5 billion in 2022 (Frontier Economics, 2022). The challenges of over and undernutrition are further complicated by micronutrient deficiencies, or 'hidden hunger'. Together, undernutrition, overnutrition and micronutrient deficiencies, is termed the 'triple burden of malnutrition' (**figure 1.1**) (UNICEF and WHO, 2023).



**Figure 1.1 Global prevalence of aspects of the triple burden of malnutrition**

Prevalence (%) thresholds used to determine whether a country is experiencing a high prevalence for a given form of malnutrition: stunting in children aged under 5 years:  $\geq 20\%$ ; anaemia among women of reproductive age (15–49 years):  $\geq 20\%$ ; overweight (including obesity) in adult women aged  $\geq 18$  years: body mass index of  $\geq 25\text{kg/m}^2$   $\geq 35\%$ . Based on latest data available for 143 countries.

Adapted from: UNICEF/WHO/World Bank Joint Child Malnutrition Estimates Expanded Database: Stunting, Wasting and Overweight, (March 2019, New York), NCD Risk Factor Collaboration 2019, WHO Global Health Observatory 2019.

In acknowledgement of the importance of nutrition and its impact on public health costs, nutrition is the key focus of the UN Sustainable Development Goal two, to ‘End hunger, achieve food security and improved nutrition and promote sustainable agriculture’ (United Nations, 2015). Moreover, nutrition is key to the success of at least 11 of the 17 Goals; No poverty (SDG 1), Zero hunger (SDG 2), Good health and well-being (SDG 3), Quality education (SDG 4), Gender equality (SDG 5), Decent work and economic growth (SDG 8), Reduced inequalities (SDG 10), Responsible consumption and production (SDG 12), Climate action (SDG 13), Life below water (SDG 14), Life on land (SDG 15). Finally, the UN has declared a Decade of Action on Nutrition (2016–2025) highlighting the high political priority of improving population health through systemic change to achieve better nutrition (United Nations, 2016). The food environment, encompassing the marketing, access to food and food pricing is a key element of achieving these goals and targets.

### 1.1.1 The food environment

Encompassing the social, cultural, environmental, digital and food policy landscapes, the food environment has the ability to impact food choices, affect malnutrition rates and in turn, the health of the nation (Evans, 2022). The food environment incorporates

the marketing, access and the price of food thereby playing a large role in dietary choice, particularly for people living in urban areas, where cheap, energy-dense and nutrient-poor food options are widely available (Vilar-Compte et al., 2021). The preferential consumption of low-quality foods is often driven by affordability and poorer accessibility to healthier foods (Jacobs and Kromhout, 2019), or a lack of knowledge about what constitutes a healthy diet (Whatnall et al., 2022).

Poorer food choices can also be driven by poor food literacy whereby people lack the appropriate skills and knowledge necessary to make informed decisions about foods (Silva et al., 2023). Food literacy is an aspect of health literacy which enables individuals to make informed decisions about their diet and how it impacts their health (Silva, 2023). Poor food and health literacy is a global issue (Lancet, 2022) with people struggling to discriminate trustworthy evidence based advice from misinformation (Pilgrim and Bohnet-Joschko, 2019). Several factors affect people's food literacy, including modern lifestyles with less cooking, less food preparation knowledge (Wolfson et al., 2019), and less education of healthy foods cited as just some of the factors (Baker et al., 2020). Whilst food literacy doesn't have a clear linear relationship with health, socioeconomic disparity must also be considered as those with lower levels of education and income, have poorer health literacy (Sørensen et al., 2015). The challenge of low food literacy is coupled with a rise in the accessibility of ultra-processed foods which are highly palatable, and nutrient poor, alongside omnipresent information about food and diets that can negatively affect food choices.

Additionally, high levels of food marketing of these nutrient poor foods is regularly associated with poorer food choices (Tsochantaridou et al., 2023). Whilst public health interventions such as clearer food labelling is generally associated with better food choices, (Shangguan et al., 2019), it is unable to compete with clever marketing tactics; in the USA alone, the food industry spent \$7.5bn on marketing in 2022 (Statista, 2023b). The negative impact of food marketing in food choices is most apparent in children and teenagers; and calls for public policies to limit exposure to commercials and advergames are regularly debated (World Health Organization, 2023). The UK Government have made positive steps in this regard, with restrictions on the marketing of 'less healthy products' between 17:30 – 21:00 on UK television and paid marketing online, effective October 2025 (Department of Health & Social Care, 2024). Also included in key aspects of the food environment, is the availability of nutritional

information in public spaces such as the internet and social media; described in detail in the next sections.

### **1.1.2 Public interest in nutrition**

The general public are becoming more likely to access information on healthy diets and nutrition with the internet becoming a primary source for information (Adamski et al., 2020). Google trends analysis shows year on year increases in searches for 'healthy diet' since 2014 (Saura et al., 2020) and over half of EU citizens (55%) now seek health and nutrition information online (Eurostat, 2022). However, whilst this ubiquitous access to information means the public can search for nutrition and diet advice readily, it does not mean evidence-based, high quality information will be found, as the internet remains largely unregulated (Zhang et al., 2018). As reliance on the internet increases, the quality of online nutrition information has become an urgent issue, as misinformation can negatively influence consumer beliefs (Wakefield et al., 2010).

## **1.2 Nutrition communication**

Traditionally, print newspapers were the preferred source of nutrition news for the public but with a drive towards novelty and attention-grabbing headlines, research has found that these articles are not always evidence based, and do not reflect nutritional guidelines (Kininmonth et al., 2017). Similar quality issues have also been reported with health news in the press (Robinson et al., 2013) with many news articles found to be oversimplified and unbalanced, whilst leaving out key quality information (Oxman et al., 2021).

More recently, the internet has become an important source of nutrition information (Kamiński et al., 2020), and indeed the preferred information source for many people (Ramachandran et al., 2018). However, the digital environment is vulnerable to different quality issues than print news. Any person or company can start a website, post on social media, and leave comments on other sites (Adams, 2010). Professional bloggers have increased (Oksman et al., 2016) and, in the context of nutrition, many nutrition bloggers have thousands of followers, but no nutritional science training or relevant qualifications (Adamski et al., 2020). Indeed, it has been found that only 6% of American food bloggers have nutrition degrees, despite offering nutrition advice (Dickinson et al., 2018). There is notable variation in the quality of articles online, with previous research finding 45% of articles on vegan diets contained poor or very poor

information (El Jassar et al., 2019b). While weight management blogs written by social media influencers were of poor quality (Sabbagh et al., 2020), as were blogs relating to obesity (Ellis et al., 2020). In addition, an assessment of the quality of websites providing consumer information on dietary and herbal supplements for weight loss, found that the highest scoring websites were dedicated health portals, and the lowest were commercial websites (Ng et al., 2021).

The lack of regulation and quality control online allows misinformation and low quality content to be published quickly creating an environment where the ill-informed have a greater voice than the trained experts (Mozaffarian and Forouhi, 2018). This is particularly concerning as older people and adolescence are more likely to face challenges with digital health literacy (Kington et al., 2021), and those with low digital health literacy, are less likely to fact check (Murakami et al., 2024). The history of health and nutrition communication in the UK, the shift in the media landscape and the challenges this pose, will be reviewed and discussed in depth in **chapter 2**, alongside an overview of the digital nutrition environment.

### **1.2.1 Assessment of information quality**

Where previous research has assessed the quality of different types of nutrition information online, the number of studies has been small, the quality assessment criteria variable, and search terms often relate to specific dietary patterns. Several studies have assessed the quality of online health information, but most have used newly created unvalidated criteria, or criteria that are designed to assess expert authored patient facing criteria. This type of information is not comparable to publicly authored, non-clinical information. The DISCERN tool (Charnock et al., 1999) was designed to assess patient facing clinical information on treatment choices and quality of life, and has been used to assess a wide range of health topics including dentistry (Eksi Ozsoy, 2021), sexual health (Fode et al., 2020), and cardiovascular disease (Song et al., 2021). However, whilst DISCERN is validated tool with high interrater reliability, it is not suitable for public health nutrition and non-clinical information.

Robinson and colleagues developed an assessment tool to measure the quality of health-related news in print newspapers (Robinson et al., 2013). This tool has subsequently been used to assess media reporting on a wide range of information including: nutrition (Kininmonth et al., 2017), Brexit-related food issues in the UK (Strong and Wells,

2020b), and air pollution–related health outcomes (Sun et al., 2020). However, this tool is not sensitive enough to assess the quality of online information. Alternative quality assessment criteria have also been used to assess the accuracy of information in other settings. For example, weight management blogs (Sabbagh et al., 2020), childhood obesity in UAE (Awofeso et al., 2019), cancer information for patients (Saltaouras et al., 2019), and healthy eating blogs (Allen et al., 2018) (Nguyen et al., 2019). However, these assessment criteria were not validated.

Evaluations of existing quality assessment tools designed to measure health information have been conducted. Paterson and colleagues identified 151 quality indicators in the literature, and noted that most lacked evidence of validity (Paterson et al., 2015). Additionally, Zhang and colleagues identified conflicting results concerning the effectiveness of the widely used validated tools, DISCERN, HONcode and JAMA, to assess health information (Zhang et al., 2015). They also found that studies using alternative assessment criteria, typically used unstandardised sets of criteria that were complex and impractical to use (Zhang et al., 2015). Both reviews concluded that the quality of online information is problematic, as are the heterogeneous assessment criteria used. Moreover, they concurred with previous conclusions that quality assessment tools are often complex, and that the effort of finding and applying the criteria outweighs the benefit (Eysenbach et al., 2002). A more recent review of assessment tools and criteria called for specific tools to be designed for information disseminated via social media (Afful-Dadzie et al., 2021a).

In summary, there is a lack of standardised, validated, quality assessment tools that are suitable to assess the quality of online nutrition information. Print news, health information and expert authored patient facing information is different to public authored nutrition information and social media content. The current available tools also only consider the content, they do not consider the source of the information which can be key to the quality. The need for suitable, validated assessment tools will be further discussed in detail in **chapter 3**.

### **1.2.2 Social media**

Social media enables individuals to connect, share information and create wide reaching cross community networks. This facilitates a rapid spread of information (Toraman et al., 2022). The social network X (formally Twitter, referred to as X for consistency

throughout this thesis, except in **chapters, 2, 3 and 4** as these chapters are presented as published), is a popular network for discussing noteworthy events from around the world with characteristics that make it more akin to a broadcast medium (Meeyoung et al., 2012). This has attracted traditional media sources (Oxman et al., 2021), companies and high-profile users to join, meaning users are exposed to a wide range of information and sources, as well as being sources of information themselves (Himmelboim et al., 2017). Therefore, X, as with all social media platforms, can mean people are regularly exposed to conflicting nutrition information that can undermine dietary guidelines (Vijaykumar et al., 2021) and have detrimental effects on consumer beliefs and healthy dietary intentions (Clark et al., 2019). Inconsistent information may also reduce engagement with evidence-based recommended nutrition behaviours (Lee, T., 2018).

When users are posting and resharing information, research suggests that the source of health information is important as this affects how users evaluate the information and how likely they are to propagate the information through their networks (DeAndrea and Vendemia, 2016). It has been found that three in ten people who share links to articles on Facebook and X do so without fully reading the content first (OFCOM, 2017), suggesting that the source of information may be a bigger driver than the content. Therefore, it is important to understand who is sharing information, how the source of information impacts sharing behaviours, and the flow of information through social media platforms.

### **1.2.3 Social networks**

Networks are a key function of information flow on social media as they create virtual communities that share information and build communities of common interest (Erz et al., 2018). These communities are unique in that virtual relationships can be built with individuals, brands, organisations and influencers (Eaton et al., 2023). Examining the information flow through these relationships provides unique insights into what nutrition and diet information the public are reading, sharing, and engaging with; as well as providing important insight on societal opinion during significant events (Eskandari et al., 2022).

Platforms such as X create vast networks that allow users to engage in a wide range of issues. Social Network Analysis (SNA) allows for investigation of these networks by applying mathematical network and graph theory to visualise information transfer as



relational networks of connected nodes. SNA enables the visualisation of the flow of information and influence of social interactions (Wasserman, 1994), and the identification of network ‘influencers’, which may differ from paid social media influencers (discussed further in section 1.3.2). SNA can also provide insight into the language being used to discuss nutrition, that is the sentiment of the discourse. This can be useful to understand and monitor public opinion on a wide range of policy debates including fiscal policies (Bridge et al., 2021), and front of pack labelling (Irawan, 2022).

SNA has been applied to multiple topics including perceptions on climate change (Holmberg, 2015), palaeontological communications (Bex et al., 2019), food poverty (Eskandari et al., 2022), political views (Chakraborty and Mukherjee, 2023) and mask wearing during COVID-19 (Ahmed et al., 2020). These network interactions can have positive effects on health promotion efforts with positive associations found with breastfeeding practices (Moukarzel et al., 2021a), (Moukarzel et al., 2021b), and vaccine uptake (Wang, et al., 2021; Yousef et al., 2022). Conversely, negative discourse has been shown to have the opposite effect on vaccine uptake (Yousef et al., 2022), increasing vaccine hesitancy (Sussman et al., 2023); therefore it is important to understand the role sentiment can have on public opinion. The influence of networks and the role they have in disseminating nutrition information and affecting public opinion will be discussed in detail in **chapter 4**, in the context of my investigation of the nutrition network.

### **1.3 Risks to public health**

Public health communications are traditionally utilised with the aim of improving public health by persuading the public to adopt healthier lifestyles and behaviours. However, these positive health interventions have been challenged by the public shift in health seeking behaviours with less reliance on expert advice (Lynn et al., 2020), and with a wide range of non-nutrition experts now involved in the online nutrition discourse (Ramachandran et al., 2018). Consequently, the public are regularly exposed to conflicting information that has the potential to undermine national and international nutrition guidelines, including WHO advice (Vijaykumar et al., 2021). This provides a considerable challenge to the public to be able to accurately differentiate between high- and poor-quality information. Therefore, whilst it is important to improve the quality of information, it is also important to improve the public’s ability to discriminate between

high- and low-quality information in order to judge information quality themselves (Oxman et al., 2021).

### **1.3.1 Misinformation**

Misinformation has the potential to create a perception of scientific uncertainty and a lack of consensus between experts (Mozaffarian and Forouhi, 2018), increasing negative perceptions of health policy (Chang, 2013). So great is the significance of widespread misinformation that the World Economic Forum determined it to be one of the most problematic trends of the era (WEF, 2013). With anyone able to create content, and social media enabling the rapid dissemination of such content (Lynn et al., 2020), misinformation and disinformation continues to increase (Adamski et al., 2020).

Misinformation from non-experts can have severe consequences as it influences attitudes and people struggle to correct these erroneous beliefs. Ironically, attempts to correct these false beliefs can have the opposite effect by unintentionally reinforcing the memory and causing people to misremember the false information as true (Peter and Koch, 2016). Political misinformation is amplified by online discussions (Perl et al., 2018), and encourages unconstructive debate (Koop and Jansen, 2009). Concerningly, there is no evidence to suggest nutrition misinformation behaves differently. This is particularly problematic in nutrition as there is a rise of self-proclaimed experts giving misleading dietary advice that can potentially alter dietary patterns and adherence to dietary guidelines (Diekman et al., 2022). Therefore, it is imperative that the nutrition information available online is evidence-based and aligns with dietary advice. The challenges of contradictory information and the sharing of misinformation will be discussed in greater detail in **chapters 3 and 4**.

### **1.3.2 Polarisation**

Like misinformation, polarising discourse and views can have detrimental effects on public understanding of scientific matters as it can be used as a strategy to raise doubt over the evidence. This strategy has been used to discredit the climate change evidence (McCright and Dunlap, 2011) creating ‘scientific polarisation’. Where polarisation exists, confidence in the scientific community is typically worse, and the focus on scientific uncertainty strengthens public opinion that scientists cannot agree on the evidence (Penders et al., 2017). In nutrition, polarised views tend to focus on policy

implications, with policy changes that are regulatory or have fiscal impact, having greater polarisation (Cullerton et al., 2022).

There have also been extreme examples of the potential harm of the widening divide in public discourse as seen when Donald Trump supporters attacked the US Capitol Building (Arora et al., 2022), and more recently, the riots across the UK instigated by the far-right movement and exacerbated by social media (BBC News, 2024). Social media can play a significant role in polarisation, with evidence that individuals seek evidence that aligns with their own beliefs, leading to the formation of more extreme opinions (Alstyne and Brynjolfsson, 2005).

### **1.3.3 The rise of the ‘Influencer’**

Another matter of concern in nutrition and public health is the rise of the ‘influencer’. A social media influencer is an individual whose opinions can persuade others to change attitudes and behaviours (Sabbagh et al., 2020). Such is their power, that brands spent US\$35 billion globally in 2024 on influencer marketing alone (Statista, 2024). As such, influencers are a central component of networks on social media, creating an illusion of interpersonal relationships that generate trust (Appel et al., 2020). Research suggests that non-experts and influencers on social media have the potential to influence food choices, dietary patterns and food preparation techniques (Pilgrim and Bohnet-Joschko, 2019). Influencers have been found to have a strong impact on followers dietary choices when they are discussing vegan diets (Pilař et al., 2021), regardless of the quality of information. Influencers promoting unhealthy snacks significantly increased calorie consumption in children (Coates et al., 2019), and adolescents are more likely to remember unhealthy foods promoted by an influencer (Kucharczuk et al., 2022). Concerningly, although perhaps unsurprisingly, a recent survey conducted by UNESCO found that 62% of influencers and social media content creators do not fact check before posting information (UNESCO, 2024).

Due to the perceived negative impact of influencers, dietitians who use social media to communicate dietary advice do not consider themselves to be influencers as they feel this lacks authenticity, however they do want to have influence (Marauri-Castillo et al., 2024). The rise of the influencer has contributed to a worrying trend of non-nutrition professionals having a louder voice than nutrition professionals and having more

influence on population diets (Engel et al., 2024). The role of influencers and how their impact might be mediated is investigated in **chapter 5**.

## **1.4 Gaps in knowledge and methodology**

There is a paucity of research investigating nutrition information in the media compared with other sources of nutrition information such as food labelling, food marketing and food education. This thesis specifically focuses on the quality of information, the online dialogue relating to nutrition, and networks.

### **1.4.1 Quality criteria and assessment tools**

Little is known about the quality of nutrition information online, partly because of the lack of suitable assessment methods and tools. Whilst there is an increasing body of research that has assessed the quality of online health information, it is difficult to compare between studies as multiple assessment tools and quality criteria have been used so it is not possible to draw conclusions. The wide range of complex, often unvalidated, assessment criteria applied to health information has resulted in calls for a standardised quality assessment method that is suited to online content (Afful-Dadzie et al., 2021). Finally, no available tools are specific enough for the nuances of nutrition information. Where criteria have been applied to nutrition, the criteria in question were either developed to assess clinical information or were developed before the wide adoption of the internet (Charnock et al., 1999). Alternative assessment tools have assumed nutrition training by the assessor (Saltaouras et al., 2019), which precludes non-nutrition healthcare professionals being able to apply the tool.

Given the possibility for anyone to be an author online, and the rise in influencers, it is also important to identify who is sharing poor quality information so recommendations can be made to improve the quality. Therefore, it is vital that a means of assessing the credibility and quality on online nutrition information is developed and validated. As called for in the literature (Eysenbach et al., 2002; Zhang et al., 2015; Oxman et al., 2021), a validated, simple to use assessment tool is needed that could be applied to online nutrition information over time to support the need for interventions to improve quality and restrict the spread of nutrition-related misinformation.

### **1.4.2 Information quality**

Little is currently known about the quality of nutrition information shared online. With the digital environment being such an important resource for nutrition information, it is essential to understand the quality of nutrition advice published online and what is being propagated through networks. No standardised, validated set of criteria has been previously created to measure this, or to assess whether high- or low-quality information is more likely to be shared on social media. Similarly, little is known about what sources are originally sharing high- or low-quality information. Source credibility is Important as It can Impact the accuracy of the Information. Findings can also be used to inform the public on which online sources provide evidence-based nutrition advice and to provide guidelines to encourage authors to publish evidence-based articles.

### **1.4.3 Network analysis**

There is a gap in understanding of the key nutrition themes being discussed on X, the flow of information through networks and the key actors in relation to nutrition. Whilst social and semantic analysis has been used to investigate specific topics within nutrition, such as sugar sweetened beverage taxation in the UK (Bridge et al., 2021), breastfeeding practices (Moukarzel et al., 2020a; Moukarzel et al., 2020b), and vegan diets (Pilař et al., 2021), the broader topic of nutrition has not been considered. Given the potential for nutrition to impact public health, this is a critical gap in understanding. Understanding how X users interact, who is influencing the flow of nutrition information, and the language used, could have the potential to improve communication by nutrition professionals. Moreover, understanding the nutrition information network could support a set of recommendations to help professionals influence the debate and to discourage the public from propagating misinformation or poor-quality nutrition information.

## **1.5 Aims and objectives**

The gaps identified in the literature, along with the calls in the literature for standardised assessment criteria, led the focus for this body of work. Work began with the development and validation of a set of quality assessment indicators specifically suited to assessing the quality of online nutrition information. The 10 indicators, defined as the Online Quality Assessment Tool (OQAT), is accompanied by a comprehensive set of instructions allowing other researchers to apply the OQAT to different datasets, which will eventually allow comparison between studies using the tool.

Following the validation and pilot phase, the QQAT was used on a broad data set collected via X to assess the quality of nutrition information and to identify the determinants of high-quality information so recommendations could be made to improve the quality of nutrition online. The QQAT was also applied to determine which original sources were sharing high quality information as this had not previously been assessed in the literature.

Finally, whilst the QQAT quantifies quality, it is not able to provide any insight into the motivations for reposting content and how information propagates through social networks. Therefore, to ensure this was a comprehensive body of work considering all factors of nutrition information on online and on social media, SNA was carried out on the #nutrition network. The #nutrition network has not been previously assessed to our knowledge.

### **1.5.1 Aims**

This thesis had the following overarching aims:

*To assess the quality of nutrition information online, and to determine who is involved in the online discourse and how nutrition information propagates through networks.*

The rationale for this work was to encourage higher quality nutrition articles to be written and disseminated and to reduce the propagation of poor-quality information that does not align with dietary guidelines. It also aimed to highlight the need for the regulation of online nutrition information.

### **1.5.2 Objectives**

These aims motivated the following chapter objectives:

## **Chapter 2 Nutrition Communication in Public Health and the Media**

1. To comprehensively summarise the evidence available on nutrition and diet information in the media and digital environments.

## **Chapter 3 Development and validation of a quality assessment tool to assess online nutrition information**

1. To search the literature for available assessment criteria used to assess the quality of online nutrition information, as well as more broadly health information given anticipated paucity of nutrition assessment criteria.
2. To develop and validate a suitable quality assessment tool to quantify the quality of online nutrition information.
3. To pilot the validated assessment tool on a subset of nutrition related articles posted as URLs on X in 2021.

#### **Chapter 4 Content quality versus sharing practices on social media: A cross-sectional analysis of nutrition information on Twitter**

1. To use the newly developed and validated online quality assessment tool to assess the quality of online nutrition information disseminated via X.
2. To examine the quality of retweeted articles, comparing these to unshared content and determine whether the high- or low-quality information is more likely to be reposted, and determine which sources were sharing the highest quality nutrition information.

#### **Chapter 5 Social network and linguistic analysis of the #nutrition discourse on the platform X, formerly known as Twitter**

1. To examine the #nutrition conversations on X utilising SNA and linguistic methods.
2. To investigate the influential actors and how they influence the flow of information
3. To investigate the most frequently discussed topics in the network and the sentiment of the associated discourse.

## 1.6 References

- Adams, SA. (2010). Revisiting the online health information reliability debate in the wake of "web 2.0: an inter-disciplinary literature and website review. *Int J Med Inform.* **79**(6): 391-400.
- Adamski M. Truby H. Klassen K. et al. (2020). Using the internet: Nutrition information-seeking behaviours of lay people enrolled in a massive online nutrition course. *Nutr.* **12**(3): 750.
- Afful-Dadzie, E. Afful-Dadzie, A. and Egala, SB. (2021). Social media in health communication: A literature review of information quality. *Health Inf Manag J.* **52**(1): 3-17.
- Ahmed, W. Vidal-Alaball, J. Segui, F. et al. (2020). A social network analysis of tweets related to masks during the COVID-19 pandemic. *Int. J. Environ. Res. Public Health.* **17**(21).
- Allen, M. Dickinson, KM. and Prichard, I. (2018). The Dirt on Clean Eating: A cross sectional analysis of dietary intake, restrained eating and opinions about clean eating among women. *Nutr.* **10**(9).
- Appel, G. Grewal, L. Hadi, R. et al. (2020). The future of social media in marketing. *J. of the Acad. Mark. Sci.* **48**(1): 79-95.
- Arora, SD. Singh, GP. Chakraborty, A. et al. (2022). Polarization and social media: A systematic review and research agenda. *Technol. Forecast. Soc. Change.* **183**: 121942.
- Awofeso, N. Imam, SA. and Ahmed, A. (2019). Content Analysis of Media Coverage of Childhood Obesity Topics in UAE Newspapers and Popular Social Media Platforms, 2014-2017. *Int J Health Policy Manag.* **8**(2): 81-89.
- Baker, P. Machado, P. Santos, T. et al. (2020). "Ultra-processed foods and the nutrition transition: Global, regional and national trends, food systems transformations and political economy drivers." *Obes Rev* **21**(12): e13126.
- BBC News (2024). "Why are there riots in the UK?"  
<https://www.bbc.co.uk/news/articles/ckg55we5n3xo>. Accessed August 2024.
- Bex, RT. Lundgren, L. and Crippen, KJ. (2019). Scientific Twitter: The flow of paleontological communication across a topic network. *PloS One.* **14**(7): e0219688-e0219688.
- Bridge, G. Flint, S. and Tench, R. (2021). A mixed-method analysis of the #SugarTax debate on Twitter. *Public Health Nutr.* **24**(11): 3537-3546.



- Chakraborty, A. and Mukherjee, N. (2023). Analysis and mining of an election-based network using large-scale twitter data: a retrospective study. *Soc. Netw. Anal. Min.* **13**(1): 74-74.
- Chang, C. (2013). Men's and women's responses to two-sided health news coverage: a moderated mediation model. *J Health Commun.* **18**(11): 1326-1344.
- Charnock, D. Shepperd, S. Needham, G. et al. (1999). "DISCERN: an instrument for judging the quality of written consumer health information on treatment choices." *J Epidemiol Community Health.* **53**(2): 105-111.
- Clark, D. Nagler, RH. and Niederdeppe, J. (2019). Confusion and nutritional backlash from news media exposure to contradictory information about carbohydrates and dietary fats. *Public Health Nutr* **22**(18): 3336-3348.
- Coates, AE. Hardman, CA. Halford, JC. et al. (2019). Social media influencer marketing and children's food intake: a randomized trial. *J. Pediatr* **143**(4).
- Cullerton, K. Patay, D. Waller, M. et al. (2022). Competing public narratives in nutrition policy: insights into the ideational barriers of public support for regulatory nutrition measures. *Health Res Policy Syst* **20**(1): 86.
- DeAndrea, D. C. and Vendemia, MA. (2016). How affiliation disclosure and control over user-generated comments affects consumer health knowledge and behavior: A randomized controlled experiment of pharmaceutical direct-to-consumer advertising on social media. *J. Med. Internet Res.* **18**(7): e189.
- Dickinson, KM. Watson, MS. and Prichard, I. (2018). Are Clean Eating Blogs a Source of Healthy Recipes? A Comparative Study of the Nutrient Composition of Foods with and without Clean Eating Claims. *Nutr* **10**(10).
- Diekman, C. Ryan, CD. and Oliver, TL. (2022). Misinformation and Disinformation in Food Science and Nutrition: Impact on Practice. *J Nutr.* **153**(1):3-9.
- Eaton, MC. Probst, YC. and Smith, MA. (2023). Characterizing the Discourse of Popular Diets to Describe Information Dispersal and Identify Leading Voices, Interaction, and Themes of Mental Health: Social Network Analysis. *JMIR Infodemiology* **3**: e38245.
- Eksi Ozsoy, H. (2021). Evaluation of YouTube videos about smile design using the DISCERN tool and Journal of the American Medical Association benchmarks. *J. Prosthet. Dent.* **125**(1): 151-154.
- El Jassar, OG., El Jassar, IN. and Kritsotakis, E. (2019). Assessment of quality of information available over the internet about vegan diet. *Nutr Food Sci.* **49**(6): 1142-1152.

- Ellis, CH. Evans, CEL. and Moore, JB. (2020). "Systematic assessment of obesity information on the microblogging platform Twitter." *Proc Nutr Soc.* **79**(OCE3): E791.
- Engel, E. Gell, S. Heiss, R. et al. (2024). Social media influencers and adolescents' health: A scoping review of the research field. *Soc Sci Med.* **340**: 116387.
- Erz, A. Marder, B. and Osadchaya, E. (2018). Hashtags: Motivational drivers, their use, and differences between influencers and followers. *Comput Hum Behav.* **89**: 48-60.
- Eskandari, F. Lake, AA. and Butler, M. (2022). COVID-19 pandemic and food poverty conversations: Social network analysis of Twitter data. *Nutr Bull.* **47**(1): 93-105.
- Eurostat (2022). "EU citizens: over half seek health information online." European Union. <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20220406-1> Accessed October 2024.
- Evans, C. E. L. (2022). Transforming food environments. Boca Raton, CRC Press.
- Eysenbach, G. Powell, J. Kuss, O. et al. (2002). Empirical studies assessing the quality of health information for consumers on the world wide web: a systematic review. *Jama* **287**(20): 2691-2700.
- Fode, M. Nolsøe AB, Jacobsen FM, et al.; EAU YAU Men's Health Working Group. (2020). "Quality of Information in YouTube Videos on Erectile Dysfunction." *Sex Med* **8**(3): 408-413.
- Frontier Economics (2022). "The annual social cost of obesity in the UK." <https://www.frontier-economics.com/uk/en/news-and-insights/articles/article-i9130-the-annual-social-cost-of-obesity-in-the-uk/> Accessed August 2022.
- Himelboim, I. Smith, MA. Rainie, L. et al. (2017). Classifying Twitter topic-networks using social network analysis. *Soc Media Soc* **3**(1).
- Hoddinott, J. Alderman, H. Behrman, JR. et al. (2013). The economic rationale for investing in stunting reduction. *Matern Child Nutr* **9**(S2): 69-82.
- Holmberg, C. (2015). Politicization of the Low-Carb High-Fat Diet in Sweden, Promoted On Social Media by Non-Conventional Experts. *Int J e-Polit* **6**(3): 27-42.
- Jacobs, DR. and Kromhout, D. (2019). "Education, diet, and incident cardiovascular disease: ecological interactions and conclusions." *The Lancet Global Health* **7**(6): e684-e685.

- Kamiński, M. Skonieczna-Żydecka, K. Nowak, JK. et al. (2020). Global and local diet popularity rankings, their secular trends, and seasonal variation in Google Trends data. *Nutr.* **79-80**: 110759-110759.
- Kininmonth, A. Jamil, N. Almatrouk, N. et al. (2017). Quality assessment of nutrition coverage in the media: a 6-week survey of five popular UK newspapers. *BMJ Open* **7**(12).
- Koop, R. and Jansen, HJ. (2009). Political Blogs and Blogrolls in Canada: Forums for Democratic Deliberation? *Soc Sci Comput Rev.* **27**(2): 155-173.
- Kucharczuk, AJ. Oliver, TL. and Dowdell, EB. (2022). Social media's influence on adolescents' food choices: A mixed studies systematic literature review. *Appetite* **168**: 105765.
- The Lancet. (2022). Why is health literacy failing so many? **400**: 1655.
- Lynn, T. Rosati, P. Santos, GL. et al. (2020). Sorting the Healthy Diet Signal from the Social Media Expert Noise: Preliminary Evidence from the Healthy Diet Discourse on Twitter. *Int. J. Environ. Res. Public Health* **17**(22).
- Marauri-Castillo, I. Rodríguez-Gonzalez, MDM. and Marín-Murillo, F. (2024). Disseminators, not influencers: communication of dietitians on social networks. *Vivat Academia. J Comm.* **157**, 1-27
- May, AM. Struijk, EA. Fransen, HP. et al. (2015). The impact of a healthy lifestyle on Disability-Adjusted Life Years: a prospective cohort study. *BMC Medicine* **13**(1): 39.
- McCright, AM. and Dunlap, RE. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. *he Sociological Quarterly*, **52**(2): 155-194.
- Meeyoung, C. Benevenuto, F. Haddadi, H. et al. (2012). The World of connections and information flow in Twitter. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans* **42**(4): 991-998.
- Moukarzel, S. Caduff, A. Rehm, M. et al. (2021). Breastfeeding Communication Strategies, Challenges and Opportunities in the Twitter-Verse: Perspectives of Influencers and Social Network Analysis. *Int. J. Environ. Res. Public Health* **18**(12): 6181.
- Moukarzel, S. Rehm, M. Caduff, A. et al. (2021). Real-time Twitter interactions during World Breastfeeding Week: A case study and social network analysis. *PLOS ONE* **16**(3): e0249302.

- Moukarzel, S. Rehm, M. and Daly, A.J. (2020). Breastfeeding promotion on Twitter: A social network and content analysis approach. *Matern Child Nutr* **16**(4): e13053.
- Moukarzel, S. Rehm, M. del Fresno, M. et al. (2020). Diffusing science through social networks: The case of breastfeeding communication on Twitter. *PLOS ONE*. **15**(8): e0237471.
- Mozaffarian, D. and Forouhi, NG. (2018). Dietary guidelines and health—is nutrition science up to the task? *BMJ*. **360**, k822.
- Murakami, K., Shinozaki, N., Okuhara, T., et al. (2024). Prevalence and Correlates of Dietary and Nutrition Information Seeking Through Various Web-Based and Offline Media Sources Among Japanese Adults: Web-Based Cross-Sectional Study. *JMIR public health and surveillance*, 10, e54805.
- Murray, C.J. Lopez, A.D. and Jamison, D.T. (1994). The global burden of disease in 1990: summary results, sensitivity analysis and future directions. *Bull World Health Organ* **72**(3): 495-509.
- Ng, JY. Ahmed, S. and Zhang, C.J. (2021). Dietary and herbal supplements for weight loss: assessing the quality of patient information online. *Nutr J*. **20**(1).
- Nguyen, T.T. Phan, T.C. Nguyen, Q.V.H. et al. (2019). Maximal fusion of facts on the web with credibility guarantee. *Inf Fusion*. **48**: 55-66.
- OFCOM. (2017). Adults' media use and attitudes.  
[https://www.ofcom.org.uk/\\_\\_data/assets/pdf\\_file/0020/102755/adults-media-use-attitudes-2017.pdf](https://www.ofcom.org.uk/__data/assets/pdf_file/0020/102755/adults-media-use-attitudes-2017.pdf). Access July 2024.
- Oksman, V. Jarvela-Reijonen, E. Puttonen, M. et al. (2016). Vitality as a Life Style Trend in Blogs: A Netnographic Approach. *Proceedings of ECSM2016*. 258-265.
- Oxman, M. Larun, L. Pérez Gaxiola, G. et al. (2021). Quality of information in news media reports about the effects of health interventions: Systematic review and meta-analyses. *F1000Res*. **10**: 433.
- Paterson, Q.S. Thoma, B. Milne, W.K. et al. (2015). A Systematic Review and Qualitative Analysis to Determine Quality Indicators for Health Professions Education Blogs and Podcasts. *J. Grad. Med. Educ.* **7**(4): 549-554.
- Penders, B. Wolters, A. Feskens, E.F. et al. (2017). Capable and credible? Challenging nutrition science." *Eur J Nutr*. **56**(6): 2009-2012.
- Perl, A. Howlett, M. and Ramesh, M. (2018). Policy-making and truthiness: Can existing policy models cope with politicized evidence and willful ignorance in a "post-fact" world? *Policy Sci*. **51**(4): 581-600.

- Peter, C. and Koch, T. (2016). When debunking scientific myths fails (and when it does not): The backfire effect in the context of journalistic coverage and immediate judgments as prevention strategy. *Sci Comm* **38**(1): 3-25.
- Pilař, L. Kvasničková, L. and Kvasnička, R. (2021). Healthy Food on the Twitter Social Network: Vegan, Homemade, and Organic Food. *Int. J. Environ. Res. Public Health*. **18**(7): 3815.
- Pilgrim, K. and Bohnet-Joschko, S. (2019). Selling health and happiness how influencers communicate on Instagram about dieting and exercise: mixed methods research. *BMC Public Health* **19**(1): 1054.
- Ramachandran, D. Kite, J. Vassallo, AJ. et al. (2018). Food Trends and Popular Nutrition Advice Online - Implications for Public Health. *Online J Public Health Inform.* **10**(2): e213-e213.
- Robinson, A. Coutinho, A. Bryden, A. et al. (2013). Analysis of health stories in daily newspapers in the UK. *Public Health*. **127**(1): 39-45.
- Sabbagh, C. Boyland, E. Hankey, C. et al. (2020). Analysing Credibility of UK Social Media Influencers' Weight-Management Blogs: A Pilot Study. *Int. J. Environ. Res. Public Health*. **17**(23): 9022.
- Saltaouras, G. Lightowler, H. Coe, S. et al. (2019). Availability and quality assessment of online nutrition information materials for pelvic cancer patients in the UK. *Eur J Cancer* **28**(4): e13039.
- Saura, JR. Reyes-Menendez, A. and Thomas, SB. (2020). Gaining a deeper understanding of nutrition using social networks and user-generated content. *Internet Interv.* **20**: 9.
- Septia Irawan, A. Shahin, B. Wangeshi Njuguna, D. et al. (2022). "Analysis of Content, Social Networks, and Sentiment of Front-of-Pack Nutrition Labeling in the European Union on Twitter." *Front Nutr* **9**: 846730.
- Shangguan, S. Afshin, A. Shulkin, M. et al. (2019). A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices. *Am J Prev Med.* **56**(2): 300-314.
- Silva, P. (2023). Food and nutrition literacy: Exploring the divide between research and practice. *Foods* **12**(14): 2751.
- Silva, P. Araújo, R. Lopes, F. et al. (2023). Nutrition and Food Literacy: Framing the Challenges to Health Communication. *Nutr.* **15**(22).

