Behavior Change for Planetary Health: Design and Implementation of Social Norm Interventions to Reduce Meat Consumption

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Abstract

Current global meat production and consumption patterns present a threat to planetary health. Excessive meat consumption is associated with an increased risk of certain types of cancer, cardiovascular disease, and obesity; while meat production is responsible for about 15% of all greenhouse gas emissions, threatens biodiversity, releases pollutants, and contributes to soil erosion. In the United Kingdom, meat consumption would need to decrease by two thirds to improve public health outcomes and to remain within planetary boundaries for stable ecosystems. Behavioral interventions may be an effective strategy to reduce meat consumption, but the empirical evidence for their effectiveness is mixed and limited. In particular, the social aspect of meat consumption has been mostly unaddressed in behavioral research.

This thesis aims to (i) provide a deeper understanding of perceptions of social norms around healthy and sustainable food choices with a particular focus on meat consumption, (ii) explore the role of demographic characteristics such as ethnicity, gender and socioeconomic position on these perceptions, and (iii) design and implement dynamic descriptive social norm messaging interventions to reduce meat consumption in real-world settings with robust study designs. The studies address gaps in the literature by (i) conducting the first nationally representative (in terms of age, gender, and socioeconomic status) survey of three largest ethnic groups in the United Kingdom for meat consumption behaviors, attitudes and norms and (ii) running the first randomized controlled trial testing dynamic descriptive social norms to reduce meat consumption in a real-world setting.

The pre-registered, robust, multi-site field interventions forming a part of this thesis found no evidence that dynamic descriptive social norm messaging interventions are effective in reducing meat consumption and/or increasing plant-

based food consumption. The nationally representative online surveys found that perceptions and influence of social norms around meat consumption are moderated by the social proximity of the referent group and by the demographic characteristics of the individual. These findings suggest that while social norms are an important influence in meat consumption, interventions that aim to leverage dynamic descriptive social norms might be constrained by their inability to credibly refer to a socially close and relevant referent group. Additionally, the incongruency between the dynamic normative messages that communicate that there is a trend towards reductions in meat consumption and the observable norm of continued meat consumption present in most food purchasing settings may contribute to the ineffectiveness of these messages.

Multimodal interventions that combine dynamic normative messages with microenvironmental changes such as increasing the availability of plant-based options or making them the default may help counter this incongruency and increase the effectiveness of dynamic normative messages. Moreover, if stronger trends of meat reduction emerge over time and become more clearly observable in food purchasing settings, dynamic normative messages can become more credible and effective. Meanwhile, at present, the evidence from this thesis indicate that efforts may need to be redirected to look beyond dynamic descriptive social norm interventions to drive the necessary changes in meat consumption to mitigate climate change and alleviate pressures in the public healthcare system caused by non-communicable diseases.

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Statement of Contribution

I declare that this thesis is entirely my own work, completed under the supervision of Professor Susan Jebb and Dr Rachel Pechey, at the Nuffield Department of Primary Care Health Sciences, University of Oxford. I have written all the chapters and the journal manuscripts featured in this thesis.

I designed the survey, created the statistical analysis plan, performed the analyses, and wrote the manuscript for the study presented in Chapter 2. Dr Christina Potter designed and conducted the experiment and collected the data for the larger experimental study that my survey formed a part of. Dr Michael Clark developed the program that calculated the environmental and health impact scores of the shopping baskets in the online experimental shopping task. Cristina Stewart contributed to the main study design and provided comments on the relevant manuscript for this chapter. Prof Richard Stevens provided insights and guidance in the selection of the correct regression models for analyzing the non-parametric and categorical data. Prof Susan Jebb and Dr Rachel Pechey contributed to the design, analysis, and writing for this chapter.

I designed the survey, created the statistical analysis plan, performed the analyses, and wrote the manuscript for the study presented in Chapter 3. I have collaborated with Dr James Painter at the Reuters Institute for Journalism and market research company YouGov for the recruitment of participants. YouGov collected and extracted the study data. Prof Richard Stevens provided insights and guidance in the development of the statistical analysis plan and the interpretation of results. Prof Susan Jebb and Dr Rachel Pechey contributed to the design, analysis and writing for this chapter.

I created the statistical analysis plan, performed the analyses, and wrote the manuscript for the study presented in Chapter 4. The study was designed and conducted by Dr Kerstin Frie, Cristina Stewart, Prof Susan Jebb, Prof Suzanne Higgs, and Dr Brian Cook. The data was collected and extracted by the commercial partner we collaborated for the study. Prof Susan Jebb and Dr Rachel Pechey contributed to the analysis and writing for this chapter.

I wrote the protocol, designed, conducted, created the analysis plan, performed the analyses, and wrote the manuscript for the study presented in Chapter 5. Rees Bramwell, Sarah Bartolo, and David Woodhouse from our commercial partner Eurest UK helped with the recruitment of worksites, the visual design of the intervention materials, and the extraction of data respectively. Elizabeth Biggs and Cinja Jostock assisted me in the intervention fidelity checks through phone calls and visits to participating worksites. Prof Susan Jebb and Dr Rachel Pechey contributed to the protocol, design, analysis and writing for this chapter.

All tables and figures in this thesis are my own creation. I hereby declare that no part of this thesis has been previously submitted for any other degree at this or any other University. Parts of this thesis have been previously published or submitted for publication as peer-reviewed journal articles.

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List of Abbreviations

CI	Confidence interval
DPhil	Doctorate of Philosophy
EAT-Lancet	The EAT-Lancet Commission on Food, Planet, Health
EPOS	Electronic point of sale
GHG	Greenhouse gas emissions
LCA	Life cycle assessment
LEAP	Livestock, Environment, and People Project
NDNS	National Diet and Nutrition Survey
NHANES	National Health and Nutrition Examination Survey
OOH	Out-of-home
OR	Odds ratio
OSF	Open Science Framework
RCT	Randomized controlled trial
SEP	Socioeconomic position
SES	Socioeconomic status
TPB	Theory of Planned Behavior
UK	United Kingdom
US	United States of America
WEIRD	Western, educated, industrialized, rich, democratic

Chapter 1: Introduction

Summary

This introductory chapter provides a detailed background to the work presented in this thesis. First, existing evidence on the negative impact of meat production and consumption on planetary health is presented. Then, a number of social and psychological factors that shape meat consumption behaviors are discussed. This is followed by an overview of the literature on behavioral interventions to reduce meat consumption which include information provision and education, economic incentives and taxes, labelling and creative naming, and microenvironmental changes to the food purchasing environment. The strengths and limitations of these interventions are critiqued. Following this, the potential of targeting other mechanisms to design interventions to reduce meat consumption is addressed. The concept of social norms and relevant literature is introduced. Evidence on the effectiveness of social norm-based interventions to change eating behaviors is presented, and the scarcity of research on such interventions being used to reduce meat consumption is highlighted. Finally, the aims of this thesis and the gaps in the literature it fills are explained, and the following chapters are outlined.

Current global diets are a threat to planetary health, i.e. the health of human beings and of the environment in which they live in. It is projected that within the next 20 years, if global dietary patterns do not change, environmental pressures caused by food production and consumption will increase by 50 to 92%, mainly through an increase of greenhouse gas emissions (Springmann, Clark, et al., 2018). Risks to human health caused by suboptimal diets include heart disease, cancer, and diabetes and are estimated to have led to 11 million deaths in 2017, which was more than the deaths attributable to tobacco consumption (Afshin et al., 2019). One of the biggest contributors to current unsustainable and unhealthy diets is the overconsumption of processed and unprocessed red meat, which have both the largest negative impacts on human health and the environment (Clark et al., 2019).

In the following sections of this introduction, I will present evidence on the negative impacts of meat consumption on planetary health, discuss some of the reasons why people continue to overconsume meat despite its negative impacts, and provide an overview how this overconsumption has been attempted to be changed by behavioral interventions. I will then critique the main shortcomings of these interventions and highlight the potential of targeting social norms for reducing meat consumption. Finally, I will summarize existing research on social norm-based interventions for reducing meat consumption and explain how this thesis has aimed to address some of the gaps in the literature and introduce the following chapters.

1.1 Meat consumption and its impacts on planetary health

Non-communicable diseases are now the leading causes of death globally, accounting for 74% of global deaths in 2019 (WHO, 2020). Evidence from international epidemiological studies indicate that there is a clear link between diet and ischaemic heart disease, colorectal cancer, and diabetes (Afshin et al., 2019),

which are among the top 10 leading causes of death in high income countries (WHO, 2020). In particular, the International Agency for Research on Cancer and World Health Organization have identified processed meat as a level 1 carcinogen and red meat as a level 2 carcinogen (Bouvard et al., 2015). Evidence also suggests that excess meat consumption could be associated with increased risk of cardiovascular disease, colorectal cancer, and obesity (Papier et al., 2021; Rouhani et al., 2014). In line with this evidence, the United Kingdom's (UK) National Health Service guidelines recommend restricting intake of red and processed meat to 70g per day (NHS,2024).

Research shows that foods associated with improved health such as fruits, vegetables, legumes, and grain cereals are also among those with lowest environmental impact in terms of greenhouse gas emissions (GHG), loss of biodiversity, and excessive land and water use (Clark et al., 2019). Meat production, on the other hand, requires large amounts of water, releases pollutants, and contributes to soil erosion (Godfray et al., 2018; Ranganathan et al., 2016). It also uses more than 75% of total agricultural land globally (Ritchie et al., 2023) and is responsible for about 14.5% of all greenhouse gas emissions (Lazarus et al., 2021). Compared to plant-based protein sources, meat products emit significantly more GHG emissions mainly through deforestation, increase in soil carbon and methane release (Poore & Nemecek, 2018; Scarborough et al., 2023). Meat sourced from ruminant animals, such as beef, sheep, and goat, have a larger negative environmental impact compared to pork and poultry due being more resource intensive to rear and because the animals emit methane (Clark et al., 2019).

Evidence from the Global Dietary Database which collates individual dietary data from 185 countries suggests that the world's population reports to eat an average of 51 grams of unprocessed and 17 grams of processed meat every day, although levels of consumption differ by region (e.g. 7g/day in South Asia compared to 114 g/day in

Central/Easter Europe and Central Asia) (Miller, Reedy, et al., 2022). A systematic review of nationally representative nutrition surveys found that globally, processed meat consumption was 90% greater and red meat consumption was 18% greater than the optimal amounts of intake of 2 and 23g respectively (as calculated by the authors as the amount of intake to minimize risk of death from disease, for details see Afshin et al., 2019). This overconsumption can be traced back to the growth of the global population and increased global income, especially in the second half of the 20th century. Socioeconomic changes during this time which led to the industrialization of meat production have created easier access to and increased demand for meat products. Global meat production has tripled in the past fifty years and per capita consumption is estimated to have increased by 20 kg in the same timeframe to a global average of 42.8 kg per year (Ritchie et al., 2023).

A modelling study of potential scenarios for global dietary changes has found that achieving sustainability goals and curbing GHG emissions from agriculture and land use is not possible by just a part of the global population becoming vegetarian or vegan, but through widespread reduction of meat consumption across the whole population (Eker et al., 2019). This kind of global meat consumption reduction would not only keep us within planetary boundaries for stable ecosystems, but also improve public health outcomes. The EAT-Lancet Commission on Food, Planet and Health (EAT-Lancet), a commission consisting of physicians, nutritionists, epidemiologists, economists, sociologists, ecologists, climate scientists, and other researchers has created a new "reference diet" for both improving human health and for protecting the planet through promoting sustainable food systems in 2019. EAT-Lancet has concluded that a considerable reduction of red meat and a modest reduction of other animal product consumption is necessary to achieve these goals. (Willett et al., 2019). To illustrate, the United Kingdom (UK) population currently eats 82.3 kg of meat per

year on average (Ritchie et al., 2023), which is about three times more than what is recommended by the EAT-Lancet diet.

An epidemiological study of 364,745 adults participating in the European Prospective Investigation into Cancer and Nutrition (EPIC) study has found that adherence to the EAT-Lancet diet was associated with a lower risk of stroke and coronary heart disease as well as a reduction in GHG emissions and land use (Colizzi et al., 2024). Another study of about half a million adults participating in the UK Biobank study has found that high adherence to the EAT-Lancet diet was associated with lower risk of cancer as well as of overall mortality, but did not find a decrease in risk of stroke or major cardiovascular events (Karavasiloglou et al., 2023). A widespread shift in diets is necessary for preventing increased burdens on the health system and mitigating the impacts of climate change, but the question remains on how this can be achieved on a large and sustainable scale.

1.2 Beyond nutrition: Socio-cognitive justifications of meat consumption

In order to understand how to change meat consumption, we need to first explore the motivations for this behavior. Meat is a rich source of nutrients such as vitamin B12, vitamin D, vitamin A, and zinc, as well as a source of protein (Key et al., 2022). However, a cohort study of 6342 UK adults exploring the impact of following different diets has shown that omnivores, vegetarians, and vegans all met the recommended intake levels of calcium, vitamin A, vitamin B12, and zinc; while all fell below the threshold for vitamin D intake; and vegetarians and vegans did not meet the threshold for iodine and selenium intake. All participants also exceeded the reference nutrient intake value for protein consumption, with omnivores getting only 6% of their energy from protein compared to vegans (Lawson et al., 2024). This result has been echoed in a review that put together evidence from studies with cohorts from the European

Union, France, the UK, and the United States of America (US) and found that vegetarians consume protein at a level that is considerably above the recommended daily allowance (Mariotti & Gardner, 2019). These findings suggest that a primarily plant-based diet with minimal meat and dairy consumption can provide the necessary nutritional benefits for a healthy adult. Despite this fact, and the evidence that overconsumption of meat can be detrimental to planetary health outlined above, eating meat is an integral part of a large number of cultures and diets across the globe (Henchion et al., 2022; Ostermann et al., 2024). So, why are people still motivated to consume meat?

Social psychologist Melanie Joy has coined the term "the three Ns of justification" for meat consumption, namely that it is "normal, necessary, and natural" (2010). These were later expanded by psychologist Jared Piazza and colleagues to include "nice" as the 4th N of justification (2015). The "niceness" of meat consumption refers to the hedonistic reasoning of sensory enjoyment and the conviction that this experience cannot be achieved through consuming other food products. For example, research has shown that taste is the primary barrier for individuals to switch from meat products to plant-based analogues (Carlsson et al., 2022b; Segovia et al., 2022). The "naturalness" of meat consumption refers to the belief of a rationalization hierarchy between humans and animals that dictates the former must consume the latter. The justification of this hierarchy often happens through a denial of mind to animals, where individuals do not acknowledge or deliberately underestimate the cognitive and emotional abilities of the animals whose flesh they consume to justify their dominance over them (Piazza et al., 2015). The "necessity" of meat consumption is centered around the idea that meat consumption is essential for a nutritious diet, and that meat products provide nutritional benefits that cannot be replaced by any plant-based resources. The "normality" of meat consumption refers to not just the fact

that eating meat is common practice in most cultures, but that it is also the approved and expected behavior. Negative stereotypes associated with veganism, vegetarianism or other meat-excluding diets foster the idea that individuals following these diets are outliers who could be excluded from social environments. The abundant availability of meat-based options in food retailers like supermarkets and restaurants contrasted with the scarcity of plant-based ones also reinforces the social norm of eating meat.

Demographic characteristics of individuals such as their gender and socioeconomic status (SES) also play a role in their meat consumption behaviors (Cheah et al., 2020; Kemper et al., 2023). Evidence shows that on average, men consume more meat than women and see it as an integral part of their diet while women express more openness to reducing their consumption (de Boer et al., 2017; Hinrichs et al., 2022; Rothgerber, 2013; Rozin et al., 2012). This discrepancy might be because people think high levels of meat consumption are associated with masculinity whereas vegetarianism is seen as feminine (Rozin et al., 2012; Ruby & Heine, 2011). Indeed, research has found that men are more likely to reject the idea of reducing their meat consumption or becoming vegetarian in the future (Nakagawa & Hart, 2019).

The relationship between SES and meat consumption seems more complex compared to gender. While meat consumption has historically been viewed as a symbol of affluence and financial status (Westhoek et al., 2011), recent research has found an "inverted-U" relationship between SES and meat consumption, where consumption first increases as people get more affluent, and then decreases for the top proportion of high SES individuals (Clonan et al., 2016; Maguire & Monsivais, 2015). This could be explained by the fact that people in higher SES groups may have more awareness about the negative environmental and health impact of meat consumption and may also have more disposable income to afford plant-based meat substitutes,

protein supplements, and other nutrition sources that are often perceived and marketed as luxury products.

Reducing meat consumption requires individuals to go against these justifications and societal norms that are entrenched in the collective psyche and change their existing behaviors. The next section provides an overview of existing literature on how behavioral interventions can help achieve this change.

1.3 A critical review of existing behavioral interventions to reduce meat consumption

The academic study of reducing meat consumption is a relatively recent phenomenon. Moreira and colleagues (2022) conducted a bibliometric analysis of research around reducing meat consumption that described the patterns of publication, input from individual authors, top journals in the field, and locations of studies. Examining research that was published until 2020, they found that while the first study to explore attitudes and behaviors of meat consumers was published in 1994, there has been a 16-year gap in the literature, with the next study being published in 2011. Overall, they identified only 67 articles, with most studies being published between 2018-2020. A significant proportion of research on the topic of meat reduction has focused on testing the effect of various behavioral interventions. A cross-discipline systematic review that looked at meat reduction intervention studies published between 2001-2019 also identified 67 articles, with most of the research being conducted after 2015 (Kwasny et al., 2022). The novelty and recency of meat consumption and reduction research means that evidence for 'what works' in terms of behavioral interventions is mixed and limited. Below, I provide a short overview of some of the interventions that were most widely studied.