- Song, S. Xue, X. Zhao, YC. et al. (2021). Short-Video Apps as a Health Information Source for Chronic Obstructive Pulmonary Disease: Information Quality Assessment of TikTok Videos. *J Med Internet Res.* **23**(12): e28318.
- Sørensen, K. Pelikan, JM. Röthlin, F. et al (2015). Health literacy in Europe: comparative results of the European health literacy survey (HLS-EU). *Euro J Public Health*, 25(6), 1053–1058.
- Statista (2023). Food advertising in the United States – statistics & facts. <https://www.statista.com/statistics/1415875/monthly-food-ad-spend-in-the-us>. Accessed October 2024.
- Statista (2024). "Influencer Advertising - Worldwide." <https://www.statista.com/outlook/amo/advertising/influencer-advertising/worldwide>. Accessed June 2024.
- Strong, H. and Wells, R. (2020). Brexit-related food issues in the UK print media: setting the agenda for post-Brexit food policy. *Br Food J.* **122**(7): 2187-2201.
- Sun, X. Yon, DK. Nguyen, TT. et al. (2024). Dietary and other lifestyle factors and their influence on non-communicable diseases in the Western Pacific region. *Lancet Reg Health West Pac.* **43**.
- Sun, Z. Cang, J. Ruan, Y. et al. (2020). Reporting gaps between news media and scientific papers on outdoor air pollution–related health outcomes: A content analysis. *Int. J. Health Plan. Manag.* **35**(1): 221-232.
- Sussman KL, Bouchacourt L, Bright LF, et al. (2023). COVID-19 topics and emotional frames in vaccine hesitation: A social media text and sentiment analysis. *Digit Health* **9**: 20552076231158308.
- Toraman, C. Şahinuç, F. Yilmaz, EH. et al. (2022). Understanding social engagements: A comparative analysis of user and text features in Twitter. *Soc. Netw. Anal. Min.* **12**(1): 47.
- Tsochantaridou A, Sergentanis TN, Grammatikopoulou MG, et al. (2023). Food Advertisement and Dietary Choices in Adolescents: An Overview of Recent Studies. *Children (Basel)* **10**(3).
- UNESCO (2024). Behind the screens: insights from digital content creators; understanding their intentions, practices and challenges. <https://unesdoc.unesco.org/ark:/48223/pf0000392006.locale=en> Accessed November 2024.
- UNICEF and WHO (2023). "Levels and trends in child malnutrition: UNICEF/WHO/World Bank Group Joint Child Malnutrition Estimates: Key

- findings of the 2023 edition." United Nations Children's Fund (UNICEF), World Health Organization (WHO), International Bank for Reconstruction and Development/The World Bank, New York. Accessed August 2024.
- United Nations. (2015). Sustainable Development Goals.  
<https://sustainabledevelopment.un.org/?menu=1300>. Accessed August 2024.
- United Nations (2016). "UN Decade of Action on Nutrition 2016-2025. Accessed August 2024.
- Van Alstyne, M, and Brynjolfsson, E. (2005). Global Village or Cyber-Balkans? Modeling and measuring the integration of electronic communities. *Manag Sci.* **51**(6): 851-868.
- Vijaykumar, S. McNeill, A. and Simpson, J. (2021). Associations between conflicting nutrition information, nutrition confusion and backlash among consumers in the UK. *Public Health Nutr* **24**(5): 914-923.
- Vilar-Compte, M. Burrola-Méndez, S. Lozano-Marrufo, A. et al. (2021). Urban poverty and nutrition challenges associated with accessibility to a healthy diet: a global systematic literature review. *Int. J. Equity Health.* **20**(1): 40.
- Wakefield, MA. Loken, B. and Hornik, RC. (2010). Use of mass media campaigns to change health behaviour. *The Lancet* **376**(9748): 1261-1271.
- Wang, BR. Liu, B. and Zhang, Q. (2021). An empirical study on Twitter's use and crisis retweeting dynamics amid Covid-19. *Natural Hazards:* **107**(3), 2319–2336..
- Wasserman, S. (1994). Social network analysis : methods and applications. Cambridge, Cambridge University Press.
- World Economic Forum, F. E. M. (2013). Global risks 2013, World Economic Forum. Accessed July 2024
- Whatnall, M. Ashton, LM. Adam, MTP. et al. (2022). How Can We Support Healthy Eating in Young Adults with Low Diet Quality? A Survey of Users of the 'No Money No Time' Healthy Eating Website. *Nutr.* **14**(24).
- Wolfson, JA. Ramsing, R. Richardson, CR. et al. (2019). Barriers to healthy food access: Associations with household income and cooking behavior. *Prev Med Rep* **13**: 298-305.
- World Health Organization (2024). Non-communicable diseases. Institute for Health Metrics and Evaluation – IHME.
- World Health Organization (2023). WHO recommends stronger policies to protect children from the harmful impact of food marketing.  
<https://www.who.int/news/item/03-07-2023-who-recommends-stronger->

policies-to-protect-children-from-the-harmful-impact-of-food-marketing.

Accessed June 2024.

World Obesity Federation (2023). World Obesity Atlas 2023.

<https://www.worldobesity.org/resources/resource-library/world-obesity-atlas-2023>. Accessed June 2024.

Yousef, M. Dietrich, T. and Rundle-Thiele, S. (2022). Actions Speak Louder Than Words: Sentiment and Topic Analysis of COVID-19 Vaccination on Twitter and Vaccine Uptake. *JMIR Form Res* **6**(9): e37775.

Zhang, HL. Kuhnle, A. Smith, JD. et al. (2018). Fight under uncertainty: Restraining misinformation and pushing out the truth. *ACM Int. Conf. Adv. Soc. Netw. Anal. Min.* 266-273.

Zhang, Y. Sun, Y. and Xie, B. (2015). Quality of health information for consumers on the web: A systematic review of indicators, criteria, tools, and evaluation results. *J. Assoc. Inf. Sci. Technol.* **66**(10): 2071-2084.



## **Reflections on developments in the field since the literature review was published as a textbook chapter in 2022**

It's important to note the growth in research considering the quality of online nutrition information and the role of social media in perpetuating misinformation since this textbook chapter was published in 2022. The body of literature relating to online nutrition and health misinformation has accelerated since 2022 with an estimated growth rate of more than 8% per year (Polyzou et al., 2023). This growth in scholarly interest in digital nutrition information is paralleled by a public increase in online nutrition information seeking (Ruani et al., 2023; Murakami et al., 2024).

As noted in the discussion, social media and the broader online environment is a fast-moving space with substantial changes since 2022 making research repeatability challenging. Most notably for this research, Twitter changed ownership in October 2022, which resulted in numerous changes including: changing the name to X (July 2023), reduced content moderation and reinstating banned users, monetising verified accounts, and restricting free access to academic users for research purposes. These changes have seen X becoming politicised with the reduced regulation leading to more controversial ideologies being shared, and an increase in users leaving the platform. Specifically, there has been an estimated decrease of 22.1% of users since the change in ownership and policies (Forbes, March 2025).

Despite the challenges of research into social media and access to X data, the literature pertaining to social media continues to grow. Thematic analysis across 37 papers investigating multi social media platforms found the range of nutrition related topics varied widely, including dietary choices, cooking, diet and health conditions, and public health policy (Molenaar et al., 2023). Broader research into the quality and accuracy of online nutrition information has found overly complex and inaccurate dietary advice online (Fappa and Micheli, 2025), a finding that was also seen in Instagram posts (Denniss et al., 2024). Investigations into videos on TikTok found 64% of content creators called themselves experts, without any verification of their 'expert' status (Munro et al., 2024), whilst research into X networks discussing popular diet trends found that almost 90% were not expert users (Eaton et al., 2023).

Recent research has also considered e-health literacy, AI and digital nutrition literacy. It has been suggested that the integration of ChatGPT, alongside e-health literacy could

improve health services by supporting individuals to understand health information and to interpret test results more accurately (Coşkun et al., 2024). There is also recent evidence that nutrition literacy education may improve food security by increasing confidence in food knowledge and cooking (Duffy et al., 2024). However, a review of the literature concluded that limited research has been conducted on the efficacy of food and nutrition literacy interventions, and that these are needed to develop effective interventions to promote healthy dietary habits (Silva, 2023).

In summary, the landscape of online nutrition information and social media has evolved rapidly since 2022, posing both opportunities and challenges for researchers. While misinformation and data access challenges persist, emerging technologies such as AI, and a focus on digital nutrition literacy, present opportunities for improving the accuracy, accessibility, and impact of nutrition information. This focus should be alongside strategies to improve the public's critical skills enabling them to identify high quality, evidence-based information.

## References

- Coşkun, AB. Elmaoğlu, E. Buran, C. et al. (2024). Integration of Chatgpt and E-Health Literacy: Opportunities, Challenges, and a Look Towards the Future. *J Health Rep Technol.* **10**(1), 139748.
- Denniss, E. Lindberg, R. Marchese, LE. et al. (2024). #Fail: the quality and accuracy of nutrition-related information by influential Australian Instagram accounts. *Int. J. Behav. Nutr. Phys. Act.* **21**(1), 16.
- Duffy, V. Avelino, D. Lituma-Solis, B. et al. (2024). Multi-Level Intervention Combining Digital Food and Nutrition Literacy Education With PSE Changes to Improve Nutrition Security. *J Nutr Educ Behav.* **56**(8), S95-S96.
- Eaton, MC. Probst, YC. and Smith, MA. (2023). Characterizing the Discourse of Popular Diets to Describe Information Dispersal and Identify Leading Voices, Interaction, and Themes of Mental Health: Social Network Analysis. *JMIR infodemiology.* **3**, 38245.
- Fappa, E. and Micheli, M. (2025). Content accuracy and readability of dietary advice available on webpages: A systematic review of the evidence. *J Hum Nutr Diet.* **38**(1), 13395.
- Forbes. (2025). Elon Musk's X Sees Popularity Slide After Election — While Threads, Bluesky Make Gains. Accessed June 2025.
- Molenaar, A. Jenkins, EL. Brennan, L. et al. (2023). The use of sentiment and emotion analysis and data science to assess the language of nutrition-, food- and cooking-related content on social media: a systematic scoping review. *Nutr Research Rev.* s0954422423000069.
- Munro, E. Wells, G. Paciente, R. et al. (2024). Diet culture on TikTok: a descriptive content analysis. *Public Health Nutr.* **27**(1), 169.
- Murakami, K. Shinozaki, N. Okuhara, T. et al. (2024). Prevalence and Correlates of Dietary and Nutrition Information Seeking Through Various Web-Based and

- Offline Media Sources Among Japanese Adults: Web-Based Cross-Sectional Study. *JMIR Public Health Surveill.* **10**, 54805.
- Polyzou, M. Kiefer, D. Baraliakos, X. et al. (2023). Addressing the spread of health-related misinformation on social networks: an opinion article. *Front Med.* **10**, 1167033.
- Ruani, MA. Reiss, MJ. and Kalea, AZ. (2023). Diet-Nutrition Information Seeking, Source Trustworthiness, and Eating Behavior Changes: An International Web-Based Survey. *Nutrients.* **15**(21).
- Silva, P. 2023. Food and nutrition literacy: Exploring the divide between research and practice. *Foods.* **12**(14), 2751.

## **Chapter 2 Nutrition communication in public health and the media**

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### **2.1 Introduction**

The wider food environment does not just include the food available in different physical spaces but also includes nutrition information which could originate from a number of different sources. Nutrition information plays a role in guiding people to make food choices but perhaps is often given less emphasis compared to food marketing by food companies. This chapter provides a discussion of the quality and impact of nutritional information in the public domain including information from public health bodies in newspapers and social media.

In the UK, the majority of people obtain nutritional information from the media which includes printed newspapers, television, online news and, in the last decade, social media. A 2017 report from a UK supermarket found that almost a quarter of young people refer to social media for dietary advice, and based on this advice, 50% think that cutting out a food group (e.g. gluten or dairy) can create a healthy lifestyle. As these are key sources of information, the quality of all nutrition-related reporting plays a fundamental role in population health. However, research highlights poor-quality reporting, and in the case of social media, it is largely unregulated. Misinformation and disinformation, or what is more colloquially termed ‘fake news’, also challenges adherence to nutrition guidelines as it creates erroneous beliefs and polarises opinion. It also erodes the public’s trust in science and creates a perception that nutrition scientists ‘cannot make up their minds’. Social media campaigns such as Change4Life in the UK reach a large number of people and are also discussed.

### **2.2 Health and nutrition communication**

Public health messaging plays an important role in behaviour change in many countries around the globe including the UK. The application of evidence into practice and influencing public health policy through public health messaging is a key aspect of Public Health England, including through the social media campaign, Change4Life.

## 2.2.1 History of health and nutrition communication in the UK

Health communication has been integral in the UK for over a century, starting with communication framed around the importance of personal hygiene and moderate eating and drinking to support the war effort (**figure 2.1**).

Year	Health Communication
1914	First World War begins
1917	Department for Information established. <i>Focused on reductions of food and alcohol, and improved sexual health and personal hygiene to aid the war effort.</i>
1918	Food rationing ( <i>sugar, meat, flour, butter, margarine and milk</i> ).
1918	First World War ends
1939	Second World War begins
1940	Ministry of Food established to provide a nutritionally adequate diet to war time Britain. <i>Promotion through leaflets and radio announcements, they educated the public on reducing food waste, encouraged healthy eating and growing own food.</i>
1942	Rationing reinstated to most foods, except fruit and vegetables.
1945	Second World War ends
1948	UK National Health Service established.
1954	Food rationing ends
1960	Communications focus on vaccinations against communicable diseases.
1964	Cohen Report published <i>recommending that public health communications use advertising and journalistic methods</i>
1965	Advertising smoking on television announced illegal.
1968	Health Education Council established.
1970	Anti-smoking campaigns now linked with disease risk and celebrities used to for health communication
1975	'Is your body coming between you and the opposite sex?' <i>Obesity messaging focused towards weight and physical appearance, disease risk was secondary.</i>
1990	HIV and Aids promotion coupled with promotion of safer sexual practices.
1992	Raising awareness of sugars intake and oral health.
1994	'Balance of Good Health', UK dietary guidelines (early Eatwell Guide).
2003	'5 a day' message introduced <i>in response to WHO recommendations that 400g of fruit and vegetables per day has a protective effect.</i>
2007	Smoking in public places banned.
2009	Change4Life launched - <i>a UK social marketing plan to address obesity.</i>
2013	Public Health England (PHE) established.
2012	Start4Life launched <i>in acknowledgment of the lifespan approach.</i>
2016	UK Eatwell Guide - <i>update to the 2007 Eatwell Plate to include making sustainable choices for planetary health.</i>
2016	'One You' launched by PHE to target middle age and older adults.

**Figure 2.1 Timeline of health communication in the UK**

Advertising agencies were used to create campaigns with engaging slogans and images; examples of which can be found at the Imperial War Museum (<https://www.iwm.org.uk/learning/resources/second-world-war-posters>). Early campaigns focused on consuming less wheat and meat, reducing food waste and consuming less alcohol, although the latter had less to do with health risk or war-time rationing, and was instead

used as propaganda to encourage workplace productivity. The Second World War saw nutrition campaigns focus on nutrients with potatoes promoted for energy, carrots for vision (vitamin A) and leafy vegetables as nutrient powerhouses in order to feed the nation and support the war effort. By the 1960s, there was a marked shift towards the challenges of affluence, and health communication began to consider obesity for the first time in 1975. However, the emphasis was on physical appearance, with the relationship between weight gain and disease risk being a secondary message. More recently, public health campaigns in the UK have focused on reducing the risk of non-communicable diseases.

### **2.2.2 Social marketing campaigns**

Different types of public health communication exist which can be broadly categorised as informed decision-making interventions (such as food labelling covered in Chapter 13), persuasion-oriented interventions and advocacy interventions. Persuasion-oriented interventions are used to encourage a specific behaviour such as encouraging the wearing of helmets for cycling or improving dietary behaviour. Advocacy encompasses larger and more comprehensive social marketing campaigns such as reducing smoking. Andreas in the 1990s defined social marketing campaigns as the “application of commercial marketing technologies to the analysis, planning, execution and evaluation of programs designed to influence the voluntary behaviour of target audiences in order to improve their personal welfare” (Piggin and Lee, 2011). There are benefits in using this approach as complex messages can be conveyed and behaviour change techniques applied to large populations whilst also adapting the materials for different groups of consumers. Communication concerned primarily with providing clear messages around managing risk, and crisis management is also an important tool in public health, which we have experienced first-hand during the COVID-19 epidemic, leading to dramatic changes in our behaviour such as social distancing and wearing masks. This type of communication also includes food poisoning outbreaks.

A review of health communication commissioned by the European Centre for Disease prevention and control (ECDC) (<https://www.ecdc.europa.eu/en/health-communication>) highlighted the need for good quality research into health communication and evaluation in order to assist in the development and evaluation of effective campaigns (Piggin and Lee, 2011). The necessary steps in designing and assessing a campaign include identifying specific target audiences and their needs;

evaluating the message; pilot testing the messages; guiding message development; identifying appropriate communication channels that are more likely to reach and influence the target audience; monitoring progress of the campaign and evaluating the effectiveness of the campaign on target audiences and public health.

In 2017, the World Health Organization (WHO) published the Strategic Communications Framework for effective communications (World Health Organization, 2017). The WHO principles for effective communications are based on a framework consisting of six principles: accessible, actionable, credible and trusted, relevant, timely and understandable.

### **2.2.3 Case study: UK Change4Life social marketing campaign**

The Change4life campaign in the UK was implemented in 2009 and informed by a published document Healthy Weight, Healthy Lives: a cross government strategy for England published by the Department of Health (Armstrong et al., 2021) in 2008 as well as a consumer insight report (Department of Health, 2008). The aim of the campaign is to “drive, coax, encourage and support people... [to] eat well, move more and live longer”. One of the central goals of the campaign is to reduce childhood obesity. Between 2009 and 2011, £75 million of funding was provided by DoH and £14m per year between 2011 and 2014 (Department of Health, 2011). The design of the Change4Life campaign was guided by the theoretical framework developed by WHO, UNICEF and FAO, the Communication for Behavioural Impact (COMBI) framework (World Health Organization, 2012). The six main steps involve defining the behaviour objectives, market analysis, refining objectives, pre-paring plans and budget and monitoring and evaluation. Although this framework was originally produced to be used for communication during outbreaks of communicable diseases, it is suitable for a wide range of public health communications including reducing risks of non-communicable diseases such as obesity. Guidelines for the Change4Life campaign include the use of simple messaging, branding with identifiable colours and fonts and an accessible and fun tone. Controversially, the decision was made early on that the word ‘obesity’ would not appear in any of the Change4Life campaign’s marketing materials as it is a sensitive issue for parents; this is discussed by Piggin and Lee (2011).

Evaluating social marketing campaigns is a challenge and evaluation of Change4Life has mostly focused on awareness of the campaign and perceived behaviour change rather than actual behaviour change and short-term outcomes rather than long term.

Nevertheless, improvements in children's snacks in terms of fats and sugars due to the Change4life campaign have been reported (Wrieden and Levy, 2016).

## **2.3 Nutrition in the media**

In the 21st century, there is a plethora of nutrition information available to consumers from sources other than public health communications. Through print media, television, internet and social media, consumers are continually exposed to nutritional information. Some of the information disseminated through these media channels has come from scientific studies that have been published in reputable scientific journals and reported by journalists, but much of the information available has no scientific basis, or the science has been misinterpreted by journalists, or in the case of social media, misinterpreted by the public.

### **2.3.1 Newspapers**

Printed newspapers have been a key source of information in the UK since the 17th century when the printing press was invented making it easier and cheaper to print material in large quantities for distribution. Originally printed to share news, an increase in education and literacy led to new publications being created in the early 20th century which shared more popular stories such as sports and features. The increase in publications has led to more feature-style content which tends to focus on issues of human interest, lifestyle, health (including nutrition) and personal improvement which typically have an entertaining storytelling narrative rather than a scientific basis. Where nutrition is covered as news, journalists often tend to be concerned with what is novel, what affects the public and public health challenges and there is an over- emphasis on pieces of information that contradict a large amount of existing evidence and provide a sensational headline (Goldacre, 2008). This drive for a sensational story to entertain readers could be why research has found that nutrition reporting in print news is not always evidence based, is poor quality, biased and does not always reflect current nutritional guidelines (Kininmonth et al., 2017). However, a survey of readers reported that the general public want to be provided with good quality news once there is consensus among nutrition professionals (Goldberg and Hellwig, 1997).

A small number of studies have reported on the quality of newspaper articles related to health in general or nutrition specifically. A study of 141 nutrition-related articles in five popular UK print newspapers over a period of 6 weeks which used a validated



quality assessment tool (Robinson et al., 2013) found that the news articles were typically satisfactory quality (Kininmonth et al., 2017). The mean quality score varied by newspaper; however, these differences could be explained by different factors related to newspaper articles. Articles that were larger in size and were written by a named journalist, often a health correspondent, tended to be better quality, while articles about obesity tended to be lower in quality (compared with articles on cardiovascular disease, type 2 diabetes or cancers). Common reasons for poor-quality articles were a lack of information on study design, statistics and/or limitations and little background or context provided. Fewer but higher-quality articles in the news may be preferable to larger numbers of poor-quality articles.

As internet penetration has increased, consumers have switched to digital content. Consequently, print newspaper circulation has declined over the last decade, with a reported 53% decrease in circulation since 2012 (OFCOM, 2019). This has resulted in more people reading nutrition articles on online newspaper websites which can be shared although this generally happens less often than on other social media sites.

### **2.3.2 Blogs**

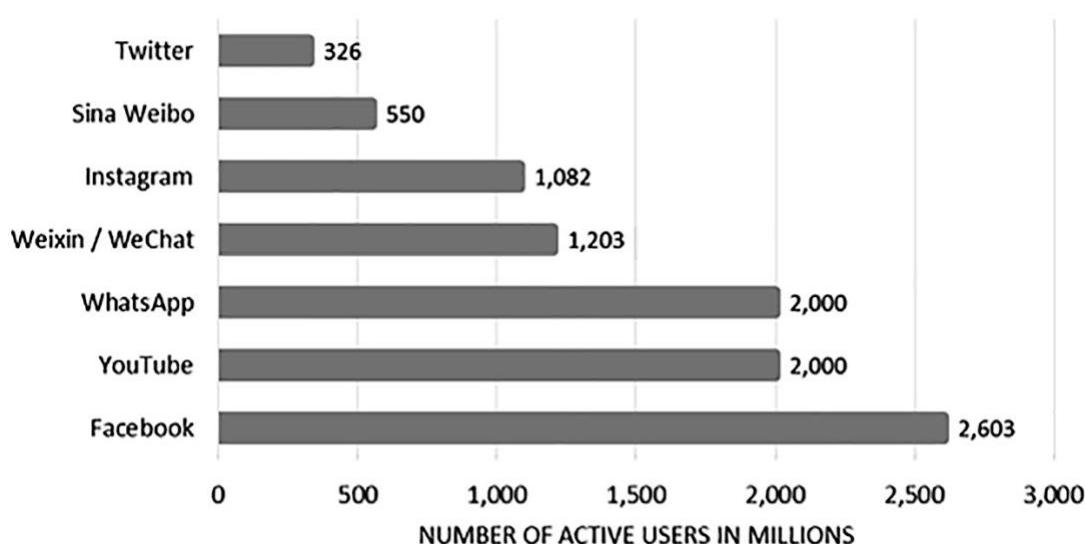
In addition to news media, there has been a proliferation of professional bloggers over the last two decades, many of whom have thousands of followers, but no formal nutritional science training. It is reported that blogs do not encourage healthy diets and only 6% of American food bloggers have nutrition degrees, despite offering nutrition advice (Garza et al., 2019). A recent study found that blogs shared through the microblogging platform Twitter were of poorer quality, were less likely to cite journals and authors and were less likely to include references compared to online news reports and press releases. Conversely, blogs were more likely to be shared and to inspire comment compared to other articles analysed (Ellis et al., 2020). However, there is little research available in this area related to nutrition.

### **2.3.3 Online social media**

Social media presents opportunities and challenges for sharing news, information and opinion. The development of a range of social media platforms including Facebook, Twitter and Instagram has changed the way millions of individuals interact with information, making the internet more interactive and creating a shift from the user

being a passive consumer, to the user being an active participant (Obar and Wildman, 2015). This creates a virtual space that supports information sharing which research suggests can also influence health behaviours (Grilli et al., 2002).

Facebook remains the most popular social network (**figure 2.2**) and usage of social media continues to grow globally with 4.4 billion people with one or more social media accounts in 2019 (DataReportal, 2019). Weibo and WeChat are the most popular channels in the People's Republic of China as there are restrictions on using Facebook and Twitter. All the social media channels share similar characteristics allowing users to share text, pictures, images and videos with their networks, and to tag other users and create conversations.



**Figure 2.2 Most popular social networks worldwide as of July 2020, ranked by number of active users (in millions) using data from Data Reportal.**

Data available from <https://datareportal.com>

Whilst social media can potentially reduce knowledge translation gaps and create communities of best practice, it is unclear whether this is applicable to nutrition information. There is evidence to suggest social media can empower people to develop healthier lifestyles; however, other studies have found that it is not viewed as a useful source of health information within some groups (Khobzi et al., 2019). It is likely that the source of health information is important as this affects how users evaluate the information and how likely they are to propagate the information through their own networks (DeAndrea and Vendemia, 2016). However, it is often difficult to know whether the source has reported the science correctly or whether the information shared

is evidence based. Likes and shares could be seen as affirmation through reinforcement increasing the perception that it is evidence based. This information can be in contrast to public health messages and dietary guidelines further supporting the perception of confused messaging from scientists. This is particularly prevalent in the current era of ‘fake news’.

## **2.4 False information and ‘fake news’**

A lack of trust in the information provided by scientists and medical experts can lead to the sharing of false information. In nutritional science, the erosion of trust is most evident when new, unexpected results undermine previously understood links between food and/or nutrients and disease risk. Reporting new evidence in the media (remembering that journalists are looking for novel information) may appear to suggest that a given nutrient is harmful one moment, then healthy, then harmful again (Mozaffarian and Forouhi, 2018). This has been seen recently as evidence has changed in relation to dietary cholesterol found in eggs and can erode the public’s confidence in nutritional science and dietary guidelines.

Worryingly, a 2017 survey by the Academy of Medical Sciences (AMS) reported that only 37% of the public trust the evidence from medical research. Question marks over funding, conflict of interest and author accountability can damage the public’s trust in science and lead the public to believe that conclusions in science are ever-changing. In addition, the time period between the scientific development and policy changes can create the appearance of controversy which is exacerbated by media reporting creating public confusion (Garza et al., 2019). This may have an impact on the effectiveness of health communication across all media but particularly in social media.

Misinformation, disinformation or ‘fake news’, whilst not exclusive to nutritional science, poses a threat to the public understanding of nutritional information and adherence to dietary guidelines. Interest in misinformation by far predates the digital age and can be traced back to research into how and why rumours spread published in 1947 (Allport and Postman, 1947). In today’s connected world, information is consumed at a rate previously unknown; however, this information is not always true. Both truths and untruths can be shared through social media networks with minimum quality control. The colloquial term for untruths is ‘fake news’, but the definition is broader than this with research identifying three distinct categories of information

behaviour: information, disinformation and misinformation (Fallis, 2015). These are looked at in turn.

#### **2.4.1 Misinformation**

An early definition of misinformation was information that might not be true but remains informative (Fox, 1983). Later, different types of misinformation were defined, including concealment, ambivalence, distortion and falsification, although this did not differentiate between misinformation and disinformation (Zhou and Zhang, 2007). Karlova and Lee added to the debate saying misinformation may also be inaccurate, uncertain, vague or ambiguous, suggesting that information which is incomplete may also be a form of deception, which would instead qualify as disinformation (Karlova and Lee, 2011). Misinformation tends to be ‘accidental’, but the informativeness of it may depend on the relationship between the speaker and the receiver, for example, if the receiver knows the information is incorrect (Karlova and Fisher, 2013).

The recent SARS-CoV-2 pandemic provides a very real example of scientific misinformation that led to the WHO expressing their concerns. From injecting disinfectant to drinking cow urine, the public were exposed to a wide range of false and potentially harmful information to ‘cure’ COVID-19 symptoms. One study investigating COVID-19 rumours reported 82% of claims were false and estimated that 800 people died and a further 5,876 were hospitalised as a result of drinking highly concentrated alcohol after believing rumours on social media that it would kill the virus (Islam et al., 2020).

#### **2.4.2 Disinformation**

Disinformation is ‘deliberately false information’ and does not necessarily need to be inaccurate, but it must be misleading and deliberately deceptive. The intentions behind creating and sharing such information are difficult to define; however, cited reasons include social motivation, benevolent reasons or personally motivated, antagonistic reasons (Karlova and Fisher, 2013).

Fallis (2015) identifies three important identifiers of disinformation: it is information, it is misleading and it is intentionally misleading. Instances of disinformation include deceptive advertising, government propaganda, falsified photographs, internet frauds and fake websites and blogs. It has been argued that disinformation could be more informative than misinformation because the implication is deliberate; however, if

people believe disinformation, it can do significant harm, threatening information integrity.

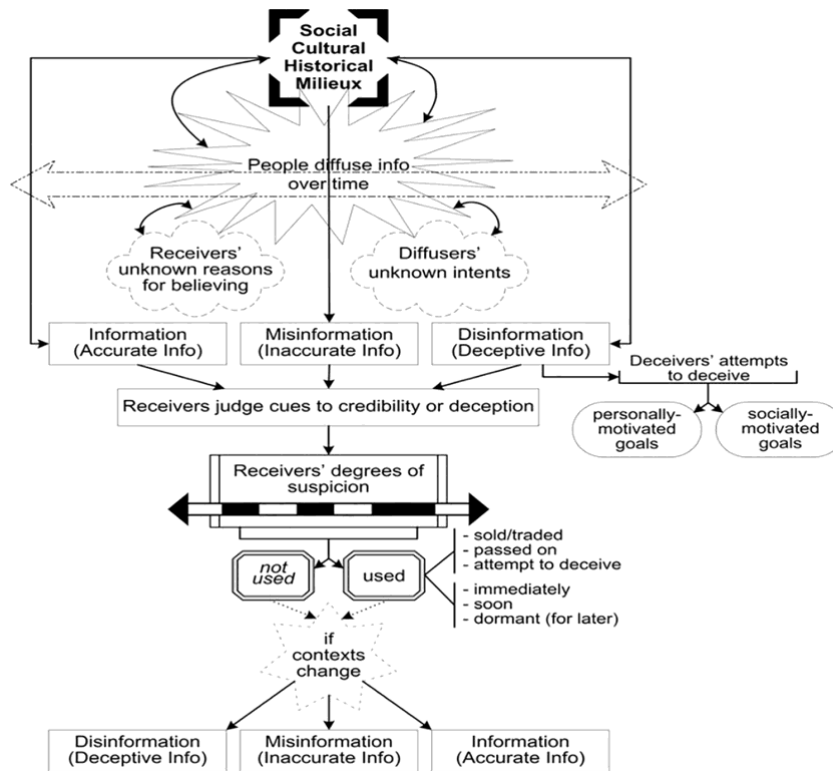
### **2.4.3 Fake news**

Fake news is a colloquial term and is often used interchangeably with misinformation and disinformation making comparisons across research challenging. Fake news sits within the larger context of misinformation and disinformation; and researchers have defined it as a form of falsehood intended to primarily deceive people by mimicking the look and feel of real news. Informativeness depends on the situation as different situations instil different meanings, and these meanings are interpreted depending on the knowledge of the receiver (Buckland, 1991). This could underpin why fake news is challenging to define and identify.

### **2.4.4 Sharing false information**

Karlova and Fisher's 2013 model (**figure 2.3**) shows how misinformation and disinformation can evolve through social networks and diffusion. Through personal experience and context, receivers make judgements about the truth of the information and make a decision on the information and whether to propagate. Considering the motivations for sharing misinformation, Karlova and Fisher state that many individuals may enjoy sharing information and news, even though they may not believe such information themselves as they take pleasure in disseminating it through their social networks. In this way, misinformation and disinformation diffuse across social groups. Social media supports making dissemination easier, wider and faster.

Other explanations suggest confirmation bias, whereby individuals find information which supports their beliefs to be more persuasive. Algorithms and personalised browsing support this theory as users are more likely to be exposed to content which aligns with pre-existing attitudes and browsing behaviours. Individuals may also share news because they do not recognise it is false as they fail to think analytically about the information they are reading.



**Figure 2.3 Social diffusion model of information, misinformation and disinformation**

Reproduced under license CC BY-NC-ND 3.0 (Karlova and Fisher, 2013).

Alternatively, false news articles could be shared because they tend to be more novel and therefore spread faster than real news. Sentiment analysis suggests that false news articles inspire fear, disgust and surprise which could make individuals more likely to share (Vosoughi et al., 2018). Some of these motivations are supported by earlier findings by Chen et al. (2015) who investigated the top reasons that students share misinformation (**table 2.1**). Personality research suggests that extroverts are more likely to knowingly share misinformation as a way of socialising and seeking opinions which is independent of gender.

Information literacy, the ability to identify, locate, evaluate and effectively use information have been cited as key to identifying misinformation and disinformation (Karlova and Fisher, 2013). Knowledge of the source of information provides context and can inform the interpretation and validity judgements. Types of source information include who the author is, when the document was published, and the quality controls in place. This information can be used to evaluate the quality of the information, its trustworthiness and its interpretation. Intervention studies have found that knowledge

on the dangers of sharing misinformation can reduce the number of likes and shares; however, other studies have reported that it does not deter participants from sharing, suggesting that knowledge does not necessarily translate to behaviour and that stronger interventions are needed.

**Table 2. 1 Top five reasons for sharing misinformation on social media by gender**

Rank	Men	Women
1	The information can be a good topic for conversation	The information can be a good topic for conversation
2	The information is interesting	The information is interesting
3	Sharing helps me get other people's opinions regarding the information/event	The information is new and eye-catching
4	The information is new and eye-catching	Sharing helps me interact with other people
5	The information is current	I can express my opinion by sharing that information

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**Source: Reprinted with permission from Elsevier (Chen et al., 2015).**

#### **2.4.5 Media as a propagandist**

Industries as well as public health policy makers are involved in communicating messages which can be picked up by the media. The food industry has been accused of using similar tactics to the tobacco industry to influence policy through heavy promotion and public relations investment, and by distorting the science. The objective of the tobacco strategy was to fund new research to refute the detrimental effects of tobacco on health focusing on other carcinogens, such as asbestos causing controversy and scientific uncertainty. In having access to the science and in reporting the controversy to the public, the media play a key role as a propagandist altering public belief and impacting policy makers (Weatherall et al., 2018). By emphasising the importance of individuals making healthy choices rather than industries' role in creating unhealthy environments, the responsibility shifts to the consumer. This strategy can also be mapped to nutrition communication on social media (which in turn means the public), as the propagandist, with influence over the public and policy makers

(Frederick et al., 2016). The media can shape public opinion through media framing, which exerts pressures on policy makers mobilising policy change (Roland, 2018). In the case of nutrition, the media may selectively share a biased sample of the evidence with the public and policy makers, dividing opinion from scientific consensus. Sensational headlines and novel or contradictory evidence capitalise on scientific uncertainty and do not favour scientific clarity. Missing details such as references, quotes from the author, the strength of the evidence and its application to humans are often omitted further reducing clarity. Evidence of media framing to affect policy was seen in the USA in response to banning sugar-sweetened beverage (SSB) cup sizes over 16 oz, with suggestions that the news media delayed policy development and implementation (Donaldson et al., 2015).

## **2.5 Conclusions and recommendations**

In order to improve the quality of available nutritional information, high-quality social marketing campaigns are needed based on established theoretical frameworks as well as robust standards for reporting nutritional studies in the news media, whether in print or online. In a bid to improve science reporting within Science, Technology, Engineering and Mathematics (STEM) in the UK, the Science Media Centre, on behalf of the Academy of Medical Sciences, has created a labelling system to be used by press officers and journalists to assess how robust a study is and its application to the population (Science Media Centre, 2018). Learned societies such as The UK Nutrition Society ([www.nutritionandsociety.org](http://www.nutritionandsociety.org)) have a role in publishing and disseminating high-quality nutritional science and in working closely with organisations like the Science Media Centre to ensure that experts are contacted for media quotes and advice. In addition, more research is needed on the quality of information shared on social media and the steps that need to be taken to ensure that it is easy to determine the source and quality of online nutritional information.

## **2.6 References**

- Allport, GW. and Postman, L. (1947). *The Psychology of Rumor*, New York: Holt, Rinehart & Winston.
- Buckland, M. (1991). Information as thing. *J Am Soc Inf Sci Tec*, **42**, 351.
- Chen, X. Sin, S-CJ. Theng, Y-L. et al. (2015). Why students share misinformation on social media: motivation, gender, and study-level differences. *J Acad Libr*, **41**, 583–592.



- Datareportal. (2019). Global digital overview [Online]. Available:  
<https://datareportal.com/reports/digital-2019-global-digital-overview> [Accessed January 2020].
- Deandrea, DC. and Vendemia, MA. (2016). How affiliation disclosure and control over user-generated comments affects consumer health knowledge and behavior: A randomized controlled experiment of pharmaceutical direct-to-consumer advertising on social media. *J Med Internet Res*, **18**, e189.
- Department of Health (2011). Change4Life: Three year social marketing strategy. <https://www.gov.uk/government/publications/change4life-three-year-social-marketing-strategy> Accessed August 2020.
- Department of Health (2008). Healthy weight, healthy lives: A cross government strategy for England. <http://www.dh.gov.uk/en/Publicationsandstatistics/> Accessed August 2020.
- Donaldson, EA. Cohen, JE. Truant, PL. et al (2015). News media framing of New York City's sugar-sweetened beverage portion-size cap. *Am J Public Health*, **105**, 2202–2209.
- Ellis, CH., Evans, CEL. and Moore, JB. (2020). Systematic assessment of obesity information on the microblogging platform Twitter. *Proc Nutr Soc.* **79**(OCE3), E791.
- Fallis, D. (2015). What is disinformation? *Library Trends*, **63**, 401–426.
- Fox, C. J. (1983). Information and Misinformation: An Investigation of the Notions of Information, Misinformation, Informing, and Misinforming. Westport, CT: Greenwood.
- Frederick, DA. Saguy, AC. Sandhu, G. et al. (2016). Effects of competing news media frames of weight on antifat stigma, beliefs about weight and support for obesity-related public policies. *Int J Obes*, **40**, 543–549.
- Garza, C. Stover, PJ. Ohlhorst, SD. et al. (2019). Best practices in nutrition science to earn and keep the public's trust. *Am J Clin Nutr*, **109**, 225–243.
- Gold, N. (2020) Using Twitter Data in Research Guidance for Researchers and Ethics Reviewers. <https://www.ucl.ac.uk/data-protection/sites/data-protection/files/using-twitter-research-v1.0.pdf>
- Goldacre, BM. (2008). Bad Science. New York: Harper Collins.
- Goldberg, JP. and Hellwig, JP. (1997). Nutrition research in the media: the challenge facing scientists. *J Am Coll Nutr*, **16**, 544–550.