1.3.1 Information provision and educational interventions

A large body of evidence has established that in Western countries, knowledge of the negative effects of meat production on the environment is still limited and many do not consider that reducing meat consumption as a pro-environmental behavior (de Boer et al., 2013; Hartmann & Siegrist, 2017; Lentz et al., 2018; Macdiarmid et al., 2016; Sanchez-Sabate & Sabaté, 2019; van Bussel et al., 2022; Wellesley et al., 2015; Wynes et al., 2018). People also express more concern about their own health over the environment in the context of meat consumption (Clonan et al., 2016; Neff et al., 2018), and prioritize health benefits when making food choices over other factors (Hoek et al., 2017). This hierarchy of concern, combined with the lack of awareness of how meat production affects the environment, and the belief that eating meat is necessary for good health, might mean that most individuals do not see a need for reducing their meat consumption.

Targeting this lack of awareness, providing information on the negative health and environmental impacts of excessive meat consumption either in the form of online vignettes, training sessions, or text messages has been used widely as an intervention for meat reduction. Information provision is cost-effective and easy to implement. It is also an intervention that does not take away agency from the individual and does not demand any structural changes from food providers. Some studies have found evidence that both health and environmental messages can encourage intentions to reduce meat consumption or hypothetical choices of reduced meat options (Grummon et al., 2023). However, while information provision can lead to increased awareness around the negative impacts of meat consumption, this awareness does not necessarily lead to reduce meat consumption (Verain et al., 2017). While some studies have found that health information was more effective than environmental information (Segovia

et al., 2022), there is evidence that suggests meat-eaters may still be unlikely to reduce their meat consumption even after being exposed to information that it is bad for their health (Valli et al., 2019). Indeed, a 2018 systematic review has found that while information provision could lead to intentions to reduce, there was no evidence that they were effective in changing actual behavior (Bianchi, Dorsel, et al., 2018). As discussed above, most people still do not believe meat consumption reduction can benefit the environment and have an entrenched belief that eating meat is a nutritional necessity. Current evidence suggests that information interventions may not be enough to challenge these strong beliefs.

1.3.2 Economic interventions

Increasing the price of meat products, either through introducing a meat tax or through creating a price difference between meat-based and plant-based options has been proposed as a potential method to incentivize a reduction in meat consumption. A modelling study calculating optimal tax levels for internalizing the health costs associated with overconsumption of processed and red meat found that an average of 25% tax on processed meat and 4% on red meat could reduce deaths by 9% and reduce health costs by 14% (Springmann, Mason-D'Croz, et al., 2018). Despite these promising findings, the public opinion on the introduction of a tax is not a positive one. A survey of a nationally representative sample of UK adults found only 27% of respondents found increasing prices to be an acceptable meat reduction policy (Pechey, Reynolds, et al., 2022). Similarly, a survey study of a nationally representative sample of UK adults that measured the acceptability of eight different net-zero policies also found that introducing taxes for red meat and dairy was the least popular policy, although a higher percentage of 47% of respondents said they supported this policy (Poortinga et al., 2023).

While the support and acceptability of a potential meat tax policy remains low, researchers have tested the effectiveness of such taxes in a variety of online and field settings. A randomized controlled trial (RCT) that asked participants from the UK to choose meals on a hypothetical online food delivery platform assessed the impact of a "meat tax" of an average of 10% found no evidence of an effect of this intervention on the likelihood of choosing meat-based dishes or on the GHG emissions of the chosen meal (Lohmann et al., 2024). Similarly, another RCT that used a hypothetical online supermarket setting in the Netherlands and increased the prices of meat products by 30% found no evidence of an effect on this intervention, but a significant decrease in grams of meat 'purchased' was achieved when the price increase was combined with an informative message about the negative environmental impacts of meat consumption (Vellinga et al., 2022). Contrastingly, an RCT using a hypothetical online supermarket setting in the USA found that introducing a tax of 30% on meat products led to a decrease from 3.5 to 3.1 average items of meat products being selected compared to control. When the tax intervention was combined with health and environmental warnings, this number decreased to 2.7 items of meat products selected (Taillie et al., 2022). To my knowledge, the only field experiment that tested the effectiveness of an economic intervention to reduce meat consumption created a £0.87 price difference between vegetarian and meat based main meals at a university cafeteria. This study found that vegetarian meal sales increased by 3.2 percentage points, although meat based meal sales remained unchanged (Garnett et al., 2021).

1.3.3 Naming and labelling interventions

A number of studies have explored whether naming dishes based on their suitability for certain diets (e.g. vegetarian, vegan), their content (e.g. plant-based), the origin of their ingredients (e.g. "Mediterranean vegetables") or their sensory

features (e.g. “moreish creamy risotto”) made a difference in their selection. One study has suggested that labelling dishes as “vegetarian” can be unappealing to meat-eaters and those who want to reduce their meat consumption (Zinn et al., 2023). A field experiment in UK cafés has found naming plant-based dishes that emphasized their taste or origin of their ingredients like “Cumberland-spiced” or “field-grown” increased the likelihood of their selection (Bacon et al., 2019). However, another study on university campus café sales has found that labelling dishes as “vegetarian” or “vegan” led to a higher likelihood of them being chosen compared to “plant-based” labels (Rosenfeld et al., 2022). A systematic review on microenvironmental changes to reduce meat consumption found that in four studies, changing the labels and descriptions of meat alternatives did not make a difference in their selection (Bianchi, Garnett, et al., 2018), while labelling meat-containing dishes as “meat” rather than “standard” did decrease their selection (Stewart et al 2016).

Introducing labels that highlight the environmental impact of meat products (often dubbed “eco-labels”) has also been widely tested as an intervention to reduce meat consumption. An online study of adults in the US found that introduction of ecolabels enabled participants to perceive the relative sustainability of food products better and had a modest effect on their intentions to increase their purchase of sustainable products (Taillie et al., 2024). A number of online studies asking participants to make hypothetical meal or product choices have found some evidence of the effectiveness of ecolabels for either decreasing the selection of meat products or increasing the selection of more sustainable options (Arrazat et al., 2023; Betz et al., 2022), although evidence to the contrary has been generated as well (Lohmann et al., 2024). In field settings, there has also been mixed findings regarding the effectiveness of eco-labels in the selection of sustainable products. An experiment at a university restaurant in Sweden using traffic-light style labels found that there was both an

increase in the selection of green (i.e more sustainable) label meat dishes and a decrease in the selection of red (i.e less sustainable) label meat dishes (Brunner et al., 2018). Similarly an experiment in five university cafeterias in the UK testing the impact of carbon labels that had corresponding colors (green for fewer emissions, orange for more emissions) found that the probability of customers selecting a high carbon meal decreased significantly (Lohmann et al., 2022). Contrastingly, a university cafeteria study in Norway that used traffic light labels and compared them to single red and single green labels found that only the traffic light labels significantly decreased meat based meal sales, but this effect disappeared over time following the first three weeks of the intervention (Slapø & Karevold, 2019). A trial in two university college dining halls testing environmental and health labels found no evidence of an effect of the labelling intervention on meat consumption (Vasiljevic et al., 2024). Finally, an RCT in worksite cafeterias in the UK that tested eco labels that ranged from A (most sustainable) to E (least sustainable) also found no evidence of an effect of the labels on the environmental impacts of the meals chosen (Pechey, Bateman, Cook, Potter, et al., 2022).

1.3.4 Microenvironmental interventions

Another intervention that targets the microenvironment of food purchase is increasing the availability of meat-free food options. Previous research has found that doubling the proportion of vegetarian options at three university cafeterias led to an significant increase in the selection of these options (Garnett et al., 2019). Pechey, Bateman, Cook, et al. (2022a) replicated these findings in a natural experiment in a different university cafeteria, but found a considerably small impact of the intervention in a natural experiment across 18 worksite cafeterias, noting issues regarding intervention implementation. At a university cafeteria in the US, an

intervention to serve a low red meat menu one day a week (i.e. reducing the availability of red meat) at a university cafeteria found that this led to a significant reduction of the GHG emissions of the cafeteria, but did not measure any purchasing and consumption behaviors of the cafeteria customers (Lambrecht et al., 2023). In an online hypothetical supermarket setting, Jostock et al. (2024) tested an availability intervention in combination with prominent positioning of more environmentally sustainable products and found that these interventions in combination led to participants having shopping baskets with less environmental impact, but increasing the availability alone did not lead to a significant change. While there is a robust body of evidence that increasing the availability of healthier food options leads to an increase of their selection (for a mega-analysis, see Pechey, Hollands, et al., 2022), the research on how the availability of meat-free options affect their selection is still limited.

Changing defaults by making meat-free dishes or dishes containing smaller portions of meat the pre-selected options, has been shown to be an effective intervention to reduce meat consumption, despite a small number of studies and heterogenous applications of the intervention (for a detailed systematic review, see Meier et al., 2022). Default interventions are based on the assumption that individuals have a "status quo bias" (Kahneman et al., 1991; Samuelson & Zeckhauser, 1988), meaning that they perceive the risk of making a change to be greater than the disadvantage of the current state. This bias also leads individuals to lack the cognitive inertia to evaluate other options and make a change. Defaults also can signal what is socially accepted or desired in a specific context by framing the pre-selected option as what is expected to be chosen. While defaults seem to be a promising intervention for reducing meat consumption, they can only work in very specific contexts such as pre-organized meals where individuals need to indicate their choice prior to the meal, or

settings where prix-fixe menus are offered, and cannot be implemented in the majority of food choice scenarios.

While a number of interventions drawing from disciplines of psychology, economics, and marketing have been tested to reduce meat consumption in a variety of settings, the evidence is mixed and inconclusive. Information provision can lead to intentions to reduce meat consumption but seems to not effect actual behavior. "Meat taxes" or price incentives for meat-free products could have a significant effect on meat reduction, but more field studies are needed to build an evidence base for these interventions. Findings from naming interventions are in conflict as to whether calling dishes "vegetarian/vegan" or "plant-based" works better to encourage their selection, and a number of studies have found no effect of changing the description of meat-free dishes on increasing their selection. Eco-labels that either provide information on the GHG emissions of food products or rate their sustainability using a traffic light system seem to be effective in hypothetical and online settings, but evidence from field trials is mixed. Microenvironmental interventions targeting availability and defaults seem to be more promising strategies to reduce meat consumption, but the number of studies that have tested these interventions remains low, perhaps due to the fact that these structural changes can only be made in certain food purchasing environments. One of the reasons for the inconclusive evidence from a relatively large body of research might be the shortcomings of the studies and the way they have tested a variety of interventions to reduce meat consumption, which will be discussed below.

1.3.5 Limitations of behavioral interventions to reduce meat consumption

It has been established above that the study of meat consumption and its reduction is relatively recent, with most research being conducted after the second half of 2010s. This novelty, coupled with pressures of publication bias, and challenges of conducting

field studies, has resulted in a number of shortcomings in the body of evidence. These include measuring intentions instead of actual behaviors, the use of weak study designs and methodologies, and a lack of diversity in sample population characteristics.

Majority of studies testing interventions to reduce meat consumption have not measured actual behavior, but relied on self-reported intentions to reduce instead (as discussed in Grundy et al., 2021; Harguess et al., 2020). Self-report measures introduce an increased risk of participant bias, where respondents assume researchers expect them to answer questions in a certain way, even if it is not reflective of their true thoughts, feelings, or behaviors. Measuring intentions as a proxy for actual behavior may also limit the validity of the findings greatly. Research has well established that intentions can be a good predictor of subsequent behavior (for a meta-analysis, see Sheeran, 2002). However, a meta-analysis examining interventions that target intentions found that "a large-to-medium sized change in intentions led to only a small-to-medium sized change in behavior", and that intentions lead to actual behaviors about "one-half of the time", a phenomenon researchers have dubbed the "intention-behavior gap" (Sheeran & Webb, 2016; Webb & Sheeran, 2006). In order to make the claim that interventions can reduce meat consumption, studies need to focus on measuring actual behavior as well as intentions.

Most studies on meat consumption and interventions to reduce it have had issues with their methodological quality (for systematic reviews, see Bianchi, Dorsel, et al., 2018; Bianchi, Garnett, et al., 2018). A high number of interventions were not tested in the field, but were assessed through laboratory experiments, online cross-sectional surveys, and measuring intentions instead of actual behavior (as found by Graça et al., 2019, e.g. Blondin et al., 2022; Garcia et al., 2021; Perez-Cueto, 2021; Thomas et al., 2017). Online studies that report a change in intentions to reduce meat consumption

and interpret this as a success of the intervention without acknowledging that this finding might not translate to real-world behaviors risk falling into the trap of disregarding the intention-behavior gap mentioned above. They also neglect the constrained and artificial nature of most online studies that rely heavily on the literacy, imagination, and focus of participants, greatly limiting the generalizability of their findings. Interventions were also often tested with single-time measures and did not have follow ups, not providing enough evidence whether the behavior change caused by the interventions were durable and sustainable over time (e.g. Segovia et al., 2022). Interventions that were tested for a longer period varied in their duration, ranging from as short as two days to as long as nine weeks. The apparent ineffectiveness of some interventions may have been due to the limited time they have been implemented, not allowing study participants to be exposed to them long enough to create meaningful behavior change. A number of intervention studies also did not have an appropriate control group, but instead employed pre-post or crossover designs (e.g. Garnett et al., 2019; Perez-Cueto, 2021), creating a risk of order and carry-over effects.

Sample characteristics have been a considerable barrier in the generalizability of evidence in meat consumption research. In particular, a lack of diversity in the gender, education status, ethnicity, and nationality of study samples has presented a limitation in the external validity of existing studies. A considerable proportion of the meat consumption reduction research has been conducted on university campuses with either entirely or majority student populations (e.g. Collins et al., 2019; Einhorn, 2020; Mollen et al., 2013; Robinson et al., 2013; Rosenfeld et al., 2022; Stok et al., 2016; Wolstenholme et al., 2021). Students currently enrolled in higher education only comprise about only 3% of the world's population (3.2% in the UK), and are more likely to come from higher socioeconomic backgrounds and from areas with less deprivation (Atherton, 2024; Bolton, 2020). A systematic review has shown that higher education

attainment has repeatedly been linked to lower meat consumption (Kwasny et al., 2022). It is clear that studies measuring behaviors of student samples cannot be generalized to the wider population with confidence. Therefore, interventions that have shown promise with these samples need to be retested with nationally representative samples for ensuring generalizability.

A systematic review on consumer attitudes around environmental concerns and meat consumption found that most studies included in the review used convenience samples, instead of recruiting for national representativeness, or based on certain demographic quotas (Sanchez-Sabate & Sabaté, 2019). This has often meant that certain demographic groups have been overrepresented in meat consumption research, whereas there is little to no data for others. Over-recruitment of female participants is one of the main problems with this subfield of research (e.g. Segovia et al., 2022; Sharps et al., 2021). Graça and colleagues (2019) have found that 37% of studies they included in their synthesis of evidence for reducing meat consumption had samples that were biased towards female participants. As discussed in section 1.2, female individuals are more likely to be open to and have higher intentions of reducing their meat consumption, as well as being more likely to follow a plant-based diet compared to males. Studies that overrecruit females may therefore overestimate the associations between certain measures or the effect of an intervention being tested which may not hold external validity once retested with a more representative sample.

Another problem that plagues not only meat consumption research, but all subfields of psychology and behavioral sciences is the fact that majority of the research is being conducted with Western, Educated, Industrialized, Rich and Democratic (WEIRD) samples (Henrich et al., 2010). WEIRD people make up about 80 to 95% of research participants of studies published in top psychology journals, although they represent only 12% of the world's population (Apicella et al., 2020). The

unrepresentativeness of this subgroup of people in terms of not just psychological phenomenon like memory, attention, categorization, and moral reasoning (Henrich et al., 2010) but also sociocultural practices means that findings relating to eating behavior and meat consumption in particular are in danger of providing an incomplete understanding that should not be extrapolated. Despite this, a meta-review of interventions to reduce animal product consumption has found that the majority of the studies had WEIRD samples (Grundy et al., 2021). Lack of gender, ethnic, socioeconomic and geographic diversity in meat consumption reduction research presents the serious risk of skewing and narrowing our understanding of the mechanisms that drive this behavior and the true effectiveness of interventions addressing it which needs to be acknowledged and challenged.

This section has provided an overview of interventions that targeted cognitive, economic, and microenvironmental mechanisms that impact meat consumption. However, the social aspect of eating behaviors has been mostly unaddressed when it comes to interventions to reduce meat consumption.

There is a strong body of evidence that shows eating is a social behavior and that people are influenced by the behaviors and opinions of others when making food choices (Robinson, Thomas, et al., 2014; Stok et al., 2016). The following sections will make a case for why leveraging social norms can be an effective way for reducing meat consumption, provide a summary and critique of the very few studies conducted in this field so far, and outline how the studies that constitute this thesis have aimed to address the gaps in existing research.

1.4 The potential of social norm-based interventions to reduce meat consumption

Social norms can be described as a set of informal, unwritten rules or standards for behavior generally agreed upon by the members of a social group. Social norms can constitute effective decision heuristics for finding a contextually appropriate way to behave, especially in new and unfamiliar situations (Cialdini et al., 1990; Fehr & Fischbacher, 2004). The social norms literature distinguishes between descriptive and injunctive norms. Descriptive social norms are the generally accepted ways of behaving that are currently and commonly observed and can constitute a pattern for an individual to inform their own behavior (Brachem et al., 2019; Cialdini & Goldstein, 2004), while injunctive norms indicate ideal, desired or approved ways of thinking and acting that may not match the observed behavior of the social group. Recent literature has made a further distinction between "static" and "dynamic" descriptive norms where the latter refers to past changes and expected future trends in the approval and adoption of a given behavior (de Groot et al., 2021; Sparkman & Walton, 2017).