- Grilli, R. Ramsay, C. and Minozzi, S. (2002). Mass media interventions: effects on health services utilisation. *Cochrane Database of Syst Rev*, **2002**(1).
- Islam, MS. Sarkar, T. Khan, SH. et al. (2020). COVID-19: Related infodemic and its impact on public health: A global social media analysis. *Am J Trop Med Hyg*, **103**(4), 1621–1629.
- Karlova, NA. and Lee, JH. (2011). Notes from the underground city of disinformation: A conceptual investigation. *Proc Assoc Inf Sci Technol*. **48**, 1–9.
- Karlova, NA. and Fisher, K. (2013). A social diffusion model of misinformation and disinformation for understanding human information behaviour. *Inf Res*, **18**(1).
- Khobzi, H. Lau, RYK. and Cheung, TCH. (2019). The outcome of online social interactions on Facebook pages: A study of user engagement behavior. *Internet Res*, **29**, 2–23.
- Kininmonth, A. Jamil, N. Almatrouk, N. et al. (2017). Quality assessment of nutrition coverage in the media: A 6-week survey of five popular UK newspapers. *BMJ Open*, **7**(12): e014633.
- Mozaffarian, D. and Forouhi, NG. (2018). Dietary guidelines and health: Is nutrition science up to the task? *BMJ*, **360**, k822.
- Obar, JA. (2015). Social media definition and the governance challenge: An introduction to the special issue. *Telecommun Policy*, **39**, 745–750.
- OFCOM. (2019). News consumption in the UK: 2019. Available: [https://www.ofcom.org.uk/data/assets/pdf\\_file/0027/157914/uk-news-consumption-2019-report.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0027/157914/uk-news-consumption-2019-report.pdf) Accessed April 2020.
- Piggin, J. and Lee, J. (2011). ‘Don’t mention obesity’: Contradictions and tensions in the UK Change4Life health promotion campaign. *Journal of Health Psychology*, **16**, 1151–1164.
- Public Health England. (2018). A century of public health marketing. Available: <https://publichealthengland.exposure.co/100-years-of-public-health-marketing> Accessed April 2019.
- Robinson, A. Coutinho, A. Bryden, A. et al. (2013). Analysis of health stories in daily newspapers in the UK. *Public Health*, **127**, 39–45.
- Roland, D. (2018). Social media, health policy, and knowledge translation. *J Am Coll Radiol*, **15**, 149–152.
- Science Media Centre. (2018). A new labelling system for medical research press releases. Available: <https://www.sciencemediacentre.org/a-new-labelling-system-for-medical-research-press-releases/> Accessed July 2020.

- Vosoughi, S. Roy, D. and Aral, S. (2018). The spread of true and false news online. *Science* **359**, 1146.
- Weatherall, JO. O'Connor, C. and Bruner, JP. (2018). How to beat science and influence people: Policymakers and propaganda in epistemic networks. *Br. J. Philos. Sci.* **71**(4), 1157–1186.
- World Health Organization (2012). Communication for behavioural impact (COMBI). <https://apps.who.int/iris/handle/10665/75170>
- World Health Organization (2017). WHO strategic communications framework for effective communications. <https://www.who.int/mediacentre/communication-framework.pdf>
- Wrieden, WL. and Levy, LB. (2016). ‘Change4Life smart swaps’: Quasi-experimental evaluation of a natural experiment. *Public Health Nutr.* **19**, 2388–2392.
- Zhou, L. and Zhang, D. (2007). An ontology-supported misinformation model: Toward a digital misinformation library. *IEEE Trans Syst Man Cybern A Syst Hum.* **37**, 804–813.

## Chapter 3 Development and validation of a quality assessment tool to assess online nutrition information

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### 3.1 Abstract

**Setting:** The internet is an important source of health information but is unregulated.

Little research has focused on the assessment of digital information related to nutrition.

**Aim:** To develop and validate a novel online quality assessment tool (OQAT) for quality assessment of online nutrition information.

**Method:** The OQAT was developed and validated in six distinct stages. After reviewing the literature, a framework and criteria were developed and formalised. Next the quality assessment criteria were piloted on a subset of data and criteria refined. The established criteria were then validated against a previously validated assessment tool and reliability was tested. Finally, the validated OQAT was used to assess the quality of articles from a 24hr collection period, 19 April 2021.

**Results:** The final OQAT consisted of 10 key questions. Twenty-six news articles were assessed independently by two raters. Comparison of scores found moderate internal consistency ( $\alpha=0.382$ ). Cohen's Kappa coefficient demonstrated high interrater agreement ( $k=0.653$ ,  $p<0.001$ ). The OQAT was tested on 291 relevant URLs, which were determined to be either poor 3% ( $n=9$ ), satisfactory 49% ( $n=144$ ), or high quality 48% ( $n=139$ ) articles. There was a statistically significant difference in OQAT scores between blogs, news articles and press releases,  $\chi^2(2) = 23.22$ ,  $p<0.001$ , with a mean rank OQAT score of 138.2 for blogs, 216.6 for news articles, and 188.7 for press releases.

**Conclusion:** This novel tool provides a reliable and objective method for assessing the quality of nutrition content online. It could potentially be used by researchers to assess the quality of online information in different settings and by organisations to inform readers of the quality of information being accessed.

### 3.2 Introduction

The internet, including social media, is one of the most important source of nutrition information for the general population (Adamski et al., 2020), however, it is largely unregulated (Zhang et al., 2018). The quality of online nutrition information is important as misinformation leads consumers to believe that the scientific evidence is contradictory (Mozaffarian and Forouhi, 2018) and negatively influences consumer beliefs (Wakefield et al., 2010). Additionally, contradictory information increases uncertainty about health research more generally. Furthermore, the perception of conflicting health reports in the media can increase negative attitudes towards health policy and reduce adherence to guidelines (Chang, 2013). Nutrition guidelines are a key component of the wider health agenda with the World Health Organization making recommendations on diet quality aimed at individuals and the wider food environment. However, there is a rise in self-proclaimed experts online that share misleading information about food and nutrition that can shape perceptions and influence diet (Diekman et al., 2022). People are therefore regularly exposed to conflicting nutrition information from television, online news and social media (Vijaykumar et al., 2021) that undermines these recommendations. Prolonged exposure to inconsistent nutrition information over a period of time has been shown to have detrimental effects on consumer beliefs and healthy dietary intentions (Clark et al., 2019). Inconsistent dietary information may also reduce engagement with recommended nutrition behaviours such as fruit and vegetable consumption.

Previous research has assessed the quality of different types of health information but rarely online health information, and even less frequently nutrition information online. For example, patient facing treatment information (Charnock et al., 1999), health news in print newspapers (Robinson et al., 2013) and patient orientated websites (El Jassar et al., 2019) have all been evaluated systematically. A tool developed and applied to health information in newspapers by Robinson and colleagues (Robinson et al., 2013) has subsequently been used to assess the quality of printed newspapers including; nutrition information (Kininmonth et al., 2017), Brexit-related food issues in the UK (Strong and Wells, 2020), and media reporting on air pollution–related health outcomes (Sun, Z. et al., 2020). In addition, alternative quality assessment criteria have been used to assess media coverage of childhood obesity in UAE newspapers (Awofeso et al., 2019) and the veracity of information shared by social media influencers on Instagram (Sabbagh et al., 2020). Blogs, including recipes, have also been considered including, homemade infant

milk (Davis et al., 2020), healthy living blogs (Boepple and Thompson, 2014) and the nutrient profile of ‘clean eating’ blogs (Allen et al., 2018; Dickinson et al., 2018). Acknowledging the increase of blogs as a public facing source of nutrition information, the construct of blogs written by Dietitians has been considered (Mete et al., 2019), and content analysis of Dietitian vs non-Dietitian authored blogs (Chan, T. et al., 2020) but neither study extended to other types of online content. Studies assessing the quality of online nutrition information have either used newly developed, unvalidated assessment criteria, or criteria designed to assess patient facing health information which do not transfer effectively to nutrition information and make quality comparison across studies challenging. The DISCERN tool (Charnock et al., 1999) has been widely used to assess the quality of nutrition related information online however, while it is validated with high interrater reliability, it is designed to be patient facing and to assess clinical information such as treatment options, risk/benefits of treatment and quality of life. These assessment criteria are not suitable for public health nutrition information in a non-clinical setting.

Existing reviews have evaluated existing quality assessment tools for assessing the quality of general online health information, as opposed to nutrition specifically (Zhang et al., 2015); and educational blogs aimed at healthcare professionals (Paterson et al., 2015). Paterson et al identified 151 quality indicators in the literature, noting that most scoring systems lacked evidence of validity. Consistent with prior reviews (Eysenbach et al., 2002), Zhang et al (Zhang et al., 2015) concluded that quality was defined and measured differently with different studies using different criteria. Both reviews found that the quality of information varied across websites and concluded that overall quality was problematic. To our knowledge, the existing quality assessment tools currently used to assess the quality of online nutrition information are based on medical guidelines and although these instruments were designed as a guide for consumers to evaluating health information quality, the number of criteria included make them impractical to use and questions have been raised about their validity (Zhang et al., 2015). A more recent systematic review of the suitability of existing criteria and instruments used in evaluating health information on social media highlighted the need for future research to identify specific assessment tools and quality evaluation criteria for information shared on social media (Afful-Dadzie et al., 2021).

Disseminating news through social media has become an integral part of online news distribution and consumption, with users contributing both as content creators and content distributors (Kalsnes and Larsson, 2018). However social media has been criticised for having ‘disturbed media power structures’; that is, a structure which enables reduced influence of professional media and allows public actors to play a greater role in shaping debate (Pearce et al., 2019). Online communication can amplify political misinformation (Perl et al., 2018), and encourage unconstructive discussion (Koop and Jansen, 2009). Therefore, in the context of widespread sharing of misinformation and disinformation, it is important to understand the quality of the information that has the potential to be widely shared (Su and Borah, 2019).

Among social media and microblogging platforms, Twitter is a popular social network for discussing news and nutrition-related information globally (Karami et al., 2018). One crucial function of Twitter is as a platform for information sharing, including Uniform Resource Locators (Andreotta et al., 2019) to external online content. The act of sharing content on Twitter is active and demonstrates engagement with the content as research shows that not all online content generates active participation (Pantic, 2020). On Twitter, information sharing is considered either as ‘first degree sharing’, i.e. generating original content and/or posting from an external source, or ‘second degree sharing’, i.e. retweeting a tweet (Veltri and Atanasova, 2017). Mixed methods frameworks have been used to carry out qualitative analysis in other areas such as on climate change commentary on Twitter (Andreotta et al., 2019), and have used content analysis to assess the emotion of tweets (Veltri and Atanasova, 2017; Fownes et al., 2018). While these frameworks considered thematic analysis of the narrative, they did not look at the quality of the information shared.

In summary, there is a lack of suitable standardised quality assessment criteria to assess the quality of online nutrition information (Paterson et al., 2015; Afful-Dadzie et al., 2021). Where quality assessment tools have been developed for online nutrition-related information, they have been more specifically focused towards clinical information (Charnock et al., 1999), or have assumed use by informed readers with existing knowledge (Saltaouras et al., 2019). In addition, source credibility is a key consideration online as this can impact the virality of content (Wang et al., 2019). Therefore, assessment of the media source, as well as content type, is essential to understand where high- and low-quality information is being published online.

### **3.2.1 Aims**

Based on the diverse and often unvalidated quality assessment criteria used in the literature, and the lack of a universally accepted tool for assessing online nutrition information, this study aimed to:

1. develop a novel tool for objective assessment of the quality of online nutrition information,
2. validate the novel assessment tool,
3. assess the novel assessment for interrater reliability and face validity,
4. pilot test to assess the quality of a sample of online nutrition information published on Twitter and assess the relationship between source and quality.

### **3.3 Methods**

The Online Quality Assessment Tool (OQAT) was developed and validated in six distinct stages and then used to assess the quality of articles from one 24hr period. Firstly, a literature search was carried out searching for validated tools designed to assess the quality of online information. Second, a framework and criteria were developed based on the literature mapping the quality assessment criteria on the framework. Third, the criteria were discussed and agreed within the research team. Fourthly, the quality assessment criteria were piloted on a subset of data and the wording of the criteria were refined and criteria were removed if deemed to be duplication. In the fifth stage, the established criteria were validated against an existing print media assessment tool, and reliability was tested. Finally, upon completion of the validation and reliability testing, the validated OQAT was used to assess the quality of articles from a 24hr collection period, 19 April 2021.

#### **3.3.1 Development of a novel online quality assessment tool (OQAT)**

A literature search was conducted to identify articles using tools to assess the quality of online and print nutrition and health information on Web of Science, PubMed and the ACM (Association for Computing Machinery) Digital Library in 2020 and updated in 2021. The literature search focused on validated and un-validated tools assessing quality of nutrition information or health information more generally, online and in print news. Papers were excluded if they were not health or nutrition related, they assessed nutrition or health literacy, or they assessed videos, images or audio such as podcasts.



To develop section one of the OQAT, a framework of quality evaluation criteria, and corresponding indicators, critical to the assessment of online information was constructed, informed by previously evaluated quality assessment tools (Zhang et al., 2015). The framework was based on two key research papers from the literature; the validated Robinson tool (Robinson et al., 2013; Kininmonth et al., 2017) that the authors were already familiar with and had previously been used to assess nutrition information in print news; and a systematic review (Zhang et al., 2015) which categorised the criteria and indicators used in 165 research studies to assess the quality of online health information for consumers. The tool by Robinson was selected as it has been used widely to assess nutrition specific information in newspapers (Kininmonth et al., 2017), and includes objective questions that do not assume the rater has a large amount of prior knowledge of nutrition. The tool also assesses public facing information, rather than information for clinical patients, or practitioners, which differs from other tools, and places emphasis on evidence-based reporting. These were deemed as important criteria for creating an informative novel tool to assess online nutrition information. The systematic review was selected as it is a comprehensive review of existing validated and unvalidated assessment criteria used to assess health information online.

Five of the 21 questions on the Robinson tool were selected as they were relevant for online information (full details are documented in **appendix A, table A1**). Three of which were not explicitly stated by Zhang et al., 2015. Misleading news and headlines, and causal inference (Haber et al., 2018) can have detrimental effects on public health, and therefore the authors felt it was important to include these questions from the Robinson tool. Two major categories were identified by Zhang et al, content, and design. This study only considers content therefore all criteria categorised as design were discounted at the first stage. Content-related measures were further classified into 5 criteria with 28 corresponding indications. The criteria and indicators were selected for the OQAT based on relevance to an individual article as opposed to the wider site, and being represented in at least 50% of the articles reviewed to ensure robust indicators were selected. Initially 13 indicators were selected.

Once the framework, criteria and indicators were defined the quality indicators were initially piloted on 20 randomly selected URLs from the 24-hour collection period, 19 April 2021, and assessed by two trained raters. These represented news articles and

blogs. Both raters had formal nutrition education. The criteria were refined based on discussion within the team on the relevance of the criteria and the existence of high correlation between indicators. The resulting 10 quality assessment indicators were grouped into the three relevant categories as per Zhang et al: currency, credibility and reliability, as described below.

- 1) *Currency* refers to whether the content is up to date. The main indicators include the publication date and when the article was last updated.
- 2) *Credibility* criteria consider authoritativeness and trustworthiness. Authoritative refers to whether the content was contributed by creditable sources and cites credible sources. Trustworthiness is whether a source is truthful or biased. The credibility indicators, as identified by Zhang et al (Zhang et al., 2015), overlap with the technical criteria identified by Eysenbach et al (Eysenbach et al., 2002).
- 3) *Reliability* refers to whether the content of a webpage is understandable for general consumers without a nutrition or science background. It does not consider readability and accessibility of the whole website.

Given the infinite nature of online content, the inclusion of currency was deemed necessary to evaluate whether the article includes up to date scientific evidence and policy information. Positive responses to all 10 indicators were considered essential for a high-quality source of nutrition information. Articles were scored positively if they met the criteria and zero if they did not. There were no negative scores. From a minimum of zero, the maximum score achievable was 10. A full breakdown of the marking criteria and instructions can be found in appendix (**Appendix A, table A2**)

After scoring, articles were categorised as poor, satisfactory and high quality based on the quality score; 0-2 indicated poor quality, 3-6 indicated satisfactory quality and 7-10 indicated high quality. The three cut offs were selected based on Rasch analysis (see statistical analysis, section 3.3.6) which identified the minimum requirements for each category.

To enable the content analysis and comparison of content type, section two of the OQAT was developed to capture the type of information shared (i.e., news article, blog, press release, video, social media, promotional), and the original source. This differs from other research evaluating social media content, which has focused on the social

media user (Warner-Söderholm et al., 2018) and network analysis (Himmelboim et al., 2017). In the context of validating the OQAT, the source and content type were determined by manually evaluating the webpage, with two trained raters, both with formal nutrition training, independently reviewing a subset of URLs and meeting to discuss discrepancies. Content was categorised as per section two of the OQAT, with each article reviewed assigned to a category for *Media source type*, that is, *professional blog*, *news article* or *NGO*, and a category for *Content type*, that is, *blog*, *news*, *advertising* or *video* (**Appendix A, table A2, section 2**).

### **3.3.2 Expert panel evaluation**

Face validity indicates whether the criteria measure what the developers intended them to measure (Bradette-Laplane et al., 2017). This was assessed by two independent experts as per the literature (Anderson et al., 2002; Bradette-Laplane et al., 2017; Mikhail et al., 2020). The panel was selected based on their publication record in the area of online information quality, the quality of media reporting or the role of social media in information literacy. The panel reviewed the assessment criteria and related instructions and provided comment on the clarity and content.

### **3.3.3 Validation of the novel OQAT**

The novel OQAT was validated against an existing tool developed to assess quality of health information in the print idea (Robinson et al., 2013). It was not possible to validate with a high-quality existing tool to assess online nutrition information as this does not currently exist. Therefore, only news articles were used for validation against the validated tool developed to assess UK print news using URLs shared on two randomly selected dates in 2021, 19 April and 12 June 2021. Two trained researchers independently assessed all nutrition-related news articles excluding information not categorised as news (such as blogs). Any significant discrepancies were discussed and consensus reached.

### **3.3.4 Inter-rater reliability**

Inter-rater reliability was carried out to ensure the measure was independent of the raters and could therefore be repeated with different raters. To test reliability, two trained raters, both with formal nutrition training, used the OQAT independently to score a randomly selected subset of the URLs shared on 19 April 2021. A minimum of 50 observations is recommended for reliability testing (Vet, 2011) therefore this was the

minimum number included by authors. This included a random subset of blogs (due to the large number), all news articles and all press releases. Any significant discrepancies between the two raters were identified, the articles were discussed and consensus was reached.

### **3.3.5 Pilot data collection**

Twitter was used to collect Uniform Resource Locators (URLs) (Andreotta et al., 2019) for analysis. Tweet Archiver (Digital Inspiration), was used to automatically webscrape Twitter for posts containing the term ‘nutrition’ or #nutriton during a randomly selected 24 hour period in 2021, 19 April 2021, using Random.org. The data was then screened and those without a URL were discounted. The URLs were then screened for eligibility and relevance, discounting advertising, recipes, original research papers and articles which did not relate to human health.

Two trained raters, both with formal nutrition training, used the tool independently to score the relevant URLs identified during the 24-hour period. Any discrepancies were discussed and consensus was reached. Articles were excluded if topically irrelevant, linked to social media or were advertising or product promotion. Articles on climate change, animal nutrition, food and agricultural policy were discounted if they did not directly relate to nutrition and human health. In addition, URLs were discounted if they were part of discussion forums or were in video format.

### **3.3.6 Statistical analysis**

The Statistical Package for the Social Sciences (SPSS) Version 28.0 was used for statistical analysis. The internal consistency of the OQAT quality score was calculated using Cronbach alpha. This indicates the degree to which items measuring the same general construct produce similar scores. Validity of quality scores for news articles was determined by the intraclass correlation coefficient. This statistic allows for the calculation of the agreement between the OQAT and the Robinson tool.

As the data was ordinal, a weighted Kappa coefficient (McHugh, 2012) was used to measure the agreement between the two raters. Kappa was chosen to assess the interrater agreement rather than correlation coefficients as correlation coefficients only assess covariation in data and do not reflect agreement on the actual scores. Cohen’s Kappa can range from  $-1$  to  $+1$ , where 0 represents the amount of agreement that can be

expected from random chance, and 1 represents perfect agreement between the raters. Scores >0.81 can be considered as near perfect agreement.

For the quality analysis, Shapiro-Wilk's test was used to test for normal distribution, a p-value of <0.01 was taken for significance. The non-parametric Kruskal-Wallis H test was used to compare the OQAT scores of blogs, news articles and press releases due to the non-normality of the data. Rasch analysis was used for the estimation of cut-off levels that represented distinct levels of quality of information, using Winsteps (Linacre, 2023). The dichotomous Rasch Model was fitted to two sets of data, one for Rater 1 and another for Rater 2, using the Joint Maximum Likelihood (JMLE) method and model assumptions were checked for unidimensionality using the principal component analysis of Rasch residuals (PCAR) and other fit statistics were used to evaluate item fit (Ho, 2019). Cut-off points were estimated using a table of score-to-measure that compared the relationship between each raw score, from 0 to 10, with Rasch model estimates of the location (JMLE measures) and their standard errors (SE) according to the procedure suggested by Wright (Wright, 2001).

### **3.4 Results**

#### **3.4.1 Development of the Online Quality Assessment Tool (OQAT)**

Based on a review of quality assessment tools in the literature designed to assess online health information and print news, the following elements were defined for section one:

*Three Criteria:* rules by which the quality of information is judged. Criteria reflect the values held by the evaluator regarding what is important for determining the quality of nutrition information.

*10 Indicators:* observable attributes associated with the webpage content, which indicate whether the webpage content meets a given criterion.

Initially, 14 indicators were identified. However, during the development phase, the criteria were refined based on discussion within the team on the relevance of the criteria and the existence of high correlation between indicators. The highly correlated indicators, such as publication date, date of last review and date of next review, were removed, as was citing an author, and citing a journal, as this could be determined by asking if the article contained links to high quality sources.

The final version of section one of the novel OQAT consisted of 10 key quality indicators adapted from Robinson and additional sources. To ensure suitability for online use, the three criteria were based on the quality assessment from Zhang (**table 3.1**) (Zhang et al., 2015). All indicators were scored positively, and an article could score between the values of zero and ten.

**Table 3. 1 Quality Assessment Criteria for the Novel Online Quality Assessment Tool (OQAT)**

Section One: Quality assessment	
Criteria	Indicators
Currency (whether the content is up to date)	Publication date or date of last update
Credibility (authoritative and trustworthiness)	Authorship – author name Authorship - credentials Attribution – high quality peer review references Attribution – quote a specialist Disclosure – financial or professional disclosures, bias disclosure
Reliability	Adequate and accurate background Headline – true reflection of the article and evidence Does not generalise – from animal or lab studies Does not have the potential to cause undue harm or optimism

Section two of the OQAT is a content analysis codebook (**table 3.2**). URLs were manually reviewed and categorised by media source and content type to allow for quality comparison by content type. Instructions on categorising URLs are available in **Appendix A, table A2**.

**Table 3. 2 Content analysis codebook****Section Two: Media source and content type**

<b>Media source type</b>
1. Blog – personal
2. Blog – professional
3. Company (products and services)
4. Government organisation (e.g. PHE, FDA)
5. Magazine
6. Non-governmental Organisation (NGO)
7. Professional news (e.g. CNN, The Guardian, The Huffington Post, BBC)
8. Research institute/University
9. Social media (e.g., YouTube, Instagram, etc.)
10. Unrelated
<b>Content type</b>
1. News article
2. Blog
3. Scientific report - out of scope for analysis
4. Press release
5. Video - out of scope for analysis
6. Picture - out of scope for analysis
7. Social medial (e.g. Twitter/Facebook status) - out of scope for analysis
8. Promotional - out of scope for analysis

As part of the OQAT development, the criteria were sent to two independent experts for review. Suggestions were made that the OQAT could be improved by scoring poorly if the article is more than 5 years old. The authors agree with this suggestion given the infinite nature of online content and initially included the ‘date of last update’ as a quality indicator; however, this was highly correlated with publication date and therefore was removed. The inclusion of a publication date allows readers to make an informed decision on the relevance of the evidence. However, highlighting that an article is out of date, or updating the content regularly is made as a recommendation in the discussion. Additionally, the reviewers suggested that it would be valuable to better identify articles with multiple links to multiple content, both high and low quality. Again, this is discussed in the discussion as part of the recommendations.

### 3.4.2 Validation of the Online Quality Assessment Tool (OQAT)

Following comment from the expert panel, the instructions were refined for clarity and to avoid ambiguity. The panel did not suggest modifying the criteria or indicators therefore these were accepted as having face validity. The OQAT was validated against an existing validated tool designed to measure the quality of health information in UK print newspapers (Robinson et al., 2013) using data scraped from Twitter on 19 April 2021 and 12 June 2021 (due to the limited number of news articles shared on 19 April 2021). Over this randomly selected 24-hour period, 2,894 tweets were collected from Twitter posts that contained the word 'nutrition' or #nutrition, 1,007 posts included a URL. Each URL was reviewed manually (**figure 3.1**) and categorised as per the OQAT codebook (**table 3.2**).

To validate the OQAT, only news articles were assessed as this type of information is what the previously validated tool was designed to assess. A total of  $n=26$ , news articles were assessed by two trained raters independently using both the OQAT and the existing tool (Robinson et al., 2013). Raters met to discuss and agree any discrepancies. Comparison of scores (**table 3.3**) using Cronbach's alpha found moderate internal consistency ( $\alpha=0.502$ ).

**Table 3.3 Tabulation of scores on the Robinson and the Online Quality Assessment Tool (OQAT) by tertile for news articles**

		OQAT			Total
		Poor	Average	High	
Robinson Tool	Poor	0	2	3	5
	Average	0	6	9	15
	High	0	0	6	6
Total		0	8	18	26

### 3.4.3 Reliability testing

After reviewing manually, 291 posts with URLs remained. These represented a total of 260 blogs, 26 news and 5 press releases. News articles and press releases were over sampled and 100% of these sources were included due to the small numbers in these categories. Out of the 260 blogs, 100 blogs were randomly selected using Excel random generator. Six blogs were excluded as the URLs were broken at the time of review.



Therefore, in the final sample to assess interrater reliability, 94 blogs, 26 news articles and 5 press releases shared on 19 April 2021 (total  $n=125$ ) were assessed. Discrepancies were identified, discussed and consensus reached (**table 3.4**). The weighted Kappa coefficient demonstrated high interrater agreement ( $k=0.653$ ,  $p<0.001$ , 95% CI 0.524 to 0.782).

**Table 3.4 Interrater reliability by tertile for all data assessed**

Before		Rater 2			Total
		Poor	Average	High	
Rater 1	Poor	2	1	1	4
	Average	1	45	10	56
	High	0	10	55	65
Total		3	56	66	125

#### 3.4.4 Fit

The Rasch analysis of the data from Rater 1 indicated that 9 out of the 10 items complied to the recommended OUTFIT mean squares between 0.5 – 1.5 for being “productive for measurement” (**table 3.5**). Item 9 had a very low OUTFIT mean square below 0.5 and is “less productive for measurement, but not degrading”. i.e., it does not affect the general fit of the items to the Rasch model. There was a slight difference in the item fits for Rater 2, with most the same items fitted in the same range, except for item 6 that was in the range of 1.5-2.0 and considered to be “unproductive for measurement, but not degrading”. All Items within these three OUTFIT ranges were acceptable and no further attempt was made to improve the fit of items. The Rasch model assumption of a single measure that represents a single dimension was confirmed with separate PCAR analyses. The data from Rater 1 had an unexplained variance in the first contrast of 1.83 and the data from Rater 2 had a value 1.93, both of which was smaller than 2.0 that has been used to indicate likelihood of whether the Rasch measure was unidimensional (Linacre, 2023). An additional check of unidimensionality examined the values for disattenuated correlation from the comparisons between sets of items that were classified after a PCAR. All values were the recommended value of 0.87, indicating that the measure was an adequate measurement of a single latent variable (Ho, 2019).

### 3.4.5 Estimation of cut-off points

The Wright (Person-to-item) Map allows the representation of the questions (ITEMS) and information sources (PERSON) on the single latent Rasch measure. Three statistically independent levels were found for both sets of data independently with the rescaled Rasch cut-off points shown in the supplementary material as lines in **figures A.1 and A.2** (Appendix A, **figure A.1 and A.2**). The corresponding raw scores for both sets of data were estimated independently and were low (0-2), medium (3-6) and high (7-10).

### 3.4.6 Testing the OQAT for quality assessment of online information

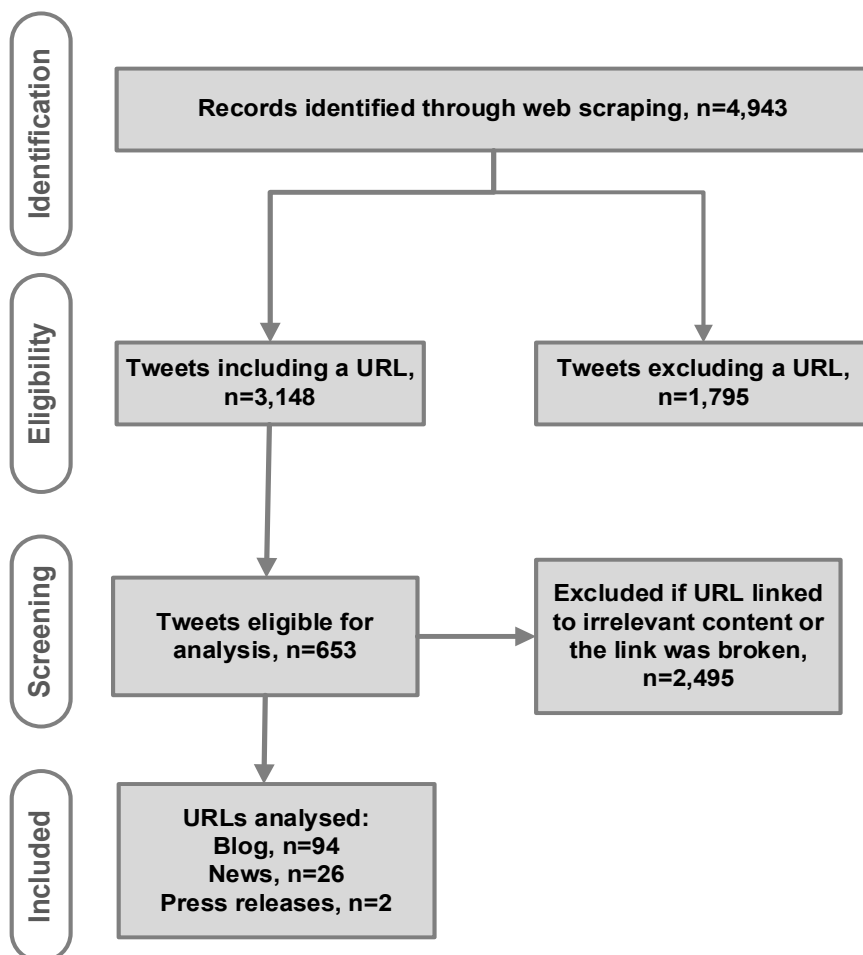
The data scraped from Twitter on 19 April 2021 ( $n=2,894$ ) were reviewed for eligibility (**figure 3.1**) and manually categorised as per the OQAT codebook (**table 3.2**). Articles ( $n=361$ ) not related to nutrition and human health were excluded.  $N=291$  articles were analysed, these represented 260 blogs, 5 press releases and 26 news articles.

**Table 3.5 Item fit statistics for the dichotomous Rasch Model**

Item <sup>1</sup>	JMLE measures $\pm$ SE <sup>2</sup>		OUTFIT mean square	
	Rater 1	Rater 2	Rater 1	Rater 2
Disclosure - 6. Does the article disclose any financial or professional conflict?	8.33 $\pm$ 0.28	8.35 $\pm$ 0.24	1.24	1.94
Specialist - 5. Does the article quote a specialist?	7.44 $\pm$ 0.23	7.61 $\pm$ 0.21	1.29	1.34
Reference - 4. Does the article include references to high quality peer review resources that can be accessed <b>in</b> 1-click?	6.73 $\pm$ 0.22	6.82 $\pm$ 0.20	0.99	0.78
Credentials - 3. Does the article state the authors credentials or provide access to a biography?	5.74 $\pm$ 0.22	6.74 $\pm$ 0.20	0.68	0.71
Result - 10. The article does NOT have the potential to cause undue harm or optimism.	5.07 $\pm$ 0.23	5.02 $\pm$ 0.23	0.79	0.86
Author - 2. Does the article state the author's name?	4.33 $\pm$ 0.25	5.24 $\pm$ 0.22	0.79	0.78
Accurate - 7. Does the article provide adequate and accurate background?	3.75 $\pm$ 0.29	4.85 $\pm$ 0.24	0.92	0.74
Representative - 8. Is the headline a true reflection of the article and evidence?	3.67 $\pm$ 0.29	4.21 $\pm$ 0.28	1.14	1.44
Date - 1. Does the article state the publication date or date of last update?	3.58 $\pm$ 0.30	4.12 $\pm$ 0.29	0.78	0.79
Generalise - 9. The article does NOT make generalisations from animal or lab studies?	1.4 $\pm$ 0.60	0.97 $\pm$ 0.98	0.16	0.26

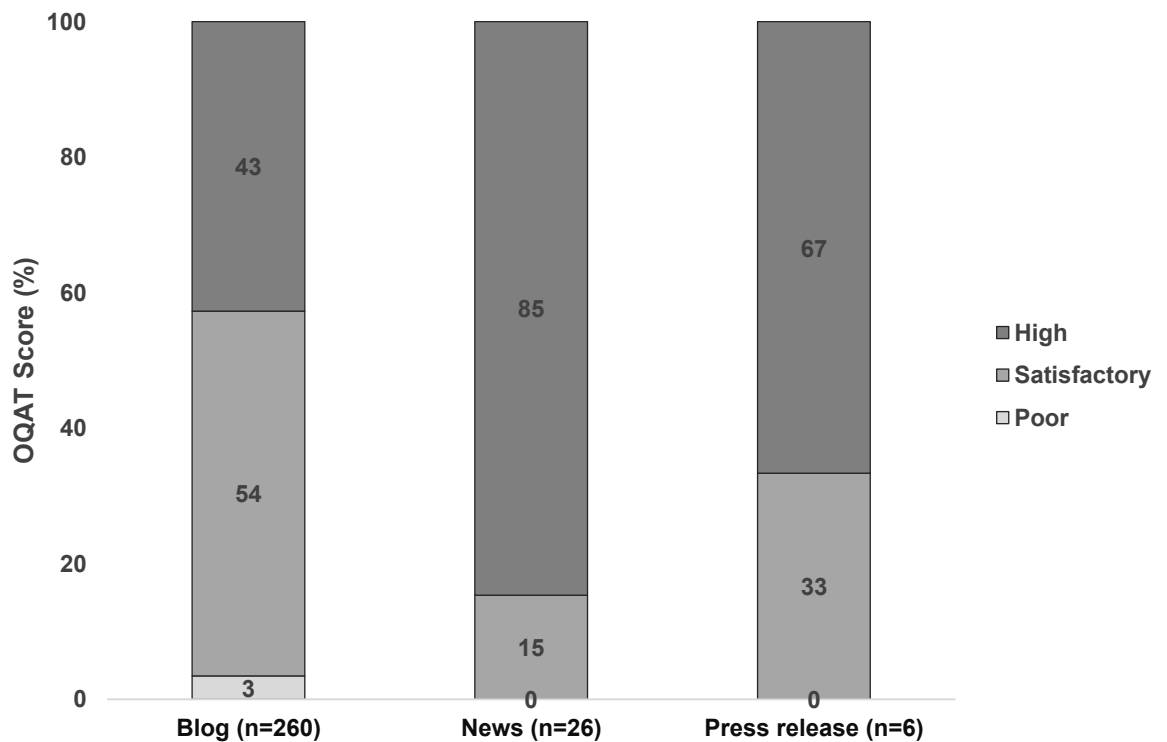
<sup>1</sup> Question items (indicators) have been ordered based on their order of fit. The estimate for items 10 and 2 were reversed for Rater 2 compared to Rater 1.

<sup>2</sup> The JMLE estimates have been rescored from their logit values to a measure range of 0-10.



**Figure 3.1** Flow diagram of identification and screening of tweets from 19 April 2021 for analysis to test the novel tool for assessing the quality of online nutrition information

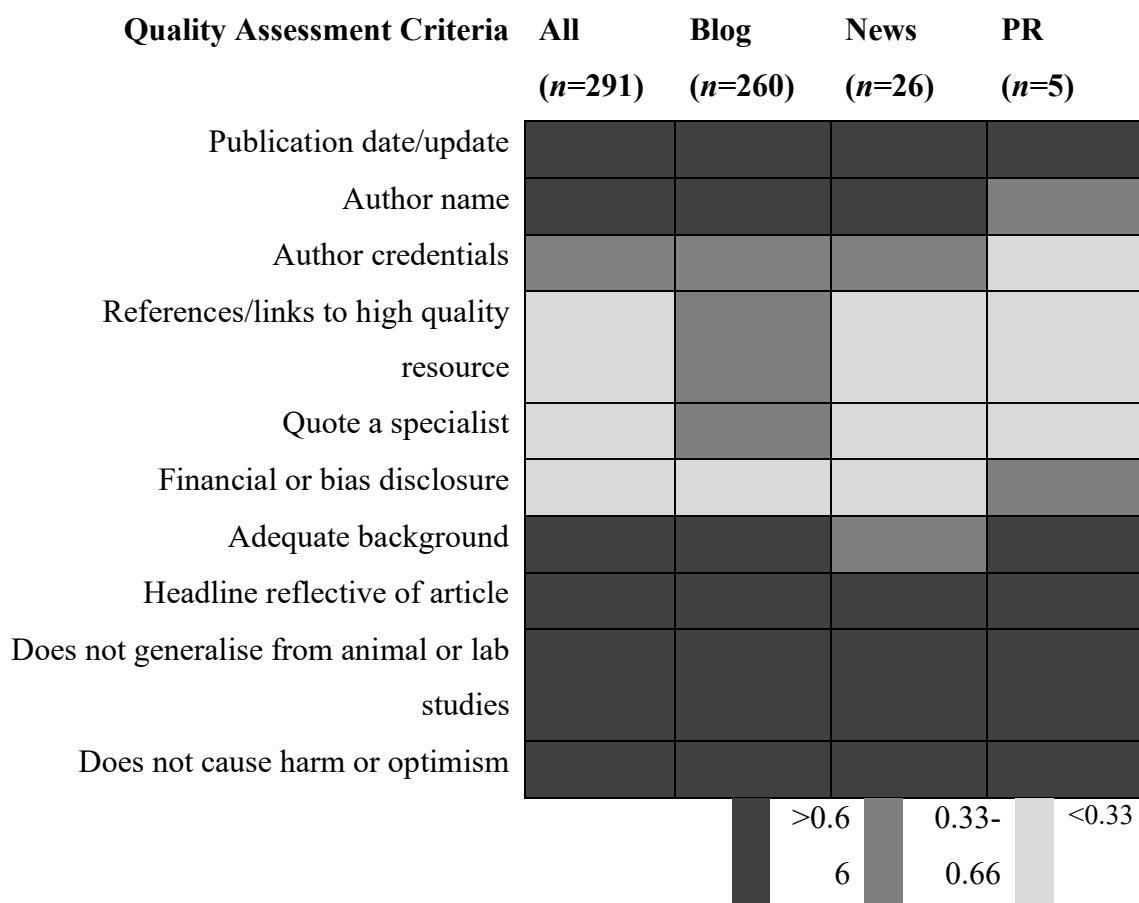
The OQAT was pilot tested on the relevant URLs ( $n=291$ ). The scores generated were not normally distributed, as assessed by Shapiro-Wilk's test ( $p < .001$ ). Three percent ( $n=9$ ) of articles were categorised as poor, 49% ( $n=144$ ) as satisfactory, and 48% ( $n=139$ ) were defined as high quality articles (**figure 3.2**).