Individuals or groups who are observed for social norm signals that indicate accepted and desired behavior in a given context are called referent groups (Paluck & Shepherd, 2012). Social Identity Theory (Tajfel, 1974; Tajfel & Turner, 1979; Turner et al., 1987) suggests that stronger associations with a group makes an individual more likely to want to conform to the behaviors set out by said group, making them more inclined to behave coherently and consistently with the social group with which they identify (Childers & Rao, 1992). This means that the influence of a norm can be increased if the individual finds the norm referent group relevant and proximate to their own identity, making the individual more likely to model the norm (Jiaying Liu et al., 2019; Jinyu Liu et al., 2019; Stok et al., 2012; Stok et al., 2016; Verhallen & Post,

2020). This may be due to perceived similarities between the individual and the referent group helping the individual to have a higher belief in their self-efficacy for engaging with the behavior or feel that their self-identity is congruent with the behavior (Higgs, 2015). Individuals also have more opportunities to exchange information with, observe the behavior of, and learn the judgments and values of their close social circles, which means that they can become more confident in their knowledge of social norms of their proximal referent groups. In the context of eating behavior, studies have found evidence that the referent group moderated the level of influence of social norms in the consumption or avoidance of certain food items, where individuals followed the norm when it was presented as coming from a group they identified with as opposed to an out-group (Robinson, Thomas, et al., 2014; Stok et al., 2012). Individuals were also found to be more likely to mimic an eating behavior when they express a desire to be associated with or perceive themselves to be similar to the person or group modelling the behavior (Cruwys et al., 2015).

Social norms have been proven to be influential in different eating contexts like increasing fruit and vegetable intake, and preference of healthy snacks (Collins et al., 2019; Gonçalves et al., 2021; Huitink et al., 2020; Mollen et al., 2013; Raghoebar, Haynes, et al., 2019; Raghoebar, van Rongen, et al., 2019; Robinson, Fleming, et al., 2014; Robinson et al., 2013; Thomas et al., 2017). More specifically, a systematic review examining the communication of information about descriptive eating norms has found that the majority of studies reported changes in the eating behaviors of participants exposed to the norms (Robinson, Thomas, et al., 2014). Despite the well-established knowledge that social norms influence a variety of eating behaviors, and evidence suggesting that social norms can influence meat consumption in particular (Çoker & van der Linden, 2020), research testing the effectiveness of social norm

based interventions to increase the consumption of plant-based foods and reduce meat consumption has been extremely limited (Kwasny et al., 2022).

A meta-review on consumption of animal products found that communicating normative information that others were reducing their meat consumption was a reliable intervention to motivate individuals to reduce their own consumption, but across five reviews, only four unique studies about social norms were identified (Grundy et al., 2021). These five reviews, which were about interventions promoting sustainable eating behaviours (Taufik et al., 2019), interventions reducing meat consumption (Harguess et al., 2020), randomized controlled trials testing interventions to promote household action on climate change (Nisa et al., 2019), quantifying the GHG emission reductions of pro-environmental behavioral interventions (Wynes et al., 2018), and synthesizing evidence for reducing meat consumption and following plant based diets (Graça et al., 2019) all found only one single article that included four separate studies using social norm messaging as an intervention to encourage a switch from meat- to plant-based meals.

These studies were conducted by Sparkman and Walton (2017), who coined the term "dynamic descriptive norms" to refer to norms that are currently changing towards a specific direction. Despite also being called "trending norms" in some research (Cialdini & Jacobson, 2021; Mortensen et al., 2019), and having been previously tested without being acknowledged as a a different type of descriptive norm (for a seminal example from political science research, see Gerber & Rogers, 2009), dynamic norms have found their place in the literature following the publication of Sparkman and Walton's 2017 article. Dynamic norms provide information about the changes and trends in others' behavior, creating an opportunity to pre-conform by "anticipat[ing] ongoing change and a future world in which that behavior is normative and then conform to the emerging norm as if it were current reality" (Sparkman &

Walton, 2017). Using dynamic descriptive norms in interventions where the target is to discourage individuals from performing a currently commonly adopted behavior (e.g. choosing meat-based meals for lunch) and communicating that an increasing proportion of people are moving away from that behavior (e.g. starting to choose plant-based meals for their lunch more often) might be a promising strategy.

Three out of four studies in Sparkman and Walton (2017) were online surveys with MTurk users in the USA, where participants were exposed to messages with either dynamic or static norms and were asked to express their interest in reducing their meat consumption. While the studies found that those in the dynamic norm condition expressed more interest in reduction than those in the static condition, one study found no difference between dynamic norm and the control condition. The fourth study, taking place at a university campus café and measuring real food purchasing behavior following exposure to either static or dynamic norm messages or to no message, found that participants in the dynamic norm condition purchased more meat-free meal choices than those in the static norm condition, but found no difference between dynamic norm and control conditions.

These studies were followed by four further field experiments in the US by the same authors (Sparkman et al., 2020). While dynamic descriptive norm messaging was found to be effective in increasing the selection of meat free meal choices in a campus café setting and during the lunch service of a fine dining restaurant compared to control, they were not effective in an online lunch delivery website and created the opposite effect by decreasing meat-free meal choices during the dinner service of the same fine dining restaurant.

At the start of my studies towards a Doctorate of Philosophy degree in October 2020, the eight studies published in two articles by Sparkman and colleagues were the only evidence that suggested dynamic descriptive social norms could be effective in

reducing meat consumption. However, the evidence favoring the effectiveness of the interventions were mixed, the studies were conducted mostly in a university campus and its immediate surroundings with a largely student population, and the study designs did not follow the gold standard of employing randomized controlled trials. This presented a need for dynamic descriptive social norm-based interventions to reduce meat consumption to be tested in a variety of settings, locations, with diverse samples and robust study designs, which my proposed plan for my studies intended to fill.

In the four years that followed, there has been a growing body of evidence in this field from different countries, with different contexts and methodologies. Two online surveys conducted with Dutch, German, and Italian participants found that exposure to dynamic descriptive norm messages have effectively changed intentions to reduce meat consumption (Carfora et al., 2022; de Groot, 2022). However, a direct replication of one of the online studies in Sparkman and Walton (2017) that was conducted in the UK found no evidence of the norm message having an effect on intentions (Aldoh et al., 2021). Similarly, an online survey with university students in the Netherlands did not find an effect of a dynamic norm message either alone or in combination with a static norm message on intentions to increase plant-based meal consumption (Malta et al., 2024). Online choice experiments that either manipulated the strength of the dynamic norm (Weikertova & Urban, 2023) or combined it with other visual or written prompts relating to overconsumption of meat (Zumthurm & Stämpfli, 2024) and measured the hypothetical selection of meat-free meals also did not find an effect of the norm messages. The effect of dynamic descriptive norm messaging has also been tested on real-life meat consumption behavior, measured via changes in meal-purchase sales from various food settings, including university campus cafes in the UK and New Zealand (Patel et al., 2024), and an online supermarket in the Netherlands

(van der Vliet et al., 2024) and have found no effect of their interventions on food choices.

These studies shared some of the same caveats as other behavioral interventions mentioned above, including being tested with single-time measures (Carfora et al., 2022; de Groot, 2022; Sparkman & Walton, 2017), not having an appropriate control group and employing pre-post or crossover designs (de Groot et al., 2021; Patel et al., 2024; Sparkman & Walton, 2017), using university campuses as study settings with either entirely or majority student populations as the study sample (Patel et al., 2024; Sparkman & Walton, 2017), overrecruiting female participants (van der Vliet et al., 2024; Weikertova & Urban, 2023), and being conducted with WEIRD samples (all studies mentioned above).

1.5 Aims of this thesis

This thesis aims to provide a more comprehensive understanding of perceptions of social norms around meat consumption, including exploring the role of demographic characteristics, and to design theoretically grounded dynamic descriptive social norm messaging interventions to be tested in real-world settings with robust study designs.

The first study of the thesis (Çoker, Jebb, et al., 2022) investigated whether social proximity of referent groups (e.g. general population vs friends and family) moderates perception of social norms around healthy and sustainable food choices. It also explored the effect of perception of social norms on the healthiness and sustainability of food choices made in an experimental online supermarket shopping task. The results indicated that the social proximity of the referent group moderates the perceived prevalence of social norms and that making healthy food choices was perceived as a more prevalent norm than making sustainable ones.

The second study built on these findings and aimed to explore whether the magnitude of these differences varies across different ethnic groups. Using an online survey, the second study became the first piece of research that explored ethnic differences in attitudes, beliefs, perception of social norms, and behaviors relating to meat consumption between the three largest ethnic groups in the UK (Çoker et al., 2024). This study provided evidence that perceptions of social norms around healthy and sustainable food choices can influence individuals' own choices and showed that ethnic groups significantly differ in how much importance they place on social norms around food choices and how much they want to conform to them.

Building from these findings, the latter two studies of the thesis then focused on assessing the effect of social norm interventions to reduce meat consumption in field settings with large and demographically diverse samples. The third study employed a randomized cross-over trial design in retail store restaurants across the UK to test the effect of a dynamic descriptive social norm messaging intervention to reduce meat consumption (Çoker, Pechey, et al., 2022). The trial found no evidence of an effect of the intervention, however, there were concerns regarding the design and implementation of the intervention.

The fourth and final study aimed to address these concerns as well as tailoring the intervention message to increase the perceived social proximity of the referent group and emphasize conformity to the norm and employing a more robust study design. The study employed a randomized controlled trial design to test the new dynamic descriptive social norm message in in worksite cafeterias across the UK (Çoker et al, submitted). This trial also did not find any evidence of an effect of the intervention despite improved study design and implementation.

The following chapters will present each study in detail and a general discussion expanding on the implications of the findings and avenues for future research will follow.

Chapter 2: Perceptions of Social Norms Around Healthy and Sustainable Food Choices and the Role of Referent Groups

Summary

This chapter details the results of a survey conducted with a nationally representative sample of UK adults (N = 2488) that measured perceptions of social norms, attitudes, intentions, and behaviors around meat consumption. The study investigated whether having a close vs. a distant social group as the referent changed perceptions of social norms around making healthy and sustainable food choices. It also assessed whether participants' perceptions of norms for each referent group were associated with their food choices in a virtual grocery shopping task. It further explored associations between attitudes towards the impact of meat production on the environment, intentions to reduce meat consumption, self-reported reduction of said consumption, and food choices in the shopping task, and whether these associations were influenced by perceptions of social norms. The findings suggest that framing social norms around making healthy and sustainable food choices to refer to a closer social referent group may change how they are perceived and their ability to encourage sustainable and healthy food purchasing. The findings also support the growing literature that identifies an intention-behaviour gap in meat consumption reduction, and further asserts the association between attitudes, norm perceptions, and intentions as put forward in the Theory of Planned Behaviour. Parts of this chapter were published in a peer-reviewed journal article: Çoker et al (2022), Frontiers in Psychology, https://doi.org/10.3389/fpsyg.2022.974830.

2.1 Introduction

Chapter 1 has introduced the terminology of social referents (Paluck & Shepherd, 2012), and Social Identity Theory (Tajfel, 1974; Tajfel & Turner, 1979; Turner et al., 1987) which suggests that individuals are more likely to conform to the behaviors of a social referent that they have strong positive associations with. Individuals also tend to demonstrate "ingroup favoritism", meaning that they ascribe more positive attributes to the behaviors and attitudes of the social referents they associate with (their "ingroup"), while being more likely to disprove of the behaviors and attitudes of social referents they do not feel social proximity to (their "outgroup") (Sherif, 1958; Tajfel & Turner, 1979).

In addition to this, Focus Theory of Normative Conduct (Cialdini et al., 1990) suggests that the influence of social norms on behavior is moderated by "normative focus", on in other words, how salient a norm is given a certain context. I hypothesized that norm salience would increase when the referent group is more socially proximate to the individual and extend that this effect will also be present in the association between social norms and intentions.

Theory of Planned Behavior (TPB, Ajzen, 1985) posits those perceptions of social norms, personal attitudes (i.e., beliefs about the expected outcome of a behavior), and perceived behavioral control (i.e. how much agency an individual believes they have over their behavior) influence intentions and behaviors. I have previously shown that while TPB constructs meaningfully predict meat consumption reduction intentions. However, attitudes and social norms might play different roles in forming these intentions depending on whether meat consumption reduction is framed as sustainable or healthy behavior. (Çoker & van der Linden, 2020). I therefore

hypothesized that there might be a difference in perceptions of social norms between sustainable and healthy food choices in the present study.

Chapter 1 has detailed evidence that shows social norms can influence eating behavior, and highlighted that referent groups might moderate this influence. However, there is very little research and evidence on how individual characteristics might moderate perceptions of and responses to social norms in the context of eating behaviours. Only a small number of studies that looked at associations between eating behavior and social norms included both men and women in their sample and very few conducted analyses that explored gender differences, while even fewer looked at differences based on age, income, or education, highlighting the need for more studies with diverse samples in the area (for systematic reviews detailing these studies, see Robinson, Thomas, et al., 2014; Yamin et al., 2019)

To provide a basis for understanding existing norms and to better inform future norm-based intervention studies, the present study explored the role of the referent group in the perception and influence of social norms around healthy and sustainable food choices. Recruiting a large and representative sample of the UK, I examined the relationship between social norms and food purchasing behaviour using a virtual supermarket setting. I explored how individuals' perceptions of making healthy and sustainable food choices as normative behaviours differed when the norm was framed to refer to a close ("people I share my meals with") versus a distant ("most people in the UK") referent group. I also explored whether participant characteristics such as gender, age, income and education moderated their normative perceptions.

2.2 Methods

2.2.1 Participants and Procedure

The data for the present analysis was collected as part of a post-task survey following a larger food labelling intervention study led by researchers in the LEAP team[1]. The labelling study examined the effects of environmental impact and nutrition labels on food purchasing using an online experimental supermarket platform. The study protocol was reviewed and approved by the University of Oxford's Central University Research Ethics Committee [R65010/RE004]. Participants were recruited through Dynata, an online market research company, and the sample was nationally representative of the UK in terms of gender, age, education, and income. Participants were included if they met the criteria of being aged 18 and above, based in the UK, able to read in English, willing and able to give informed consent, and having access to and familiarity with a computer and the Internet. Since the main task of the study required participants to make food choices that included meat and dairy, people following a vegetarian or vegan diet were excluded from participation (see Appendix 2.1). Eligible participants were then directed to view the information sheet and provide informed consent (see Appendix 2.2). Participants were then taken to an online virtual supermarket platform where they were asked to choose products corresponding to items on a shopping list prepared by the researchers. Participants did not spend any real money, nor receive the products they chose but were asked to imagine they were shopping for actual purchase and select things they would normally choose in their daily lives. Participants' shopping baskets were assessed and assigned total health and

[1] N.B. The labelling intervention study was previously published at a peer reviewed journal, but was later retracted on October 2024 due to an error with product labels matching their actual environmental and nutrition scores (https://doi.org/10.1016/j.appet.2024.107711). I was not involved in the labelling intervention study, and a discussion with the corresponding author of the main study ascertained that the error did not impact the analyses reported in this chapter.

environmental impact scores ranging from 0 (most healthy/sustainable) to 100 (least healthy/sustainable). The study allocated participants to one of three intervention arms which displayed labels on food items that indicated their environmental impact, health impact, both impacts, or to a control arm with no labels. After completing the shopping task, participants were directed to a post-experiment survey where they provided information on their demographic characteristics and eating habits (see Appendix 2.3). At this time, they were also presented with four social norm statements (detailed in the measures sections below) and asked to state their level of agreement with each statement.

2.2.2 Measures

Perceptions of Social Norms. Participants were asked to state their level of agreement with four statements (Table 2.1) on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree". The statements differed in their domain (sustainable versus healthy) and referent group (distant versus close) in order to assess perceived social norms around food choices.

Meat Production Attitudes. Participants were asked to report their beliefs on the environmental impact of producing meat and meat products (beneficial, harmful, no effect, don't know (Table 2.2).

Meat Reduction Intentions. Participants were asked whether they have considered reducing the amount of meat they eat (has reduced, wants to reduce, wants no change, wants to increase) (Table 2.3).

Table 2. 1 Social Norm Statements

	Domain	Referent Group
1. "Most people in the UK will try to choose the food items that are better for the environment"	Sustainable	Distant
2. "People who I share my meals with will try to choose the food items that are better for the environment."	Sustainable	Close
3. "Most people in the UK will try to choose the food items that are better for their health."	Healthy	Distant
4. "People who I share my meals with will try to choose the food items that are better for their health."	Healthy	Close

Table 2. 2 Meat Production Attitude Items

"The following statement best reflects my beliefs regarding the impact of producing meat and meat products on the environment":
I believe that producing meat and meat products has a harmful effect on the environment.
I do not know how producing meat and meat products affects the environment.
I believe that producing meat and meat products has no effect on the environment.
I believe that producing meat and meat products has a beneficial effect on the environment.

Table 2. 3 Meat Reduction Intention Items

"Have you considered reducing the amount of meat that you eat?"
Yes, I've reduced the amount of meat I eat in the past 5 years.
Yes, I would like to reduce the amount of meat I eat, but haven't yet.
No, I'm happy with the amount of meat I eat / don't eat.
No, I would like to eat more meat.