**Figure 3.2 Percentage of articles in each category as assessed by the novel Online Quality Assessment Tool (OQAT)**

A Kruskal-Wallis H test showed that there was a significant difference in OQAT score between the blogs, news and press releases,  $\chi^2(2) = 23.22$ ,  $p < .001$ , with a mean rank OQAT score of 138.2 for blogs, 216.6 for news articles, and 188.7 for press releases.

To allow for analysis by criteria, mean scores were calculated for each quality assessment criterion to allow for comparison by criteria and article type. Scores were categorised as positive if they were  $>0.66$  or negative  $<0.33$ . Blogs were least likely to state author credentials, quote a specialist or disclose any financial bias. Across all article types, a specialist quote was least likely to be included as well as disclosure on financial conflict or bias (**figure 3.3**).



**Figure 3.3 Mean Online Quality Assessment Tool (OQAT) score per criterion by content type**

### 3.5 Discussion

Successful development, reliability testing and validation of this novel Online Quality Assessment Tool (OQAT) has addressed a gap in the existing literature by providing a validated quality assessment tool suitable for assessing online nutrition information. It is vital that a means of assessing the quality and credibility of online nutrition information is developed due to the lack of current regulation on the internet, the increasingly common access to poor quality nutrition information, and the growing dependence on online sources for nutrition information. A quality assessment tool is needed to assess changes in the quality of information shared on social media over time if steps are taken in the future to intervene and restrict the spread of nutrition-related misinformation online.

Currently no such mechanism exists for evaluating nutrition-related online information, although several studies have attempted to assess the quality of a variety of different types of online information. These have included assessment of specific dietary advice

for cancer patients (El Jassar et al., 2019), vegan diets (Sabbagh et al., 2020) and impact of social media influencers (Pantic, 2020). However many of these assessment criteria remain unstandardised, and/or unvalidated (Zhang et al., 2015) (Paterson et al., 2015). In addition to the lack of standardisation, most of the tools discussed in the literature were designed and tested before the vast expansion of social media usage and therefore are not well suited to assess the quality of information shared in this way (Afful-Dadzie et al., 2021). Importantly, the initial testing of our novel OQAT instrument, which compared the quality of nutrition information from different sources, demonstrates that our new tool is sufficiently sensitive to detect differences in quality of online information.

An important characteristic of online content is the ability to update the content at any time, and its infinite duration. The OQAT was designed to better assess the unique characteristics and wider range of online, freely available public facing content (which is easy to access, can be written by anyone at any time and is often discursive yet informative). This differs from other tools designed to assess print news (Robinson et al., 2013) or patient facing information (Charnock et al., 1999). The OQAT captures this key currency information which is necessarily different to other available tools. The OQAT is also designed to capture the unique online capability of utilising hyperlinks to external sources, such as research journals and author biographies, both of which are key to determining the credibility of the online article and have been shown to impact spread of information (Wang et al., 2019).

Validation was found to have moderate internal consistency but perhaps would not be expected to be higher given that online news is provided in a different format than paper-based editions. The validation results show that the OQAT is more suitable for online content than current tools but perhaps would not be suitable for nutrition-related news in print newspapers. It is more inclusive, agile and more suitable for assessing content that is not based on a traditional press release. Nevertheless, high interrater reliability was reported providing evidence that the assessment tool was robust. The high interrater reliability suggests that the OQAT met the objective to be an objective tool that could be used by trained raters. Face validity was essential to judge the understanding of the criteria and the associated instructions. The expert panel did not recommend any major changes to the criteria, instead they suggested improving the

wording of questions to avoid ambiguity, as seen in other studies in order to improve reliability (Anderson et al., 2002; Bradette-Laplane et al., 2017; Mikhail et al., 2020).

Our data show, at least on the day sampled, that blogs were the most prevalent nutrition-related content type shared via Twitter. This has also been found in the context of obesity-related content (Ellis et al., 2020) but not in the context of online content related to climate change, where news was the most shared (Veltri and Atanasova, 2017), and professional media outlets were the most prolific actors (Newman, 2017). This indicates that nutrition articles are different from other topics in the news such as climate change (Newman, 2017), and politics (Chadwick et al., 2018; Perl et al., 2018), which may therefore require a different approach towards the assessment of quality.

An initial assessment of quality of information indicated that blogs were not only the most prevalent but also the lowest quality article type. This supports previous work in the literature (El Jassar et al., 2019b; Ellis et al., 2022), where information in blogs has been measured against dietary advice and found to score poorly on providing scientific evidence and including expert opinion (El Jassar et al., 2019; Mete et al., 2019; Sabbagh et al., 2020). The lack of evidence based information in blogs found in our study was consistent with the literature pertaining to print news (Kininmonth et al., 2017), obesity (Ellis et al., 2020), anti-climate change blogs (Pearce et al., 2019) and public authored political blogs (Koop and Jansen, 2009). All of which identified the damage poor quality non-expert written blogs can have on the public debate. Seeking expert opinion, a sign that the writer was aware of the importance of peer review, was also lacking in many sources; consistent with the published literature (Robinson et al., 2013). More encouragingly, the vast majority of articles scored positively on listing an author, an assessment criterion which has previously been shown to positively affect article quality (Robinson et al., 2013; Kininmonth et al., 2017).

The main strength of the tool is that it provides a set of standardised assessment criteria, as called for by Afful-Dadzie et al (Afful-Dadzie et al. 2021), to assess the quality of online content. The quality assessment criteria could expand the OQAT relevance beyond researchers as it could be employed as a checklist by content writers, or as a framework for consumers to assess the quality of online nutrition information, providing a motivation for publishing higher quality information. Similarly, the OQAT



may later be suitable for other evidence-based online articles such as more general preventative health information, pending further research.

Further strengths of this study include the OQAT development, which was based on previously validated criteria (Robinson et al., 2013), and methodology (Paterson, 2015; Adamski, 2020) developed and made relevant for online content. However, validation against a tool that was used to inform the development of the OQAT is a limitation. However, there is no gold standard tool to validate against, and there is a lack of validated tools in the literature; therefore, validating the tool using the Robinson tool was deemed the most appropriate method. The data collection was novel in that it used Twitter as the source of URLs, enabling objective selection of a cross section of content designed to disseminate nutrition information. As Twitter has over 200 million active users, using Twitter ensures that the URLs being assessed have been interacted with. This is preferable to a Google search, which may return content that does not stimulate reader engagement (Pantic, 2020). By creating a tool that can be used for all nutrition-related online content, the OQAT also builds on recent studies that have previously categorised the positive characteristics of Dietitian authored blogs (Mete et al., 2019), and compared the quality of the blogs to those from lay authors (Chan et al., 2020).

This study had several limitations. While a thorough literature review was conducted to identify online and print quality assessment tools and extended to wider health information, some tools may have been missed as a systematic review was not conducted as part of this research. The uniqueness of the OQAT created challenges during the validation process. As the previously validated tool was designed to assess nutrition-related news (Robinson et al., 2013), it was necessary to validate the OQAT using only news articles. However, this type of information is not commonly shared on Twitter. This further supports the need for a quality assessment tool that can assess diverse types of online content, as articles categorised as ‘blogs’ are shared more frequently than ‘news’ on Twitter. Similarly, the disproportionately high number of blogs, while representing the type of content being shared, did not allow for a comprehensive comparison of quality of all content types. A further limitation of the quality assessment methods is that the raters were not blind to the article source. One possible effect of this may have been to moderate the article score if the source was trusted, or not trusted, by the rater. However, the questions were worded as clearly as possible to reduce the risk of bias. A further limitation is that the indicators were not

weighted. Rasch analysis indicated the unweighted items were broadly adequate to assess quality and meet the objective of classifying articles into three quality levels without the need for weighting. However, this is the first iteration of the OQAT and future refined and improved versions may consider weighting.

A limitation of the study, and the OQAT more generally, is that only webpages are considered. Therefore, the wider limitations of a website are not considered, for example if references cannot be accepted or if author credentials cannot be prominently displayed. This is because the OQAT was designed to measure online articles as they relate to evidence-based nutrition, and not the usability or accessibility of websites which could include other information such as events or advertising which were out of scope. Similarly, the OQAT does not include readability scores as these can be assessed by external software such as Flesch-Kincaid readability test. The OQAT was validated using articles identified with the word and hashtag nutrition and written in English. Relevant information could have been missed if a tweet used alternative descriptive words such as ‘diet’ or ‘healthy lifestyle’. Future research should consider broader search terms. Finally, apart from publication date, the OQAT does not consider how up to date the article is as this is challenging to determine in nutrition as some research and guidelines are relevant 30 years later. Future versions of the OQAT should consider how to reliably deal with this.

Importantly however, the successful development and validation the OQAT has led to a number of recommendations for practice. Online content, and blogs in particular, are a popular source of nutrition information for the public (Mete et al., 2019) but they vary widely in quality (Boepple and Thompson, 2014; Davis et al., 2020; Ellis et al., 2020). Based on the findings from the OQAT development and validation, and the wider literature, a series of recommendations to content writers are suggested. Online content that gives dietary advice must be evidence based and provide the evidence to the reader through references or hyperlinks. References and hyperlinks should link to scientific evidence rather than circular links within the website – it is best practice to include an identifying feature for scientifically validated weblinks.

Given the infinite lifespan of online content, articles should be reviewed and updated regularly (annually as a minimum) and include a warning or caveat if the content is more than 5 years old or be removed from the website, so the reader is informed on how

up to date the evidence is and not unknowingly exposed to out of date nutrition information. Blog authors need to give a brief, referenced summary of the evidence ensuring the most up to date evidence is stated to ensure the reader has a comprehensive background to the topic. Additionally, authors should not overstate the evidence. Notably, many blogs reviewed by the OQAT scored poorly as they suggested health can be improved by regularly eating one nutrient or food type over a short period of time, or similar overstatements leading to increased risk of causing undue harm or optimism. Finally, any funding should be explicitly stated so that a reader is informed whether the author has been paid to write about a certain food or topic. Further research is needed to determine whether nutrition information is more likely to be shared if it is lower quality.

### 3.5.1 Conclusions

The development and validation of this novel online quality assessment tool (OQAT) adds to a body of literature assessing quality of information in the media and online. This study contributes to the methodology of assessing the quality of online information. It has further developed existing tools and guidelines to create a tool that is designed to be simple to use and, with further testing, could be used by non-nutritionists to measure the distinct characteristics of online information. This tool is a reliable and objective method that can be used in future research and practice; either by researchers to assess the quality of online information in different settings and by organisations to inform readers of the quality of information being accessed. While this tool was validated using nutrition information, it may also be suitable for other evidence-based online articles such as more general health information.

### 3.6 References

- Adamski, M. Truby, HM Klassen, K. et al (2020). Using the Internet: Nutrition Information-Seeking Behaviours of Lay People Enrolled in a Massive Online Nutrition Course. *Nutr.* **12**(3), 750.
- Afful-Dadzie, E. Afful-Dadzie, A. and Egala, SB. (2021). Social media in health communication: A literature review of information quality. *Health Inf Manag J.* **52**(1), 3–17.
- Allen, M. Dickinson, KM. and Prichard, I. (2018). The Dirt on Clean Eating: A Cross Sectional Analysis of Dietary Intake, Restrained Eating and Opinions about Clean Eating among Women. *Nutr.* **10**(9), 1266.
- Anderson, AS. Bell, A. Adamson, A. et al. (2002). A questionnaire assessment of nutrition knowledge--validity and reliability issues. *Public Health Nutr.* **5**(3), 497-503.

- Andreotta, M. Nugroho, R. Hurlstone, et al. (2019). Analyzing social media data: A mixed-methods framework combining computational and qualitative text analysis. *Behav Res Methods*. **51**(4), 1766-1781.
- Awofeso, N. Imam, SA. and Ahmed, A. (2019). Content Analysis of Media Coverage of Childhood Obesity Topics in UAE Newspapers and Popular Social Media Platforms, 2014-2017. *Int J Health Policy* **8**(2), 81-89.
- Boepple, L. and Thompson, JK. (2014). A content analysis of healthy living blogs: Evidence of content thematically consistent with dysfunctional eating attitudes and behaviors. *Int J Eat Disord*. **47**(4), 362-367.
- Bradette-Laplante, M. Carbonneau, É. Provencher, V. et al. (2017). Development and validation of a nutrition knowledge questionnaire for a Canadian population. *Public Health Nutr*. **20**(7), 1184-1192.
- Chadwick, A. Vaccari, C. and O'Loughlin, B. (2018). Do tabloids poison the well of social media? Explaining democratically dysfunctional news sharing. *New Media Soc*. **20**(11), 4255-4274.
- Chan, AKM. Nickson, CP. Rudolph, JW. et al. (2020). Social media for rapid knowledge dissemination: early experience from the COVID-19 pandemic. *J Anaesth*. **75**(12), 1579-1582.
- Chan, T. Drake, T. and Vollmer, RL. (2020). A qualitative research study comparing nutrition advice communicated by registered Dietitian and non-Registered Dietitian bloggers. *J Health Commun*. **13**(1), 55-63.
- Chang, C. (2013). Men's and women's responses to two-sided health news coverage: a moderated mediation model. *J Health Commun*. **18**(11), 1326-1344.
- Charnock, D. Shepperd, S. Needham, G. et al. (1999). DISCERN: an instrument for judging the quality of written consumer health information on treatment choices. *J Epidemiol Community Health* (1979). **53**(2), 105-111.
- Clark, D. Nagler, RH. and Niederdeppe, J. (2019). Confusion and nutritional backlash from news media exposure to contradictory information about carbohydrates and dietary fats. *Public Health Nutr*. **22**(18), 3336-3348.
- Davis, SA. Knol, LL. Crowe-White, KM. et al. (2020). Homemade infant formula recipes may contain harmful ingredients: a quantitative content analysis of blogs. *Public Health Nutr*. **23**(8), 1334-1339.
- Dickinson, KM. Watson, MS. and Prichard, I. (2018). Are Clean Eating Blogs a Source of Healthy Recipes? A Comparative Study of the Nutrient Composition of Foods with and without Clean Eating Claims. *Nutr*. **10**(10), 1440.
- Dickman, C. Ryan, CD. and Oliver, TL. (2022). Misinformation and Disinformation in Food Science and Nutrition: Impact on Practice. *J Nutr*. **153**(1), 3-9.
- Digital Inspiration. Available from: <https://digitalinspiration.com/product/twitter-archiver/> Accessed October 2021.
- El Jassar, OG. El Jassar, IN. and Kritsotakis, E. (2019). Assessment of quality of information available over the internet about vegan diet. **49**(6), 1142-1152.
- Ellis, CH., Evans, CEL. and Moore, JB. (2020). Systematic assessment of obesity information on the microblogging platform Twitter. *Proc Nutr Soc*. **79** (OCE3).
- Ellis, C.H., Moore, J.B. and Evans, C.E.L. (2022). Development and validation of a novel quality assessment tool to measure the quality of nutrition information online. *Proc Nutr Soc*. **81** (OCE1).
- Eysenbach, G. Powell, J. Kuss, O. et al. (2002). Empirical studies assessing the quality of health information for consumers on the world wide web: a systematic review. *Jama*. **287**(20), 2691-2700.
- Fownes, JR. Yu, C. and Margolin, DB. (2018). Twitter and climate change. *Sociology compass*. **12**(6), e12587.

- Haber, N. Smith, E. Moscoe, E. et al. (2018). Causal language and strength of inference in academic and media articles shared in social media (CLAIMS): A systematic review. *PLoS One*. **13**(5), 0196346.
- Himmelboim, I. Smith, MA. Rainie, L. et al. (2017). Classifying Twitter topic-networks using social network analysis. *Social Media Soc.* **3**(1).
- Ho, P. (2019). A new approach to measuring Overall Liking with the Many-Facet Rasch Model. *Food Qual Prefer.* **74**, 100-111.
- Kalsnes, B. and Larsson, AO. (2018). Understanding News Sharing Across Social Media: Detailing distribution on Facebook and Twitter. *Journal Stud.* **19**(11), 1669-1688.
- Karami, A. Dahl, AA. Turner-McGrievy, G. et al. (2018). Characterizing diabetes, diet, exercise, and obesity comments on Twitter. *Int J Inf Manag.* **38**(1), 1-6.
- Kininmonth, A. Jamil, N. Almatrouk, N. et al. (2017). Quality assessment of nutrition coverage in the media: a 6-week survey of five popular UK newspapers. *BMJ Open.* **7**(12).
- Koop, R. and Jansen, HJ. (2009). Political Blogs and Blogrolls in Canada: Forums for Democratic Deliberation? *Soc Sci Comput Rev.* **27**(2), 155-173.
- Linacre, J.M. (2023). Winsteps® Rasch measurement computer program (Version 5.4.0). *Portland, Oregon: Winsteps.com.*
- McHugh, ML. (2012). Interrater reliability: the kappa statistic. *Biochem Med.* **22**(3), 276-282.
- Mete, R. Curlewis, J. Shield, A. et al. (2019). Reframing healthy food choices: a content analysis of Australian healthy eating blogs. *BMC public health.* **19**(1), 1711.
- Mikhail, D. Rolls, B. Yost, K. et al. (2020). Development and validation testing of a weight management nutrition knowledge questionnaire for adults. *Int J Obes.* **44**(3), 579-589.
- Mozaffarian, D. and Forouhi, NG. (2018). Dietary guidelines and health—is nutrition science up to the task? *BMJ.* **360**, k822.
- Murray, CJ. Lopez, AD. and Jamison, DT. (1994). The global burden of disease in 1990: summary results, sensitivity analysis and future directions. *Bull World Health Organ.* **72**(3), 495-509.
- Newman, TP. (2017). Tracking the release of IPCC AR5 on Twitter: Users, comments, and sources following the release of the Working Group I Summary for Policymakers. *Public Underst Sci.* **26**(7), 815-825.
- Pantic, M. (2020). Engagement With Live Blogs: When Passive Consumption Overpowers Participation. *Electronic News.* **14**(1), 22-36.
- Paterson, QS. Thoma, B. Milne, WK. et al. (2015). A Systematic Review and Qualitative Analysis to Determine Quality Indicators for Health Professions Education Blogs and Podcasts. *J Grad Med Educ.* **7**(4), 549-554.
- Pearce, W. Niederer, S. Özkula, SM. et al. (2019). The social media life of climate change: Platforms, publics, and future imaginaries. *Wiley Interdiscip Rev Clim.* **10**(2).
- Robinson, A. Coutinho, A. Bryden, A. et al. (2013). Analysis of health stories in daily newspapers in the UK. *Public Health.* **127**(1), 39-45.
- Saltaouras, G. Lightowler, H. Coe, S. et al. (2019). Availability and quality assessment of online nutrition information materials for pelvic cancer patients in the UK. *Eur J Cancer Care.* **28**(4), e13039.
- Strong, H. and Wells, R. (2020). Brexit-related food issues in the UK print media: setting the agenda for post-Brexit food policy. *Br Food J.* **122**(7), 2187-2201.

- Sun, Z. Cang, J. Ruan, Y. et al. (2020). Reporting gaps between news media and scientific papers on outdoor air pollution–related health outcomes: A content analysis. *Int J Health Plan Manag.* **35**(1), 221-232.
- Veltri, GA. and Atanasova, D. (2017). Climate change on Twitter: Content, media ecology and information sharing behaviour. *Public Underst Sci.* **26**(6), 721-737.
- Vet, HCW de. 2011. *Measurement in medicine: a practical guide*. Cambridge; Cambridge University Press.
- Vijaykumar, S. McNeill, A. and Simpson, J. (2021). Associations between conflicting nutrition information, nutrition confusion and backlash among consumers in the UK. *Public Health Nutr.* **24**(5), 914-923.
- Wakefield, MA. Loken, B. and Hornik, RC. (2010). Use of mass media campaigns to change health behaviour. *The Lancet.* **376**(9748), 1261-1271.
- Wang, XH. Chen, L. Shi, JY. et al. (2019). What makes cancer information viral on social media? *Comput Hum Behav.* **93**, 149-156.
- Warner-Söderholm, G. Bertsch, A. Sawe, E. et al. (2018). Who trusts social media? *Comput Hum Behav.* **81**, 303-315.
- Wright, BD. (2001). Separation, Reliability and Skewed Distributions: Statistically Different Sample-independent Levels of Performance. *Rasch Measurement Transactions* **14**(4), 786.
- Zhang, HL. Kuhnle, A. Smith, JD. et al. (2018). Fight under uncertainty: Restraining misinformation and pushing out the truth. *Proc. IEEE ACM Int Conf Adv Soc Netw Anal Min.* 266-273.
- Zhang, Y. Sun, Y. and Xie, B. (2015). Quality of health information for consumers on the web: A systematic review of indicators, criteria, tools, and evaluation results. *J Assoc Inf Sci Technol.* **66**(10), 2071-2084.

## Chapter 4 Content quality versus sharing practices on social media: A cross-sectional analysis of nutrition information on Twitter

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### 4.1 Abstract

**Objective:** To use the validated Online Quality Assessment Tool (OQAT) to assess the quality of online nutrition information.

**Setting:** The social networking platform formerly known as Twitter (now X).

**Design:** Utilising the Twitter search application programming interface (API; v1.1), all tweets that included the word ‘nutrition’, along with associated metadata, were collected on seven randomly selected days in 2021. Tweets were screened, those without a URL were removed and the remainder grouped on retweet status. Articles (shared via URL) were assessed using the OQAT, and quality levels assigned (low, satisfactory, high). Mean differences of retweeted and non-retweeted data were assessed by Mann-Whitney U test. The Cochran-Mantel-Haenszel test was used to compare information quality by source.

**Results:** In total, 10,573 URLs were collected from 18,230 tweets. After screening for relevance, 1,005 articles were assessed (9,568 were out of scope) sourced from: professional-blogs ( $n=354$ ), news-outlets ( $n=213$ ), companies ( $n=166$ ), personal-blogs ( $n=120$ ), NGOs ( $n=60$ ), magazines ( $n=55$ ), universities ( $n=19$ ), government ( $n=18$ ). Rasch measures indicated the quality levels; 0-3.48, poor, 3.49-6.3, satisfactory and, 6.4-10, high quality. Personal and company-authored blogs were more likely to rank as poor quality. There was a significant difference in quality of retweeted ( $n=267$ , sum of rank, 461.6) and non-retweeted articles ( $n=738$ , sum of rank, 518.0),  $U = 87475$ ,  $p=0.006$ , but no significant effect of information source on quality.

**Conclusions:** Lower-quality nutrition articles were more likely to be retweeted. Caution is required when using or sharing articles, particularly from companies and personal blogs, which tended to be lower-quality sources of nutritional information.

**Keywords:** Nutrition communication, quality assessment, digital health, online information, social media, Twitter, X

## 4.2 Introduction

It is becoming increasingly common for the public to turn to the internet and social media sources for nutrition information (Ramachandran et al., 2018). However, the digital environment has minimal regulation and varying quality (El Jassar et al., 2019), which increases the risk of exposure to misinformation (Vijaykumar et al., 2021) and knowledge distortion (Steils and Obaidalahe, 2020). To add to the complexity, social media facilitates rapid dissemination of content (Lynn et al., 2020), allowing myths to spread quickly (Adamski et al., 2020) potentially creating an environment where ‘often the loudest, most extreme voices drown out the well informed’ (Mozaffarian and Forouhi, 2018).

In recent years there has been a proliferation of professional bloggers giving lifestyle and dietary advice (Oksman et al., 2016; Mete et al., 2019). In the context of nutrition, many bloggers have thousands of followers, but no relevant nutritional science qualifications (Adamski et al., 2020). Indeed, it has been found that only 6% of American food bloggers have nutrition degrees (Dickinson et al., 2018). This type of non-expert generated content may explain the variation in quality of the digital environment. For example, healthy eating blogs from credentialed experts were found to be higher quality in comparison to non-experts, with 43% of all blogs reviewed aligning with dietary advice (Mete et al., 2019). Similarly, articles on COVID-19 and vitamin D are inconsistent with the scientific evidence (Heer et al., 2022), and articles giving information on vegan diets are varied and unreliable (El Jassar et al., 2019).

Supporting these results, personal and commercial blogs (Ng et al., 2021) have been found to consistently be of poorer quality than other sources of online information (El Jassar et al., 2019; Ellis. et al., 2025), providing lifestyle and nutrition advice that is subjective and unbalanced (Armstrong et al., 2021). In part, this could be explained by coverage of the UK Article 12(c) on Nutrition and Health Claims Regulation (*Department of Health and Social Care Guidance Nutrition and Health Claims: Guidance to Compliance with Regulation (EC) 1924/2006*). Although this regulation prohibits health professionals discussing certified health claims in commercial communications, non-professionals, celebrities, and ‘influencers’ do not fall under this regulation and can discuss health claims, whether certified or not (Ashwell et al., 2022).



Similar patterns of poor-quality nutrition information being disseminated by non-expert bloggers has been evidenced on social media (Kabata et al., 2022). A study using Instagram, found weight management posts by social media influencers to be of poor quality (Sabbagh et al., 2020). The ‘healthy diet’ discourse on Twitter has been found to be dominated by ‘non-health professionals’ and largely constitutes poor quality information that contradicts public health advice (Lynn et al., 2020). Beyond just quality, examining social media can provide unique insights into the nutrition and diet information reaching, and influencing, large segments of the general population (Harris et al., 2014). In addition, it is important to understand sharing practices as Twitter posts are also subject to likes and retweets. Previous research has investigated emotion as a motivator for retweeting news (Vosoughi et al., 2018), but to our knowledge, information quality, and whether quality is a predictor of engagement, has not been investigated. Therefore, in the context of widespread sharing of misinformation, it is important to understand the quality of the information that has the potential to be widely shared and how this influences the debate in question (Su and Borah, 2019).

Nutrition research is at particular risk of misunderstanding as people have daily interactions with food, and beliefs may be rooted in cultural practices, assumption and intuition, more than sound science (Brown et al., 2014). Prolonged exposure to inconsistent nutrition information over a period of time can have detrimental effects on consumer beliefs (Mozaffarian and Forouhi, 2018, Clark et al., 2019), and impact adherence to recommended nutrition behaviours such as fruit and vegetable consumption (Lee et al., 2018). Therefore, it is increasingly important to be able to differentiate between high- and low-quality nutrition information and determine the sharing practices of different types of information. However, to date it has been difficult to compare the quality across existing studies due to their use of multiple quality criteria and different assessment tools. Notably, Afful-Dadzie and colleagues examined the quality of health information shared on online and found that most of the literature relied on three quality assessment tools (Afful-Dadzie et al., 2021). Afful-Dadzie et al concluded these tools were outdated and not fit for purpose; moreover they called for standardised quality assessment criteria suitable for social media and online content. In response to this, we have developed and validated a novel quality assessment tool, specifically suited to assessing the quality of online nutrition information (Ellis et al., 2025).

The current study uses the aforementioned newly developed assessment tool to address a further gap in the literature, namely to assess the quality of online nutrition information disseminated via Uniform Resource Locators (Andreotta et al., 2019) via Twitter. Twitter was of interest in this study as it remains a popular platform for discussing news and nutrition-related information. A crucial function of Twitter as a platform, is information sharing (Andreotta et al., 2029), including URLs to external articles which is active and demonstrates engagement with content. Twitter also allows second-degree sharing, or retweeting, giving a further indication of the content the public are engaging with. Therefore we specifically aimed to examine the quality of retweeted articles, shared via URL, in comparison to unshared content, in order to determine: 1) whether the high- or low-quality information is more likely to be retweeted, and 2) which information sources were sharing the highest quality nutrition information.

### **4.3 Methods**

Using our previously validated tool designed to measure the quality of online nutrition information (Ellis et al., 2025), we aimed to analyse the quality of a randomly selected subset of nutrition related articles posted via URL on Twitter in 2021. While Twitter changed its name to X in July 2023, the data collected for this study was collected from Twitter, therefore we will continue to refer to the platform as Twitter and use the terms tweets and retweets throughout.

#### **4.3.1 Data collection and screening**

The Twitter Search Application Programming Interface (API), as it was known before the rebrand to X, was used to gather data. The dataset comprised all English language tweets including the word ‘nutrition’ by month from 1 January 2021 to 31 December 2021. A full year was collected to allow a random sample from across the year to be analysed which would not be affected by any predetermined seasonal effects, usually seen in December and January (Kamiński et al., 2020).

The tweets themselves were out of scope in this study as the OQAT was designed to measure the quality of longer form online articles written to give dietary and nutrition advice to the public. Similarly, because the character restrictions of Twitter, the posts themselves are unlikely to score high on the OQAT criteria. Instead Twitter was used to; 1) collect articles (shared via URL) that the public have interacted with at least once

(through the initial act of posting) for the quality assessment; and 2) to assess the type on online article that the public are engaging with and whether quality was a factor in the decision to reshare articles.

Using [www.random.org](http://www.random.org), four days were selected for analysis, 24 January, 11 August, 21 November and 22 November 2021. There were more tweets collected that had not been retweeted, therefore three additional days were randomly selected: 26 May, 12 June and 14 December 2021, and the retweeted tweets were included for analysis. This gave approximately the same number of URLs in each category (retweet and no retweet) before screening for relevance. The data were then filtered by those containing a URL, tweets that did not include a URL were discounted. This established two datasets: URLs with and without retweets.

Each eligible article (shared via URL) was reviewed manually and categorised based on the Online Quality Assessment Tool (OQAT) codebook (Ellis et al., 2025) to identify the website source and the content type. The URLs were included if they were related to human health, and discussed any of the following: diet and disease risk, diet and disease management, nutrition and dietary advice, scientific research papers relating to human nutrition, or, specific macro or micronutrients. Articles were excluded if topically irrelevant, linked to social media or consisted of advertising and product promotion. Articles that related to climate change, animal nutrition, food and agricultural policy were discounted if they did not directly relate to nutrition and human health. In addition, articles were discounted if they were part of discussion forums, videos, or linked to other social media accounts as the OQAT was only designed to measure written information. Finally, scientific research papers were also excluded. This was because research papers are not necessarily intended to be public facing or to give dietary advice, therefore have less direct impact on dietary choices. Additionally, when we developed the OQAT and carried out pilot testing, scientific studies scored 9/10 (noting they do not include expert quotes) therefore this could have skewed the results; however, press releases were included as the public facing aspect of scientific papers.

Two trained raters used the tool independently to score the relevant articles against the 10 OQAT indicators. The indicators were designed to measure three criteria: 1) Currency: publication date, author name, and credentials; 2) Credibility; links to high quality references, specialist quote, transparency, and 3) Reliability; adequate

background, reflective headline, does not over generalise, does not have potential to cause undue harm or optimism. Indicators were scored positively, and an article could score between the values of 0 and 10. A higher OQAT score indicated a higher quality article. During previous validation, the OQAT had moderate internal consistency ( $\alpha = 0.382$ ). Cohen's Kappa coefficient demonstrated high interrater agreement ( $k = 0.653$ ,  $p < 0.001$ ). Full details on the development of the criteria and indicators can be found in the published validation report <sup>(13)</sup>.

Any discrepancies were discussed among raters until consensus was reached. After scoring, articles were ranked into three categories using the OQAT measure obtained from the Rasch analysis described in the next section. The source of the article was also recorded by the OQAT. Articles were manually categorised by raters and categorised as one of the following 10 sources; 1 Blog – personal, 2 Blog – professional, 3 Company, 4 Government organisation, 5 Magazine, 6 Non-Governmental Organisation (NGO), 7 Professional news, 8 Research institute/University/publisher, 9 social media (out of scope), 10 unrelated (out of scope). Raters met to discuss and agree any ambiguity. Rater one checked a random sample of rater two's scores to ensure correct application of the OQAT, any discrepancies were discussed and agreed. Rater reliability was checked using Rasch model; results are presented in the supplementary material (**appendix B**).

#### **4.3.2 Statistical analysis**

The Statistical Package for the Social Sciences (SPSS v 28.0) was used for statistical analysis and the R computing environment (v 4.2.3) was used for data visualisation. After all tweets including the word 'nutrition' posted in 2021 were collected, tweets were collated and those including a URL were identified. The raw data were charted to visualise the annual data collection. The data collect and screening were visualised in a flowchart. Descriptive statistics were reported including total scores, medians and Interquartile Ranges were calculated for each media source and by retweet.

A total measure for evaluating quality was obtained by fitting the Rasch dichotomous model to the 10 item OQAT questionnaire using Winsteps (v5.3.2.0). The Rasch model has been applied in many disciplines (Gibbons et al., 2011; Wu et al., 2021) and is intended for the examination of measurement instruments such as the OQAT. Rasch outfit mean squared errors of 0.5-1.5 were used to determine adequate fit of items to the

Rasch model. In this study, Rasch allowed for a single interval scaled measure that represented the underlying construct of quality, as measured from 10 question items (the quality measure) without the need to assign weight in advance. Therefore, quality levels (low, satisfactory, high) were established by determining statistically significant levels in the Rasch measures based on the procedures suggested by Wright (Wright, 2001). Prior to determining the quality levels, interrater reliability was also examined with a separate Rasch model, to confirm that data could be combined in a single analysis.

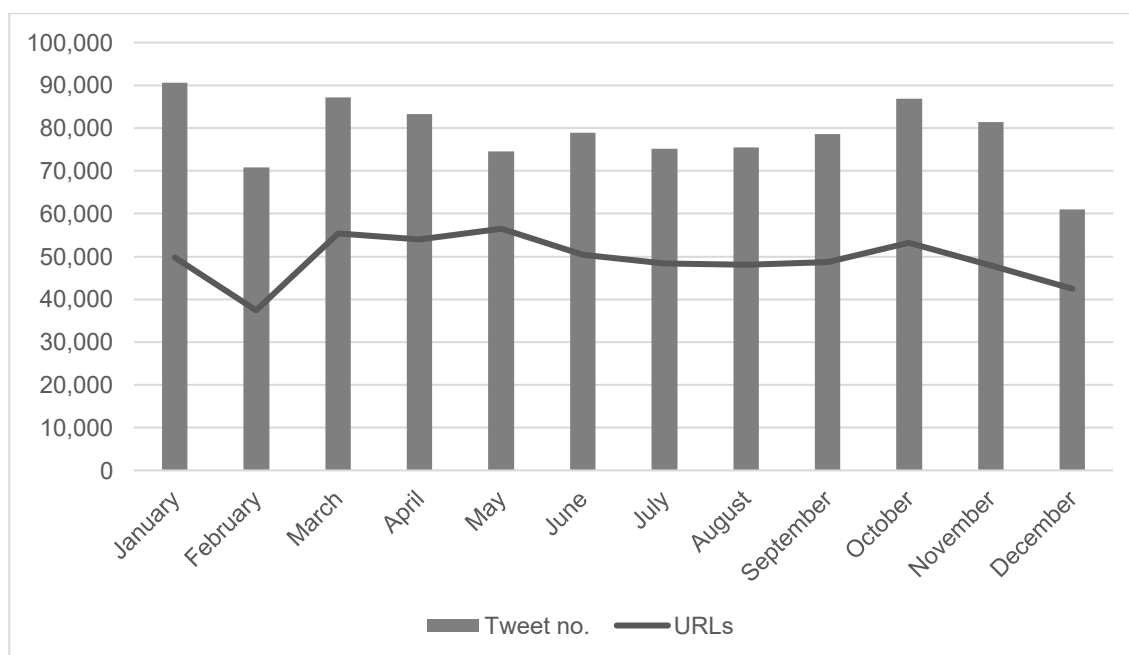
As the data was categorical, the Cochran-Mantel-Haenszel test (Mantel and Haenszel, 1959) was used to examine the associations between high, satisfactory and low-quality articles, and whether they were more or less likely to be retweeted. The contingency analysis is displayed as a Fourfold graph to allow the categorical data to be visualised (Friendly, 2015). The Woolf test (Woolf, 1955) was used to test the homogeneity between log odds ratios in each strata to determine whether the Cochran-Mantel-Haenszel test was valid. Cochran-Mantel-Haenszel test was also used to investigate whether there was a significant difference between sources, when comparing by whether they were retweeted. Cochran-Mantel-Haenszel test was chosen as it is more robust when some of the strata contain small frequencies. After the contingency and chi-square analysis, articles were manually reviewed by rater one to see whether it was possible to infer any rationale for differences between groups.

The Shapiro-Wilks Test was used for normality of retweets and non-retweeted data indicated that the data were not normally distributed ( $p < 0.001$ ). The natural logarithm was used to transform the data but did not rectify the distribution and therefore non-parametric tests were used to compare tweets and retweets. The Mann-Whitney U test was used to analyse any differences in rank scores of retweeted and unshared data.

## **4.4 Results**

### **4.4.1 Data collection**

Over the full 12-month collection period, 943,869 tweets were collected, and of these 591,907 contained an URL (**figure 4.1**).



**Figure 4. 1 Total number of tweets categorised as nutrition information and URLs collected by month in 2021**

During the analysis period, 10,573 URLs were collected from 18,230 Twitter posts.