Shopping basket environmental impact scores. Environmental impact scores were calculated by linking ingredient lists with a global environmental Life Cycle Assessment (LCA) database and based on greenhouse gas emissions, water use, biodiversity loss and water pollution. Impacts for the four indicators were collapsed into a single product-level score (0-100; lowest-highest impact; most sustainable to least sustainable). These scores were derived by identifying the composition of each ingredient in a food product, and then estimating the composition of each ingredient in each food using prior known information from similar products, nutrition information for that product, and UK labelling regulations on how ingredients must be reported on packaging information. Each ingredient in a product was then sorted into a food category to pair with publicly available LCA environmental database. The estimated composition and the environmental database, which provides estimates of the environmental impacts per 100g of each food commodity, were then used to estimate the environmental impact per 100g of each product for the four environmental indicators listed above (Poore & Nemecek, 2018). The scores for these indicators were then aggregated into a single composite product-level score which range from 0 (lowest environmental impact; most environmentally sustainable) to 100 (highest environmental impact; least environmentally sustainable). Detailed

information on calculating the environmental impact scores is described elsewhere (Clark et al., 2022).

Shopping basket health impact scores. Health scores were calculated using the NutriScore method (Chantal et al., 2017) which considered the composition of 'nutrients to limit' (e.g. sugars, saturated fats) and 'nutrients to encourage' (e.g. proteins and fibre) and which assigned a score each product from 0 (most nutritious) to 100 (least nutritious). Each product was given a NutriScore based on seven food components: energy, saturated fat, salt, sugar, fibre, protein, and the number of fruits, vegetables, nuts, and some oils. Each of these seven components was given a score (scores for the first four components range from 0-10; scores for the last three components range from 0-5) against pre-set thresholds. In general, but with exceptions for certain types of foods (e.g., fats, cheese, etc.) and for drinks, the scores for the first four components were summed together (for a maximum of 40), and then the summed score of the last three components (a maximum of 15) were subtracted from the summed score of the first four components. This numeric score could therefore range from -15 to 40, with lower scores indicating a better nutrition quality. This numeric score was then scaled to range from 0 to 100, such that 0 indicates the best possible nutrition composition and 100 indicates the worst possible nutrition composition.

2.2.3 Data Analysis

The research questions were contextualized within existing social norm theories and a logic model was created (see Figure 1). Based on TPB and the Focus Theory of Normative Conduct, I hypothesized that both attitudes (measured as beliefs regarding the environmental impact of meat production), and perceived social norms would have a significant association with intentions (measured as meat consumption change)

and behaviors (measured as the environmental score of the shopping basket). Adding to these theories, I hypothesized that attitudes and perceptions of social norms would be significantly associated with each other (Figure 2.1).

The social norms rating data was treated as an ordinal variable and checked for normality with Q-Q plots. As the data was non-normally distributed, analyses proceeded with non-parametric tests. Average Likert scale ratings were calculated for each social norm item for measuring the perceived social norms around healthy and pro-environmental food choices. The mean level of agreement with social norm statements for close vs. distant referent group items were compared with Wilcoxon signed rank tests. Multinomial logistic regressions were used to explore the effect of participant characteristics (age, gender, and educational attainment) on agreement with social norm statements.

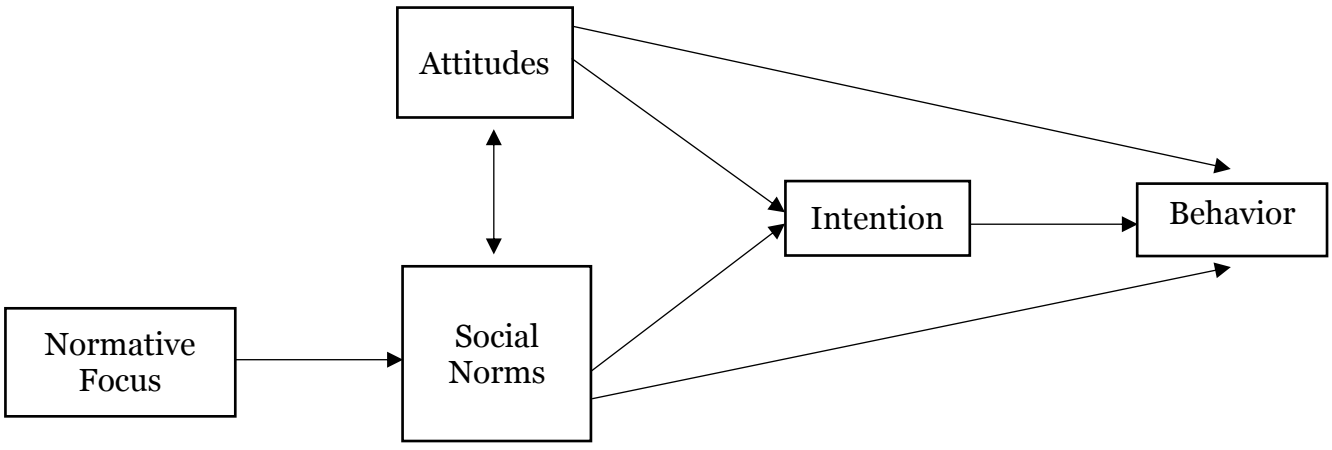
In order to assess the relationship between meat production attitudes, meat reduction intentions, and perceptions of social norms, multinomial logistic regression models were run. No change in consumption and neither agreeing nor disagreeing with the norm statement were selected as the base outcomes, and belief that meat production had no effect on the environment selected was as the base comparison category for attitude.

Linear regressions using robust estimators of variance to overcome problems of heteroskedasticity and non-normal residuals, were run to assess the effect of agreement with social norm statements referring to both close and distant referent groups making sustainable food choices on the environmental impact score of participants' shopping basket, with intervention arm allocation entered as a covariate. The same procedure was repeated for assessing the health score of the shopping baskets with the health social norm statements. Linear regressions were also run to

assess the effect of individuals' attitudes on the impacts of meat production for the environment on their shopping basket environmental impact score.

Since the present study was part of a larger investigation to assess the effects of labelling food products with environmental and health impact information on food choices, checks were conducted to ensure that there were no effects of the prior study. The potential priming effect of allocation of intervention arms on perceptions of social norms was investigated. Kruskal-Wallis one-way analyses of variance were run in order to compare the average Likert scale rating of pro-environmental social norms of participants in each of the allocation groups (control vs. environmental vs. environmental + health labels) and the average Likert scale rating of health social norms of participants in each of the allocation groups (control vs. health vs. environmental + health), treating the outcome (average Likert scale ratings) as a categorical, non-continuous variable.

Figure 2. 1 Logic model based on TPB and Focus Theory of Normative Conduct



2.3 Results

2.3.1 Participant characteristics

In total, 2488 eligible participants completed the survey. 2481 out of 2488 participants answered the social norm questions. 55.4% of the participants were female, 41.8% had received higher education (bachelor's degree or above), and 23.76% fell into a higher income bracket (£40,000 and above) (Table 2.4).

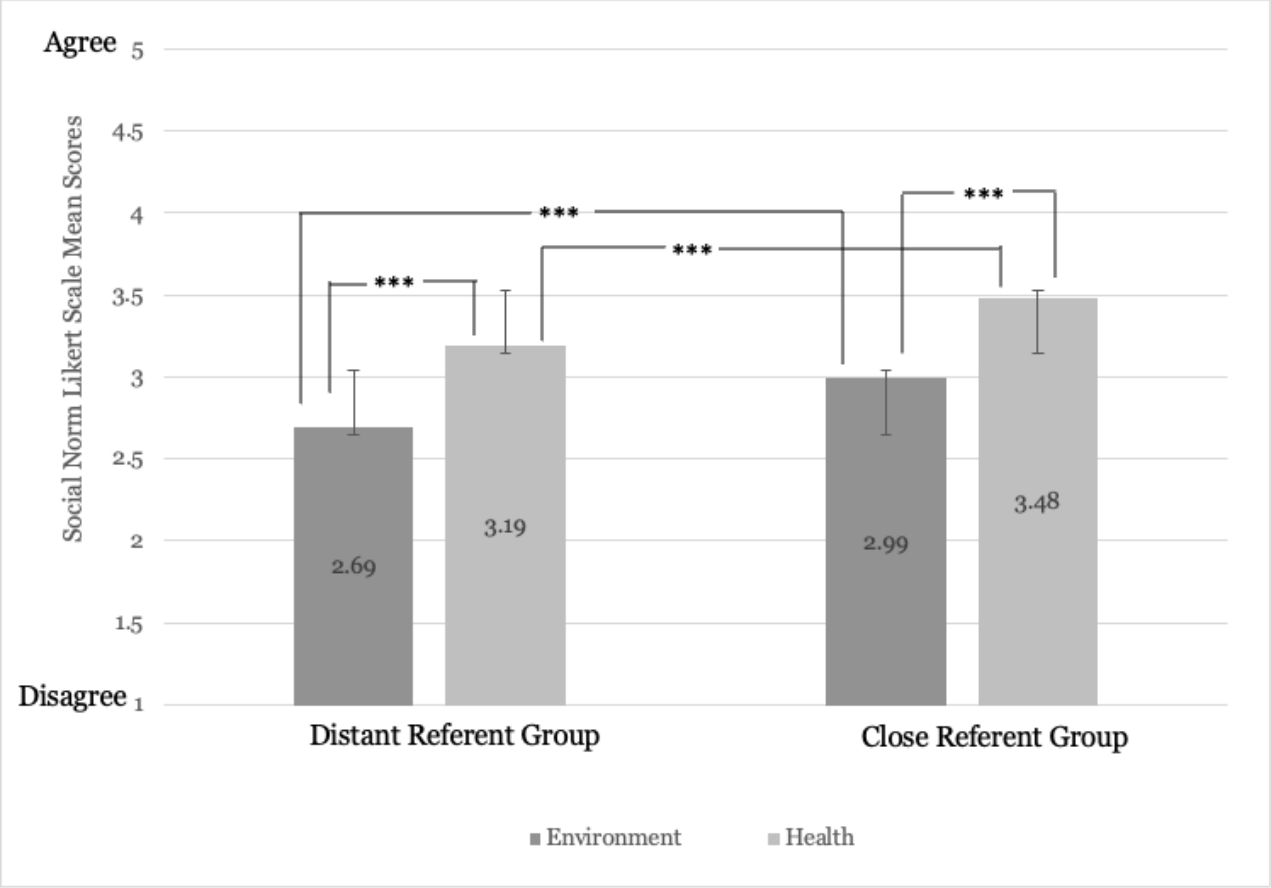
2.3.2 Differences in perceptions of social norms based on referent group and domain

The means and standard deviations of the Likert scale ratings (possible range: 0-5) of all four social norm items are shown in Figure 2.2. Wilcoxon signed rank tests indicated that participants were more likely to perceive making healthier food choices to be the norm compared to sustainable choices, regardless of referring to distant ($Z= -23.96$, $p<0.001$) or close ($Z= -23.84$, $p<0.001$) referent groups. With regards to the differences between referent groups, Wilcoxon tests indicated that participants perceived their close referent group to make both healthier ($Z= -12.08$, $p<0.001$) and more sustainable ($Z= -13.27$, $p<0.001$) food choices compared to the UK general population ($N = 2481$).

Table 2. 4 Demographic characteristics of participants (n=2481)

Demographic categories	Frequency	Valid Percentage
Age (years)		
18-24	344	12.6
25-34	478	17.5
35-44	552	20.2
45-54	609	22.3
55+	747	27.4
Gender		
Female	1377	55.4
Male	1111	44.6
Not specified	242	
Education		
1-4 GCSEs	326	13.2
5+ GCSEs or 1 A-level	462	18.7
2+ A-levels	648	26.3
Bachelor's degree	702	28.4
Graduate degree	331	13.4
Not specified	261	
Income		
Less than £15,000	638	27.9
£15,000 – 24,999	520	22.7
£25,000- 39,999	588	25.7
£40,000-75,000	436	19.0
Over £75,000	109	4.8
Not specified	439	

Figure 2. 2 Means of responses to social norm items (1 = strongly disagree – 5 = strongly agree) (***= p<0.001).



2.3.3 Effects of participant characteristics on perception of social norms.

The ordinal social norm data violated the assumptions of both linear regressions (non-normal distribution of residuals) and ordinal logistic regressions (expected odds between groupings were not proportional). Therefore, to explore the effects of demographic characteristics on perceived social norms around healthy and pro-environmental food choices, I built multinomial logistic regression models for each social norm item separately by entering the demographic variables as predictors. The neutral "neither agree nor disagree" category was selected as the base for the outcome and the lowest income and education subgroups, and youngest age subgroup were chosen as the reference category for the predictors. Since the model required a number

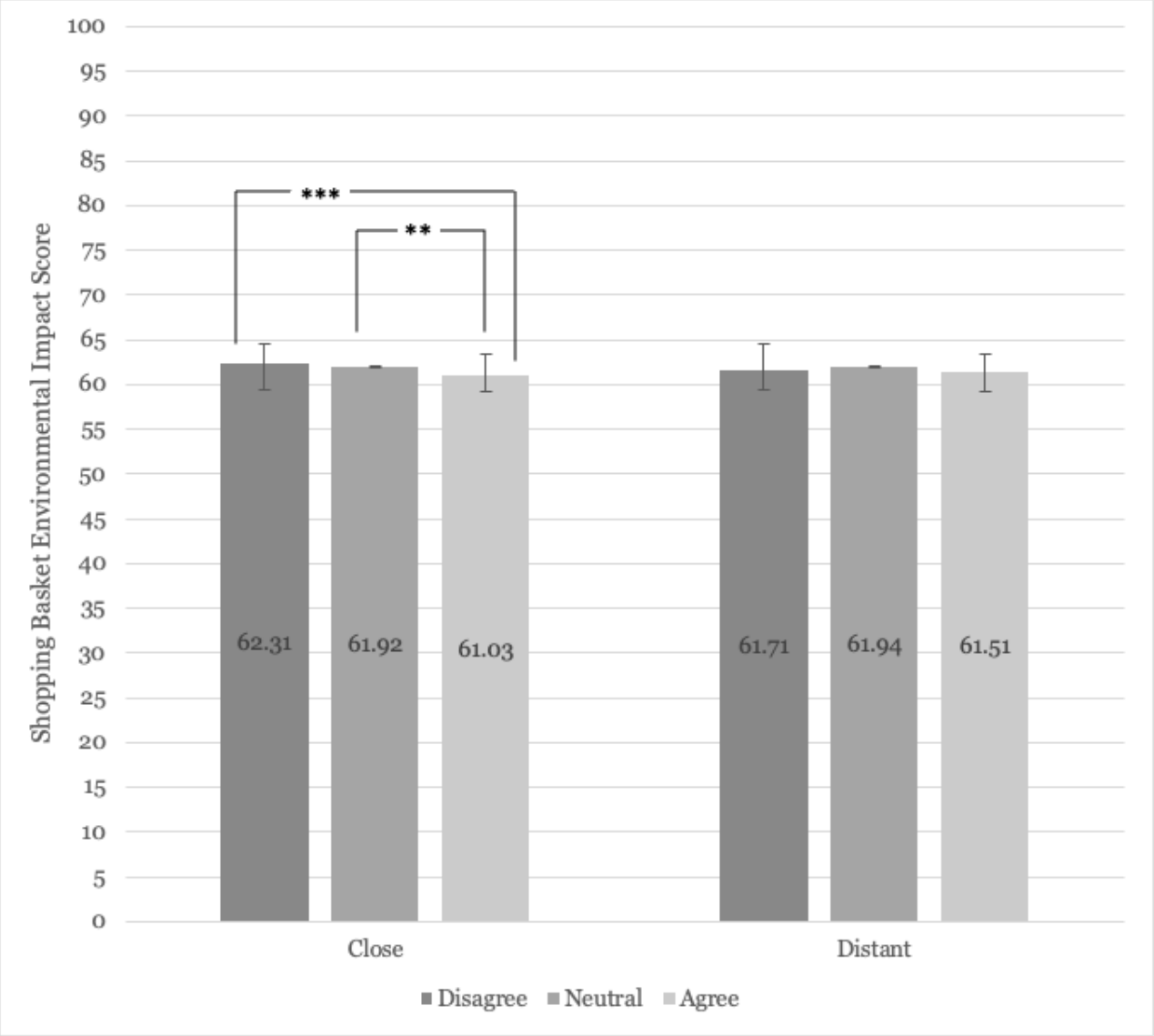
of statistical tests to be run on the data simultaneously, I used a Bonferroni correction to adjust the critical p-value. With the more conservative threshold for significance, only an effect of age was observed in the social norm item for the sustainability domain and distant reference group. Compared to the youngest age group (18-24) those aged 25-54 were less likely to disagree (25-34: B=-.56, p=.002; 35-44: B-.66, p=.000); 45-54: B=-.65, p=.000) than answer 'neither agree nor disagree' to the statement "Most people in the UK will try to choose the food items that are better for the environment", while those aged 45 and above were less likely to agree than answer 'neither agree nor disagree' (45-54: B=-.85, p <.001; 55+: B=-1.11, p=.000); indicating that older participants were less likely to have a strong opinion with regard to how much the general UK population think about the environment when making food choices than the youngest participants. (Table 2.5).