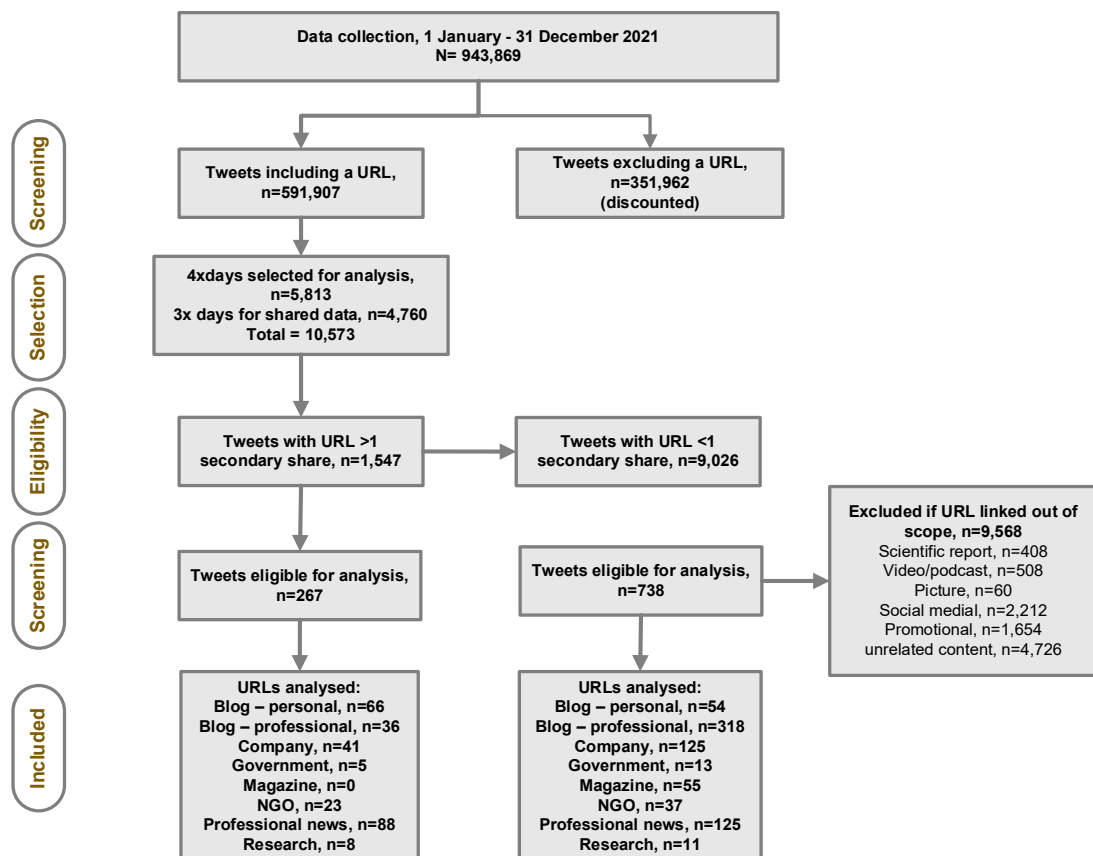
After manual screening for relevance these represented: professional blogs  $n=354$

(35.2%), news  $n=213$  (21.2%), companies  $n=166$  (16.5%), personal blogs  $n=120$

(11.9%), NGOs  $n=60$  (6.0%), magazines  $n=55$  (5.5%), research institutes or publishers

$n=19$  (1.9%), government organisations  $n=18$  (1.8%), 9,568 articles were excluded as

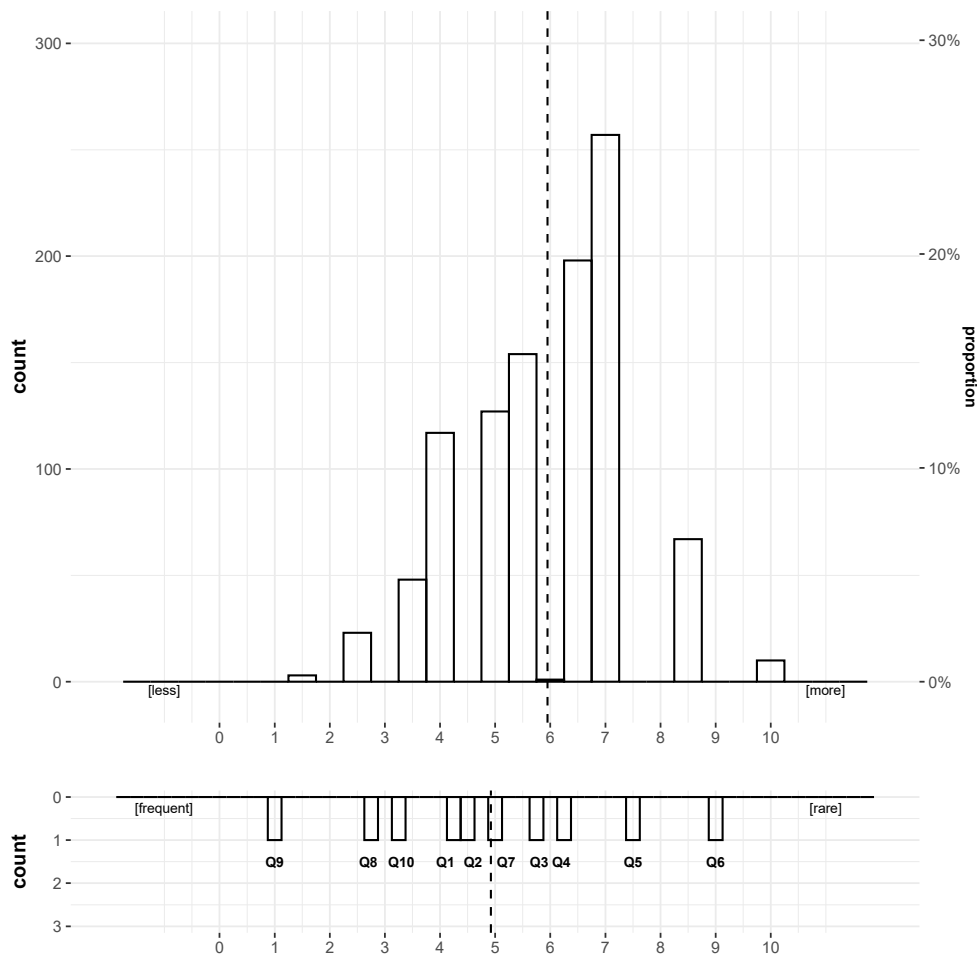
they were out of scope (**figure 4.2**).



**Figure 4. 2 Flow diagram of identification and screening of tweets for analysis to assess the quality of online nutrition information**

#### 4.4.2 Fit and inter-rater analysis

Rasch analysis was conducted to ensure the OQAT criteria and indicators measured what they were designed to measure and to check inter-rater reliability. The Rasch analysis of the data indicated that all 10 items complied to the recommended OUTFIT mean squares between 0.5 – 1.5 for being “productive for measurement” (Wright, 2001). Rasch analysis also confirmed that all sources met indicator 9, and that indicators 4, 5 and 6 were necessary for an article to be classified as high. Figure three shows the fit with outliers removed for Q6 and Q9 to improve fit. Removing the outliers improved the fit but did not change the conclusions.



**Figure 4. 3 Wright map illustrating the quality of each article and discriminating quality assessment criteria.**

The upper plot shows the quality of each article. The lower plot illustrates the fit of all quality assessment criteria. Shaded areas from left to right of the plot correspond increasing levels of quality (low, satisfactory, high). All estimates were rescaled from 1-10. The dotted line represents the mean score.

The Wright map (**figure 4.3**) shows the indicators (Q1 -Q10) ranked by prevalence, left to right. Details of what these indicators are designed to measure can be found in the author's previous paper (Ellis et al., 2025). The lower plot indicates the indicator (Q1-10) by order of prevalence, left to right. indicators on the left were more likely to be scored positively in the articles than those on the right. Therefore, we can see that all articles scored positively on Q9, and the least likely criterion to be met was Q6. The shading on the lower plot indicates the quality rank (low, satisfactory and high quality), therefore we are able to determine that; Q9, Q8 and Q10 were necessary for an article to score 3 and be deemed low quality, Q1, Q2, Q7 and Q3, were necessary for articles to



be classified as satisfactory, and Q5 and Q6 were required for an article to be high quality.

To ensure inter-rater consistency, Rasch model was used to compare the two independent sets of rater scores. The distribution confirms that the value added to each criterion by each rater is the same inferring consistency between rater (Appendix B, **figure B.1 and B.2**).

#### **4.4.3 Descriptive analysis**

To assess quality, articles were categorised as poor, satisfactory, and high quality based on the OQAT measure; 0-3.48 indicated poor quality, 3.49-6.3 indicated satisfactory quality and 6.4-10 indicated high quality. The quality levels are as identified by the OQAT using Rasch analysis which identified the minimum requirements for each category (Ellis et al., 2025).

The relevant articles (n=1005) were assessed using the OQAT. As per the OQAT guidelines, 33% (n=335) of articles were categorised as high quality, 59% (n=595) as satisfactory, and 7% (n=74) were defined as poor quality articles (**table 4.1**).

**Table 4.1 Online Quality Assessment Tool ranks by shared status, content type and media source**

		<i>Shared (Y/N)</i>	<i>N</i>	<i>%</i>	<i>Median</i>	<i>IQR</i>	<i>Poor (%)</i>	<i>Satisfacto ry (%)</i>	<i>High (%)</i>
<b>Total (n=1005)</b>		<b>Yes</b>	267	26.57	5.5	1.43	25 (9.4)	176 (65.9)	66 (24.9)
		<b>No</b>	738	73.43	6.3	2.37	49 (6.6)	419 (56.8)	270 (36.6)
		<b>Total</b>	1005	100	7.0	3	74 (7.4)	595 (59.2)	336 (33.4)
<b>Media Type</b>	<b>Blog – Personal</b>	<b>Yes</b>	66	55.0	4.87	1.35	12 (18.2)	47 (71.2)	7 (10.6)
		<b>No</b>	54	45.0	5.5	2.09	7 (13.0)	37 (68.5)	10 (18.5)
		<b>Total</b>	120	12.0	5.55	2.10	19 (15.8)	84 (70.0)	17 (14.2)
	<b>Blog – Professional</b>	<b>Yes</b>	36	10.2	6.3	1.26	1 (2.8)	28 (77.8)	7 (19.4)
		<b>No</b>	318	89.9	6.3	2.37	23 (7.2)	162 (50.9)	133 (41.8)
		<b>Total</b>	354	35.2	6.3	2.37	24 (6.8)	190 (53.7)	140 (39.5)
	<b>Company</b>	<b>Yes</b>	41	24.7	4.87	1.72	7 (7.1)	30 (73.2)	4 (9.8)
		<b>No</b>	125	75.3	4.87	2.10	16 (12.8)	92 (73.6)	17 (13.6)
		<b>Total</b>	166	16.6	4.87	1.10	23 (13.9)	122 (73.5)	21 (12.7)
	<b>Government</b>	<b>Yes</b>	5	27.8	5.55	2.60	1 (20.0)	3 (60.0)	1 (20.0)
		<b>No</b>	13	72.2	4.87	1.39	1 (7.70)	11 (84.6)	1 (7.7)
		<b>Total</b>	18	1.8	4.87	1.60	2 (11.1)	14 (77.8)	2 (11.1)
	<b>NGO</b>	<b>Yes</b>	23	38.3	6.3	1.69	1 (4.3)	15 (65.2)	7 (30.4)
		<b>No</b>	37	61.7	5.55	1.43	2 (5.4)	30 (81.1)	5 (13.5)
		<b>Total</b>	60	6.0	5.55	1.43	3 (5.0)	45 (75.0)	12 (20.0)
	<b>News</b>	<b>Yes</b>	88	41.3	6.3	0.94	3 (3.4)	48 (54.4)	37 (42.0)
		<b>No</b>	125	58.7	7.24	0.94	-	53 (42.4)	72 (57.6)

<b>Magazine</b>	<b>Total</b>	213	21.2	7.24	0.94	3 (1.4)	101 (47.4)	109 (51.2)
	<b>Yes</b>	-	-	-	-	-	-	-
	<b>No</b>	55	100	6.30	1.69	-	28 (50.9)	27 (49.1)
	<b>Total</b>	55	5.5	6.3	1.69	-	28 (50.9)	27 (49.1)
<b>Research Institute</b>	<b>Yes</b>	8	42.1	6.3	3.15	-	5 (62.5)	3 (37.5)
	<b>No</b>	11	58.9	6.3	1.69	-	6 (54.4)	5 (45.5)
	<b>Total</b>	19	1.9	6.3	1.69	-	11 (57.9)	8 (42.1)

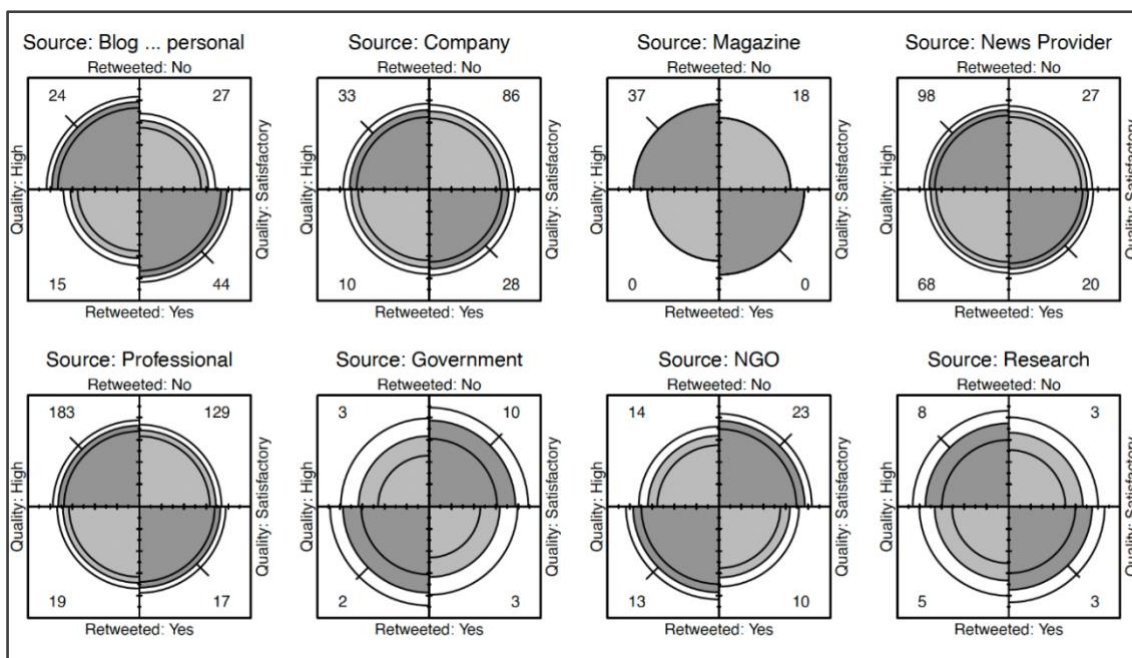
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#### 4.4.4 Retweet and no retweet comparison

Articles that were not retweeted ( $n=738$ , mean=6.03) scored higher on the OQAT than those that had been retweeted ( $n=267$ , mean=5.731). There was a significant difference in the quality of retweeted ( $n=267$ , sum of rank, 461.62) and non-shared data ( $n=738$ , sum of rank, 517.97),  $U = 87475$ ,  $p=0.006$ . Articles categorised as poor and satisfactory by the OQAT, with a score of  $<6.3$ , were more likely to be retweeted. Similarly, articles defined as high quality had fewer retweets.

#### 4.4.5 Media source

The media source of the article was recorded by the OQAT. The Woolf Test was used to test homogeneity of the logs ratio for each strata to ensure the Cochran-Mantel-Haenszel test assumptions were met and it was the most appropriate test,  $p=0.853$ . The mean scores for each media source were calculated with professional news outlets having the highest score, mean=6.67, and company blogs the lowest, mean=5.11 (table 4.1). When comparing retweeted and unshared by source, news had the highest mean score (retweeted 6.47, unshared 6.42), however, personal blogs had the lowest retweeted mean (4.92) and company blogs not retweeted has the lowest mean (5.14).



**Figure 4. 4 Fourfold display of article quality (High vs Satisfactory) by source.**

In each panel the darker shaded diagonal areas with greater area than the off-diagonal areas, show a positive association. The confidence rings for adjacent quadrants overlap if the odds ratio for quality and retweet does not differ significantly from 1.

#### 4.4.6 Quality by media source

The Cochran-Mantel-Haenszel test was used to investigate whether there was a significant difference between sources, when comparing by whether they were retweeted. Results comparing high and satisfactory articles are displayed in **figure four**. When analysing the source quality, a comparison of high- and low-quality articles was also carried out (not presented) but because the group sizes of the low-quality articles was small, there was no significant difference,  $X^2_{MH} = 1.2487$ ,  $df = 1$ ,  $p = 0.264$ . Similarly, there was no significant difference between; satisfactory and low,  $X^2_{MH} = 0.017$ ,  $df = 1$ ,  $p = 0.898$ ; or between high and satisfactory,  $X^2_{MH} = 0.888$ ,  $df = 1$ ,  $p = 0.346$  (**figure 4.4**). The low numbers of retweets in most groups may have influenced the significance. **Figure 4.4** shows the differences within groups, for example the government and research categories had low numbers of retweeted articles.

#### 4.5 Discussion

In this study we measured the quality of a representative subset of public facing online nutrition information using a validated tool designed specifically for nutrition research; addressing an important gap in the literature. Importantly, we investigated whether Twitter users were more likely to retweet high- or poor-quality information and which media sources were more likely to share higher quality nutrition information. Our results show, for the first time, a significant difference in the quality of retweeted and non- retweeted nutrition articles, with lower quality content more likely to be retweeted.

There remains a paucity in the nutrition literature on whether the quality of information is a predictor of sharing, although poorer quality videos have been found to have more views and likes (Batar et al., 2020). Additionally, the lack of evidence based information retweeted in our study was consistent with the literature pertaining to anti-climate change blogs (Pearce et al., 2019) and public authored political blogs (Koop and Jansen, 2009). In this study, higher quality nutrition sources were less likely to be retweeted. Indeed, articles defined as poor or satisfactory were more likely to be retweeted. This suggests that either quality is not an important consideration for Twitter users when choosing to retweet, or that people are generally unable to discriminate between high- and low-quality nutrition information. As articles ranked satisfactory were the most retweeted, further investigation was carried out into whether users were more likely to retweet articles scoring high or low within the satisfactory range. There

was not enough evidence to determine whether quality was a factor affecting retweet decisions for these users.

Analysis of climate change content shared on Twitter found that the accuracy of content does not impact sharing, rather novel content was more likely to be shared and retweeted (Veltri and Atanasova, 2017). There is also another possibility, in that people do not read articles before sharing and therefore are not able to make an informed decisions on quality (OFCOM, 2017). However, in this study more satisfactory than low quality articles were retweeted in this study suggesting that some quick ‘sense checks’ of quality may be taken before sharing. This aligns with previous research which suggests that some members of the public do engage in rapid checks to validate online health information before sharing (Sillence et al., 2007).

Article quality varied greatly however poorer quality information was more likely to be retweeted than high quality. This supports previous work whereby online blogs scored poorly when measured against dietary advice. In particular, content which scored poorly was less likely to provide references to scientific evidence, provide expert quotes or to declare any author conflicts of interest (El Jassar et al., 2019; Mete et al., 2019; Sabbagh et al., 2020). When comparing the quality of articles by source, the group sizes were not equal so calculating effect size was not possible. There appears to be a relationship between the source and the quality of the article, with commercial websites scoring lower, and professional news outlets scoring higher. This is supported by the literature. YouTube videos are higher quality when produced by experts, (Batar et al., 2020), and lifestyle websites written by commercial companies lack objectivity and transparency (Armstrong et al., 2021). Similarly, commercial websites giving advice on dietary supplements are more likely to be poor quality than those authored by health experts (Ng et al., 2021).

Interestingly, our results show magazine articles were unique in that they did not have any retweets, regardless of the quality of the article. In-depth analysis of these articles suggests that magazine articles may be distinctive in that they target a specific cohort such as women, marathon runners or vegans. The language used for magazine articles was simple and they were targeted towards the public, however they were more likely to give healthy eating advice to a specific group with specific requirements which may not have been novel enough to retweet (Veltri and Atanasova, 2017). Articles targeting

women may be less likely to be retweeted as fewer women use Twitter compared to men (Statista, 2023). Magazine articles were also more likely to be subscription based with access limited therefore people may be less willing to retweet content that their networks are unable to access.

A further novel finding was that articles shared by government agencies were also less likely to be retweeted than other sources (Pew Research, 2020), particularly if they were giving public health advice. Articles that related to population health and diets which were written for public health professionals were more likely to be retweeted. This could be due to academics and professionals being encouraged to use Twitter as a medium to disseminate research and network with peers. This could also be because the retweets were from other organisations, and these resources are therefore being used in a professional capacity, however this level of network analysis was out of scope for this study.

Including scientific references (Q4), quoting a specialist (Q5), and disclosing conflicts of interest or financial interests (Q6) were necessary criteria for articles to be deemed high quality. As shown in the Wright Map (**figure 3**), these essential (Q4, Q5, Q6) were the least likely indicators to be achieved. This is consistent with the published literature whereby seeking expert opinion, a sign that the writer was concerned with fact checking, was lacking in many articles (Robinson et al., 2013). The lack of evidence based information shared was also consistent with the literature pertaining to print news (Kininmonth et al., 2017), obesity (Ellis et al., 2020), and dietary advice to cancer survivors (Keaver et al., 2022). All of which highlighted the damage poor quality non-expert written information can have on public health and adherence to dietary guidelines. More encouragingly, the vast majority of articles scored positively on naming an author, an assessment indicator which has previously been shown to positively affect article quality (Robinson et al., 2013; Kininmonth et al., 2017). In our dataset, this criterion was necessary for an article to be ranked as satisfactory.

At the point of data collection, only five articles had greater than five retweets. This was notable as most retweeted articles had just one or two retweets. The most retweeted post was a high-quality article originally published by the World Food Programme, and originally tweeted by António Guterres, Secretary General of the United Nations. The next highest retweeted post was a link to a satisfactory article posted by a high-profile

Twitter user with 4 million followers. Both of these Twitter users have large networks suggesting that the user network could be more influential than the quality of the article, however, as networks were not investigated in this research, we do not have enough information to confirm the influence of Twitter networks.

#### **4.5.1 Strengths and limitations**

The main strength of this study is that it used a validated set of standardised assessment criteria (Ellis et al., 2025), as called for in the literature (Afful-Dadzie et al., 2021; Armstrong et al., 2021), to assess the quality of nutrition information available online and shared on Twitter. By using a tool developed specifically to assess the quality of nutrition-related online content, our findings build upon recent studies that have categorised the positive characteristics of Dietitian authored blogs (Mete et al., 2019), and compared the quality of the blogs to those from lay authors (Chan et al., 2020). A further strength is the high inter-rater reliability. In this study, the two raters applied the OQAT consistently when rating the independent set of sources. In addition, to the authors knowledge, this is one of the only studies to quantify the quality of nutrition information by the source publishing the content.

Our data collection was novel in that it used Twitter as the source of articles (shared via URLs) to objectively select a cross section of online articles designed to disseminate nutrition information. Therefore, each article analysed was interacted with at least once through the initial tweet reducing the likelihood of collecting passive content which does not stimulate reader engagement (Pantic, 2020). Additionally, these articles have increased chances of being viewed by the public as they are in the public domain in at least two formats, on the website and on Twitter. The random selection of days for analysis was a strength as it reduced the risk that the discourse was affected by seasonal variation (Kamiński et al., 2020).

However, there are some limitations to this study. The disproportionately lower number of retweeted articles compared to non-retweeted made comparison between groups difficult. Nonetheless, a greater number of nutrition related articles not being retweeted is in line with the authors previous research investigating obesity articles online (Ellis et al., 2020) and studies using the OQAT (Ellis et al., 2025). In addition, the differing numbers between the sources limited comparison between these groups. Future research



could also categorise articles differently comparing the quality of the type of content shared and not just the source.

A further limitation of the study methodology was that the raters were not blind to the article source. This could have introduced rater bias and caused the rater to moderate the article score based on subjective opinion. However, the OQAT criteria and indicators were worded as clearly as possible to reduce the risk of this type of bias, and inter-rater reliability was analysed to check that the OQAT was being applied consistently. In addition, only webpages were considered, therefore the wider limitations of the general website function are not considered. Similarly, this study did not consider article readability, as these can be assessed by external software such as Flesch-Kincaid readability test. Finally, only English language tweets and articles were included in the data set, so these findings may not be generalisable to tweets in other languages or non-English speaking countries. Approximately 40% of all tweets are written in English therefore a large proportion of nutrition related content was not considered in this research, and worthy of further exploration.

Although meta-data was collected, we are not able to infer motivations for retweeting beyond quality, or any information about social networks. This is a limitation and an area for further research using social network theory to investigate Twitter networks, what users are sharing and retweeting, and who are the users sharing nutrition information. Similarly, this study did not consider which device users were sharing from so cannot make any inferences on whether users are more likely to share content on phones versus laptops, nor did we consider the feasibility of sharing through Twitter buttons on websites. However, future research considering the dissemination of content through networks could consider these factors.

Importantly, this research investigating the quality of information has led to a number of recommendations. Online content remains a popular source of nutrition advice for the public (Mete et al., 2019, Sabbagh et al., 2020), but the quality is variable (Boepple and Thompson, 2014; Davis et al., 2020; Ellis et al., 2020). Our recommendations to authors of online nutrition content are firstly, that to be considered high quality content, any article providing dietary advice must be evidence-based and include hyperlinks to the evidence or provide references. Secondly, hyperlinks and references must directly cite the evidence, and not opinion-based articles self-promoting other content on the same

website. As digital content easily allows for hyperlinking content and an increasing proportion of nutritional journals are open access, it is proposed it is best practice to include scientifically validated weblinks.

In addition, online content has an infinite lifespan, therefore should include a published date, and a review date. This was an essential criterion for articles to be considered of satisfactory quality. It is a necessary addition to ensure the reader can make informed decisions on the relevance and quality of the evidence presented and whether it includes out of date research. Another criterion required to be considered high quality is to include endorsements from specialists and subject matter experts. Expert quotes act as a mark of quality informing the reader that this is a well-researched article that has been subject to informal peer review. Finally, any funding or conflicts of interest should be explicitly stated for an article to be deemed high quality. This informs the reader of any potential author or publication bias, and again allows the reader to make an informed decision on whether the article is trustworthy. Further recommendations are included in the OQAT development and validation paper (Ellis et al., 2025).

These findings demonstrate the essential features necessary for articles to be deemed high-quality. Specifically, including scientific references, quoting a specialist, and transparency. In this research, these indicators were the least likely to be achieved, therefore educating content writers on the importance of including these is essential to improve the quality of information. With further testing, the quality assessment indicators from the OQAT could be employed as a checklist for content writers providing a framework for higher-quality information. Similarly, as the public appear to be more likely to repost poor quality articles, improving digital health and media literacy could be a beneficial intervention. A simple tool such as the OQAT, could have far reaching benefits for the public if it was applied as a framework for readers to assess the quality of information before reading. Although we caveat that OQAT use would need to be tested in a representative group before this could be implemented.

Further research should consider using the OQAT on a larger data set with more homogenous groups to test whether the differences observed are significant. The current dataset is limited to one social networking site, Twitter, which does not capture all social media users and represents only one platform for sharing health information. Future research is needed that compares different public sources of nutrition and diet

information and different social media platforms. In addition, future research should consider the broader influences on retweeting beyond quality, with consideration given to the influence of the person posting the original tweet, the reach of their social media network and the influence of the site where the article is originally published. Finally, it is important for future research to explore the wider nutrition discourse on social media and the flow of information through networks to understand motivations for sharing nutrition content and key actors involved.

#### 4.5.2 Conclusions

The quality assessment of online nutrition information using a validated tool designed specifically for this purpose adds to a body of literature assessing quality of information in the media and online. This study contributes to the understanding of which sources of information the public are likely to engage with and what factors may motivate them to engage with it.

#### 4.6 References

- Adamski, M. Truby, H. M Klassen, K. et al. 2020. Using the Internet: Nutrition Information-Seeking Behaviours of Lay People Enrolled in a Massive Online Nutrition Course. *Nutr.* **12**(3), 750.
- Afful-Dadzie, E. Afful-Dadzie, A. and Egala, SB. 2021. Social media in health communication: A literature review of information quality. *Health Inf Manag J.* **52**(1), 3–17.
- Andreotta, M. Nugroho, R. Hurlstone, MJ. et al. 2019. Analyzing social media data: A mixed-methods framework combining computational and qualitative text analysis. *Behav Res Methods.* **51**(4), 1766-1781.
- Armstrong, M. Halim, NK. Raeside, R, et al. 2021. How Helpful and What Is the Quality of Digital Sources of Healthy Lifestyle Information Used by Australian Adolescents? A Mixed Methods Study. *Int J Environ Res Public Health.* **18**(23).
- Ashwell, M. Hickson, M. Stanner, S. et al. 2022. Nature of the evidence base and strengths, challenges and recommendations in the area of nutrition and health claims: a position paper from the Academy of Nutrition Sciences. *Br J Nutr.* 1-18.
- Batar, N. Kermen, S. Sevdin, S. et al. 2020. Assessment of the Quality and Reliability of Information on Nutrition After Bariatric Surgery on YouTube. *Ob Surg.* **30**(12), 4905-4910.
- Boepple, L. and Thompson, J.K. 2014. A content analysis of healthy living blogs: Evidence of content thematically consistent with dysfunctional eating attitudes and behaviors. *Int J Eat Disord* **47**(4), 362-367.
- Brown, AW. Ioannidis, JPA. Cope, MB. et al. 2014. Unscientific beliefs about scientific topics in nutrition. *Ad Nutr.* **5**(5), 563-565.
- Chan, AKM. Nickson, CP. Rudolph, JW. et al. 2020. Social media for rapid knowledge dissemination: early experience from the COVID-19 pandemic. *Anaesthesia.* **75**(12), 1579-1582.

- Clark, D. Nagler, RH. and Niederdeppe, J. 2019. Confusion and nutritional backlash from news media exposure to contradictory information about carbohydrates and dietary fats. *Public Health Nutr.* **22**(18), 3336-3348.
- Davis, SA. Knol, LL. Crowe-White, KM. et al. 2020. Homemade infant formula recipes may contain harmful ingredients: a quantitative content analysis of blogs. *Public Health Nutr.* **23**(8), 1334-1339.
- Department of Health and Social Care. 2021. Department of Health and Social Care Guidance Nutrition and Health Claims: Guidance to Compliance with Regulation (EC) 1924/2006.
- Dickinson, KM. Watson, MS. and Prichard, I. 2018. Are Clean Eating Blogs a Source of Healthy Recipes? A Comparative Study of the Nutrient Composition of Foods with and without Clean Eating Claims. *Nutr.* **10**(10), 1440.
- El Jassar, OG. El Jassar, IN. and Kritsotakis, E. 2019. Assessment of quality of information available over the internet about vegan diet. *Nutr & Food Sci.* **49**(6).
- Ellis, CH. Evans, CEL. and Moore, JB. 2020. Systematic assessment of obesity information on the microblogging platform Twitter. *Proc. Nutr. Soc.* **79**(OCE3), E791.
- Ellis, CH. Moore, JB. Ho, P. et al. 2023. Development and validation of a quality assessment tool to assess online nutrition information. *DIGITAL HEALTH.* **9**.
- Friendly DM (2015) *Discrete Data Analysis with R : Visualization and Modeling Techniques for Categorical and Count Data*: CRC Press.
- Gibbons, CJ. Mills, RJ. Thornton, EW. et al. 2011. Rasch analysis of the Hospital Anxiety and Depression Scale (HADS) for use in motor neurone disease. *Health Qual Life Outcomes.* **9**(1), 82.
- Harris, JK. Moreland-Russell, S. Tabak, RG. et al. 2014. Communication about childhood obesity on twitter. *Am. J. Public Health.* **104**(7), 62.
- Heer, RS. Sandhu, P. Wenban, C. et al. 2022. Vitamin D in the news: A call for clear public health messaging during Covid-19. *Nutrition and Health.* **28**(4), 733-739.
- Kabata, P. Winniczuk-Kabata, D. Kabata, PM. et al. 2022. Can Social Media Profiles Be a Reliable Source of Information on Nutrition and Dietetics? *Healthcare.* **10**(2).
- Kamiński, M. Skonieczna-Żydecka, K. Nowak, JK. et al. 2020. Global and local diet popularity rankings, their secular trends, and seasonal variation in Google Trends data. *Nutrition.* **79-80**, 110759.
- Keaver, L. Huggins, MD. Chonail, DN. et al. 2022. Online nutrition information for cancer survivors. *J. Hum. Nutr. Diet.* **36**(2), 415-433.
- Kininmonth, A. Jamil, N. Almatrouk, N. et al. 2017. Quality assessment of nutrition coverage in the media: a 6-week survey of five popular UK newspapers. *BMJ Open.* **7**(12).
- Koop, R. and Jansen, H.J. 2009. Political Blogs and Blogrolls in Canada: Forums for Democratic Deliberation? *Soc. Sci. Comput. Rev.* **27**(2), 155-173.
- Lee, C.-J. Nagler, RH. and Wang, N. 2018. Source-specific Exposure to Contradictory Nutrition Information: Documenting Prevalence and Effects on Adverse Cognitive and Behavioral Outcomes. *Health Commun.* **33**(4), 453-461.
- Lynn, T. Rosati, P. Santos, GL. et al. 2020. Sorting the Healthy Diet Signal from the Social Media Expert Noise: Preliminary Evidence from the Healthy Diet Discourse on Twitter. *Int J Environ Res Public Health.* **17**(22), 8557.
- Mantel, N. and Haenszel, W. 1959. Statistical aspects of the analysis of data from retrospective studies of disease. *J Natl Cancer Inst.* **22**(4), 719-748.
- Mete, R. Curlew, J. Shield, A. et al. 2019. Reframing healthy food choices: a content analysis of Australian healthy eating blogs. *BMC Public Health.* **19**(1), 1711.

- Mozaffarian, D. and Forouhi, NG. 2018. Dietary guidelines and health—is nutrition science up to the task? *BMJ*. **360**, k822.
- Ng, JY. Ahmed, S. and Zhang, CJ. 2021. Dietary and herbal supplements for weight loss: assessing the quality of patient information online. *Nutr J*. **20**(1) 72.
- OFCOM. 2017. *Adults' media use and attitudes*. Available from: [https://www.ofcom.org.uk/data/assets/pdf\\_file/0020/102755/adults-media-use-attitudes-2017.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0020/102755/adults-media-use-attitudes-2017.pdf). Accessed July 2020.
- Oksman, V. Jarvela-Reijonen, E. Puttonen, M. et al. 2016. Vitality as a Life Style Trend in Blogs: A Netnographic Approach. In: Bernadas, C. and Minchella, D. *Proc 3rd Euro Conf Soc Media*. 258-265.
- Pantic, M. 2020. Engagement With Live Blogs: When Passive Consumption Overpowers Participation. *Electronic news*. **14**(1), 22-36.
- Pearce, W. Niederer, S. Özkula, SM. et al. 2019. The social media life of climate change: Platforms, publics, and future imaginaries. *Wiley Interdiscip Rev Clim..* **10**(2).
- Pew Research. 2020. For Global Legislators on Twitter, an Engaged Minority Creates Outsize Share of Content. <https://www.pewresearch.org/global/2020/05/18/global-legislators-on-twitter-an-engaged-minority-creates-outsize-share-of-content/>.
- Ramachandran, D. Kite, J. Vassallo, AJ. et al. 2018. Food Trends and Popular Nutrition Advice Online - Implications for Public Health. *Online J Public Health Inform.* **10**(2), e213.
- Robinson, A. Coutinho, A. Bryden, A. et al. 2013. Analysis of health stories in daily newspapers in the UK. *Public Health*. **127**(1), 39-45.
- Sabbagh, C. Boyland, E. Hankey, C. et al. 2020. Analysing Credibility of UK Social Media Influencers' Weight-Management Blogs: A Pilot Study. *Int J Environ Res Public Health*. **17**(23), 9022.
- Sillence, E. Briggs, P. Harris, PR. et al. 2007. How do patients evaluate and make use of online health information? *Soc sci med (1982)*. **64**(9), 1853-1862.
- Statista. 2023. Distribution of X (formerly Twitter) users worldwide as of January 2023, by gender. <https://www.statista.com/statistics/828092/distribution-of-users-on-twitter-worldwide-gender/>. Accessed February 2024.
- Steils, N. and Obaidalahe, Z. 2020. “Social food”: Food literacy co-construction and distortion on social media. *Food Policy*. **95**, 101932.
- Su, Y. and Borah, P. 2019. Who is the agenda setter? Examining the intermedia agenda-setting effect between Twitter and newspapers. *J Inf Technol Politics*. **16**(3), 236-249.
- Veltri, GA. and Atanasova, D. 2017. Climate change on Twitter: Content, media ecology and information sharing behaviour. *Public Underst Sci*. **26**(6), 721-737.
- Vijaykumar, S. McNeill, A. and Simpson, J. 2021. Associations between conflicting nutrition information, nutrition confusion and backlash among consumers in the UK. *Public Health Nutr*. **24**(5), 914-923.
- Vosoughi, S. Roy, D. and Aral, S. 2018. The spread of true and false news online. *Science* **359**(6380), 1146.
- Woolf, B. 1955. On estimating the relation between blood group and disease. *Ann Hum Genet*. **19**(4), 251-253.
- Wright, BD. 2001. Separation, Reliability and Skewed Distributions: Statistically Different Sample-independent Levels of Performance. *Rasch Measurement Transactions*. **14**(4), 786.
- Wu, M. Gani, H. Viney, S. et al 2021. Effect of ginger-enriched pasta on acceptability and satiety. *Int J Food Sci Technol*. **56**(9), 4604-4614.

## Chapter 5 Social network and linguistic analysis of the #nutrition discourse on the social network platform X, formerly known as Twitter

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### 5.1 Abstract

**Introduction:** Social network analysis (SNA) of social media content allows information transfer to be visualised, identifies influential actors, and reveals public opinion. However, to date no research has investigated content related to nutrition on X. This study examined the #nutrition conversations on X (formerly Twitter) utilising SNA and linguistic methods.

**Methods:** NodeXL Pro was used for network, semantic and sentiment analyses on English language posts including ‘#nutrition’ collected between 1–21 March 2023. The #nutrition network included 17,129 vertices (users) with 26,809 edges (relationships). NodeXL Pro was used to assess the structure of the network and the actors involved by calculating the network metrics.

**Results:** The results show a low density, dispersed network (graph density=0.001) with most users communicating heavily with a small number of other users. These subgroup community cluster structures restrict information flow outside of the subgroups (modularity=0.79). These network structures rely on influential users to share information (betweenness centrality range, 0 to 23,375,544). Notably, influential users were typically from both personal and not-for-profit accounts. Semantic analysis identified 97,000 word-pair edges with the most frequently discussed topics related to *health, healthy lifestyle and diet*, with a positive sentiment found across the network.

**Discussion:** By using SNA, semantic, and sentiment analyses, this study found a dispersed X network with a high proportion of unconnected users who did not have relationship with other users in the network. The findings reveal a publicly driven debate focused on healthy diets and lifestyle, with information primarily propagated through reposting.

## 5.2 Introduction

Social media allows people to connect with each other, share information and build networks. With many people engaging with social media daily, the spread of information is ubiquitous and rapid (Toraman et al., 2022). Networks are an important aspect of social media, as virtual communities can be built creating a space to share news and information relating to a common interest, and followers are able to follow conversations using hashtags (Erz et al., 2018). Hashtags permit networks to be built with brands, organisations, and influencers; such virtual communities have changed the way the public access health and nutrition information (Eaton et al., 2023). Therefore, examining social media can provide unique insights into nutrition and diet information, reaching and influencing large segments of the general population (Harris et al., 2014).