2.3.4 Effects of perceptions of social norms on shopping basket environmental scores

Those who agreed with the social norms statement "People who I share my meals with will try to choose the food items that are better for the environment" had a .90-point (p < .01, 95% CIs: [-1.49, -.28]) and 1.3-point (p<.001, 95% CIs: [-1.92. -.66]) reduction in their environmental impact, in comparison to those who were neutral and disagreed with the item, respectively. (Figure 2.3). This relationship remained statistically significant after intervention arm (environmental labels, health labels, both, neither) was included in the models as a covariate (agree vs. neutral .80-point decrease, p < .01, 95% CIs: -1.40, -21; agree vs. disagree: 1.2-point decrease, p<.001, 95% CIs: -1.83. -.57). For verification, environmental impact scores of those who disagreed with the close referent group social norm statement were also compared to those who were neutral, and no difference was found (.40-point decrease in negative environmental impact, p > .05, 95% CIs: -.97, .17). There was no evidence that those

who agreed with the "Most people in the UK will try to choose the food items that are better for the environment" social norm statement had statistically significantly different shopping basket scores compared to those who were neutral (.43-point decrease, $p > .05$, 95% CIs: [-1.12, .25]) and to those who disagreed (.21-point decrease, $p > .05$, 95% CIs:[-.88, .48]) (Table 2.6)

Figure 2. 3 Mean environmental scores (0-100; lowest-highest impact) of participant shopping baskets by perceptions of social norms around sustainable food choices across referent groups.



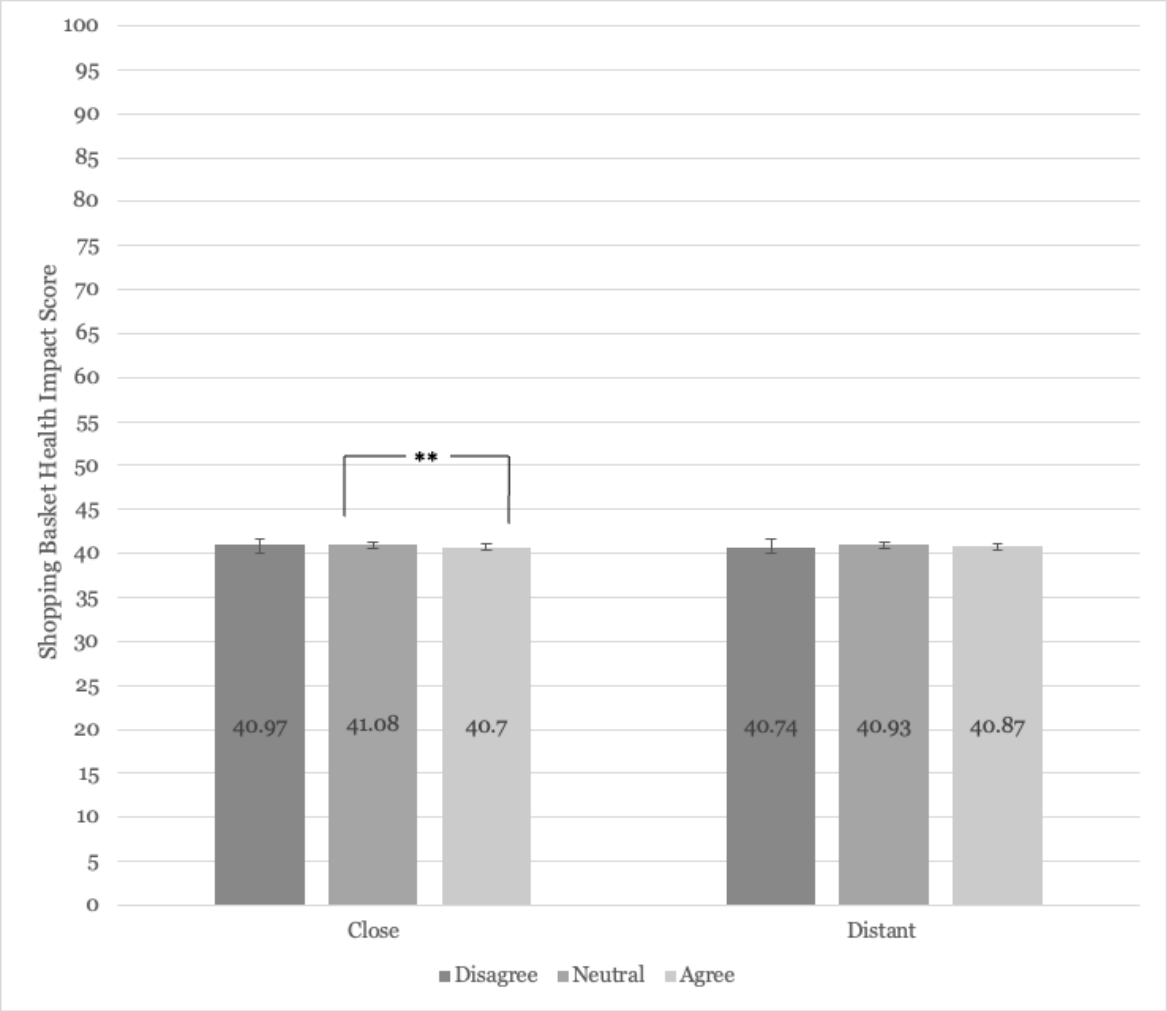
2.3.5 Effects of perceptions of social norms on shopping basket health scores.

Similar to the environmental scores, agreeing with the social norm statement for the close referent group ("People who I share my meals with will try to choose the food items that are better for their health.") agreement with the social norm statement for the distant referent group (Figure 2.4) was associated with a .38-point reduction ($p < .05$, 95% CIs: -.68, -.08) in shopping basket health impact scores compared to being neutral towards this statement. This relationship remained statistically significant after intervention arm (environmental labels, health labels, both, neither) was included in the model as a covariate statement (.38-point decrease $p < .05$, 95% CIs: -.68, -.07). Contrastingly, there wasn't a statistically significant reduction of shopping basket health impact scores when comparing those who agreed with the item to those who disagreed (.27-point decrease, $p > .05$, 95% CIs: -.68, .13).

For verification, health impact scores of those who disagreed with the item were also compared to those who were neutral, and no difference was found (.10-point increase in negative health impact, $p > .05$, 95% CIs: -.33, .53).

There was no evidence that those who agreed with the statement for the distant referent group ("Most people in the UK will try to choose the food items that are better for their health.") had statistically significantly different shopping basket scores compared to those who were neutral (.06-point decrease, $p > .05$, 95% CIs: -.37, .25) and to those who disagreed (.13-point increase, $p > .05$, 95% CIs: -.21, .47) with this statement. (Table 2.7)

Figure 2. 4 Mean health scores (0-100, best-worst health impact) of participant shopping baskets by perceptions of social norms around healthy food choices across referent groups.



2.3.6 Priming effect of intervention arm on perception of social norms

Compared to the control group, being exposed to either health or environmental labelling, or both, did not lead to any difference in participants' perceptions of social norms, providing no evidence for a priming effect. Moreover, there were no significant differences in responses to the four social norm items between intervention groups.

2.3.7 Effects of meat production attitudes on perceptions of social norms

Those who believed meat production was harmful were less likely to think that the distant reference group made healthy and environmentally conscious food choices compared to the comparison category of those who stated that meat production had no effect on the environment. However, this group was also more likely to think that their close referent group made healthy food choices compared to those who thought meat consumption had no effect on the environment (Table 2.8).

2.3.8 Effects of meat production attitudes on meat reduction intentions.

Compared to those who believed meat production had no effect on the environment, those who thought it was beneficial were significantly more likely to want to increase their meat consumption while those who thought it was harmful were significantly less likely. Those who did not express an opinion on the impacts of meat production and those who thought it was harmful for the environment were significantly more likely to want to reduce or to have recently reduced their meat consumption (Table 2.9).

2.3.9 Effects of perceptions of social norms on meat reduction intentions.

Compared to those who had neither agreed nor disagreed with statements on perception of social norms, those who endorsed environmental norms in both the distant and close groups were more likely to want to reduce or to have recently reduced their meat consumption. Contrastingly, those who did not perceive there to be environmental and health norms in the distant group were more likely to have recently reduced their meat consumption. Those who endorsed the health norm in the distant group were more likely to want to reduce their meat consumption. Finally, those who endorsed the health norm in the close group were more likely to have reduced their meat consumption (Table 2.10).

2.3.10 Effects of meat production attitudes on shopping basket environmental scores.

Compared to those who believed that meat production had no effect on the environment, those who believed it has a harmful effect had a lower environmental impact score for their shopping basket (1.86-point decrease, 95% CIs: -2.56 to -1.17, p <.000). There were no significant differences in scores for those who thought meat production was beneficial for the environment and those who did not express an opinion compared to those with a no effect response (Table 2.11).

2.3.11 Effects of meat reduction intentions on shopping basket environmental scores.

Compared to those who didn't want to change their meat consumption, those who had recently reduced their meat consumption had a statistically significantly lower environmental impact score of their shopping basket. (1.74-point decrease, 95% CIs: -2.33, -1.14). This coefficient remained statistically significant after intervention arm was included in the model as a covariate (Table 2.12).

Table 2. 5 Multinomial Logistic Regression Model for Social Norm Items and Demographics

Independent Variables	Environment, Distant		Environment, Close		Health, Distant		Health, Close	
(Base = Neither agree nor disagree)	Disagree	Agree	Disagree	Agree	Disagree	Agree	Disagree	Agree
Gender (Female)								
Male	.06 (.524)	-.06 (.632)	-.10 (.360)	-.23 (.028)	.19(.101)	-.26(.012)	-.15(.301)	-.14(.154)
Age (18-24)								
25-34	-.56 (.002)	-.23 (.282)	-.12 (.526)	.07 (.700)	-.60(.004)	-.08(.683)	.02(.915)	.17(.339)
35-44	-.66 (.000)	-.48(.023)	-.16 (.382)	-.16 (.390)	-.45(.025)	-.05(.785)	-.03(.910)	.16(.351)
45-54	-.65(.000)	-.85(.000)	-.36 (.048)	-.35 (.054)	-.48(.013)	-.14 (.274)	-.01(.966)	.16(.337)
55+	-.39(.027)	-1.11(.000)	-.35(.059)	-.47 (.013)	-.54(.006)	-.50(.008)	-.72(.005)	.25(.137)
Education								
5 or more GSCEs	.02 (.893)	.01(.941)	.08 (.678)	.10 (.590)	-.13 (.539)	-.22(.195)	.03(.907)	-.04(.821)
2 or more A-levels	.41 (.011)	-.09(.627)	.11 (.505)	.26 (.142)	.10(.628)	-.08(.625)	.26(.234)	.43(.008)
Bachelor's degree	.37 (.026)	.07(.721)	-.11 (.531)	.26 (.146)	.03(.869)	-.14(.419)	.21(.365)	.35(.033)
Post-graduate degree	.35 (.071)	.00(.990)	.03 (.891)	.51 (.014)	.24(.284)	-.30(.132)	.12(.669)	.47(.015)
Income (Less than £15,000)								
£15,000-£24,999	-.03 (.822)	-.08 (.640)	-.35 (.015)	-.20(.174)	-.05 (.750)	.22 (.120)	.00(.993)	.28(.044)
£25,000-£39,999	-.07 (.603)	.09(.592)	-.41(.005)	-.03 (.823)	-.07(.643)	.15(.274)	-.16(.387)	.07(.585)
£40,000-£74,999	.28 (.066)	.52(.006)	.04 (.824)	.42 (.011)	.19(.292)	.42(.008)	-.16(.480)	.41(.007)
£75,000+	.27(.265)	.19(.563)	-.84 (.004)	-.14(.569)	-.19(.509)	.04(.879)	-1.06(.024)	.25(.297)
Pseudo R^2	.0193		.0149		.0125		.0171	
Model chi^2 (df=26, p<0.001)	91.93		73.99		61.22		75.24	

N= 2274, Bonferroni Correction critical p value = .003

Table 2. 6 Linear Regression Model for effects of environmental social norms and intervention condition on environmental impact of shopping baskets

	Environment, Distant		Environment, Close	
Independent Variables	β (p-value)	[CI] (95%)	β (p-value)	[CI] (95%)
Model 1 (Norm only)				
Disagree	-.23	[-.77, .31]	.40	[-.17, .97]
Agree	-.43	[-1.12, .25]	-.90**	[-1.49, -.28]
Model 2 (Norm + Condition)				
Disagree	-.23	[-.77, .31]	.40	[-.17, .97]
Agree	-.39	[-1.1, .29]	-.80**	[-1.40, -.21]
Condition				
Sustainable	-1.53***	[-2.38, -.68]	-1.46***	[-2.3, -.61]
Healthy	-.39	[-1.2, .43]	-.36	[-1.2, .46]
Sustainable + Healthy	-2.2***	[-3.04, -1.33]	-2.14***	[-2.99, -1.28]
R^2 (M1)	.0007		.0068	
(M2)	.0182		.0235	
F (2, 2478) (M1)	0.84		8.09	
F (5,2475) (M2)	9.22		11.07	

Table 2. 7 Linear Regression Models for effects of health social norms and intervention condition on health impact of shopping baskets

	Health, Distant		Health, Close	
Independent Variables	β	[CI] (95%)	β	[CI] (95%)
Model 1 (Norm only)				
Disagree	-.19	[-.54, .16]	-.10	[-.53, .33]
Agree	-.06	[-.37, .25]	-.38*	[-.68, -.08]
Model 2 (Norm + Condition)				
Disagree	-.19	[-.54 - .16]	-.10	[-.53, .34]
Agree	-.06	[-.37, .25]	-.38*	[-.68, -.07]
Condition				
Eco	.02	[-.44, .49]	.02	[-.46, .50]
Health	-.07	[-54, .41]	-.07	[-.55, .41]
Eco + Health	-.16	[-.62, .30]	-.16	[-.66, .32]
R^2 (M1)	.0005		.0026	
(M2)	.0009		.0	
F(2, 2478) (M1)	0.58		3.27	
F(5,2475) (M2)	0.46		1.52	

Table 2. 8 Multinomial Logistic Regression Model for Associations Between Perceptions of Social Norms and Meat Attitudes

Independent Variables	Environment, Distant		Environment, Close		Health, Distant		Health, Close	
(Base = Neither agree nor disagree)	Disagree	Agree	Disagree	Agree	Disagree	Agree	Disagree	Agree
Meat Attitudes (Base=No effect)								
Beneficial	.29(.145)	.44 (.055)	-.25 (.238)	.31(.145)	-.08 (.766)	.18 (.930)	-.05 (.870)	.71(.000)
Harmful	1.07(.000)	.04 (.829)	.02 (.907)	.17(.315)	.53 (.003)	-.38 (.011)	.32(.104)	.62(.000)
Don't know	.07(.617)	-.14 (.424)	-.27(.070)	-.44(.009)	-.10 (.569)	-.16 (.253)	.03 (.882)	.18(.206)
Pseudo R^2	.0322		.0462		.0172		.0234	
Model chi^2 (df=12, p<0.001)	167.33		249.30		91.81		112.67	
N= 2481								

Table 2. 9 Multinomial Logistic Regression Model for Effects of Meat Attitudes on Meat Consumption Intentions

Independent Variables	Wants to Increase	Wants to Reduce	Has Reduced
(Base = Neither agree nor disagree)			
Meat Attitudes			
(Base=No effect)			
Beneficial	.949 (.001)	-.312 (.272)	.353 (.189)
Harmful	-1.08 (.006)	1.57 (.000)	2.59 (.000)
Don't know	-.654 (.023)	.573 (.001)	.934 (.000)
Pseudo R^2	.0919		
Model chi^2 (df=9, p<0.001)	534.32		
N= 2483			

Table 2. 10 Multinomial Logistic Regression Model for Effects of Perceptions of Social Norms on Meat Consumption Intentions

Independent Variables	Environment, Distant		Environment, Close		Health, Distant		Health, Close	
(Base = Neither agree nor disagree)	Disagree	Agree	Disagree	Agree	Disagree	Agree	Disagree	Agree
Meat Consumption Intentions (Base=No change)								
Wants to increase	.268 (.268)	.665 (.024)	.386 (.105)	.303 (.306)	-.353 (.241)	-.076 (.745)	.181 (.526)	-.336 (.162)
Wants to reduce	.173 (.163)	.883 (.000)	-.131 (.328)	.953 (.000)	.221 (.137)	.379 (.003)	-.027 (.874)	.235 (.051)
Has reduced	.319 (.002)	.638 (.000)	-.408 (.001)	1.23 (.000)	.368 (.003)	.064 (.561)	-.034 (.836)	.772 (.000)
Pseudo R^2	.0082		.0367		.0041		.0135	
Model chi^2 (df=6, p<0.001)	47.78		203.09		23.83		78.27	
N= 2481								

Table 2. 11 Linear Regression Model for effects of meat production attitudes and intervention condition on environmental impact of shopping baskets

	Meat Production Attitudes	
Independent Variables	β (p-value)	[CI] (95%)
Model 1 (Attitude only)		
Beneficial	.042	[-.98, 1.06]
Harmful	-1.87***	[-2.56, -1.17]
Don't Know	-.391	[-1.08, .30]
Model 2 (Attitude + Condition)		
Beneficial	.063	[-.946, 1.07]
Harmful	-1.79***	[-2.48, -1.09]
Don't Know	-.332	[-1.02, .36]
Condition		
Sustainable	-1.43***	[-2.28, -.58]
Healthy	-.301	[-1.11, .51]
Sustainable + Healthy	-2.08***	[-2.94, -1.23]
R^2 (Model1)	.0175	
(Model2)	.0340	
F (3, 2479) (Model1)	14.27	
F (6, 2476) (Model2)	14.27	

Table 2. 12 Linear Regression Model for effects of meat reduction intentions and intervention condition on environmental impact of shopping baskets

	Meat Reduction Intentions	
Independent Variables	β (p-value)	[CI] (95%)
Model 1 (Intention only)		
Wants increase.	1.07	[-.04, 2.17]
Wants decrease.	-.435	[-1.06, .19]
Has decreased	-.1.74***	[-2.33, -1.14]
Model 2 (Intention + Condition)		
Wants increase	.911	[-.23, 3.05]
Wants decrease	-.423	[-1.04, .19]
Has decreased	-.1.78***	[-2.37, -1.19]
Condition		
Sustainable	-1.45***	[-2.29, -.61]
Healthy	-.337	[-1.15, .48]
Sustainable + Healthy	-2.19***	[-3.04, -1.35]
R^2 (M1)	.0175	
(M2)	.0354	
F (3, 2479) (M1)	13.69	
F (6, 2476) (M2)	14.60	

2.4 Discussion

This survey examined individuals' perceptions of social norms regarding the environmental and health impact of food choices for both distant (general UK population) and close (people they share their meals with) referent groups. It also measured attitudes around meat production and its effects on the environment, intentions of reducing meat consumption, and behaviors around food choices in an online shopping task assessed with an environmental and a health score.