The social media platform X (formerly Twitter) has enabled the creation of networks that go beyond sharing news, and consequently, has been used to freely and quickly engage in advocacy and lobbying (Hunt, 2021). Social Network Analysis (SNA) facilitates investigation of such networks by applying mathematical network and graph theory to visualise information transfer as relational networks of connected nodes. The theory posits that individuals are part of an extensive network of social interactions that can be visualised as a flow of behaviour, influence, or ideas (Wasserman, 1994). Measuring node connectivity (centrality) permits the identification of ‘influencers’ within the network and provides insight into individuals’ motivations to engage with other users and share content.

SNA has been utilised to examine wide range of topics including political views (Chakraborty and Mukherjee, 2023), gender difference in climate activism (Holmberg and Hellsten, 2015), and the impact of food poverty (Eskandari et al., 2022). Previous research has also considered the impact of X networks in public health promotion, in the context of promoting breast feeding practices (Moukarzel et al., 2021a), disease outbreaks (Vijaykumar et al., 2018), and vaccination uptake (Yousef et al., 2022). SNA has also been a useful tool to monitor and understand public opinion on policy debates, including front of pack labelling (Irawan, 2022), mask wearing to stop the transmission of infectious disease (Ahmed et al., 2020), and fiscal policies (Bridge et al., 2021). In addition to SNA, sentiment analysis of online discourse is also a useful tool as it provides insight into public opinion. For example, investigation into COVID-19 vaccination found a predominately negative discussion (66%) (Yousef et al., 2022),

which increased vaccine hesitancy (Sussman et al., 2023). However, to our knowledge, no research has specifically examined nutrition networks and the sentiment of the discourse leaving a gap in the literature. It is important to understand how the general public are engaging with nutrition content as the evidence from related health subjects suggests non-experts are leading the debate (Engel et al., 2024). This is problematic as it perpetuates misinformation, negatively impacting dietary choices (Vijaykumar et al., 2021). By developing a more complete understanding of who is leading the debate, the type of content that gains attention, and the language popular posts use, this research will add to the wider body of literature, and we hope empower nutritionists to lead the debate with evidence-based nutrition information.

### **5.2.1 Influencers**

Influencers have become a key component of social media networks creating personas that generate trust and the illusion of an interpersonal relationship. Research has identified a variety of reasons to explain the following of influencers. These include increasing knowledge (Alhothali and Aljefree, 2023), self-improvement (Zaman et al., 2023), and entertainment (Croes and Bartels, 2021). Notably, X users that discuss healthy food have been found to be strongly influenced by influencers (Pilař et al., 2021). Conversely, while dietitians who use social media to communicate dietary advice want to have influence, they do not consider themselves to be influencers as they feel influencers lack authenticity (Marauri-Castillo et al., 2024). Yet research by Lee and colleagues found authenticity one of the key reasons people follow influencers (Lee et al., 2022), and the ‘influencer’ community was the second largest community in a social network analysis on discussions on vegan food (Pilař et al., 2021). However, more recent research analysing the motivation to engage on X, found that semantic content was more important than the author (Appel et al., 2020). While SNA allows the identification of key influencers in a network and to measure the level of their influence, semantic and sentiment analysis facilitates an understanding of the content shared.

### **5.2.2 Aims and objectives**

This study builds on our previous research (Ellis et al., 2024) that investigated the quality of nutrition information available online and shared on Twitter (now known as X). Specifically, the results showed that poorer quality nutrition information was more likely to be re-shared and highlighted the importance of understanding user networks to predict motivations of sharing (Ellis et al., 2024). To our knowledge, previous work



examining nutrition information shared on X have been limited to content analysis with no research to date that has assessed the flow of information through social networks. While more focussed SNA has been used to investigate sugar tax (Bridge et al., 2021), breastfeeding practices (Moukarzel et al., 2020b), and vegan diets (Pilař et al., 2021), none have examined the broader topic of nutrition. Therefore, using SNA, semantic and sentiment analyses, along with data visualisation, the aims of this study were to: 1. investigate the characteristics of the #nutrition network, 2. identify the influential actors and characterise how they influence the flow of information, 3. investigate how nutrition debates are portrayed on X, 4. identify the most frequently discussed topics in the #nutrition network, and 5. measure the sentiment of the #nutrition network.

### **5.3 Methods**

X was selected for this study as it was designed to encourage information and opinion sharing. In addition, X is also used for professional networking and used by NGOs, companies and organisations, as well as personal users, to disseminate information, thereby is a rich source of data for researchers. Lastly, when the study was initiated, real time network information could be collected. It is important to note that the data collected for this study was collected prior to July 2023 before the rebranding of Twitter to X, but for consistency we refer herein to the platform as X.

#### **5.3.1 Data retrieval**

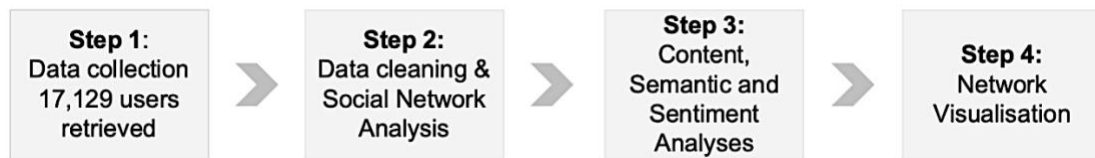
Posts were directly imported, analysed and visualised using the Microsoft Excel plugin, NodeXL Pro (Network Overview for Discovery and Exploration in Excel; version 1.0.1.510). The Twitter Search application programming interface (API, v1.1), as it was known then before the rebrand to X, was used to gather data. NodeXL Pro has been used previously to explore social media networks across a range of research including COVID-19 (Eskandari et al., 2022), climate change (Yuan et al., 2022), and professional health networks (Probst and Peng, 2019). The NodeXL Pro was selected over currently available open-source software as it allows for advanced network analysis as well as detailed content, semantic, and sentiment analyses.

All English language posts, and associated metadata (likes, reposts and mentions) that included #nutrition, or were posted in response to a post that included the hashtag, were strategically collected daily in longitudinal fashion from 2023-03-01 00:00:00 to 2023-03-21 23:59:59 (Greenwich Mean Time). Hashtags were used for the search term as

hashtags add significance beyond the initial act of posting, allowing users to link their posts to broader issues and campaigns (Ahmed, 2018). Hashtags also allow for the creation of networks which can be computationally investigated to provide a snapshot of the debate relating to a campaign or trending topic (Bridge et al., 2021). The use of hashtags enables unconnected users to view and comment on messages that have included the hashtag, therefore including this in the search term ensured the network was representative of the debate on X during the selected period. There were no geographical restrictions on the search query.

There were several reasons for the selected data collection period. Initially, March was identified based on research investigating Google Trends that established that March falls outside of season peaks of public interest in nutrition (Passos et al., 2020), such as religious holidays, seasonal trends (Palomo-Llinares et al., 2021) and World Nutrition Day (28 May). At the time of data collection, NodeXL Pro was limited by Twitter's Search API (removed by X at the end of March 2023) that constrained returns to 18,000 posts on each request run daily for the three weeks. From pilot work giving us a sense of #nutrition posting volume (daily retrievals on average exceeding the Twitter Search API), and in light of Smith's argument for SNA of shorter chunks of time (Smith et al., 2009), we rationalised that a longitudinal design of repeated daily retrievals over 3 weeks in combination with our use of the hashtag would permit us to investigate the characteristics, influential actors, topics and sentiment of the #nutrition network on X at the time.

The data gathered from X included vertices (or nodes, i.e., users; see Appendix C, **table C.1** for definitions of network theory terminology and metrics), edges (connections between vertices), metadata about the post and the user interactions, and metrics that allow the assessment of user influence within a network. These metrics include the centrality measures: betweenness, closeness and eigenvector centrality. In brief, high betweenness identifies nodes between other nodes suggesting high influence (Freeman, 1977), while high closeness centrality indicates close proximity to other nodes and thus high influence (Sabidussi, 1966). Whereas high eigenvector centrality identifies nodes that are connected to many nodes who themselves have high scores, again suggesting high influence within the network (Newman, 2018). An overview of the data collection and analysis methods is illustrated in **figure 5.1**.



**Figure 5. 1 Overview of research methods in NodeXL Pro**

### **5.3.2 Data cleaning**

Data were manually cleaned removing any posts that were not written in English. As this was a large data set, further steps were taken to prepare the data and make it more manageable. Duplicate edges (where the same two users are discussing the same thing) were counted and merged, and after sorting the edges by date, old posts (pre-2023) were removed. Finally, edges with an edge weight of less than 5 were removed to focus on individuals with stronger, more frequent ties and influence.

### **5.3.3 Data analysis**

#### *Social Network Analysis*

SNA was used to investigate user relationships and flows of information within the X communities discussing #nutrition. SNA is a multi-step process, automated through NodeXL Pro, which calculates graph metrics and visualises the network permitting exploration of connections and patterns (see Smith et al., 2009 for a detailed methodology of NodeXL (Smith et al., 2009). Within the network visualizations, vertices (i.e., the X users) were grouped by cluster using the Clauset-Newman-Moore cluster algorithm (Clauset et al., 2004). The layout of the graph was generated using the Harel-Koren Fast Multiscale layout algorithm (Harel and Koren, 2004). For clearer visual analysis, the top 20 groups within the network were illustrated. The ten largest groups were further annotated to provide insight into the main types of discussions taking place, identified during the textual analysis run in parallel to the network analysis (i.e., each cluster's conversation was textually analysed).

Influence, as measured by SNA, does not necessarily relate to the number of followers or posts. Instead, it is measured by the betweenness centrality metric, a measure of influence within the network defined by the shortest number of paths that pass through it. The influential vertices (users) within a network act as a bridge between different clusters within the network (i.e., nodes between nodes). The higher the betweenness

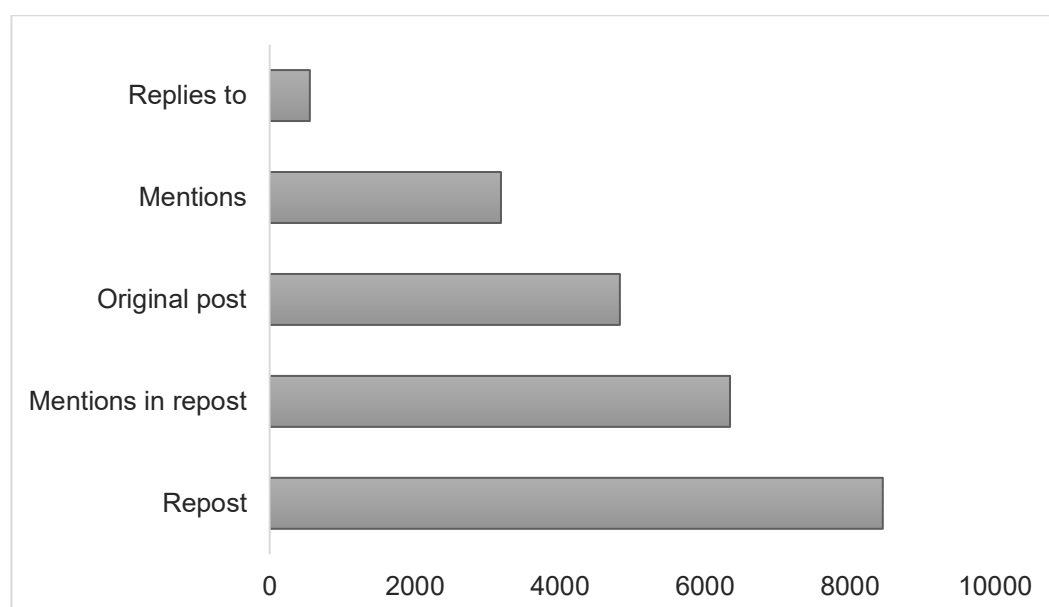
centrality number, the quicker the propagation of information through the network is, and therefore the greater the influence on information flow.

#### *Textual Analysis: Word pairs, Semantic and Sentiment Analyses*

Analysing word pairs facilitates understanding of the discourse across the network. The most common word pairs were placed in one cluster, and word pairs that appeared less frequently were placed in separate clusters (Singh et al., 2016). Once the top word pairs from the posts were identified, a new data set was created using the word pairs, and a semantic network visualisation was generated. Semantic networks are composed of linked words that reveal the relationships between ideas embedded in the network. Visualising semantic networks can reveal the most central ideas in a corpus and identify how ideas cluster together. There is no gold standard for selecting cut-off values for semantic visualisations and different studies have used different cut-offs (Ferra and Nguyen, 2017). With more than 97,000 word-pair edges identified in our #nutrition network, here only word-pairs with a frequency of more than 10 occurrences were considered to reduce processing noise as recommended in the literature and to increase the likelihood that only genuinely semantically related words were represented (Bruzzese et al., 2022; Eskandari et al., 2022). Subsequently, sentiment analysis was conducted using NodeXL Pro drawing upon the Opinion Lexicon's list of positive and negative words (Hu and Liu, 2004), which provided the number of words that matched either positive or negative words, excluding those that fit into neither category. In generating the semantic network visualisation, the top five clusters were shown to ensure clear visualisation. The larger and more prominent the word, the more repeatedly it was found within the network.

## **5.4 Results**

**Figure 5.2** shows the different types of posts published during the collection period. There were 26,809 posts published. Of these, there was more re-shared content which included reposts, mentions and replies, than original content.



**Figure 5.2 Number of posts by published category**

#### **5.4.1 Social network analysis**

The #nutrition network included 17,129 users (vertices), with 26,809 relationships (edges), graph metrics are summarised in **table 5.1**. Only 6 in 100 X users were mutually connected, which implies users prefer to share nutrition content, but not engage in debate (reciprocated relationships ratio, 0.064; **table 5.1**). Similarly, the graph density was low (0.001; **table 5.1**), suggesting that most users only communicated heavily with a few other users. The number of X users who did not have any relationships was high ( $n=3,874$ , approximately 20%; **table 5.1**). There was also a large group that contained ‘self-loops’ ( $n=5,815$ ; **table 5.1**), where users were not connected to other users; these were not removed to show the number of users that share posts without mentioning or replying to another user. Overall, these data suggest a directed network with relationships and information flows that may not be reciprocated (Hansen et al., 2010).

X users with lower geodesic distances (the shortest distance path between two users) have a greater influence on the debate because they are typically more central within the network. In this network, the maximum geodesic distance (that is, the greatest distance between the two users that are farthest from each other) was 20 (**table 5.1**). The graph (**figure 5.3**), and the associated network data, show that the online nutrition conversations were dispersed (average geodesic distance, 5.26). This network pattern suggests that, while information moved quickly within the groups that contain influential users, dissemination across the wider network was likely slower. This was

further reinforced by our finding that there was less cross-group communication between smaller clusters (modularity 0.78).

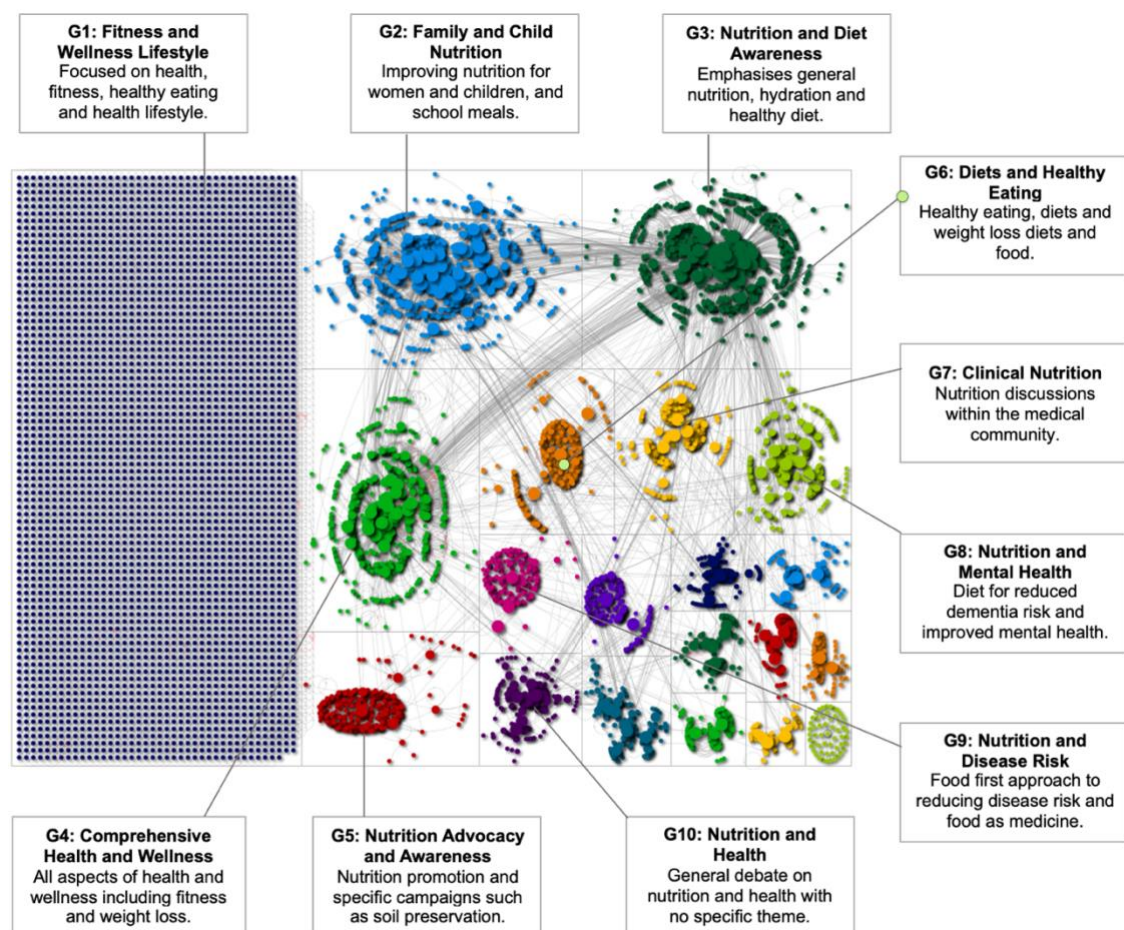
**Table 5.1 Summary of the #nutrition network debate taking place on X**

<b>Graph Metric</b>	<b>Value</b>
X users (vertices)	17,129
Total relationships (edges)	26,809
Reciprocated X user pair ratio	0.0330
Reciprocated relationships ratio	0.0640
Graph Density*	0.001
Isolated X user	3,874
Self-Loops (edge that connects to itself)	5,815
Maximum Geodesic Distance (Diameter)	20
Average Geodesic Distance	5.26
Average shortest path	5.257
Modularity (the density of connections between nodes)	0.7797

Data were harvested between 1 -21 March 2023 and analysed using NodeXL Pro.

\*calculated by comparing the ratio of the number of relationships present in the network and the number of possible relationships

The #nutrition community on X was dispersed with groups having isolated conversations with little between group crosstalk as visualised in **figure 5.3**. The largest group (G1) was an ‘isolates’ group where users conversed without mentioning each other (that is, individual posts), and the remainder of the group represented a range of large, medium, and small communicative clusters. The network had a high modularity score of 0.78 (**table 5.1**) suggesting that the groups were well-defined. Semantic analysis of the groups revealed that a range of discussions took place, ranging from fitness and lifestyle, family & child nutrition, nutrition & diet awareness, and nutrition and advocacy awareness (**figure 5.3**). There was a level of interaction between larger clusters (e.g., G2, G3 and G4; **figure 5.3**) within the network, but smaller groups (e.g., G5, G9 and G10) did not interact at the same level.



**Figure 5.3 Network visualisation of the #nutrition debate on X**

Data were harvested between 1 and 21 March 2023, analysed and visualised using NodeXL Pro. Users ( $n=17,129$  vertices) that interacted ( $n=26,809$  edges) through mentions or reposts are clustered together as groups. Each group is visualised, with the largest group of users in the upper left corner of the map (Group 1 annotated as G1) and the smallest in the lower right corner.

#### 5.4.2 Influencers (betweenness centrality)

Exploring the network graph metrics helps to identify who the influential actors were and how the information flows through the network since it is possible to identify the groups of actors across the network and identify which actors influence the debate. In this network, betweenness centrality ranged from 0 to 23,375,543.67 (indicates how much a user acts as a bridge across the network with higher scores indicating greater influence). The top 10 influencers in this network (**table 5.2**) were from personal accounts, online blogs, and not-for-profit organisations according to self-reported user profiles. These influential users had low closeness centrality (**table 5.2**), which suggests they are also central to the network. The most important X user in this network, as measured by eigenvector centrality (0.257; **Appendix C, table C.1**), was from a

personal account with high betweenness centrality showing they are also an influential user.

**Table 5. 2 Top 10 influential users in the #nutrition network ranked by their betweenness centrality score**

Rank	User classification <sup>a</sup>	Betweenness Centrality	Closeness Centrality <sup>b</sup>	Eigenvector Centrality <sup>c</sup>
1	Personal	23375544	0.163	0.257
2	Personal	10254555	0.151	0.203
3	Company	9715469	0.160	0.238
4	News	9045685	0.160	0.243
5	Blog	8066282	0.153	0.173
6	NGO	7472289	0.135	0.064
7	Personal	6731353	0.159	0.239
8	NGO	6042642	0.150	0.098
9	Personal	5650452	0.134	0.088
10	Personal	5207999	0.150	0.157

<sup>a</sup>Classification is self-selected by X users and not verified

<sup>b</sup>Position within the network

<sup>c</sup>Influence within the network

### 5.4.3 Semantic analysis

Semantic analysis showed that health was the top word associated with nutrition in this network; while healthy lifestyle, fitness, and food were also commonly associated words (**table 5.3**). The semantic network map illustrates the overall pattern of word pairs communicated in the network, with the most frequent pairs shown in groups one and two on the left of the map (**figure 5.4**).



**Table 5. 3 Top 10 hashtags, words and word pairs**

Rank	Top hashtags*	Count	Top words	Count	Top word pairs	Count
1	Nutrition	865	#nutrition	18,317	#health, #nutrition	785
2	Savesoil, nutrition	446	#health	4,223	#nutrition, #health	722
3	Health, healthylifestyle, nutrition, regime	324	food	3,174	#healthylifestyle, #nutrition	573
4	Medicine, health, nutrition	222	more	2,612	#health #healthylifestyle	530
5	Healing, hope, gratitude, love, meditation, letters, nutrition, goals, chakras,	211	nutrition	2,562	#diet, #nutrition	513
6	Nutrition, foodheroes, schoolmeals	145	health	2,476	nutritious, food	512
7	anganwaditeachers anganwadi, nutrition, ruraldistress, telangana	87	#diet	1,845	bone, health	454
8	nutrition health diet	75	#healthylifestlye	1,726	roar, #nutrition	433
9	doctor farmer healthy	65	#fitness	1,612	#savesoil, voice	433
10	meded medtwitter foamed gitwitter nutrition dietitian	58	#food	1,604	want, continue	432

Note: hashtags usually relate to trends or themes and may not appear to be English, for example, #gitwitter is used by Gastroenterologist when tagging content.



**Table 5.4 Sentiment analysis of the network**

Sentiment	Count	Salience	Example words
Positive Words	22,218	47%	support, healing, better, great, well, improve
Negative Words	6,795	15%	out, want, promoting, stop, time, weight
Total Words	46,8191	100%	

## 5.5 Discussion

This study is the first to visualise the #nutrition conversation taking place on a large social media platform known as X (formerly Twitter). The key findings in this study show that the network was dispersed without polarisation with the largest group being unconnected users who did not have relationship with other users in the network. Concerningly, the most influential actors were public users without nutrition training or expertise. The online nutrition community was more likely to propagate information through reposting, as opposed to posting original content. The most frequently discussed topics in this network was; healthy diet, food, fitness, and healthy lifestyle, with a discourse that was largely positively framed.

Our #nutrition network map illustrates community clusters of multiple smaller groups with their own influence and sources of information (Smith et al., 2014), and suggests a low-density network with a number of isolated users and high modularity. This type of network structure can restrict the flow of information, meaning individual groups of users rely on just a few influential users in that cluster to share information on a specific topic relating to nutrition (Bruzzese et al., 2022). This structure has been termed ‘bazaars’ (Bridge et al., 2021). Although there is little engagement between groups and information flow is restricted, because there is no single source of information, multiple conversations can occur concurrently within the network (as in a market bazaar), with each group having its own view (Himmelboim et al., 2017).

As with other studies investigating social networks (Lynn et al., 2020), the #nutrition network showed a wide range of actors influencing the discourse. However, the most influential users in this network were public accounts that did not mention any nutrition education or training in their profiles. Notably, this contrasts with studies looking at the

discourse on diets, which found that users with health or science backgrounds were the most influential (Eaton et al., 2023); and also with discourse on climate change, where international organisations are central to the debate (Yuan et al., 2022). Probst and colleagues (2019) found that X is being used more frequently by nutritionists as a professional network and a tool to disseminate research findings for professional development however their voices do not appear to be cutting through network noise (Probst and Peng, 2019). This is a particularly concerning finding for nutrition as the general population turn to social media often for dietary advice (Alhothali and Aljefree, 2023) and our study suggests they may be receiving poor quality advice from unqualified users.

Social network research looking at how debates are portrayed suggests that strong ties, such as those between personal contacts, have the greatest influence over the debate (Bridge et al., 2021). However, weak ties, such as those with unknown users, play an equally important role as they enable information diffusion. Similar to other health communication networks, the ratio of reposted to original content was higher (Lynn et al., 2020).

Our study finds individuals' posts were overwhelmingly associated with health, healthy diet, fitness and healthy lifestyles with #health, #healthylifestyle and #diet the most commonly associated hashtags across our network. This gives an indication of the public narrative on X suggesting that X users may be using the platform for advice on healthier diets. These findings support research that compared the USA food pyramid to X conversations, and found 'healthy food' and 'healthy diets' in the top 10 associated words (Saura et al., 2020). A separate study looking at conversations using #healthyfood also found #healthylifestyle and #healthyliving was most commonly associated with the 'healthy food' search term (Pilař et al., 2021).

The sentiment used in posts across this nutrition network was broadly positive, although it appeared to be topic dependant. These findings support other positively framed topics that have focused on healthy diets (Saura et al., 2020), organic foods, and veganism, which has shifted overtime to a more positive narrative as it has increased in popularity (Shamoi et al., 2022). A systematic review looking at data science methods to examine sentiment in food and cooking social media content, found similar results to ours with a more positive discourse overall (Molenaar et al., 2023).

However, our findings differ from more emotive topics such as front-of-pack labelling (Irawan, 2022), ultra-processed foods (Saura et al., 2020), and fiscal policies (Bridge et al., 2021), which are negatively framed. Research investigating discourse on disease also tends to be more negative (Perez-Perez et al., 2019). Similarly, findings from other disciplines have shown the online debate on climate change to be negative, and sometimes aggressive (Yuan et al., 2022), with attempts to discredit climate change scientists (Getson et al., 2021). Likewise, fear is a common emotion in political networks (Chakraborty and Mukherjee, 2023). Nutrition is therefore better placed than climate change or politics, as the discussion is generally positive, although the public appear to be leading the debate. Nutrition professionals are best placed to clearly communicate evidence-based nutrition advice on social media but were under-represented voices. Our research suggests, increasing the use of social media by credentialled Nutrition professionals could have far reaching benefits given the public's reliance on social media for nutrition advice.

This study had several limitations, most notably the short data collection period which only provides a snapshot of the discourse. Additionally, there is no comparison with other periods so it is not possible to tell whether the discourse and public opinion on nutrition changed over time or in response to real time events. This study only considered the discourse on X. As user accounts are open, X was deemed the most suitable platform to carry out public opinion research, however this limits the generalisability of results. Other social media platforms may yield different results and should be considered in future research. While this research is representative of the nutrition discourse on X during the collection period, the very use of the hashtag could bias data collection as those using the hashtag will likely have an interest in nutrition. Therefore, the debate investigated in this study may only reflect views of a specific cohort of users, rather than X users generally.

A further limitation is that no consideration was given to automated accounts known as “bots” and how they might affect the network. It is estimated that between 9% (Varol et al., 2017) and 29% (Weng and Lin, 2022) of social media activity is attributable to bots. Bots generate fewer replies, reposts, and mentions from human users and tend to repost more than humans (Lynn et al., 2020). Based on this, it is likely that our dataset included a number of bots as 20% of X users were not connected to other users, and the

network had a high repost rate. Bots are of particular concern as they can perpetuate misinformation and disproportionately spread articles from low-credibility sources (Shao et al., 2018). Therefore, future research should include a plan to mitigate the negative impact of bots. Furthermore, only English language posts were collected and analysed. With around 40% of X posts written in English, a large proportion of nutrition related posts are not considered in this research, and the findings are not necessarily applicable to non-English speaking users. X user geolocation was not used in the analysis as it is not reliably captured and is not mandatory when creating an account. Finally, as with all social media analysis, the results are difficult to replicate due to changes in users, public mood, political landscape and data collection periods (Bruzzese et al., 2022).

Nonetheless, there are notable strengths to our study. The main strength is that, to our knowledge, it is the first study that has attempted to investigate the public discourse relating to nutrition on social media and to map the network. In addition to the novel topic, it adds to the wider body of literature looking at social networks for public health communication and can contribute methodology to other mixed methods papers.

Moreover, it is also the first study to analyse what the public are discussing in relation to nutrition and to identify the key actors. The user analysis showed that there are many actors involved in the nutrition debate but more importantly, this study was able to identify the influencers in this network, and to measure how they propagate nutrition information online. This study identified that public X users without formal nutrition training were the key actors and they appeared to be particularly interested in health and healthy diets and lifestyles. This is important for understanding who may be influencing the public debate. These findings could be used to encourage those with nutrition/dietitian training to use X more to influence the debate. It could also help inform the language professionals should use to engage the public when disseminating nutrition messages on X and highlights the strength of using high profile accounts to amplify nutrition messages. Finally, the results could be used to discourage the public from sharing nutrition information as they could be propagating misinformation and poor-quality information that is not evidence based.

### 5.5.1 Future research

Future research should consider how the nutrition debate is portrayed over a longer time period. If the data collection period was long enough, this could include seasonal changes when interest in nutrition peaks (Passos et al., 2020; Palomo-Llinares et al., 2021). Given the high number of public X users discussing nutrition in our research, future research could also analyse popular dietary patterns or compliance to public health advice. This could support policy makers by informing on public opinion, the sentiment towards dietary guidelines and public acceptance of new initiatives. Not least, future research should also use communication theories to better understand what motivates users to partake in the debate on X. Motivations for reposting, liking and commenting should also be investigated as these were more common than posting original content in this research. This could also support nutrition professions to share evidence-based advice and engage in X debates in the future.

### 5.5.2 Conclusions

By using SNA, semantic and sentiment analysis, this study provides novel insight into the public #nutrition debate on X. The findings reveal a publicly driven debate which focuses on healthy diets, fitness and lifestyle. These findings are important for nutritionists and healthcare professionals as it provides understanding into how the public may be accessing nutrition information, and our study provides insight into the language that should be used to engage the public. These findings should be used to encourage nutrition professionals to engage in the online debate and be the leading voices.

## 5.6 References

- Ahmed, W. 2018. Public health implications of #ShoutYourAbortion. *Public Health*. **163**, 35-41.
- Ahmed, W. Vidal-Alaball, J. Lopez Segui, F. et al. (2020). A Social Network Analysis of Tweets Related to Masks during the COVID-19 Pandemic. *Int J Environ Res Public Health*. **17**(21).
- Alhothali, GT. and Aljefree, NM. (2023). Young adults' sought gratifications from, and perceptions of food advertising by, social media influencers: a qualitative approach. *J Health Popul Nutr*. **42**(1), 103.
- Appel, G. Grewal, L. Hadi, R. et al. (2020). The future of social media in marketing. *Acad Mark Sci Rev*. **48**(1), 79-95.
- Bridge, G. Flint, SW. and Tench, R. (2021). A mixed-method analysis of the #SugarTax debate on Twitter. *Public Health Nutr*. **24**(11), 3537-3546.

- Bruzzese, S. Ahmed, W. Blanc, S. et al. (2022). Ecosystem Services: A Social and Semantic Network Analysis of Public Opinion on Twitter. *Int J Environ Res Public Health*. **19**(22).
- Chakraborty, A. and Mukherjee, N. (2023). Analysis and mining of an election-based network using large-scale twitter data: a retrospective study. *Soc Netw Anal Min*. **13**(1), 74-74.
- Clauset, A. Newman, MEJ. and Moore, C. (2004). Finding community structure in very large networks. *Phys Rev E Stat Nonlin Soft Matter Phys*. **70**(6), 066111.
- Croes, E. and Bartels, J. (2021). Young adults' motivations for following social influencers and their relationship to identification and buying behavior. *Comput Hum Behav*. **124**, 106910.
- Eaton, MC. Probst, YC. and Smith, MA. (2023). Characterizing the Discourse of Popular Diets to Describe Information Dispersal and Identify Leading Voices, Interaction, and Themes of Mental Health: Social Network Analysis. *JMIR infodemiology*. **3**, e38245.
- Ellis, CH. Ho, P. Moore, JB. et al. (2025). Content quality versus sharing practices on social media: a cross-sectional analysis of nutrition information on Twitter. *Public Health Nutr*. **28**(1):e77.
- Engel, E. Gell, S. Heiss, R. et al. (2024). Social media influencers and adolescents' health: A scoping review of the research field. *Soc Sci Med*. **340**, 116387.
- Erz, A. Marder, B. and Osadchaya, E. (2018). Hashtags: Motivational drivers, their use, and differences between influencers and followers. *Comput Human Behav*. **89**, 48-60.
- Eskandari, F. Lake, AA. and Butler, M. (2022). COVID-19 pandemic and food poverty conversations: Social network analysis of Twitter data. *Nutr Bull*. **47**(1), 93-105.
- Ferra, I. and Nguyen, D. (2017). #Migrantcrisis: "tagging" the European migration crisis on Twitter. *J Commun Manag*. **21**(4), 411-426.
- Freeman, L.C. (1977). A Set of Measures of Centrality Based on Betweenness. *Sociometry*. **40**(1), 35-41.
- Getson, JM. Sjöstrand, AE. Church, SP. et al. (2021). Do scientists have a responsibility to provide climate change expertise to mitigation and adaptation strategies? Perspectives from climate professionals. *Public Underst Sci*. **30**(2), 169-178.
- Hansen, D. Shneiderman, B. and Smith, MA. (2010). *Analyzing Social Media Networks with NodeXL: Insights from a Connected World*. Morgan Kaufmann Publishers Inc.
- Harel, D. and Koren, Y. (2004). A Fast Multi-Scale Method for Drawing Large Graphs. *J Graph Algorithms Appl*. **6**(3), 179-202.
- Harris, JK. Moreland-Russell, S. Tabak, RG. et al. (2014). Communication about childhood obesity on twitter. *Am J Public Health*. **104**(7), 62.
- Himmelboim, I. Smith, MA. Rainie, L. et al. (2017). Classifying Twitter topic-networks using social network analysis. *Soc Med Soc*. **3**(1).
- Holmberg, K. and Hellsten, I. (2015). Gender differences in the climate change communication on Twitter. *Internet Res*. **25**(5), 811-828.
- Hu, M. and Liu, B. (2004). Mining and summarizing customer reviews. *Proc. ACM SIGKDD Int. Conf. Knowl. Discov. Data Min*. Association for Computing Machinery, 168-177.
- Hunt, D. (2021). How food companies use social media to influence policy debates: a framework of Australian ultra-processed food industry Twitter data. *Public Health Nutr*. **24**(10), 3124-3135.
- Irawan, A. Shahin, B. Njuguna, D. et al. (2022). Analysis of Content, Social Networks, and Sentiment of Front-of-Pack Nutrition Labeling in the European Union on Twitter. *Front Nutr*. **9**, 846730.



- Lee, JA. Sudarshan, S. Sussman, KL. et al. (2022). Why are consumers following social media influencers on Instagram? Exploration of consumers' motives for following influencers and the role of materialism. *Int J Advert* **41**(1), 78-100.
- Lynn, T. Rosati, P. Santos, GL. et al. (2020). Sorting the Healthy Diet Signal from the Social Media Expert Noise: Preliminary Evidence from the Healthy Diet Discourse on Twitter. *Int J Environ Res Public Health*. **17**(22), 8557.
- Marauri-Castillo, I. Rodríguez-Gonzalez, MDM. and Marín-Murillo, F. (2024). Disseminators, not influencers: communication of dietitians on social networks. *Vivat Academia*. (157).
- Molenaar, A., Jenkins, EL. Brennan, L. et al. (2023). The use of sentiment and emotion analysis and data science to assess the language of nutrition-, food- and cooking-related content on social media: a systematic scoping review. *Nutr Res Rev*. **37**(1), 43–78.
- Moukarzel, S. Caduff, A. Rehm, M. et al. (2021). Breastfeeding Communication Strategies, Challenges and Opportunities in the Twitter-Verse: Perspectives of Influencers and Social Network Analysis. *Int J Environ Res Public Health*. **18**(12), 6181.
- Moukarzel, S. Rehm, M. del Fresno, M. et al. (2020). Diffusing science through social networks: The case of breastfeeding communication on Twitter. *PLOS One*. **15**(8), e0237471.
- Newman, M. (2018). *Networks*. Oxford University Press.
- Palomo-Llinares, R. Sánchez-Tormo, J. Wanden-Berghe, C. et al. (2021). Trends and Seasonality of Information Searches Carried Out through Google on Nutrition and Healthy Diet in Relation to Occupational Health: Infodemiological Study. *Nutr*. **13**(12), 4300.
- Passos, JA. Vasconcellos-Silva, PR. and Santos, L. (2020). Cycles of attention to fad diets and internet search trends by Google trends. *Cien Saude Colet*. **25**(7), 2615-2631.
- Perez-Perez, M. Perez-Rodriguez, G. Fdez-Riverola, F. et al. (2019). Using Twitter to Understand the Human Bowel Disease Community: Exploratory Analysis of Key Topics. *J Med Internet Res*. **21**(8), e12610.
- Pilař, L., Kvasničková, L. and Kvasnička, R. (2021). Healthy Food on the Twitter Social Network: Vegan, Homemade, and Organic Food. *Int J Environ Res Public Health*. **18**(7), 3815.
- Probst, Y.C. and Peng, Q. (2019). Social media in dietetics: Insights into use and user networks. *Nutr Diet*. **76**(4), 414-420.
- Sabidussi, G. 1966. The centrality index of a graph. *Psychometrika*. **31**(4), 581-603.
- Saura, J.R. Reyes-Menendez, A. and Thomas, SB. (2020). Gaining a deeper understanding of nutrition using social networks and user-generated content. *Internet Interv*. **20**(9) 100312.
- Shamoi, E. Turdybay, A. Shamoi, P. et al. (2022). Sentiment analysis of vegan related tweets using mutual information for feature selection. *Peer J Comput Sci*. **8**, e1149.
- Shao, C. Ciampaglia, GL. Varol, O. et al. (2018). The spread of low-credibility content by social bots. *Nature Commun*. **9**(1).
- Singh, M. Bansal, D. and Sofat, S. (2016). Behavioral analysis and classification of spammers distributing pornographic content in social media. *Soc Netw Anal Min*. **6**(1), 1-18.
- Smith, M. Shneiderman, B. Milic-Frayling, N. et al. (2009). *Analyzing (social media) networks with NodeXL*. ACM. 255-264.
- Smith, MA. Rainie, L. Shneiderman, B. et al. (2014). Mapping Twitter topic networks: From polarized crowds to community clusters.