The results showed that individuals reported that they thought people who they share meals with are more likely to make sustainable and healthy food choices compared to the general population, indicating that they are more likely to perceive this to be a norm among their closer referent group. My findings are consistent with previous findings that referent groups can moderate the perceived prevalence of social norms and their influence on healthy eating behavior, increasing fruit and vegetable intake, and reducing meat consumption (Cruwys et al., 2012; Higgs et al., 2019; Jinyu Liu et al., 2019; Sparkman et al., 2020; Stok et al., 2014). The moderating role of referent groups have also been demonstrated in behavioral intervention studies. For example, a series of studies conducted in university restaurants in the US found dynamic descriptive norm messages to be effective in promoting a shift from animal to plant-based foods when customers had "a greater connection to the norm referent" used in the messaging intervention (Sparkman & Walton, 2017). While a subsequent study in the United Kingdom failed to reproduce these results, it has only used a general referent group ("people in the UK") and did not include a measure of in-group identification with the referent, which the authors have acknowledged as a limitation that warrants further study (Aldoh et al., 2021). These limited findings from social

norm intervention studies suggest that further research is necessary to understand the moderating role of referent groups in the efficacy of interventions.

The referent groups also moderated the relationship between social norms perceptions, intentions to reduce, and actual reduction of meat consumption. While those who wanted to reduce their meat consumption were more likely to perceive healthy food choice norms as prevalent among the distant referent group, those who have already reduced their consumption were more likely to perceive this as a norm among the close referent group, both compared to those who did not want to change their consumption. In this case, the proximity of the referent group may have increased the salience of the norm to make healthy food choices, which then influenced the individuals' behavior (i.e., reducing their meat consumption). On the other hand, those who have intentions to reduce but have not yet done so were more likely to perceive this norm as prevalent among the general population. This may be because norms perceived in the distant referent group are able to influence intention but are not salient enough to close the intention - behavior gap (Pristl et al., 2021).

Attitudes had significant associations with perception of social norms, intentions to reduce meat consumption, and environmental impact scores in the shopping task. In an expected direction, individuals who believed meat production was harmful for the environment were less likely to perceive sustainable food choice social norms around among the general population compared to those who thought meat production had no effect on the environment. One possible explanation for this finding could be that individuals who think meat production is negatively impacting the planet would wish to see decreased meat consumption in the general population and may be likely to underestimate the general population's attitudes and behaviors around making sustainable food choices. This echoes findings from the literature that people are likely to misperceive others' level of engagement in healthy behaviors such as fruit

and vegetable consumption (Dempsey et al., 2018; Lally et al., 2011). In contrast, these individuals gave stronger endorsements of perceived social norms around healthy and sustainable food choices for their close referent group, suggesting that their perceptions of prevalent norms in their close circle differed from those in the general population. The belief that their close referent group made more sustainable choices could have also shaped individuals' beliefs on the harms of meat production on the planet, highlighting the bidirectional connection between social norms and attitudes. Interestingly, those who believed meat production was beneficial for the environment were more likely to perceive social norms around environmentally conscious food choices to be prevalent for both referent groups compared to those with no opinion. This may suggest that the current prevalent norm of high meat consumption in the UK is congruent with these individuals' beliefs about meat production, and this is reflected in their perception of both the general population's and their close circle's behaviors. While most prominent theories of social norm, including TPB, acknowledge that both attitudes and social norms influence intentions and behaviors, they do not focus on the potential associations between the two. However, similar to how the behaviors of others influence the behaviors of an individual, these findings suggest that attitudes can influence and be influenced by perceptions of attitudes of others. Individuals who thought meat production was harmful for the environment were also more likely to want to reduce their meat consumption and to have a lower environmental impact score in the virtual shopping task, showing the clear link between attitudes, intentions and behaviors. This finding adds to the considerable body of evidence that supports that TPB is a useful model in explaining meat reduction behaviors (Cheah et al., 2020; Çoker & van der Linden, 2020; Povey et al., 2001; Zur & A. Klöckner, 2014).

A link between meat reduction behaviors and the environmental impact scores of shopping baskets in the virtual supermarket food choice experiment was also found.

One explanation for this is that individuals who have reduced their meat consumption in real life may have also chosen more meat-free options in the virtual shopping task compared to those who have not changed their meat consumption, bringing the overall environmental impact of their shopping basket down. However, the results showed no association between having an intention to reduce meat consumption and lower environmental basket scores, further highlighting the intention-behavior gap when it comes to eating and sustainability behaviors (Bamberg & Möser, 2007; Laffan et al., 2023; Loy et al., 2016; Rosenfeld & Tomiyama, 2019).

When formulating social norm messages for behavioral interventions, choosing a relevant referent group that individuals will be able to relate to in the context of the specific behavior is important in ensuring the salience of the said norm. The findings from this study suggest that using a close referent group (i.e., close others, peers, family, loved ones) that individuals are likely to consume food together with increases the perception of positive social norms (i.e., making healthy and sustainable choices) around food consumption. Future interventions that target food choices, in particular meat consumption, would benefit from framing their norm messages to refer to close referent groups other than more general ones. The associations between perceptions of norms, intentions to reduce meat consumption, and the environmental score of shopping baskets in the online task add to existing literature that suggest social norms significantly influence intentions and behaviors. Similarly, an association between individuals' beliefs on effects of meat production on the environment and their intentions and behaviors has been found, in line with existing literature on the influence of attitudes in the context meat consumption as a pro-environmental behavior. This suggests that understanding the individuals' own beliefs in addition to their perception of social norms around it can provide useful insights for a potential disconnect between attitudes and norms that are perceived to exist in the social world

and allow for the design and implementation of interventions that aim to fix misperceptions of norms.

2.4.1 Strengths and limitations

The study benefited from a large sample size of 2488 respondents that were representative of the general UK population in terms of gender, age, education and income, a rare opportunity in social norm and eating behavior research.

This study measured the perception of the presence of norms around considering environmental and health impacts of items when making food choices. However, it did not ask individuals to rate the importance of these norms, i.e., how much these norms matter to them and how much they wish to conform to the behaviors the norm prescribes. The measure for behavior was also a proxy which was assessed through a virtual shopping task, where individuals did not spend real money, nor did they need to purchase or consume real food. The nature of the study and its analyses were also simply associational and did not aim to determine any directional causality, instead mapping out links between perceptions of social norms and certain attitudes and beliefs about meat consumption and production. A plausible possibility that is not introduced in the logic model is that individuals' own beliefs and behaviors could be influencing their perceptions of social norms, where a confirmation bias may be altering their evaluation of others' beliefs and behavior and perceiving them to be more or less prevalent depending on what their own beliefs and behaviors are.

Although the study had a representative sample for the UK in terms of age, gender, education and income, it did not include any quotas for ethnic subpopulations. Due to the intrinsically cultural and social nature of eating behaviors, understanding how relevant norms are shaped across different ethnic groups and subpopulations may prove crucial for designing effective interventions to promote more sustainable food

choices within different contexts. Since the main study that preceded this survey also had an online shopping task component that required "purchase" of meat and dairy products, vegetarian and vegan individuals were also excluded from the sample, introducing a level of bias into my findings.

2.4.2 Conclusion

This study provides a clear snapshot of perceptions of norms around sustainable and healthy food choices by a representative sample for the general UK population, providing evidence for the importance of referent groups and attitudes in the perception of social norms. Future social norm interventions should consider factors such as social proximity and identity relevance when framing norm messages around a referent group in order to increase the perceived salience of norms and their potential to influence behavior.

Social norms are culture and context dependent, and, as this study has shown, can change with reference to different social groups. Attitudes are also subjective and are influenced by myriad factors, including demographic characteristics. Future research would benefit from exploring attitudes, norms, and behaviors around meat consumption across different ethnic communities in order to better understand the influence different cultures can have on these, which the following chapter will aim to address.

Chapter 3: Ethnic Differences in Meat Consumption Attitudes, Norms and Behaviors: A Survey of White, South Asian and Black Ethnic Groups in the UK

Summary

The UK has an increasingly multi-ethnic population, yet there is little research on meat consumption among its minority ethnic groups. This chapter details the results of a survey study (N=1014), which analyzed attitudes, norm perceptions and behaviors of White, South Asian and Black British respondents regarding meat consumption. Most respondents believed overconsumption of red and processed meat has negative impacts on health and the environment. South Asian respondents were significantly less likely to be meat eaters than White respondents (OR = .44, 95% CIs: .30-.65, t= -4.15, p< .001), while there was no significant difference between White and Black respondents (OR = 1.06, 95% CIs: .63-1.76, t= 0.21, p= .834). Both South Asian (OR = 2.76, 95% CIs: 1.89-4.03 t= 5.25, p < .001) and Black respondents (OR =2.09, 95% CIs: .1.30-3.35, t =3.06, p = .002) were significantly more likely to express that they were influenced by friends and family in their food choices than White respondents. South Asian (OR = 3.24 ,95% CIs: 2.17-4.84, t= 5.74, p< .001) and Black (OR = 2.02, 95% CIs: 1.21-3.39, t= 2.69, p= .007) respondents were also both significantly more likely to report they would want to eat similarly to their friends and family than White respondents. To my knowledge, this survey is the first to provide a detailed insight into the norms, beliefs and behaviors around meat consumption for White, South Asian

and Black ethnic groups living in the UK. The differences in meat consumption behaviors and norm conformity between ethnic groups found in this study raises the prospect that interventions leveraging social norms may be more effective for certain ethnic groups than others. Parts of this chapter were published in a peer-reviewed journal article: Çoker et al (2024), Appetite https://doi.org/10.1016/j.appet.2024.107359,

3.1 Introduction

I have previously established in Chapter 1 that globally, poor diets have been linked to a variety of negative health outcomes and red and processed meat intakes are above recommended values. However, underneath these global trends, diet composition and quality differ greatly across countries and ethnic groups. For example, while diets in South Asia are characterized by lower intake of red and processed meat and higher intake of whole grains, those in Europe and North America tend to have both higher intakes of red and processed meat, sugar-sweetened beverages, as well as fruit, vegetables, and legumes, making the former score higher on nutritional measures of diet quality than the latter (Miller, Webb, et al., 2022). Although global meat production has been increasing steadily, populations in Asia and Africa still mainly get the majority of their protein intake from plant-based sources and countries in these continents have some of the lowest meat consumption levels globally (Roser et al., 2023).

These national differences in dietary habits and food choices become more relevant with international immigration, when individuals move between two countries with significantly different dietary compositions, habits, and traditions. Adapting to a new country's diet may have some unexpected negative outcomes, especially if an individual is moving from a country with cultural practices and traditions that promote healthier diets to one that typically has more unhealthy components (Gilbert & Khokhar, 2008). Dietary acculturation, accompanied by changes in meal patterns, overall energy intake, increased intake of processed foods or foods high in saturated fat, sugar and salt, can lead to a number of health problems in immigrant communities (Garduño-Diaz & Khokhar, 2013). In the UK, evidence suggests that both South Asian and Black minority ethnic groups are at a higher risk of developing multiple long term

health conditions and having a stroke, and they have a higher prevalence and incidence of type 2 diabetes (Hayanga et al., 2023; Tillin et al., 2013; Tillin et al., 2015). People of South Asian ethnicity are also at a higher risk of experiencing cardiovascular diseases compared to White ethnic groups (Chaturvedi, 2003; Hippisley-Cox et al., 2013; Lawson et al., 2020). Given that quality and composition of diet is a considerable risk factor for these health outcomes (Afshin et al., 2019), it is important to understand whether and how dietary habits and food choices of these ethnic groups differ.

Despite the growth in the number of individuals belonging to diverse ethnic groups in the UK, and the evidence regarding disparities in health outcomes across these groups, there is no representative and large-scale nutrition survey for these groups (Leung & Stanner, 2011). The paucity of data concerning minority ethnic groups is often caused by issues regarding recruitment and retention of participants, language barriers, lack of trust of participants in the researchers, and culturally insensitive dietary measures (Bennett et al., 2023; Garduño-Diaz et al., 2014). These barriers may lead to under-recruitment of minority ethnic populations, as illustrated in the National Diet and Nutrition Survey (NDNS) cohort where only about 5% of the participants were Black or Asian, while 18% of all people living in England and Wales belong to a Black, Asian or other ethnic group according to the 2021 Census, (UK Gov, Bennett et al 2023).

While more research with larger and representative samples is needed to quantitively understand eating behaviors of minority ethnic groups living in the UK, there has been some evidence generation on the dietary habits and food choices of these groups using qualitative methods. Most of this qualitative research has not come from the discipline of psychology (which is my field), but from nutrition, sociology, anthropology, marketing, and consumer sciences. These studies have mainly explored the role of social connections, tradition, religion, and gender on eating behaviors and

food choices of minority ethnic groups in the UK, and some findings are highlighted below.

3.1.1 Factors influencing food choices and dietary habits of minority ethnic groups in the UK

Research has emphasized that for South Asian ethnic groups living in the UK, social gatherings, festivals, religious days, and community events have food at their center, and the meals consumed at these events are often decadent and high in calories, fat and sugar, symbolizing hospitality and celebration (Chowbey & Harrop, 2016; Emadian et al., 2017; Lawrence et al., 2007; Lawton et al., 2008). A comparison of individuals of European and South Asian origin living in Coventry found that South Asians were also more likely to live with their family, have larger families, and eat more meals communally with their household (Simmons & Williams, 1997).

Studies have also examined how food choices can be seen as a way of preserving tradition for minority ethnic groups living in the UK. For example, a focus group study with 110 parents in Luton found that both Black and South Asian parents wanted to bring their children up on a culturally traditional diet. The parents highlighted the importance of the presence of grandparents in the household as having a key role in their children's life and promoting more traditional eating practices (Cook et al., 2021). An ethnographic study of three families living in East London of Pakistani, Russian, and Algerian-Slovakian origin described how cooking traditional recipes at home was a way of enforcing emotional attachment to individuals' cultures of origin and their ancestors (Hodges & Wiggins, 2013). Similarly, a focus group study of young women of Pakistani, Bangladeshi, Somali and Zimbabwean origin living in the UK found that the participants took pride in their traditional cooking skills and placed

importance on how they acquired these skills from older generations of women in their family (Lawrence et al., 2007).

Religious practices and the restrictions they place on the consumption of certain food items have also been investigated. For example, a study looking at food shopping habits of South Asian Brits from 1947 to 1975 found that Muslim individuals were concerned about inaccessibility of halal meat, who then had no choice but to maintain vegetarian diets, demonstrating how religious requirements and restrictions can shape eating behaviors (Hamlett et al., 2008). Similarly, Pakistani and Bangladeshi young women living in Dundee have expressed that they choose fish options when eating out at fast food establishments because they can only eat halal meat (Lawrence et al., 2007).

A clear divide in gender roles when it comes to shopping for and cooking food also emerged. Qualitative interviews with Pakistani and Indian men living in Edinburgh found that cooking responsibilities were mostly taken on by the women of the household, making the men feel that their contribution to food selection and preparation was limited (Lawton et al., 2008). These findings were echoed in interviews with married overweight and obese South Asian men living in the Greater London area, who said that their wives did all the grocery shopping and cooking at home (Emadian et al., 2017). Focus groups of parents living in Luton have similarly found that in Black and South Asian families, the women were more likely to be responsible for preparing the food (Cook et al., 2021).

While existing qualitative evidence points to the importance of sociocultural factors affecting food choices of minority ethnic groups in the UK, these have often come from studies with small sample sizes, focusing on very specific subgroups (e.g. young Zimbabwean women living in Hampshire), or representing individuals living with certain health conditions (e.g. type 2 diabetes, obesity). It is important to note

that while the insights provided by these studies are useful, "food practices of minority ethnic individuals are not homogenous and vary by generation, geographic origin, age and religion" (Chowbey & Harrop, 2016), and making overgeneralizations from limited qualitative evidence must be avoided.

3.1.2. Meat consumption of minority ethnic groups in the UK

The studies summarized above have focused mostly on general composition and healthiness of diets, rather than providing information on the consumption of different types of foods. This means that there is currently little research available on how and why ethnic groups differ in their meat consumption in particular. Understanding the meat consumption behaviors of different ethnic groups is especially important in the case of the UK. The UK is a country with an average meat consumption per capita per year of around 82 kg, while some of its largest immigrant communities come from countries with remarkably lower meat consumption levels such as India (5.7 kg), Pakistan (18.6 kg), and Bangladesh (4.3 kg) (Ritchie et al., 2017). Limited evidence has suggested that minority ethnic groups coming from these countries continue to have lower meat consumption compared to other ethnicities. For example, two analyses of NDNS data found that Asian ethnic groups consumed lower proportions of meat compared to Black and White ethnic groups (Bennett et al., 2023; Stewart et al., 2021). These findings were supported by a critical review of studies assessing dietary habits of South Asian immigrants living in Western countries, which found that intake of protein was significantly lower in South Asian groups compared to White groups (LeCroy & Stevens, 2017). A working paper that looked at the UK National Health Service (NHS)'s Health Survey data from 2008 found that Asian British individuals were four times more likely to be vegetarian than White British

individuals, while Black British respondents reported to consume more meat than other ethnic groups (Leahy et al., 2010).