<https://www.pewresearch.org/internet/2014/02/20/mapping-twitter-topic-networks-from-polarized-crowds-to-community-clusters/>

- Sussman, K.L. Bouchacourt, L. Bright, L.F. et al. (2023). COVID-19 topics and emotional frames in vaccine hesitation: A social media text and sentiment analysis. *Digit Health*. **9**, 20552076231158308.
- Toraman, C. Şahinuç, F. Yilmaz, E.H. et al. (2022). Understanding social engagements: A comparative analysis of user and text features in Twitter. *Soc Netw Anal Min* **12**(1), 47.
- Varol, O. Ferrara, E. Davis, C. et al. (2017). Online human-bot interactions: Detection, estimation, and characterization. *Proceedings of the International AAAI Conference on Web and Social Media*, 280-289.
- Vijaykumar, S. McNeill, A. and Simpson, J. (2021). Associations between conflicting nutrition information, nutrition confusion and backlash among consumers in the UK. *Public Health Nutr*. **24**(5), 914-923.
- Vijaykumar, S. Nowak, G. Himelboim, I. et al. (2018). Virtual Zika transmission after the first U.S. case: who said what and how it spread on Twitter. *Am J Infect Control*. **46**(5), 549-557.
- Wasserman, S. 1994. *Social network analysis : methods and applications*. Cambridge: Cambridge University Press.
- Weng, Z. and Lin, A. (2022). Public Opinion Manipulation on Social Media: Social Network Analysis of Twitter Bots during the COVID-19 Pandemic. *Int J Environ Res Public Health*. **19**(24), 16376.
- Yousef, M. Dietrich, T. and Rundle-Thiele, S. (2022). Actions Speak Louder Than Words: Sentiment and Topic Analysis of COVID-19 Vaccination on Twitter and Vaccine Uptake. *JMIR Form Res*. **6**(9), e37775.
- Yuan, S. Chen, Y. Vojta, S. and Chen, Y. (2022). More aggressive, more retweets? Exploring the effects of aggressive climate change messages on Twitter. *New Media Soc*, **26**(8), 4409-4428.
- Zaman, A. Thapa, M. Paswan, S. et al. (2023). Social media influencer (SMI) as a human brand – a need fulfillment perspective. *J Prod Brand Manag*. **32**(2), 173-190.

## Chapter 6 Critical discussion

### 6.1 Summary of findings

To date, there has been a paucity of research investigating nutrition information online and on social media compared with other sources of nutrition information such as food labelling, food marketing and food education. Previous research has looked at specific dietary patterns such as vegan diets, but not the broader nutrition information that the public are accessing for dietary advice. To add to the complexity, previous work that has assessed the quality of online health information has used different and complex quality criteria, many of which are not validated, and none of which were created specifically to measure the quality of online nutrition information.

To address these research gaps, this thesis took a mixed methods approach to address the following aim:

*To assess the quality of nutrition information online, and to determine who was involved in the online discourse and how nutrition information propagates through networks.*

The preceding chapters describe the approaches taken to achieve this aim, and present four published papers:

**Chapter 2** *Literature review: Nutrition Communication in Public Health and the Media (Ellis and Evans, 2022)*

**Chapter 3** *Development and validation of a quality assessment tool to assess online nutrition information (Ellis et al., 2023)*

**Chapter 4** *Content quality versus sharing practices on social media: A cross-sectional analysis of nutrition information on Twitter (under review) (Ellis et al., 2024)*

**Chapter 5** *Social network and linguistic analysis of the #nutrition discourse on the platform X, formerly known as Twitter (Ellis et al., 2024)*

Key findings from across the four main chapters of this thesis are outlined in **table 6.1**. First, the literature review (**chapter 2**) found a long history of health and nutrition communication in the UK and highlighted a shift in public health seeking behaviours from newspapers and professionally authored books to digital content. The digital environment is more vulnerable to poor quality information as it can be created by

almost anyone, with little or no regulation and fact checking. In nutrition, the sharing of misinformation can create the perception of scientific uncertainty, which erodes public trust and affects adherence to dietary guidelines. The evidence reviewed in **chapter 2**, underpinned the research in the following chapters.

**Chapter 3** used the existing literature and previously published criteria to inform the development of a new quality assessment tool specific enough to assess online nutrition information. The tool was validated and tested for inter-rater reliability, and statistical methods applied to ensure criteria suitability. The tool was then applied to a large dataset in **chapter 4**, which allowed the identification of the essential quality criteria for high quality articles. The key findings were that companies were more likely to post poor quality information, and lower quality articles were more likely to be reposted by X users.

Findings from **chapter 4** suggested that quality was not a key motivator for sharing information on X; and therefore **chapter 5** considered the influence of networks on sharing practices. Results showed that non-expert X users were the more dominant voices in the nutrition debate than nutrition professionals. This may explain why quality was not a motivation for sharing, as non-expert users may not have been able to discriminate between high- and low-quality information. Unlike other scientific topics, the nutrition conversations on X were dispersed without polarising views, and debates were more likely to take place in smaller focused groups with little cross talk between groups.

## **6.2 Contributions to the evidence-base**

This PhD aimed to investigate the digital nutrition environment, to assess the quality of nutrition information online, measuring how this information dispersed through social media and to identify who was leading the debate. These findings led to a set of recommendations (**discussed under section 6.5.2**) to reduce the spread of poor-quality information, and to encourage nutrition professionals to engage in the debate. The gaps in the literature and novel contributions are discussed within each study and therefore this section summarises how this thesis as a whole has advanced the evidence-base.

**Table 6.1 Summary of key outcomes from this thesis**

Chapter	Key outcomes
2	<ul style="list-style-type: none"> <li>• Documented the role, efficacy and progress of health and nutrition communication in the UK.</li> <li>• Highlighted the key role the digital environment plays in health seeking behaviours.</li> <li>• Identified the important role the internet and social media play in dietary choices, particularly for younger age groups.</li> <li>• Highlighted the need to tackle misinformation in nutrition and improve digital health and food literacy.</li> </ul>
3	<ul style="list-style-type: none"> <li>• Identified the need for a standardised set of quality assessment criteria to measure quality and allow for cross study comparison.</li> <li>• Designed, validated and piloted a novel Online Quality Assessment Tool (OQAT).</li> <li>• Proposed a set of recommendations to improve the quality of nutrition information.</li> </ul>
4	<ul style="list-style-type: none"> <li>• Identified that poor quality information is more likely to be shared on X and reposted.</li> <li>• Identified the essential criteria for online content to be high quality.</li> <li>• Demonstrated that quality differs between sources with companies more likely to publish poor quality information.</li> </ul>
5	<p>Visualised the nutrition network finding that:</p> <ul style="list-style-type: none"> <li>• the nutrition network is dispersed without polarised views,</li> <li>• public users are more likely to be influential in the discourse than nutrition professionals,</li> <li>• nutrition information is primarily propagated through reposting,</li> <li>• health is the most semantically linked topic in the #nutrition network on X,</li> <li>• nutrition discourse is largely positively framed.</li> </ul>

### **6.2.1 Methodology – a mixed methods approach**

This thesis used a wide range of methods including computational, statistical, linguistic and network analysis methods to comprehensively review the digital nutrition environment. This mixed methods approach using techniques from other disciplines and enabled the development and validation of a novel quality assessment tool (**chapter 3**) which was able to successfully measure the quality of nutrition information published

online. Advanced statistical methods were used to ensure the model was easy to apply by allowing for a single interval scale to quantify quality, without the need to assign weight. The network and semantic approaches (**chapter 5**) provided empirical evidence on how experts can engage, and lead, the online debate. Therefore, this approach is both novel in the development and validation of the quality assessment tool and contributes to the wider literature on the quality of online information and nutrition misinformation.

### **6.2.2 Identification of routes to combat online misinformation**

The speed and ease that content can be shared online has resulted in a rapid increase in individuals and organisations seeking to influence public opinion and behaviours; nutrition is not immune to this phenomenon (Lynn et al., 2020). Whilst work has been carried out to investigate social media in health-related areas, this thesis presents the first studies to investigate the quality and dispersion of nutrition information on social media. The results presented (**chapters 4 and 5**) support the literature in that, non-expert written nutrition articles are poor quality (Mete et al., 2019) with misleading dietary advice (El Jassar et al., 2019) and conflicting information (Armstrong et al., 2021; Heer et al., 2022). This emphasises the need to improve non-expert authored content to reduce the spread of poor-quality information, and to improve the public's digital health literacy so they can access quality for themselves (Denniss, et al., 2023).

Although previous work has shown emotion to be a predictor of reposting (Vosoughi et al., 2018), this research was the first to suggest that quality is not a predictor for reposting nutrition information and dietary advice (**chapter 4**). Although the fact that X users are unable to discriminate between high- and low-quality nutrition advice, should be considered. This thesis goes on to provide potential solutions to challenge online misinformation, a widespread phenomenon that challenges the public's trust in science and affects adherence to public policy (Mozaffarian and Forouhi, 2018).

The changing landscape of social media cannot be ignored within this thesis. Previously, shifts in social media platform usage were linked with trends and new technology but more recently, social media, in particular X, has been politicised with more controversial ideologies being shared and reduced regulation. The data presented in this thesis were collected prior to Twitter becoming X therefore it is likely that results may change if replicated in 2025 with even less expert voices exercising influence and more unidirectional views being expressed as users on the political left choose other

platforms to share their views. Equally problematic, Meta (who own Facebook, Instagram and WhatsApp) have recently removed fact checking from their sites, instead encouraging the community to self-police. It is clear from the findings presented in this thesis that the public are not able to differentiate high- and low-quality information, and are more likely to share poor quality content, making community policing of nutrition content very unlikely. This could result in nutrition misinformation becoming omnipresent on social media.

Finally, anecdotal evidence suggests that social media and news feeds, have shifted from being driven by user seeking behaviours, to algorithms pushing content to users. These curated feeds are based on user preferences and search history, which can create echo-chambers of misinformation, and reinforce erroneous beliefs. Currently there are no mechanism in place to easily identify curated content.

### **6.2.3 Creation of the novel Online Quality Assessment Tool**

A key aspect of this thesis was the development of the novel Online Quality Assessment Tool (OQAT) as called for in the literature, and **chapter 3** places the OQAT in the context of other existing quality assessment criteria. Several systematic reviews have identified the need for a validated tool that is suitable to measure the quality of online information and is simple to use and interpret (Zhang et al., 2015; Lynn et al., 2020; Afful-Dadzie et al., 2021).

The OQAT is novel in that it is the first tool specifically created to measure online nutrition information, but it is also novel in that it was informed by key criteria from across the literature to create one standardised tool. The OQAT was validated and showed high interrater reliability and is supported by comprehensive instructions to allow raters to be easily trained to apply the criteria and interpret the scores. The criteria are designed to be simple yet sensitive enough to assess expert and non-expert created content as well as specific enough for the nuances of digital content.

When applying the novel OQAT to compare article quality by source, commercial and personal blogs scored most poorly. This supports the literature with commercial dietary supplement blogs (Oksman et al., 2016) and wellness websites lacking objectivity and transparency (Armstrong et al., 2021) when compared to expert-authored information.

This may be due to limited regulation for non-professionals as they fall outside of *UK Article 12(c) in the Nutrition and Health Claims Regulation* (Ashwell et al., 2022).

This work was also the first study to identify the characteristics of high- and low-quality articles about nutrition online. The OQAT could also benefit other scientific disciplines that are subject to misinformation, such as climate change sciences (Treen et al., 2020). Additionally, the OQAT is simple enough to be used by non-nutrition experts to support digital literacy.

#### **6.2.4 Social networks**

As the general population turn to social media more regularly for dietary advice (Alhothali and Aljefree, 2023), it was important to measure the impact of social networks, information dispersion and the influencers. Non-nutrition professionals dominated the #nutrition debate (**chapter 5**) as also seen with healthy diet advice on X (Lynn et al., 2020) and TikTok (Munro et al., 2024). Conversely, research looking at diet and mental health advice on X, found that those with a background in science were the dominant voices (Eaton et al., 2023). Climate change networks have also found that experts dominate the narrative (Yuan et al., 2022).

Semantic analysis provided a clear indication of the public narrative on nutrition on X with users accessing the platform looking for dietary advice. This supports studies that found ‘healthy food’ and ‘healthy diets’ in the top 10 associated words when discussing the USA Food Pyramid on X (Saura et al., 2020) and #healthylifestyle and #healthyliving (Pilař et al., 2021). The positive discourse in the nutrition network supports the literature investigating diet related topics; healthy diets (Saura et al., 2020), organic foods (Pilař et al., 2021), food and cooking (Molenaar et al., 2023), and veganism on X (Shamoi et al., 2022) and Instagram (Kadel et al., 2024). This did however differ from climate change research which tends to be more negative and aggressive (Yuan et al., 2022). These data strengthen the need for trained nutrition professionals to be the dominant voice on social media to clearly communicate evidence-based nutrition advice and provides insight into the language that should be used to engage the public.

#### **6.3 Ethical considerations**

This study did not require ethical approval as all data used were publicly available and assessable at the point of data collection. Equally, permission was not sought from X



users as only publicly available posts were included, and data analysis used aggregated data. However, care was taken to anonymise users and remove handles to ensure they were not identifiable. Whilst all data was collected when X was still Twitter with less stringent data research policies, the data analysis documented in **chapters 3, 4, and 5** complies with X's new rules which call for aggregated analysis and unidentifiable accounts. Keyword searching for information is also deemed acceptable because of the aggregate nature of the analysis.

However, despite taking these precautionary steps and adhering to X's ethical standards, there are further philosophical and ethical questions that relate to using social media for research without users' express permission. It has been suggested that X data should be considered as 'private data on public display', which would require participant consent to include their data (Gold, 2020). Whilst future research should consider data access and participant consent, there are of course limitations to this given the millions of users online. Therefore seeking X's explicit consent as a stakeholder should instead be a consideration as users give X the right to use their data. One way to ensure X's consent is through the X API which is now, controversially, a paid function. This API creates a paradox whereby commercial companies with large budgets can purchase unlimited X data for thousands of US Dollars per month, for marketing and targeted advertising purposes. However, researchers using the free API are limited to 1,500 posts per month making academic research more challenging and less valid.

## **6.4 Limitations and strengths of the PhD research**

The strengths and limitations of each study are discussed within the discussions of their respective chapters, specifically, section 3.5 in **chapter 3**, section 4.5.1 in **chapter 4**, and section 5.5.3 in **chapter 5**. This section summarises the limitations and strengths observed across the entire PhD research project, noting where these relate to an individual chapter.

### **6.4.1 Limitations**

#### **6.4.1.1 Methodology**

Care was taken to select data collection periods that avoided relevant seasonal peaks in public interest in nutrition (Kamiński et al., 2020), either by selecting specific time periods, or by choosing days at random for investigation. Despite this, a limitation of data collection in **chapters 3 and 4**, is that data was collected in 2021 which could have

been impacted by the COVID-19 pandemic. It is widely accepted that the pandemic increased health related misinformation on social media (Kbaier et al., 2024) and nutrition was not immune to this with vitamin D regularly a subject of misinformation (Henrina et al., 2021). Therefore, it is possible that the quality of information collected was impacted by the rise in COVID -19 related misinformation.

A further data collection limitation was that **chapters 3 and 4** did not have similar numbers in the data categories being compared. **Chapter 3** had more blogs than any other category (news or press release), and **chapter 4** had a disproportionately low number of reposted articles, making comparison between groups difficult in both chapters. Whilst it is likely that this is reflective of the content shared and engaged with, as other medical research has found a low volume of scientific research articles being shared on X (Lorenzon et al., 2021).

A limitation across all chapters but particularly **chapter 5**, is the short data collection period. This only allowed for a snapshot of the discourse to be captured which may be impacted by external events such as policy changes, seasonality or nutrition news being profiled in the media.

No consideration was given to automated accounts known as ‘bots’ which can imitate human behaviour on social media in **chapters 3, 4 and 5**. It is likely that bots were responsible for some reposts as bots tend to repost more than humans (Lynn et al., 2020) although this was not measured. As bots are responsible for between 9% (Varol et al., 2017) and 29% (Weng and Lin, 2022) of social media activity, these accounts could have impacted how information was diffused across the network in **chapter 5**. However, it is unclear whether bots are responsible for spreading poor quality information with some studies suggesting they are responsible for sharing misinformation (Shao et al., 2018) whilst others find no difference in bots sharing practices (Vosoughi et al., 2018).

Finally, only considering posts and articles written in English is a limitation across **chapters 3, 4, and 5**. It is estimated that only 40% of posts on X are written in English therefore a large proportion of nutrition related content could have been missed limiting the generalisability of the findings. Similarly, hashtags were used to collect data in all studies (**chapters 3, 4 and 5**). The method of using hashtags could have unintentionally

biased data collection as the very use of the hashtag, likely predicts an interest in nutrition. It is also likely that related content discussing diet and lifestyle without the nutrition hashtag were not collected, so rich informative data could have been missed. Whilst this was intentional as I was only concerned with those specifically discussing nutrition, future research should consider widening the search terms and hashtags as discussed under future research (section 6.6).

#### **6.4.1.2 Social media**

The choice to use social media as a method to collect URLs for quality analysis is both a strength and a limitation. The social media landscape is ever changing and evolving with current events shifting the narrative. Therefore, analysing social media only provided a snapshot of current opinion making generalising and replicating results difficult. Some of the challenges of reproducibility relate to longevity of accessibility (Breuer and Haim, 2024) with accounts and posts being deleted and therefore no longer available. Therefore, whilst findings may be largely reproduced, replicability would not be possible (Knöpfle and Schatto-Eckrodt, 2024). This could be mitigated by using larger data collection periods or comparing data across predefined time periods to allow more inferences to be drawn. However, generalisations from social media research will always be limited.

A further limitation is that social media platforms are privately owned. Therefore ownership (in the case of X particularly) along with data protection and access policies are subject to change; this impacted data collection and analysis in **chapter 5** with X restricting data access for research purposes. As discussed above, the current restrictions on free data access since June 2023 mean the research discussed in chapters 3, 4 and 5 could not be replicated. Whilst the findings may be reproducible on other platforms (Knöpfle and Schatto-Eckrodt, 2024), the methods could not be replicated as the data are no longer accessible (Blakey, 2024). However, making the data available on a data repository would support this open science.

Only X was considered for this study as it is open source and was freely available at the point of data collection, however this is a limitation of the thesis (**chapters 3, 4 and 5**) as it limited generalisability. If other platforms were investigated, there may have been differences in the quality information being shared. Similarly, information may diffuse differently on different social media platforms with different key actors and influencers

than those presented in **chapter 5**. Finally, as with all social media research, the results are difficult to replicate due to platform and user changes, public opinion shifts and differing data collection periods (Bruzzese et al., 2022).

#### **6.4.1.3 The Online Quality Assessment Tool (OQAT)**

One methodological limitation impacting **chapters 3 and 4**, is that the OQAT only considered webpages and not the wider website's readability and accessibility. There may have been website limitations that limited the ability to add URLs or declarations for example, but the OQAT will not pick this up. Similarly, website functionality such as 'share to socials' buttons or being configured to access on a mobile device were not considered. Readability of articles was not considered either as this can be assessed by external software such as the freely available Flesch-Kincaid readability test, however, it could have affected public engagement with articles and could be considered in the future.

Unlike some other quality assessment tools, the OQAT criteria were not weighted. This was to ensure the OQAT was simple to apply with limited training as called for in the literature (Afful-Dadzie et al., 2021). To ensure this was not a limitation, a Rasch Model was used (by a statistician) during the OQAT development (**chapter 3**) to confirm that the criteria were adequate to assess and categorise quality without the need for weighting.

There were methodological limitations in **chapters 3 and 4** during rater assessment as the raters were not blind to the article source therefore scores could have been subject to bias. Clear rater instructions accompany the OQAT to mitigate this but the possibility of mediating scores based on personal beliefs should not be discounted. Future research should consider blind review to ensure no rater bias is introduced. A further limitation of the OQAT, is that inter-rater reliability was only tested with nutrition experts. As noted above, the tool was designed to be simple to apply so it could be used by multiple stakeholders, however this was not tested.

### **6.4.2 Strengths**

Despite the noted limitations there are a number of strengths to this research.

#### **6.4.2.1 Methodology**

The mixed methods and cross-discipline approach is a key strength of this thesis (**chapters 3, 4 and 5**). When reviewing the literature pertaining to each chapter, I considered the literature relating to climate change, political sciences and social sciences, as well as the nutrition and health literature to get a broad understanding of the existing quality assessment criteria and how they are applied. I also referred to the wider literature to understand the online environment and how other disciplines classified poor quality and misinformation. Finally, a cross-disciplinary approach was utilised to assess how information disperses through the networks of other genres compared to nutrition. To complete this thorough understanding of the digital communication landscape, multidisciplinary techniques were applied including computational approaches, statistical methods, linguistic evaluation, and social network analysis to define nutrition networks online.

The statistical methods utilised were a strength of the OQAT development. With the support of a statistician who advised on Rasch methods, alternative models and ran the analysis using Winsteps (v5.3.2.0), Rasch analysis was used to determine the cut offs for the poor, satisfactory, and high-quality categories. This was a strength of the OQAT development (**chapter 3**, Rasch methods documented in Appendix A Chapter 3 supplementary material) and application (**chapter 4**, Rasch methods documented in Appendix B Chapter 4 supplementary material) as it statistically confirmed that the quality criteria scoring system did not need to be weighted or scaled, making the OQAT simpler to apply and interpret compared to other tools with more complex scoring systems (Charnock et al., 1999) (Robinson et al., 2013). Rasch analysis also enabled the identification of criteria that were essential for articles to be categorised as high, satisfactory or poor enabling recommendations to be made on how to improve the quality of future nutrition related content.

#### **6.4.2.2 Social media**

Utilising social media was a strength of this study as it remains popular for all age groups, with 63.8% of the population reporting using at least one platform, though different age groups favour different platforms (DataReportal, 2024). Such is the pace of growth, since **chapter 2** was published in 2022, global X users have increased from 326 million, to 611 million (Statista, 2024). Using social media to collect the URLs that were assessed for quality was novel and a strength of this study as it ensured that the information was not passive (Pantic, 2020). This data collection method also ensured

that the information assessed had at least two opportunities to influence the public, through the original online publication, and through the X post. Using X specifically also allowed this research to investigate the types of articles the public are engaging with and to make inferences on the reasons for this engagement, including the novel finding that quality is not a motivator for sharing nutrition information.

#### **6.4.2.3 Online Quality Assessment Tool (OQAT)**

As discussed in detail in **chapter 3**, the development of a novel assessment tool, specifically created to measure public facing online nutrition information, is a key output from, and strength of, this thesis. The OQAT is validated with high face validity, but it is also simple to employ when used alongside the accompanying instructions (Appendix A Chapter 3 **table A.2**: Instructions for using the Online Quality Assessment Tool (OQAT)). If further research on other areas of health research was conducted (as discussed in section 6.6), the OQAT could be applied to evidence-based articles from other disciplines as well as by lay readers. To my knowledge, the OQAT has already been applied to articles giving dietary advice related to Autism Spectrum Disorders.

#### **6.4.2.4 Social network analysis**

A further strength, and novel finding, of the thesis was the identification of the influencers involved in the public debate relating to nutrition in **chapter 5**. This study was able to identify that X users without formal nutrition training were the main actors influencing the debate. An important finding given that two thirds of influencers do not fact check before posting information and advice (UNESCO, 2024). An additional strength was being able to determine that users were most interested in propagating information relating to health and healthy diets and lifestyles. This provided useful insights that can be used to encourage nutrition professionals to engage more in the nutrition debate sharing evidence-based information. It allowed for the identification of the language they should be using to increase public interest and the semantically linked topics of public interest. These findings support research findings on diet related videos on TikTok that gained more engagement if they used humour (Munro et al., 2024) showing the importance of utilising relatable language.

### **6.5 Implications for public health and recommendations**

The public health implications and proposed public health benefits of each study (chapter) are discussed in detail within the discussion sections of each chapter however

these are synthesised below, together with broader public health implications and recommendations concluded from the thesis as a whole.

### **6.5.1 Public health implications**

This thesis provided new evidence that has the potential to improve public health by improving the veracity of the digital health environment relating to nutrition and dietary advice. This body of work supported this aim by designing a standardised, validated quality assessment tool for online information. This novel tool provides a mechanism to determine credible sources of online information, thereby increasing the public's access to high quality nutrition advice by improving information quality (**chapter 3**).

Importantly, this work that was able to statistically determine the key components of high-quality information for the first time, leading to the recommendations discussed below in 6.5.2. Additionally, the findings presented in **chapters 3 and 4**, could provide the framework for a checklist for professionals writing public facing content to ensure they are meeting basic quality standards.

This research was able to classify the type of media outlets that are most likely to share evidence-based information, and the sources the public should read with caution as they tend to be lower quality and more promotional in nature (**chapter 4**). As well as encouraging the public to read these types of articles critically, these findings could also be used to encourage the public to be cautious of the articles they are sharing as more poor-quality than high quality information is shared on X.

This thesis provides empirical evidence that the public are currently dominating the online debate (**chapter 5**). Linguistic analysis of the discourse provided insight into the language the public are using when discussing nutrition online, with posts more likely to relate to health, diet, healthy lifestyle, fitness and food, rather than discussing scientific evidence. The public are less likely to engage with complex scientific language, which might explain why the public narrative is more dominant as the language is more appealing to other X users. These novel findings could be used to inform guidance to support nutrition professionals to use language that engages the public, encouraging professionals to be the voice of authority on social media. This would ensure the public can find evidence-based information, in a forum they are familiar with, in language they find relatable and engaging. With more than half of the

population turning to social media for dietary advice, these findings could have a positive impact on population health.

The OQAT itself could have a positive impact on digital health literacy and health equity, as it could also be used to fact check for misinformation. It could also be used by influencers and content creators to fact check information prior to posting as recently called for by UNESCO (UNESCO, 2024). Importantly, it could be used by the public as a tool to assess the quality of information prior to sharing or implementing any dietary changes. The linguistic and semantic analysis (**chapter 5**) could be particularly helpful for public health as it enables recommendations (discussed in 6.5.2) for nutritional professionals to lead the online debate. This provides nutrition professionals the tools to use engaging positive language that the public connect with and are more likely to read and share.

### **6.5.2 Recommendations**

#### ***Recommendation 1: Improve the quality of professionally authored articles***

The findings from **chapter 4** demonstrated the essential features of high-quality articles; including scientific references, quoting a specialist, and transparency. All of which are necessary for articles to be deemed high quality. In this research, these were the criteria that were the least likely to be achieved, therefore educating content writers on the importance of including these is essential to improving the quality of information. The quality assessment criteria from the OQAT could be employed as a checklist by content writers providing motivation for publishing higher-quality information. If the OQAT was employed as a checklist, UK professional organisations such as the Association of British Science Writers (<https://www.absw.org.uk>) and the Science Media Centre (<https://www.sciencemediacentre.org>) could be encouraged to share the OQAT with journalists and science writers they work with to ensure the quality of their information is high and meets OQAT standards. As noted in the positionality statement at the beginning of this thesis, my leadership role within the Nutrition Society puts me in a strong position to be able to use this and related research, to bridge scientific evidence and public communication by working with the aforementioned organisations to improve the quality of nutritional information by content creators.



### ***Recommendation 2: Improve the quality of non-expert authored articles***

Commercial websites promoting their own products and personal blogs published the lowest quality articles (**chapters 3 and 4**). These findings could be used to encourage businesses and individuals to improve the quality of their articles by using the OQAT as a framework for writing high quality articles. Where poor quality articles are seen online, particularly those that have the potential to cause harm to the public, Registered Nutritionists and Dietitians should be encouraged to call out misinformation and poor practice. Learned societies and regulatory bodies also have a responsibility to encourage the dissemination of high-quality information by raising awareness of the risks to public health highlighted in this body of work. An alternative strategy could be to highlight high-quality articles through the development of a kite mark to signpost the public to evidence-based nutrition information.

### ***Recommendation 3: Support the public to differentiate between high- and low-quality information***

Given the public appear to be reposting poor quality articles more frequently (**chapter 4**), improving digital health and media literacy could be a beneficial intervention. Consideration must also be given to socioeconomic disparity as those with high levels of education and income, have been shown to have greater health literacy (Sørensen et al., 2015), and older people and adolescence are more likely to face challenges with digital health literacy (Kington et al., 2021). Food literacy has also been highlighted as a global issue (Silva, 2023) and a risk to public health (Lancet, 2022). Therefore, a simple tool such as the OQAT, could have far reaching benefits for the public if it was applied as a fact checking tool by readers before sharing the information with networks. Although the OQAT would need to be tested in this population before this could be implemented. Public engagement activities could also be considered to encourage the public to exercise caution when using online information for dietary advice and teach them how to identify high quality articles.

Artificial Intelligence (AI) such as ChatGPT or phone integrated AI, like Apple Intelligence and Google Gemini, may have a role in supporting digital health and food literacy by providing an option for fact checking online information, however a degree of health literacy remains essential to be able to determine if the results are factual. When asking ChatGPT ‘How to find high quality nutrition information online’, it provides nine suggestions, including recommending the use of a checklist to determine

high quality websites. However, ChatGPT recommends using HONcode, which as discussed under section 6.3.2, is no longer in use, therefore AI should be used with caution. Similarly, when ‘fact-checking’ nutrition information using AI, it is skewed towards American dietary advice and resources which may be less relevant for those outside of the USA. Therefore, a validated tool such as the OQAT is recommended to be used as part of a suite of strategies to improve digital health and food literacy and support the public in finding high quality information.

***Recommendation 4: Encourage sharing of high-quality information***

**Chapter 4** found that articles from government agencies were less likely to be reposted, particularly if they were giving public health advice. These evidence-based articles are high quality articles that the public should be encouraged to read and share. The findings from the linguistic analysis in **chapter 5** could support this by providing effective strategies for government agencies to write more accessible content with positive language that better engages the public making them more likely to read, understand and repost this high-quality content.

Similarly, as demonstrated by the social network analysis (**chapter 5**), non-experts have a strong influence on the debate. Therefore, if high profile non-expert influencers could be identified and encouraged to share higher quality evidence-based articles, it would improve the dispersion across networks. These findings could also be used to inform the public of the amount of nutrition misinformation online to encourage critical thinking, enabling the public to make more informed decisions prior to sharing articles, and more importantly, before using the advice to make dietary choices. This awareness raising could be done through expert led social media campaigns.

***Recommendation 5: Encourage nutrition professionals to lead the online debate***

The findings in **chapter 5** demonstrate that the public are dominating the online debate. Nutrition professionals are in a position to counteract misinformation by engaging with the debate and only publishing high quality, evidence-based content, that align with the OQAT criteria. Social media training for nutrition professionals should be considered to ensure they are equipped to enter the online debate which can be volatile, particularly if challenging the loudest and polarised voices.

### ***Recommendation 6: Regulation***

The panacea to challenge the publication and propagation of poor-quality information is regulation. There are regular calls for social media owners to take greater responsibility for the misinformation shared on their platforms with frameworks recommended; to date, implementation has been slow (Kington et al, 2021). The UK introduced the *Online Safety Act 2023* in 2024 but this only covers illegal and age-inappropriate content and not misinformation. In response to concerns over false information, the European commission created *The European Code of Practice on Disinformation*, a voluntary code of practice that organisations commit to, that aims to improve transparency, identify untruths, and collaborate with fact checkers. Notably, X withdrew from the Code in May 2023. More recently, Meta have announced plans to end fact checking and move to a community policing model, based on the ‘Community Notes’ system employed by X. Currently these plans are only in the USA with no mention of the UK and Europe however there are concerns that harmful disinformation will proliferate.

In lieu of robust regulation, social media platforms should take a more active role in limiting health and nutrition misinformation by checking user credentials (and not monetising them) and encouraging the use of referencing when sharing advice. Finally, as noted under recommendation 2, Registered Nutritionists and Dietitians should be encouraged to take an active role in supporting the dissemination of evidence-based information and take care not to propagate untruths or misleading advice.

### **6.6 Recommendations for further research**

Whilst this thesis addresses several gaps in the literature, it also raises questions which could be addressed in future research.

As discussed under limitations, using the OQAT on a larger data set would ensure more equal numbers in the categories being assessed; blogs and news, and reposted vs not reposted. However, it is likely that a similar pattern of engagement and content types would be observed; one strategy to manage this would be using longer data collection periods for the underrepresented categories to ensure more homogenous groups. This would allow for comprehensive comparison between categories and determine whether any observed differences are statistically significant. The OQAT could also be applied

to other social media platforms. Facebook continues to be the most accessed platform globally, and TikTok and Instagram are the most popular platforms used with 16–34-year-olds (DataReportal, 2024). Therefore, these are important platforms to focus on improving the quality of evidence-based articles given the popularity of social media for dietary advice.

The OQAT was validated using articles written in English. Further research could consider using the OQAT on articles written in other languages to see whether results are replicable (notwithstanding the challenges of replicating results with social media research). The OQAT could also be translated to other languages which may make it more applicable to non-English articles. Similarly, the semantic analysis (**chapter 5**) was able to establish that the public use words such as ‘healthy diet’ and ‘healthy lifestyle’ when discussing nutrition on X, so future research should consider using these hashtags and search terms for data collection to both ensure that relevant posts are not missed, and to see if results can be replicated.

Future research should consider rater related variables such as background, experience, and nutrition training as these could affect the way the raters apply the OQAT. It has been reported that experience in applying assessment criteria can result in greater consistency, but also greater leniency (Neittaanmäki and Lamprianou, 2024). This thesis used two raters in the development and application of the OQAT, as has been recommended by others (Faherty et al., 2020), however further investigation is needed to know if this is optimum, and whether rater selection criteria is necessary. Finally, as also discussed under the recommendations, the OQAT could have wide public health benefit if its appropriateness to non-nutrition experts is tested. To support use by non-experts, a rubric could be beneficial, particularly for criteria Q7-Q10 as these subjective criteria. Therefore, future research could focus on adapting the OQAT for non-expert use, making it suitable for fact checking and as a quality checklist.

As discussed under limitations, this research (**chapter 3 and 4**) did not consider factors beyond the article content. Future research should consider the device being used to post on social media, and whether posting is more prevalent on computers or mobile devices. Over 50% of website traffic is from mobile devices (Statista, 2025) therefore it is important for high quality websites to be optimised for mobile devices which could impact quick article sharing. Whether having ‘social share buttons’ on websites

encourages sharing of articles to social media should also be investigated, as if it does impact sharing, government organisations and websites sharing high quality evidence-based information could be encouraged to utilise share buttons to encourage the rapid sharing of high-quality information.

Reposting content was more common than sharing original research (**chapter 5**), therefore motivations for reposting, liking and commenting should be investigated. Emotion has previously been cited as a factor in reposting content on X, particularly in relation to untruths (Vosoughi et al., 2018). Climate change posts that use aggressive language propagate more quickly on X (Yuan et al., 2022), and fear is a dominant emotion in political networks (Chakraborty and Mukherjee, 2023). Whilst these findings suggest nutrition is framed more positively than politicised topics (**chapter 5**), future research should consider emotion in relation to nutrition to see whether reposting is an emotive reaction as this could support nutrition professionals to use more emotive language, whilst avoiding overexaggerations. Other nutrition related topics could also be considered as **chapter 5** showed a negative word association with weight, therefore topics relating to weight loss or maintenance, could be more motivated by emotion.

Finally, it is well established in the literature that those with poor digital health, food and media literacy are most at risk of misinformation (Coşkun et al., 2024) as they tend to lack the appropriate skills to make informed decisions about diet and health (Silva et al., 2023). Therefore, future research should consider the impact of exposure to nutrition misinformation. To better understand how to mitigate the effects of poor-quality information, research should consider how nutrition misinformation impacts dietary choices, measure the potential harmful effects of these ill-informed choices, and employ intervention studies to reduce the impact in the most at risk populations. In addition to social issues, there may be other factors impacting peoples' vulnerability to misinformation. Further research may consider this from a psychological perspective to investigate whether failure to discriminate untruths is further impacted by confirmation bias and/or echo chambers (Shu et al., 2020) so the general public can be made more aware of the importance of critical thinking and source checking. In lieu of regulation of the digital environment and openness about algorithm use, identifying why some people are more vulnerable to misinformation, may inform strategies to reduce the spread and the speed of which they propagate, and interventions to minimise impact.

## 6.7 Conclusions

We are amid a global health crisis with non-communicable diseases (NCDs) accounting for two thirds of all deaths and dietary behaviour one of the most important modifiable risk factors. Highly processed foods are ubiquitous, 35-45% of the world is food insecure, and the health of our planet is at risk through climate change, biodiversity loss and pollution. As people are encouraged to change their diet and lifestyles to overcome these challenges, they turn more frequently to digital sources of advice online and on social media. Paradoxically, food and digital health literacy remains low, at a time when misinformation is increasing in prevalence and becoming harder to identify with artificial intelligence, deepfakes and less regulation. Like access to healthy food, food and health literacy is lower in the populations that are most vulnerable therefore ensuring the nutrition information available online is evidence based, and accessible to all populations, is more important than ever.

Given the potential to improve the quality of online nutrition information, this thesis could have far reaching benefits. The findings from these studies have the potential to encourage higher quality content to be written and shared online and on social media. Crucially, with further testing, this research could support the public to be able to discriminate between high- and low-quality information, support them to use evidence-based information to inform their dietary choices, and thereby reduce the spread of misinformation.

When it comes to who is dominating the debate on social media, this research provides evidence that non-experts are the most influential voices, making it vital that professionals feel empowered to intervene and challenge misinformation, whilst continuing to propagate high quality nutrition advice. These findings provide evidence-based recommendations to encourage nutrition professionals to be the authoritative voice online using language the public both understand and find relatable.

## 6.8 References

Adamski, M. Truby, HM Klassen, K. et al. (2020). Using the Internet: Nutrition Information-Seeking Behaviours of Lay People Enrolled in a Massive Online Nutrition Course. *Nutr.* **12**(3), 750.