While individuals living in the UK who come from countries with traditionally lower levels of meat consumption seem to continue consuming less meat than the national average, there is also some evidence that suggest they may be adapting their diet towards that of their adopted country. A narrative review (Parackal, 2017) and a systematic review (Holmboe-Ottesen & Wandel, 2012) of dietary changes and health outcomes of South Asian immigrants after they have relocated to Western countries both found that these individuals increased their intake of fast foods and animal protein from meat and fish and reduced their intake of pulses, fruits and vegetables. Specifically in the UK, a dietary survey of 100 South Asian adults living in Leeds found evidence that this population had increased their meat intake or stopped being a vegetarian after migrating the UK (Garduño-Diaz & Khokhar, 2013a). Another dietary quality study of White, South Asian and African-Caribbean adults living in the UK found evidence that there was an association between time spent living in the UK and an increase in intake of red meat for both South Asian and African-Caribbean respondents (Garduño-Diaz & Khokhar, 2013b).

Limited evidence demonstrates that varying cultural, religious, and traditional practices of different ethnic groups in the UK means that they have different dietary habits and food choices. However, it also shows that some of these habits and choices have been shifting following acculturation and adaptation to life in the UK, especially when it comes to meat consumption. These shifts suggest that social norms around meat consumption and food in general are not only culture and context dependent but can also change over time.

3.1.3. The role of social norms in meat consumption of minority ethnic groups in the UK

The evidence summarized in the previous sections suggests that non-White minority ethnic groups in the UK tend to place more importance on eating together in multigenerational households and mark special occasions by sharing meals, which are characteristics of collectivistic cultures (Hofstede, 2011). Collectivistic cultures prioritize spending time with other members of society, especially close friends and family more, creating more opportunities for individuals to influence each other. On the other hand, individualistic cultures focus on independence and time spent alone, where people act in isolation. Collectivistic cultures may also value conformity and following the majority's behaviors and choices more whereas individualistic cultures may encourage objecting to normative behaviors (Hofstede, 2011; Triandis, 2001). Members of minority ethnic groups in the UK whose cultures have collectivistic characteristics may place more importance on the behaviors and opinions of their close friends and family and as a result may experience stronger normative influence on their eating behaviors compared to White ethnic groups.

As discussed in Chapter 1, the "salience" of social norms refers to the importance of the norm and how much the individual feels they should conform to the norm in order to fit in society. Norms become more salient if they pertain to close referent groups, i.e., close friends and family (Ostermann et al., 2024; Tajfel, 1974). As established in the previous chapter, understanding individuals' perception of their friends' and families' attitudes towards meat consumption, and their beliefs about the impacts of meat consumption on the planet and their health helps paint a picture of how social norms are perceived. Understanding how much individuals desire to eat similarly to their friends and family and how much they would be influenced by them

when making food choices can help gain insights into salience of social norms around eating behaviors. The findings discussed above suggest that there might be differences in levels of influence by and desire to be similar to friends and family between different ethnic groups.

Evidence that shows associations between meat consumption and gender and SES has been briefly discussed in the main introduction. However, different cultural and traditional values of minority ethnic groups regarding how and by whom meat should be consumed might change the direction or even the existence of these associations. For example, a culture may value vegetarianism as a sign of piousness (e.g. Hinduism) and might not regard it as a feminine trait. While a culture may still view meat consumption as a symbol of wealth and power, another might see prioritizing sustainability and healthy living as a sign of higher SES, meaning that while the richest members of one culture will likely have high levels of meat consumption, the richest members of the other will try to reduce their consumption. Given the lack of research and evidence in this area, it is necessary to explore whether and in which direction these associations change across different ethnic groups who have different social norms around how certain genders and SES groups should consume meat.

With little research having been done on social norms of meat consumption and its cultural significance for different ethnic groups (Ellithorpe et al., 2022), it is important to understand how different ethnic groups differ in their attitudes, beliefs and normative perceptions around meat consumption. The aim of this study was to provide data for that understanding and generate evidence on the attitudes, norms, and behaviors of White, South Asian and Black ethnic groups in the UK around meat consumption.

3.2. Methods

3.2.1 Study aims and design

The plan for the study emerged from an opportunity to collaborate with researchers from the Reuters Institute for the Study of Journalism at the University of Oxford who have been involved with the Livestock, Environment and People (LEAP) project and have previously collaborated with my supervisors. Our joint aim was to recruit a large sample of participants representing different ethnic minority backgrounds to better understand some of the attitudes, beliefs, habits, norms and behaviors around food choices and meat consumption of these under-researched populations. In order to prevent participant fatigue and attrition, we decided to limit the number of items in the survey that would address the research questions covered in this chapter to 10. I formulated my hypotheses and developed the matching survey questions, ensuring they were simple and clear. The questions aimed to explore differences between various ethnic groups in the UK in terms of their meat consumption patterns, intentions to change meat consumption, beliefs about the impact of overconsumption of meat on personal health and the environment, and perceptions of influence and support from their friends and family regarding food choices. The secondary aim was to examine interactions between ethnicity and gender and SES for the same measures and observe whether different patterns emerged for different ethnic groups.

3.2.2 Procedure

YouGov, a British international market research company, was employed for the recruitment of participants and the administration of the survey and data collection. Ethics approval for the study was obtained from the University of Oxford Central University Research Ethics Committee (Reference number: R42505/RE002). The initial sample was recruited (N= 1244) and data was collected between February 23rd

and March 2nd, 2021. I collaborated with a research liaison at YouGov to obtain and examine the raw data of the survey responses. Upon detecting an error in the age quotas for the White respondents, I had a discussion with the liaison and requested that it was fixed by recruiting additional participants (N = 200) whose data was collected between May 11th and May 14th, 2021. I conducted the data cleaning and analysis on a collated dataset that included all 1444 responses.

The sample for White British respondents were recruited separately from the sample for all other ethnic groups combined due to different stratification strategies for each sample. Both samples came from a previously selected panel of around 1,000,000 UK respondents who are either citizens or individuals ordinarily residing in the UK. The participants were invited to take part in the survey with a short welcome text (see Appendix 3.1). The ethnic minority groups sample was stratified based on region, age, gender, ethnicity, work status and country of birth, while the White sample was stratified based on age, gender, education status and social grade in order to ensure national representation.

3.2.3. Measures

The measures were developed as novel, single-item measures that were worded to be clear, concise, and capturing distinct concepts and were based on measures used in previous related research conducted within the LEAP project. (See Table 3.2 for exact wording of each question, and Appendix 3.2 for all survey questions as displayed on YouGov's online survey platform).

Demographics. Participants were asked to provide information on their gender, age, social grade, education level, and ethnicity (for a breakdown of sample demographics, see Table 3.1).

Diet identity. Participants were asked to choose the option that best described their eating habits (vegan, vegetarian, pescatarian, flexitarian, meat eater, other).

Meat consumption intentions and behaviors. Participants were asked to describe their own intentions or actions to change their meat consumption (recently decreased, want to decrease, recently increased, want to increase, no change meat eater, no change non-meat eater).

Meat consumption intentions and behaviors of friends and family. Participants were asked to describe their friends and families' intentions or actions to change their meat consumption as above.

Attitudes around meat consumption. Participants were asked to state their level of agreement for two statements: "Eating less red and processed meat is better for the environment" and "Eating less red and processed meat is healthier" on a 5-point Likert scale (strongly agree – strongly disagree).

Attitudes of friends and family around meat consumption. Participants were asked to rate the same statements as above for what they thought their family and close friends' beliefs were.

Role of friends and family in food choices. Participants were asked to state their level of agreement on a 5-point Likert scale (strongly agree – strongly disagree) for statements that measured influence ("My close friends and family influence my food choices"), importance of similarity ("It matters to me to eat similar foods to my close friends and family") and perceived support ("My close friends and family would support me if I decided to reduce my meat consumption").

Table 3. 1 Demographic characteristics of the study sample.

		White (N=403)	South Asian (N=382)	Black (N=229)
Gender				
	Men	47.6%	45.8%	37.5%
	Women	52.4%	54.2%	62.5%
Social Grade[1]				
	ABC1	62.0%	74.4%	73.4%
	C2DE	38.0%	25.6%	26.6%
Age				
	18-24	7.9%	11.8%	10.5%
	25-34	16.6%	22.8%	25.8%
	35-44	18.9%	30.4%	23.1%
	45-54	15.9%	15.2%	16.2%
	55+	40.7%	19.9%	24.4%
Education[2]				
	Lower	46.0%	27.0%	26.8%
	Higher	54.0%	73.0%	73.2%
Marital Status				
	Married/civil partner	47.3%	55.6%	34.8%
	Living as married	15.4%	5.8%	11.5%
	Separated/divorced	8.0%	4.5%	8.4%
	Widowed	3.0%	1.9%	0.4%
	Never married	26.4%	32.3%	44.9%

[1] Social grades are a UK-specific socioeconomic status classification based on occupation. (A: upper middle class (higher managerial roles) B: middle middle class (lower managerial roles) C1: lower middle class (supervisory or clerical and junior managerial roles), C2: skilled working class (skilled manual laborers), D: working class (semi- and unskilled manual laborers), and E: non-working (pensioners and unemployed with state benefits))

[2] Following the UK government's education qualification levels for England, Wales and Northern Ireland and their Scottish equivalents, we categorized Level 1-4 (e.g. no formal qualifications, apprenticeships, certificates, GCSEs) into the "lower" education category and Levels 5-8 (e.g. diplomas of higher education, bachelor's degrees, master's degrees, doctorates of philosophy) into the "higher" category.

3.2.4 Data analysis

Respondents were asked to report their ethnicity, choosing from one of the ethnic subgroups as outlined in the 2011 Census of England and Wales (UKGovernment, 2022) From this detailed subgroup level data, and following the most recent ethnicity group categorizations in the 2021 Census for England and Wales, I have grouped Caribbean, African and other Black and Black British respondents into the "Black or Black British" category. Again, in line with Census categorization, English, Welsh, Scottish, Northern Irish, Irish, Gypsy or Irish Traveler and other White respondents were grouped into the "White or White British" category. While the Census categorizes all Asian backgrounds into one group, I grouped Indian, Pakistani, Bangladeshi respondents into the "South Asian or South Asian British" category and did not include Chinese and other Asian or Asian British respondents (N=204) in this category in order to capture the significant cultural differences with regards to eating habits and meat consumption between the Indian Subcontinent and East Asia. All mixed or multiple ethnic background respondents were grouped into the "Mixed and multiple ethnic background" (N= 100) group and Arab and other ethnic backgrounds not listed as an option were all grouped into a "Other ethnic group" (N= 126), again in line with Census 2021 categorizations.

My analyses only included White (N= 403), South Asian (N =382), and Black (N = 229) groups because these constituted the only three groups that had enough respondents to make the analyses statistically adequately powered and I could be confident enough that they represented sufficiently well-defined groups. The other ethnic groups did not have enough numbers (e.g. Chinese (N=42) and Arab (N=23) groups) or were too heterogeneous (e.g. "Mixed" group including individuals with

undisclosed mixed ethnic backgrounds) to be meaningfully included in the analysis. After these exclusions, the final sample consisted of 1014 participants.

I measured socio-economic position (SEP) of participants through their education level and occupation-based social grade. Since there was a considerable overlap between these two measures, I analyzed differences in responses based on social grade only, categorizing respondents into one of the two groups: lower-SEP and higher-SEP.

The data was analyzed descriptively using STATA (16.1, StataCorp LLC). Survey weights were set using the weights assigned by YouGov who collected the raw data on behalf of myself and the collaborating researchers. For descriptive analyses, answers from 5-point Likert scale questions were collapsed into 3-points (agree, don't know, disagree) for easier interpretation. Only for the analysis of the item that measured intentions to change meat consumption, those who already did not eat meat and did not intend to change this were excluded from this specific analysis (N=390).

Statistical analyses were conducted via logistic regressions. For these, a dummy for the dependent variable was created so that "strongly agree" and "agree" answers were collapsed into one category, and all other answers were collapsed into another, enabling me to regress the likelihood of agreeing with a statement on ethnicity, gender, and social grade. For the diet identity measure, I ran two separate analyses: one for comparing the likelihood of being vegetarian or vegan against other options (pescatarian, flexitarian, and meat-eater), and the other comparing the likelihood of being a meat-eater against all others. This was done to capture nuances between completely excluding all types of meat from the diet versus different kinds of meat-eating (e.g. eating only fish and seafood, or eating all meat except pork). Since the study was hypothesis generating and not hypothesis confirming, I did not have pre-specified reference categories for ethnicity, gender or SEP. I therefore decided to have

the White ethnicity, men, and higher-SEP as my reference categories when running the regressions. Subgroup analyses for the role of gender and SEP were run in separate regressions for each ethnic group.

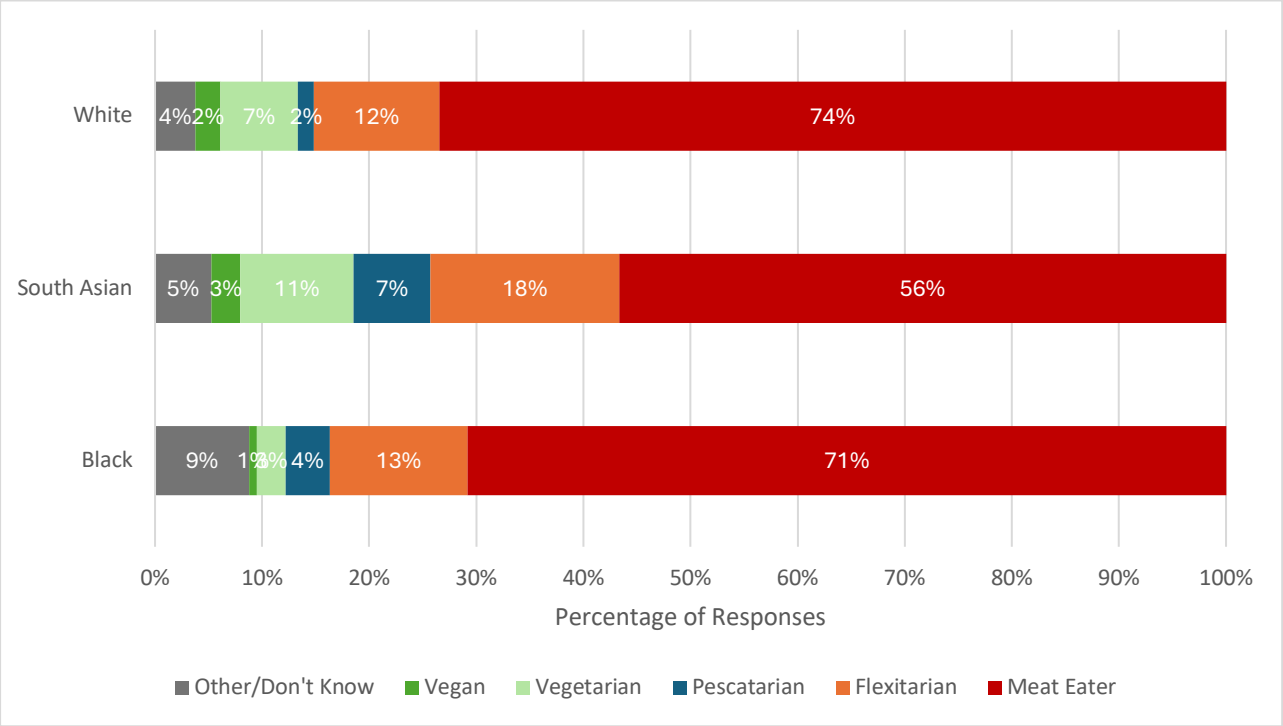
3.3. Results

3.3.1. Results by ethnicity

Diet and meat consumption. Slightly more than half of respondents with South Asian ethnicity were meat eaters while about two thirds of White and Black respondents followed an omnivore diet (see Fig 3.1). While the percentages of vegans and vegetarians remained similar across ethnic groups, more South Asian respondents followed flexitarian and pescatarian diets compared to the Black and White respondents. South Asian respondents were statistically significantly less likely to be meat eaters than White respondents (OR = .44, 95% CIs: [.30 - .65], t= -4.15, p< .001), while there was no significant difference between White and Black respondents (OR = 1.06, 95% CIs: [.63 - 1.76], t= 0.21, p= .834). However, there were no statistically significant differences between ethnic groups in their likelihood in being vegetarian or vegan, further emphasizing that the differences were between flexitarians and pescatarians.

Reduction intentions. Compared to White respondents, South Asian respondents were less likely to want to decrease or to have recently decreased their meat consumption (OR = .60, 95% CIs: [.21 - .98], t= 3.07, p= .002), while there was no significant difference between White and Black respondents (OR = .43, 95% CIs: -.08-.93, t= 1.66, p= .098). Both South Asian (OR = 1.87, 95% CIs: [.96 - 2.77], t= 4.03, p= .000) and Black (OR = 1.77, 95% CIs: [.72 - 2.83], t= 3.31, p= .001) respondents were significantly more likely to want to increase or to have recently increased their meat consumption.