- Afful-Dadzie, E. Afful-Dadzie, A. and Egala, SB. (2021). Social media in health communication: A literature review of information quality. *Health Inf Manag J* **52**(1), pp.3-17.
- Alhothali, GT. and Aljefree, NM. (2023). Young adults' sought gratifications from, and perceptions of food advertising by, social media influencers: a qualitative approach. *J Health Popul Nutr.* **42**(1), 103.
- Armstrong, M. Halim, NK. Raeside, et al. (2021). How Helpful and What Is the Quality of Digital Sources of Healthy Lifestyle Information Used by Australian Adolescents? A Mixed Methods Study. *Int J Environ Res Public Health.* **18**(23).
- Ashwell, M. Hickson, M. Stanner, S. et al. (2022). Nature of the evidence base and strengths, challenges and recommendations in the area of nutrition and health claims: a position paper from the Academy of Nutrition Sciences. *Br J Nutr* .1-18.
- Batar, N. Kermen, S. Sevdin, S. et al. (2020). Assessment of the Quality and Reliability of Information on Nutrition After Bariatric Surgery on YouTube. *Obesity Surgery.* **30**(12), 4905-4910.
- Blakey, E. 2024. The Day Data Transparency Died: How Twitter/X Cut Off Access for Social Research. *Contexts.* 23(2), pp.30-35.
- Boyer, C. Selby, M. Scherrer, JR. et al. (1998). The Health On the Net Code of Conduct for medical and health Websites. *Comput Biol Med.* **28**(5), 603-610.
- Breuer, J. and Haim, M. (2024). Are We Replicating Yet? Reproduction and Replication in Communication Research. *Media and Communication*, **12** (8382) 1-7.
- Bridge, G. Flint, SW. and Tench, R. (2021). A mixed-method analysis of the #SugarTax debate on Twitter. *Public Health Nutr.* **24**(11), 3537-3546.
- Bruzzese, S. Ahmed, W. Blanc, S. et al. (2022). Ecosystem Services: A Social and Semantic Network Analysis of Public Opinion on Twitter. *Int J Environ Res Public Health.* **19**(22).
- Chakraborty, A. and Mukherjee, N. (2023). Analysis and mining of an election-based network using large-scale twitter data: a retrospective study. *Soc Netw Anal Min.* **13**(1), 74-74.
- Charnock, D. Shepperd, S. Needham, G. et al. (1999). DISCERN: an instrument for judging the quality of written consumer health information on treatment choices. *J Epidemiol Community Health.* **53**(2), 105-111.

- Coşkun, AB. Elmaoğlu, E. Buran, C. et al. (2024) Integration of ChatGPT and E-Health Literacy: Opportunities, Challenges, and a Look Towards the Future. *J Health Rep Technol.* **10**(1):e139748.
- Datareportal. (2024). Global Social Media Statistics. Available: <https://datareportal.com/social-media-users> Accessed September 2024.
- Denniss, E. Lindberg, R. and McNaughton, SA. (2023). Quality and accuracy of online nutrition-related information: a systematic review of content analysis studies. *Public Health Nutr.* **26**(7), 1345-1357.
- Department of Health and Social Care. (2021). Department of Health and Social Care Guidance Nutrition and Health Claims: Guidance to Compliance with Regulation (EC) 1924/2006.
- Eaton, MC. Probst, YC. and Smith, MA. (2023). Characterizing the Discourse of Popular Diets to Describe Information Dispersal and Identify Leading Voices, Interaction, and Themes of Mental Health: Social Network Analysis. *JMIR infodemiology.* **3**, pe38245.
- El Jassar, O.G., El Jassar, I.N. and Kritsotakis, E. (2019). Assessment of quality of information available over the internet about vegan diet. *Nutrition & Food Science.* **49**(6).
- Faherty, A. Counihan, T. Kropmans, T. et al. (2020). Inter-rater reliability in clinical assessments: do examiner pairings influence candidate ratings? *BMC Medical Ed.* **20**(1), 147.
- Heer, RS. Sandhu, P. Wenban, C. et al. (2022). Vitamin D in the news: A call for clear public health messaging during Covid-19. *Nutrition and Health.* **28**(4), 733-739.
- Henrina J, Lim MA, Pranata R. (2021) COVID-19 and misinformation: how an infodemic fuelled the prominence of vitamin D. *Br J Nutr.* **125**(3), 359-360.
- Kabata, P. Winniczuk-Kabata, D. Kabata, PM. J et al. (2022). Can Social Media Profiles Be a Reliable Source of Information on Nutrition and Dietetics? *Healthcare.* **10**(2), 397.
- Kadel, P., Heist, N., Paulheim, H. et al. (2024). From Pixels to Palate: Communication around #vegan on Instagram and its relation with eating intentions. *Appetite*, 200, 107518.
- Kamiński, M., Skonieczna-Żydecka, K., Nowak, J.K. et al. (2020). Global and local diet popularity rankings, their secular trends, and seasonal variation in Google Trends data. *Nutrition*, **79-80**, 110759-110759.



- Kbaier, D. Kane, A. McJury, M. et al. (2024). Prevalence of Health Misinformation on Social Media-Challenges and Mitigation Before, During, and Beyond the COVID-19 Pandemic: Scoping Literature Review. *J Med Internet Res*, **26**, e38786.
- Kininmonth, A., Jamil, N., Almatrouk, N. et al. (2017). Quality assessment of nutrition coverage in the media: a 6-week survey of five popular UK newspapers. *BMJ Open*. **7**(12).
- Kington RS, Arnesen S, Chou WS, et al. (2021). Identifying Credible Sources of Health Information in Social Media: Principles and Attributes. *NAM Perspect*. 10.31478/202107a.
- Knöpfle, P. and Schatto-Eckrodt, T. (2024). The Challenges of Replicating Volatile Platform-Data Studies: Replicating Schatto-Eckrodt et al. (2020). *Media and Commun*. **12**, 7789.
- Lancet, T. (2022). *Why is health literacy failing so many?* 400. 1655.
- Levin-Zamir, D. and Bertschi, I. (2018). Media Health Literacy, eHealth Literacy, and the Role of the Social Environment in Context. *Int J Environ Res Public Health*. **15**(8), 1643.
- Lorenzon, L. Grossman, RC. and Soreide, K. (2021). Impact of Randomized Controlled Trials in the Social Media: Does Science Trend As Much As Everyday Events? *World Journal of Surgery*. **45**(1), 88-96.
- Lynn, T. Rosati, P. Santos, GL. a et al. (2020). Sorting the Healthy Diet Signal from the Social Media Expert Noise: Preliminary Evidence from the Healthy Diet Discourse on Twitter. *Int J Environ Res Public Health*. **17**(22), 8557.
- Mete, R. Curlewis, J. Shield, A. et al. (2019). Reframing healthy food choices: a content analysis of Australian healthy eating blogs. *BMC Public Health*. **19**(1), 1711.
- Molenaar, A. Jenkins, EL., Brennan, L. et al. (2023). The use of sentiment and emotion analysis and data science to assess the language of nutrition-, food- and cooking-related content on social media: a systematic scoping review. *Nutr Res Rev*. s0954422423000069.
- Mozaffarian, D. and Forouhi, NG. (2018). Dietary guidelines and health—is nutrition science up to the task? *BMJ*. **360**. k822.
- Munro, E. Wells, G. Paciente, R. et al. (2024). Diet culture on TikTok: a descriptive content analysis. *Public Health Nutr*, **27**(1), e169.

- Neittaanmäki, R. and Lamprianou, I. (2024). All types of experience are equal, but some are more equal: The effect of different types of experience on rater severity and rater consistency. *Language Testing*. **41**(3), 606-626.
- Oksman, V. Jarvela-Reijonen, E. Puttonen, M. et al. (2016). Vitality as a Life Style Trend in Blogs: A Netnographic Approach. In: Bernadas, C. and Minchella, D. eds. *Proc Euro Conf Socl Media*. 258-265.
- Pantic, M. (2020). Engagement With Live Blogs: When Passive Consumption Overpowers Participation. *Electronic news*. **14**(1), 22-36.
- Paterson, QS. Thoma, B. Milne, WK., et al. (2015). A Systematic Review and Qualitative Analysis to Determine Quality Indicators for Health Professions Education Blogs and Podcasts. *J. Grad. Med. Educ.* **7**(4), 549-554.
- Pearce, W. Niederer, S. Özkula, SM. et al. (2019). The social media life of climate change: Platforms, publics, and future imaginaries. *Wiley interdisciplinary reviews. Climate change*. **10**(2).
- Pilař, L. Kvasničková, L. and Kvasnička, R. (2021). Healthy Food on the Twitter Social Network: Vegan, Homemade, and Organic Food. *Int J Environ Res Public Health*. **18**(7), 3815.
- Robinson, A. Coutinho, A. Bryden, A. et al. (2013). Analysis of health stories in daily newspapers in the UK. *Public Health*. **127**(1), 39-45.
- Sabbagh, C. Boyland, E. Hankey, C. et al. (2020). Analysing Credibility of UK Social Media Influencers' Weight-Management Blogs: A Pilot Study. *Int J Environ Res Public Health*, **17**(23), 9022.
- Saura, JR. Reyes-Menendez, A. and Thomas, SB. (2020). Gaining a deeper understanding of nutrition using social networks and user-generated content. *Internet Interv.* **20**(9) 100312.
- Shao, C. Ciampaglia, GL. Varol, O. et al. (2018). The spread of low-credibility content by social bots. *Nature Commun.* **9**(1).
- Shu, K. Bhattacharjee, A. Alatawi, F. et al. (2020). Combating disinformation in a social media age. *Wiley Interdiscip Reviews: Data Min. Knowl. Discov.* **10**(6), e1385.
- Silberg, WM. Lundberg, GD. and Musacchio, RA. (1997). Assessing, Controlling, and Assuring the Quality of Medical Information on the Internet: Caveant Lector et Viewer—Let the Reader and Viewer Beware. *JAMA*. **277**(15), 1244-1245.
- Silva, P. (2023). Food and nutrition literacy: Exploring the divide between research and practice. *Foods*. **12**(14), 2751.

- Statista (2025). Percentage of mobile device website traffic worldwide from 1st quarter 2015 to 4th quarter 2024. Accessed February 2025.
- UNESCO (2024). Behind the screens: insights from digital content creators; understanding their intentions, practices and challenges.  
<https://unesdoc.unesco.org/ark:/48223/pf0000392006.locale=en> Accessed November 2024.
- Varol, O., Ferrara, E., Davis, C., et al. (2017). Online human-bot interactions: Detection, estimation, and characterization. In: *Proceedings of the international AAAI conference on web and social media*, 280-289.
- Vosoughi, S., Roy, D. and Aral, S. (2018). The spread of true and false news online. *Science*. **359**(6380), 1146.
- Wang, XH. Chen, L. Shi, JY. et al. (2019). What makes cancer information viral on social media? *Comput. Hum. Behav.* **93**, 149-156.
- Wang, Y. McKee, M. Torbica, A. et al. (2019). Systematic Literature Review on the Spread of Health-related Misinformation on Social Media. *Social Science & Medicine*. **240**, 112552.
- Weng, Z. and Lin, A. (2022). Public Opinion Manipulation on Social Media: Social Network Analysis of Twitter Bots during the COVID-19 Pandemic. *Int J Environ Res Public Health* **19**(24), 16376.
- Yuan, S. Chen, Y. Vojta, S. et al. (2022). More aggressive, more retweets? Exploring the effects of aggressive climate change messages on Twitter. *New Media Soc.* **26**(8), 4409-4428.
- Zhang, Y. Sun, Y. and Xie, B. (2015). Quality of health information for consumers on the web: A systematic review of indicators, criteria, tools, and evaluation results. *J Assoc Inf Sci Technol.* **66**(10), 2071-2084.

## Appendix A Chapter 3 Supplementary material

**Table A.1 Source of the final quality Indicators selected for the novel Online Quality Assessment Tool (OQAT)**

Criteria Indicator		Source	
		Zhang	Robinson
Currency	1. Does the article state the publication date or date of last update?	✓	
Credibility	2. Does the article state the authors name?	✓	
	3. Does the article state the authors credentials or provide access to a biography?	✓	
	4. Does the article include references to high quality peer review resources that can be accessed in 1-click?	✓	✓
	5. Does the article quote a specialist?	✓	
	6. Does the article disclose any financial or professional conflict?	✓	
Reliability	7. Does the article provide adequate and accurate background?	✓	✓
	8. Is the headline a true reflection of the article and evidence?		✓
	9. The article does NOT make generalisations from animal or lab studies?		✓
	10. The article does NOT have the potential to cause undue harm or optimism.		✓

**Table A.2 Instructions for using the Online Quality Assessment Tool (OQAT)**

### Introduction

This Online Quality Assessment Tool (OQAT) has been designed to classify and assess the quality of nutrition news and blogs that have been shared through the microblogging platform, Twitter.

### General instructions

Three criteria and 10 key indicators will assess the quality of a news articles and blogs. Each of the indicators represents a separate quality criterion. In addition, each article will be categorised by media and content type.

The indicators are organised in three sections as follows:

**Question 1 (currency)** focus on whether the content is up to date, and regularly reviewed and updated.

**Questions 2 - 6 (credibility)** are concerned with the reliability of the publication and the author, and whether it is a credible source of information.

**Questions 7-10 (reliability)** focus on whether the content can be understood by a lay person. Specifically, does it provide enough background, do any headlines reflect the article, does it make generalisations and does it have the potential to

cause undue harm or optimism.

### **The rating scale**

Each question is rated on a 2-point scale, *Yes* or *No*. The rating scale has been designed to be a simple yes or no answer. A positive score should be attributed if the criterion is met, a neutral score should be given if the criterion is not met.

Articles can score a maximum of 10, and a minimum of 0. There are no negative scores.

Scores should be categorised as follows:

0 - 3.48 – Poor

3.49 – 6.39 - Satisfactory

6.4 – 10.0 – High

### **General guidelines are as follows:**

A score of 1 should be given if your answer to the question is a definite 'yes' - the quality criterion has been completely fulfilled. 0 should be given if the answer to the question is a definite 'no' - the quality criterion has not been fulfilled.

After review, each article should be attributed three scores, one quality assessment score, one *Media source type* rating, and one *Content type* rating.

## OQAT for nutrition news and blogs

### Section One: Quality assessment

Criteria	Indicators	Score	
		Yes	No
Currency	1. Does the article state the publication date or date of last update?	+1	0
Credibility	2. Does the article state the authors name?	+1	0
	3. Does the article state the authors credentials or provide access to a biography?	+1	0
	4. Does the article include references to high quality peer review resources that can be accessed in 1-click?	+1	0
	5. Does the article quote a specialist?	+1	0
	6. Does the article disclose any financial or professional conflict?	+1	0
Reliability	7. Does the article provide adequate and accurate background?	+1	0
	8. Is the headline a true reflection of the article and evidence?	+1	0
	9. The article does NOT make generalisations from animal or lab studies.	+1	0
	10. The article does NOT have the potential to cause undue harm or optimism.	+1	0

### Classifying content

In addition to the quality assessment questions, you should also classify the source of the content, and the type of content based on the codebook below. Each article reviewed should be assigned a category, 1-9, for *Media source type*, and a category, 1-8, for *Content type*. Please note that these numbers are categorical.

## **Content analysis codebook**

### **Section Two: Media source and content type**

#### ***Media source type***

---

1. Blog – personal
2. Blog – professional
3. Company (products and services)
4. Government organisation (e.g. PHE, FDA)
5. Magazine
6. Non-governmental Organisation (NGO)
7. Professional news (e.g. CNN, The Guardian, The Huffington Post, BBC)
8. Research institute/University
9. Social media (e.g., YouTube, Instagram, etc.)
10. Unrelated

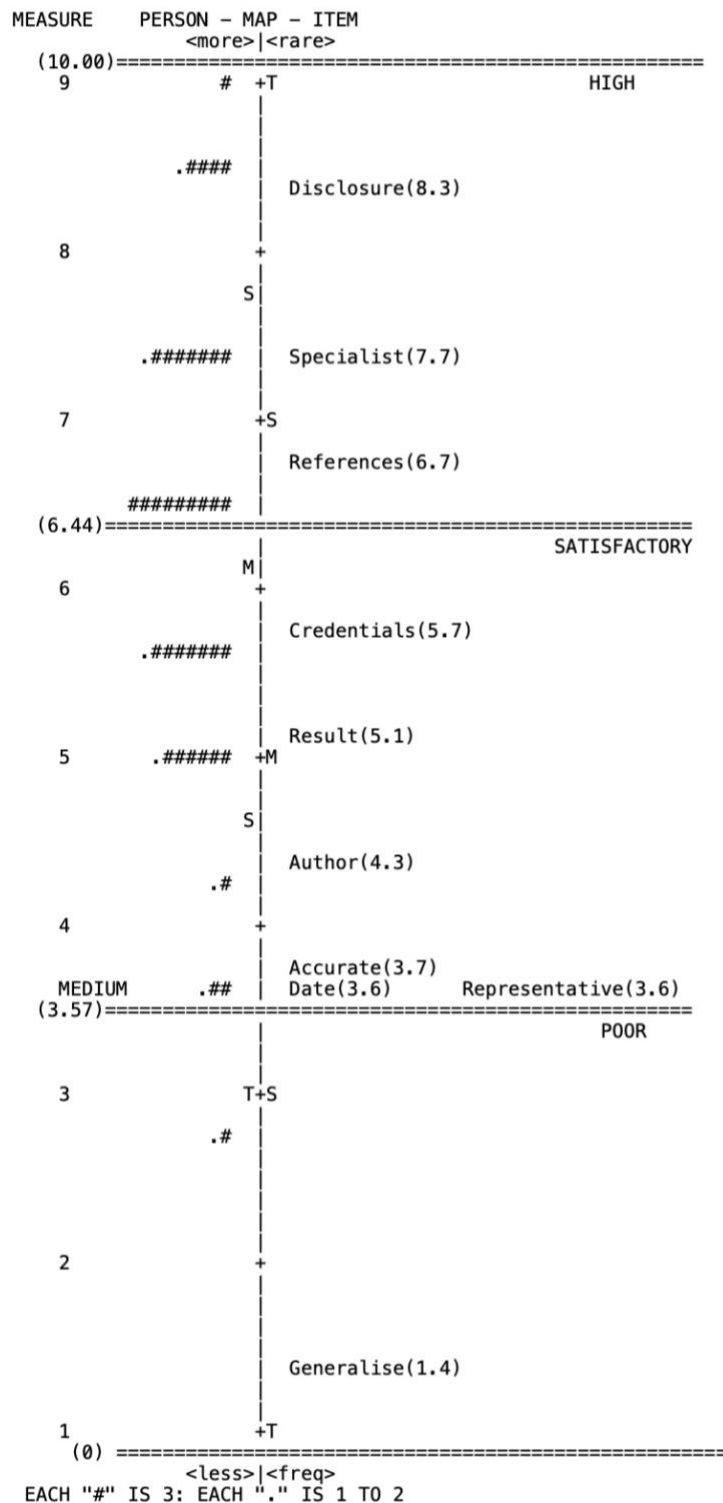
#### ***Content type***

---

1. News article
  2. Blog
  3. Scientific report - out of scope for analysis
  4. Press release
  5. Video - out of scope for analysis
  6. Picture - out of scope for analysis
  7. Social medial (e.g. Twitter/Facebook status) - out of scope for analysis
  8. Promotional - out of scope for analysis
-

**Figure A.1 Wright Maps used to determine cut-offs for poor, satisfactory and high-quality articles, Rater 1**

INPUT: 125 PERSON 10 ITEM REPORTED: 125 PERSON 10 ITEM 2 CATS WINSTEPS 5.3.2.0

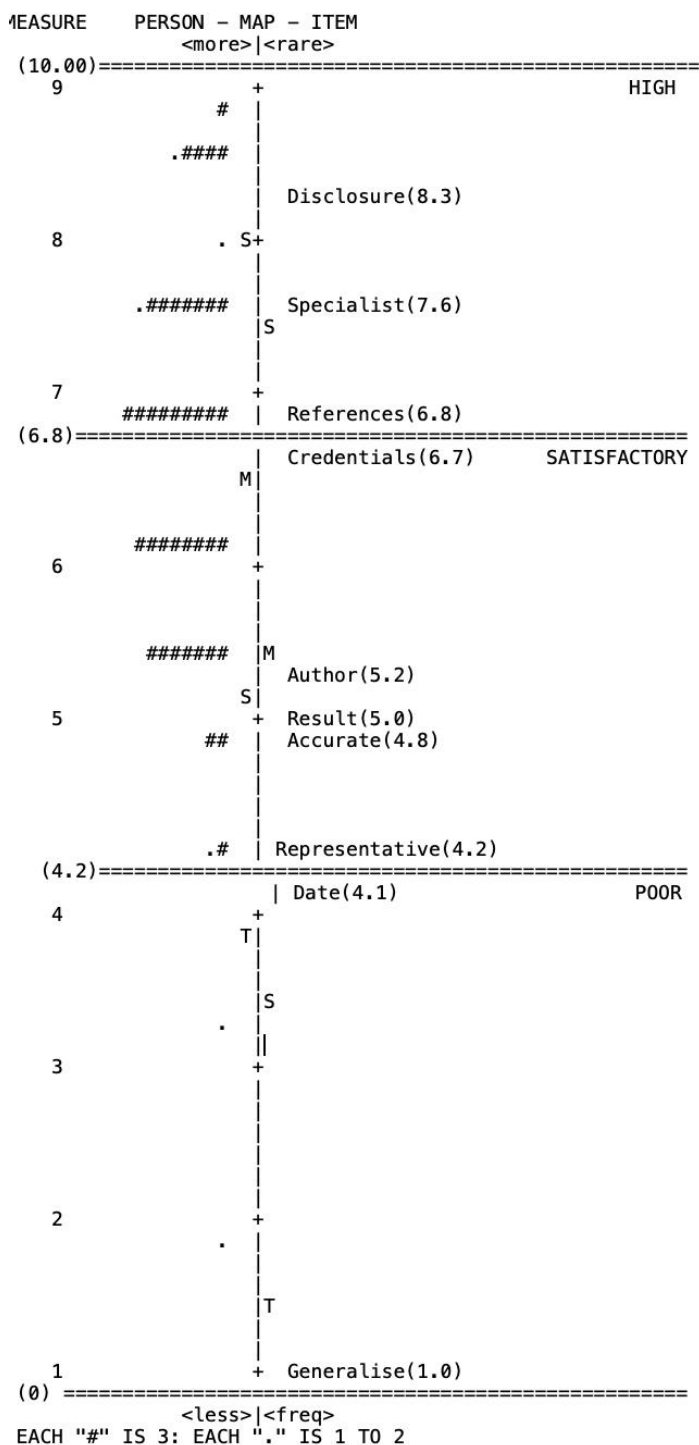


Wright Map for Rater 1 of person and item estimates rescaled to raw scores between 0-10 (logits). The symbols “#” and “.” on the left represent 3 and 1 sources (PERSON) and questions (ITEM) are shown on the right with their mean JMLE in brackets. Cut-offs are for HIGH (≥6.44), MEDIUM (≥3.57), LOW (≥0.0). See table A2 for item descriptions.



**Figure A.2 Wright Maps used to determine cut-offs for poor, satisfactory and high-quality articles, Rater 2**

INPUT: 125 PERSON 10 ITEM REPORTED: 125 PERSON 10 ITEM 2 CATS WINSTEPS 5.3.2.0



Wright Map for Rater 2 of person and item estimates rescaled to raw scores between 0-10 (logits). The symbols “#” and “.” on the left represent 3 and 1 sources (PERSON) and questions (ITEM) are shown on the right with their mean JMLE in brackets. Cut-offs are for HIGH ( $\geq 6.8$ ), MEDIUM ( $\geq 4.2$ ), LOW ( $\geq 0.0$ ). See table A2 for item descriptions.

Appendix B Chapter 4 Supplementary material

Scores by rater

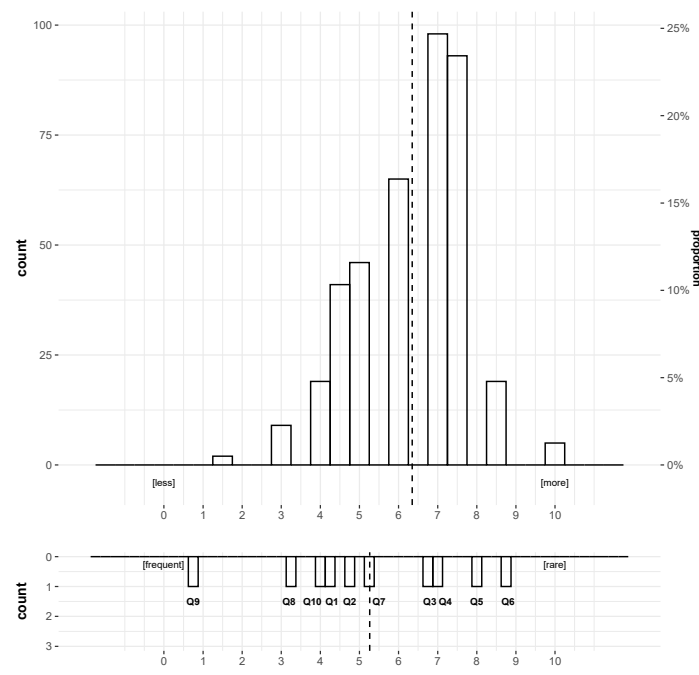


Figure B.1 Wright Map of Rater One scores

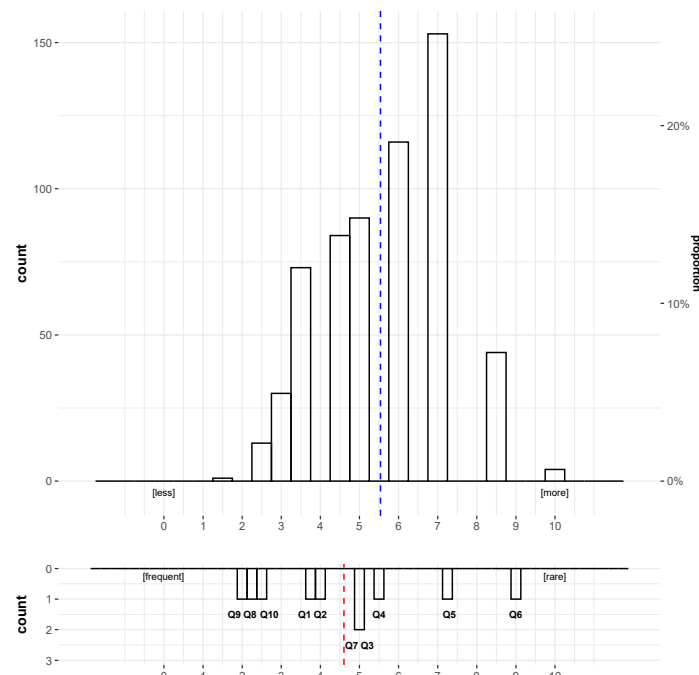


Figure B.2 Wright Map of Rater One scores

Rasch model was used to compare the two independent sets of rater scores. The distribution of scores was modelled, both including and removing outliers. Removing the outliers improved the fit, but did not change the conclusions. The distributions confirm that the value added to each indicator by each rater is the same inferring consistency.

## Appendix C Chapter 5 Supplementary material

**Table C.1 Network Theory definitions**

Metric	Description
Graph Type	Directed or undirected.
Vertices	Nodes, or in our paper X users.
Unique Edges	The connections between vertices. The direction of the arrow in the network graph indicates the direction of the relationship.
Edges with duplicates	Interactions or connections between established vertices.
Self-Loops	An edge that connects a vertex to itself. In network graphs self-loops appear as directed circles.
Connected Components	A set of vertices in a network graph that are linked to each other and to no other members within the network. Such components appear as off-shoot groups from the larger network.
Maximum Geodesic Distance	Maximum number of edges between two vertices which represents the diameter of the network.
Average Geodesic Distance	The mean number of edges that occur between two vertices within a network.
Betweenness Centrality	Quantifies the number of times a vertices acts as a bridge along the shortest path between two other vertices and was used in this study to identify the most influential actors (Du, 2019).
Eigenvector Centrality	Tells you how important an individual vertices is within the network
Graph Density	calculated by comparing the ratio of the number of edges present in the network and the number of possible edges. A graph with a high density suggests that there are a lot of edges connecting vertices together.
Modularity	The density of connections between vertices. Networks with high modularity have dense connections between nodes within the same modules (community groups) but sparse connections between vertices in different modules.

Source: Amended from Hansen D, Shneiderman B, Smith MA. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Chapter 5, Calculating and Visualizing Network Metrics. (Hansen et al., 2010)

## Appendix D Generative AI statement

I acknowledge the use of Chat GPT 4.0 <https://chatgpt.com/g/g-AOH5ruNxn-chapter-gpt> to inform the recommendations section, specifically recommendation 3, of my discussion. Chat GPT 4.0 was used in line with the University of Leeds green category in the ‘Generative AI guidance for postgraduate researchers’ policy. Chat GPT 4.0 was used, as noted on page 141 of this thesis, to discuss the potential benefits and risks to the public of using Gen AI for fact checking nutrition information.

Generative AI was not used beyond that stated above, it was not used as a research tool, to write this thesis or to check content or proofread this thesis.

The search question was asked in the chat on 3 November 2024, and the question was ‘how to find high quality nutrition information online’.

The response received is copied verbatim below:

‘Finding high-quality nutrition information online can be challenging, given the abundance of conflicting advice and unreliable sources. Here are some strategies to help ensure you’re getting accurate and evidence-based nutrition information:

### **1. Use Reputable Websites**

Look for websites affiliated with trusted institutions, research organizations, and governmental agencies. Examples include:

- **Government Health Sites:** USDA (United States Department of Agriculture), NIH (National Institutes of Health), FDA (Food and Drug Administration).
- **Health Organizations:** WHO (World Health Organization), CDC (Centers for Disease Control and Prevention).
- **Professional Organizations:** Academy of Nutrition and Dietetics, American Heart Association, and other major medical associations.

These sites are generally trustworthy because they base recommendations on scientific research and regularly update information.

### **2. Look for Content from Registered Dietitians (RDs)**

Registered Dietitians are certified professionals who specialize in nutrition. Websites and social media accounts run by RDs can be a great source of information. Many RDs blog, share articles, or post on social media platforms about nutrition topics, and they often debunk common myths.

### **3. Evaluate Research Studies Carefully**

When a site refers to studies, consider these tips:

- **Check for Peer-Reviewed Research:** Peer-reviewed journals are reviewed by experts in the field and usually offer higher-quality information.
- **Look for Systematic Reviews or Meta-Analyses:** These types of studies analyze multiple studies on the same topic and are considered highly reliable.
- **Beware of Small Sample Sizes and Short Durations:** Studies with only a handful of participants or short durations may not be generalizable.

#### 4. Avoid “Miracle” Claims and Trendy Diets

Be skeptical of any site that promotes “miracle” foods or extreme diets. Phrases like “detox,” “superfood,” “quick fix,” or “ancient secret” are often red flags for pseudoscience. High-quality nutrition is typically based on a balanced diet rather than miracle solutions.

#### 5. Use Health Information Checklists

Certain checklists can help evaluate nutrition websites and information. Here are some criteria:

- **Authorship:** Is the author a qualified professional, such as an RD or MD?
- **Sources and Citations:** Does the site link to credible, original research or major health organizations?
- **Updates:** High-quality websites regularly update information based on the latest research.
- **Transparency:** Reputable sites clearly disclose funding sources and avoid conflicts of interest.

Tools like the **HONcode** (Health On the Net) seal can also help you identify high-quality, trustworthy health websites.

#### 6. Leverage Online Nutrition Databases

Online nutrition databases offer science-based information on food content and dietary recommendations:

- **USDA’s FoodData Central:** Provides nutrient profiles for thousands of foods.
- **NIH Office of Dietary Supplements:** A go-to source for information on vitamins, minerals, and supplements.
- **PubMed:** A free research database for finding scholarly articles on nutrition and diet.

#### 7. Follow Science-Based Nutrition Resources

Some websites and blogs are dedicated to promoting nutrition information based on scientific evidence. Examples include:

- **Examine.com:** A science-backed site for information on nutrition, supplements, and their effects.
- **NutritionFacts.org:** Provides research-based insights into various nutrition topics, created by Dr. Michael Greger.
- **Harvard School of Public Health:** Has a dedicated nutrition section covering topics like diet quality, food guides, and dietary risks.

## **8. Be Cautious on Social Media**

Social media can have valuable information, but it's often mixed with misinformation. Look for certified professionals (like RDs or PhDs in nutrition) who reference studies and provide balanced perspectives.

## **9. Ask Your Healthcare Provider for Recommendations**

Your doctor or a dietitian can recommend high-quality resources for specific dietary concerns. They may suggest books, reliable websites, or apps that provide credible nutrition information.

By applying these principles, you'll be better equipped to navigate the often confusing world of online nutrition information and make well-informed dietary choices.'

## **Appendix E Intellectual Property and Commercialisation Statement**

This thesis contains original research conducted by the author, Cassandra Ellis, as part of the requirements for the degree of Doctor of Philosophy at University of Leeds. The intellectual property arising from this research is owned in accordance with the policies of University of Leeds, and any agreements with third parties, including industry or government partners, as applicable.

The author confirms that the results presented herein have not previously been commercially exploited and that no patent applications directly arising from this research were filed prior to submission of the thesis. However, certain elements of the work may possess potential for future commercialisation. Any such potential will be assessed and managed in accordance with the university's commercialisation policy.



## **Appendix F Data use statement**

This thesis is based on data collected and analysed by the author, Cassandra Ellis, as part of doctoral research conducted at University of Leeds.

Personal and sensitive data have been anonymised to ensure participant confidentiality and data privacy, in line with X and university policies. Data were securely stored using SharePoint as approved by University of Leeds. It is the author's intention to make the datasets, and related metadata, underlying this research available via the Research Data Leeds repository following the final publication of the thesis. This will facilitate reuse and support the principles of transparency and reproducibility in research.

Researchers interested in accessing the data in the meantime are invited to contact the author, Cassandra Ellis at [fsce@leeds.ac.uk](mailto:fsce@leeds.ac.uk).

## Appendix G Statement of data flow and software

This research investigates the quality, diffusion, and user engagement of online nutrition information, with a focus on the information and network on X. Data were collected from public websites and social media (Twitter/X) to assess content shared via URL, meta data and networks. The below table outlines the software used for each stage of these studies.

Chapter	Data collected	Data Source	Software
2	Literature search		Web of Science PubMed Association for Computing Machinery (ACM) Digital Library
3	URLs shared on Twitter/X	Twitter/X	<b>Data collection</b> – Tweet Archiver. Data downloaded as .csv files then transformed to Excel for cleaning, filtering and data manipulation. <b>Data analysis and visualisation</b> - SPSS Version 28.0 was used for statistical analysis. Winsteps was used for Rasch analysis
4	URLs shared on Twitter/X	Twitter/X	<b>Data collection</b> - Twitter search application programming interface (API, v1.1). Data downloaded as a .csv files then transformed to Excel for cleaning, filtering and data manipulation. <b>Data analysis and visualisation</b> - SPSS Version 28.0 was used for statistical analysis. Winsteps was used for Rasch analysis and the Fourfold display of article quality ( <b>Figure 4. 5</b> ).
5	X posts and associated metadata	X	<b>Data collection</b> - The Twitter Search application programming interface (API, v1.1) <b>Data cleaning, analysis and visualisation</b> - Microsoft Excel plugin, NodeXL Pro (Network Overview for Discovery and Exploration in Excel; version 1.0.1.510).

## **Appendix H Search term decision process**

### **How the #nutrition search term was informed by early investigations into the obesity debate shared on X**

Early investigations into the online debate on health-related topics, not published elsewhere in this thesis, supported the decision to investigate nutrition information online, and the #nutrition network. This early work considered the online reporting and discourse on obesity was used to inform the decision to investigate the quality of nutrition information online and serves as a pilot study for early iterations of the OQAT.

As a first step, tweets were gathered via the X (X is used here for consistency but data was collected from Twitter) search function during a 24-hour period on 3-4 May 2019 using the following search terms; healthy, diet, healthy diet, healthy eating, sugar, nutrition, nutrition science and obesity. Search terms were used both with and without a hashtag, and only English language tweets were considered.

Themes were manually investigated by the author. There were patterns across all search terms except sugar and obesity. Common themes relating to healthy and diet in the data collected included: technology, wellness, vegan promotion (both products and as a lifestyle), supplements and recipes. However, there was also specific themes within each search term; nutrition focused on nutrients, education and advice, sugar focused more on advertising, obesity focused on weight loss, child obesity, sleep and weight discrimination. Nutrition science was not mentioned in the selected 24-hour period.

In addition to the thematic investigations, the literature on web of science was also investigated using Boolean searches including the search terms discussed above, and online, 'Twitter', and social media. At the time, the literature highlighted increased media reporting on obesity (Atanasova, 2015) with reporting that promoted weight stigma (Stanford et al., 2018) and individual responsibility (Cain et al., 2017). Based on the thematic work, and the literature considering the digital obesity debate, obesity was chosen for the pilot study.

For the pilot study, Tweets, and associated meta data, were collected during a 24 hour period, 00:01–23:59 on 30 August 2019, using OrgneatUI vol 2019 to download data. It is no longer possible to collect historic tweets or web scrape X data.

The initial pilot study was carried out using an unvalidated version of the Online Quality Assessment Tool (OQAT) to assess the quality of the content of the URLs shared via tweets using the word obesity, or #obesity. This early work, published as an abstract, (Ellis et al., 2020), found that blogs shared the poorest quality information, but had the greatest engagement.

The pilot study also found (not reported in the abstract) a greater number of medical practitioners communicating about obesity and comorbidities, and more research shared than other search terms considered. The OQAT was less relevant for measuring the quality of scientific research papers (as discussed in **chapters 3, 4 and 6**) and the authors determined that the public may be less likely to engage in the obesity debate as the space was dominated by experts. There were also less tweets shared relating to obesity, and the articles shared via URL were less likely to be giving dietary advice than other topics considered. The authors hypothesize that this debate and actors may have shifted since the increase in accessibility of pharmaceutical weight loss interventions.

After the pilot study, the thematic analysis was revisited and nutrition was selected as it captured a broader range of users, comments and topics. The nutrition debate was not dominated by medical topics and was more focused on giving advice, therefore could have greater potential to influence dietary choices.

## References

- Atanasova, D. 2015. *Obesity frames in British and German online newspapers, 2009-2011*. ProQuest Dissertations Publishing.
- Cain, P., Donaghue, N. and Ditchburn, G. 2017. Concerns, culprits, counsel, and conflict: A thematic analysis of “obesity” and fat discourse in digital news media. *Fat Studies*. 6(2), pp.170-188.
- Ellis, C.H., Evans, C.E.L. and Moore, J.B. 2020. Systematic assessment of obesity information on the microblogging platform Twitter. *Proceedings of the Nutrition Society*. 79(OCE3), pE791 article no: E791 [no pagination].
- Stanford, F., Tauqeer, Z. and Kyle, T. 2018. Media and its influence on obesity. *Current Obesity Reports*. 7(2), pp.186-192.
- OrgneatUI. vol. 2019. <https://github.com/raahulha/OrgneatUI> accessed August 2019