Figure 3. 1 Meat consumption dietary patterns by ethnicity.



Meat and Health. The majority of the population (73.3%) agreed that overconsumption of red and processed meat has a negative impact on health. Compared to White respondents, South Asian (OR = 1.19, 95% CIs: [.78 - 1.80], t= 0.8, p= .422) and Black respondents (OR = 1.17, 95% CIs: [.72 - 1.91], t = -.62, p = .553) were not statistically significantly more likely to agree with this statement.

Meat and Environment. The majority of the population (64.3%) agreed that overconsumption of red and processed meat has a negative impact on the environment. Compared to White respondents, South Asian (OR = 1.24,95% CIs: [.85-1.81], t= 1.13, p= .260) and Black respondents (OR = .93, 95% CIs: [.55 - 1.55], t = -.29, p = .771) were not statistically significantly more likely to agree with this statement.

Perceived support for reducing meat consumption. The majority (72.5%) of respondents believed that they would have the support of their friends and family if they decided to change their meat consumption. Compared to White respondents, neither South Asian (OR = 1.13,95% CIs: [.77 - 1.68], t= 0.63, p= .530) nor Black

respondents (OR = 1.32, 95% CIs: [.69 - 2.55], t = .83, p = .405) differed in their likelihood of expecting support.

Perceived influence of friends and family in food choices. Higher proportions of respondents of Black (36.9%) and South Asian (43.5%) ethnicity agreed that their family and friends influenced their food choices (See Fig 3.2). White respondents were considerably less likely to agree with this statement (21.9%). Statistical analyses demonstrated that compared to White respondents, both South Asian (OR = 2.76, 95% CIs: [1.89 - 4.03] t= 5.25, p < .001) and Black respondents (OR =2.09, 95% CIs: [.1.30-3.35], t =3.06, p = .002) were significantly more likely to express being influenced by friends and family in their food choices.

Desire to be similar to friends and family in food choices. Higher proportions of respondents of Black (27.6%) and South Asian (38.0%) ethnicity agreed that their family and friends influenced their food choices (See Fig 3.3). Respondents of South Asian ethnicity were statistically significantly more likely to report they would want to eat similarly to their friends and family than White respondents (OR = 3.24 ,95% CIs: [2.17 - 4.84], t= 5.74, p< .001). A similar trend was observed for Black respondents, who also were statistically significantly more likely express a desire to eat similarly to friends and family compared to White respondents (OR = 2.02 ,95% CIs: [1.21 - 3.39], t= 2.69, p= .007).

Figure 3. 3 Perception of influence of friends and family on food choices by ethnicity

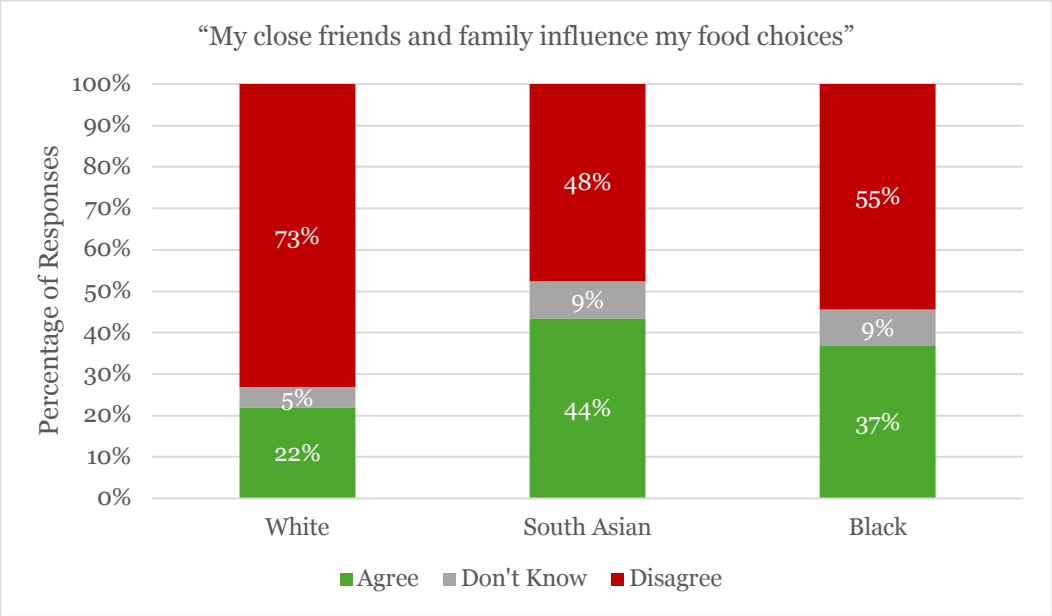


Figure 3. 2 Importance of eating similarly to friends and family by ethnicity

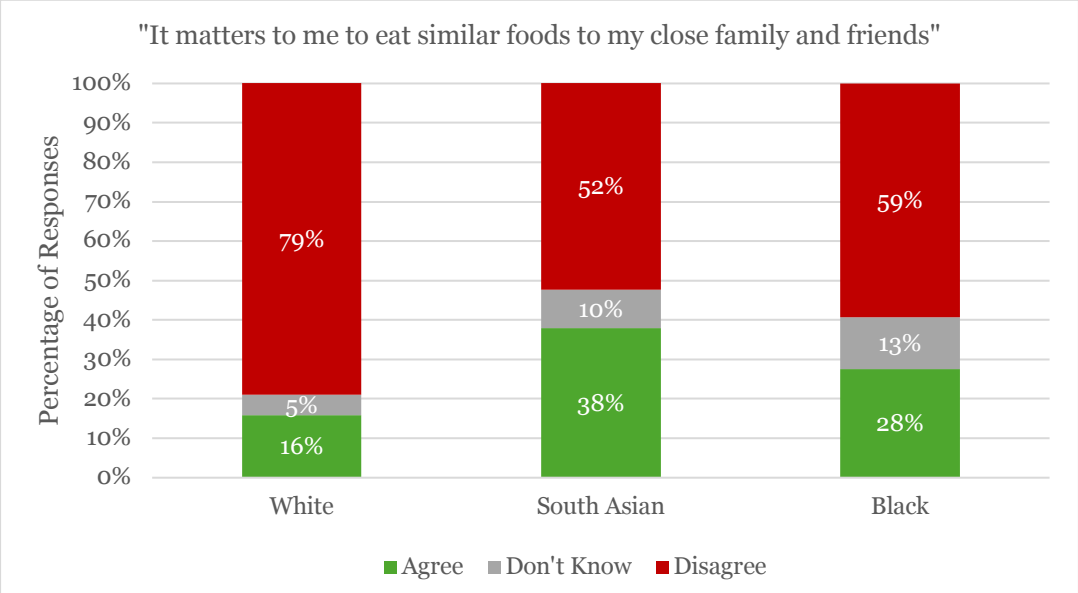


Table 3. 2 Weighted proportions for self-reported meat consumption behaviors, intentions, beliefs, and perceived influence by ethnicity.

		White (N = 403)	South Asian (N=382)	Black (N = 229)
"Which, if any, of these best describes your usual eating habits?"				
	Vegan	2.3%	2.7%	0.7%
	Vegetarian	7.3%	10.5%	2.7%
	Pescatarian	1.5%	7.1%	4.1%
	Flexitarian	11.7%	17.5%	12.9%
	Meat Eater	73.7%	56.2%	70.8%
	Other	3.6%	4.7%	8.0%
	Don't know	0.2%	0.5%	0.8%
"Are you considering decreasing or increasing the amount of meat you eat?"				
	Recently decreased	23.4%	28.8%	26.4%
	Wants to decrease	11.2%	18.1%	19.5%
	No change meat	52.5%	30.4%	37.3%
	No change no meat	11.2%	12.7%	7.0%
	Wants to increase	0.3%	3.3%	5.8%
	Recently increased	1.4%	6.8%	4.1%
"Eating less red and processed meat is better for the environment"				
	Strongly agree	27.9%	35.5%	27.0%
	Tend to agree	35.4%	32.7%	34.5%
	Don't Know	16.5%	15.1%	23.5%
	Tend to disagree	12.0%	11.3%	6.5%
	Strongly disagree	8.2%	5.4%	8.5%

"Eating less red and processed meat is healthier"				
	Strongly agree	27.8%	34.7%	38.1%
	Tend to agree	43.3%	39.8%	36.2%
	Don't Know	10.6%	10.5%	8.7%
	Tend to disagree	12.3%	9.2%	9.9%
	Strongly disagree	6.0%	5.8%	7.1%
"My close friends and family would support me if I decided to reduce my meat consumption"				
	Strongly agree	27.4%	32.5%	39.1%
	Tend to agree	42.4%	40.0%	36.2%
	Don't Know	20.3%	16.0%	17.0%
	Tend to disagree	5.7%	8.8%	5.5%
	Strongly disagree	4.1%	2.7%	2.2%
"My close friends and family influence my food choices"				
	Strongly agree	2.6%	10.2%	10.1%
	Tend to agree	19.3%	33.3%	26.8%
	Don't Know	5.0%	8.9%	8.7%
	Tend to disagree	32.9%	26.7%	26.3%
	Strongly disagree	40.3%	21.0%	28.2%
"It matters to me to eat similar foods to my close friends and family"				
	Strongly agree	3.1%	9.0%	9.4%
	Tend to agree	12.8%	29.0%	18.2%
	Don't Know	5.1%	9.7%	13.1%
	Tend to disagree	35.8%	31.1%	27.9%
	Strongly disagree	43.3%	21.3%	31.4%

3.3.2. Role of gender and socioeconomic status in meat consumption behaviors, attitudes, and norms across different ethnic groups

Diet and meat consumption. Descriptive analyses suggest across all ethnicities, women were more likely to follow non-omnivore diets than men, this difference was especially marked in the White ethnic group (81.6% versus 66.2%). Women across all ethnicities were also more likely to identify as being flexitarian than men (see Table 3). Logistic regression analysis showed that in the overall population, women were statistically significantly more likely to be vegan or vegetarian than men (OR = 2.52, 95% CIs: [1.41 - 4.52], t = 3.12, p = .002). Within-group analyses showed that White women were statistically significantly more likely to be vegan or vegetarian than White men (OR = 3.05, 95% CIs: [1.33 - 6.96], t = 2.65, p = .008), but the differences within South Asian and Black ethnic groups were statistically non-significant. Similar patterns emerged for meat-eating such that women in the overall population were statistically significantly less likely to be meat-eaters (OR = .57, 95% CIs: [.39 - .82], t= -2.99, p = .003). Within-group analyses showed that White women were statistically significantly less likely (OR = .38, 95% CIs: [.22 - .64], t= -3.61, p < .001) to be meat eaters, while there were no gender differences within the other two ethnic groups.

In the overall sample, there were no statistically significant differences between lower-SEP and higher-SEP respondents in their likelihood of being vegan or vegetarian (OR = .56, 95% CIs: [.28 - 1.08], t = -1.73, p = .084) or being a meat-eater (OR = .55, 95% CIs: [.28 - 1.08], t=-1.73, p= .084). Both White (OR = 1.95, 95% CIs: [1.15 -3.31], t= 2.48, p= .014) and South Asian (OR = 2.17 95% CIs: [1.08 - 4.35], t= 2.20, p= .029) lower-SEP respondents were statistically significantly more likely to be meat-eaters compared to their higher-SEP counterparts, while there was no significant

difference within the Black ethnic group. Within group analysis showed that there was no statistical difference between lower- and higher-SEP respondents of the three ethnic groups in terms of likelihood of being vegetarian or vegan.

Reduction intentions. There were no statistically significant differences between men and women in the overall sample in neither wanting to increase nor decrease their meat consumption. Women of South Asian ethnicity were more likely to want to increase or to have recently increased their meat intake than their male counterparts (OR = 2.85, 95% CIs: [1.11 - 7.37], t=2.18, p=.030). Contrastingly, White women were more likely to want to decrease or to have recently decreased their meat intake than their male counterparts (OR = 1.79 95% CIs: [1.12 - 2.86], t=2.43, p=.015).

In the overall sample, there were no statistically significant differences between lower-SEP and higher-SEP respondents in their likelihood of either increasing or decreasing their meat consumption. A greater proportion of lower-SEP respondents of South Asian ethnicity reported recently have decreased or want to decrease their meat consumption (60.3% versus 41.0%) while more higher-SEP respondents said they wanted an increase or recently have increased (11.9% versus 5.8%). However, within group analysis showed that there was no statistical difference between higher- and lower-SEP respondents of the three ethnic groups.

Meat and Health. There were no statistically significant differences between men and women in the overall sample in their likelihood of agreeing that overconsumption of red and processed meat had negative health impacts than women. Within group analysis showed that there was no statistical difference between men and women of the three ethnic groups.

Lower-SEP respondents were less likely to believe that overconsumption of red and processed meat was unhealthy compared their higher-SEP counterparts in the total sample (OR = .62, 95% CIs: [.42 - .91], t=-2.45, p=.014). Within group analysis

showed this difference persisted among the White (OR = .51, 95% CIs: [.32 - .82], t=-2.79, p=.005), South Asian (OR = .38, 95% CIs: [.19 - .78], t=-2.66 p=.008) ethnic groups, but not for Black respondents (OR = 2.41, 95% CIs: [.99 - 5.91] t=1.94, p=.053).

Meat and Environment. Across all ethnicities, women had a higher likelihood of believing meat consumption had negative impacts on the environment than men (OR = 1.55, 95% CIs: [1.08 - 2.21], t=2.40, p=.017). Within group analysis showed that there was no statistical difference between Black men and women as well as between White men and women, while a significant difference was observed between South Asian men and women (OR = 2.00 95% CIs: [1.07 - 3.73], t=2.19, p=.029).

Lower-SEP respondents were less likely to believe that overconsumption of red and processed meat was bad for the environment compared their higher-SEP counterparts in the total sample (OR = .63, 95% CIs: [.43 - .92], t=-2.37, p=.018). Within group analysis showed that there was no statistical difference between Black lower-SEP and higher-SEP respondents as well as respondents of South Asian ethnicity, while a significant difference was observed between White lower- and higher-SEP respondents (OR = .58 95% CIs: [.37 - .91], t=-2.38, p=.018).

Perceived support for reducing meat consumption. There were no statistically significant differences between men and women in the overall sample in their likelihood of thinking they would be supported by friends and family if they reduced their meat consumption (OR = 1.35 95% CIs: [.91 - 2.00], t =1.49, p = .136). Within group analyses showed that there also were no statistically significant differences between men and women within any of the three ethnic groups.

In the overall sample, lower-SEP respondents were less likely to anticipate support for reducing meat consumption from their friends and family compared to higher-SEP respondents (OR = .62 95% CIs: [.41 - .94] t =-2.25, p = .025). In within-group analyses, White lower-SEP respondents anticipated less support from their

friends and family compared to higher-SEP respondents (OR = .49 95% CIs: [.31 - .78] t =-3.01, p = .003). There were no statistically significant differences within Black and South Asian ethnic groups.

Perceived influence of friends and family in food choices. There were no statistically significant differences between men and women in the overall sample in their likelihood of thinking they were being influenced by friends and family in their food choices (OR = 1.06 95% CIs: [.75 - 1.50], t = .33, p = .744). Within group analyses showed that there also were no statistically significant differences between men and women within any of the three ethnic groups.

In the overall sample, lower-SEP respondents were less likely to agree with the statement that their food choices are influenced by friends and family than higher-SEP respondents (OR = .53 95% CIs: [.36 - .79], t =-3.19, p = .001). In within-group analyses, White lower-SEP respondents anticipated less influence from their friends and family compared to higher-SEP respondents (OR = .54 95% CIs: [.32 - .93] t =-2.23, p = .026). The differences were not significant for Black and South Asian ethnic groups.

Desire to be similar to friends and family in food choices. There were no statistically significant differences between men and women in the overall sample in their likelihood of expressing a desire to eat similarly to friends and family (OR = 1.03 95% CIs: [.71 - 1.49], t = .13, p = .897). Within group analyses showed that there also were no statistically significant differences between men and women within any of the three ethnic groups.

In the overall sample, lower-SEP respondents were less likely to agree that it is important for them to make food choices similar to those of their friends and family than higher-SEP respondents (OR = .56 95% CIs: [.36 - .86], t =-2.63, p = .009). This

statistical significance persisted for the White ethnic group (OR = .40 95% CIs: [.21 - .76], t =-2.80, p = .005), but not for the Black and South Asian respondents.

Table 3. 3 Weighted proportions of self-reported meat consumption behaviors, intentions, beliefs, and perceived influence by ethnicity and gender.

	White		South Asian		Black	
	Men (N=192)	Women (N=211)	Men (N=175)	Women (N=207)	Men (N=86)	Women (N=143)
"Which, if any, of these best describes your usual eating habits?"						
Vegan	1.0%	3.5%	2.3%	3.1%	0%	1.3%
Vegetarian	4.0%	10.4%	6.2%	14.6%	1.9%	3.5%
Pescatarian	0.5%	1.8%	8.1%	7.8%	4.9%	3.3%
Flexitarian	8.7%	14.6%	16.4%	18.6%	10.9%	14.7%
Meat Eater	81.6%	66.2%	59.9%	52.7%	75.1%	67.1%
Other	3.8%	3.5%	6.7%	2.6%	7.2%	8.7%
Don't know	0.5%	0%	0.4%	0.6%	0%	1.4%
"Are you considering decreasing or increasing the amount of meat you eat?"						
Recently decreased	18.7%	27.7%	27.6%	29.9%	22.4%	30.0%
Wants to decrease	11.6%	10.8%	5.0%	11.5%	16.0%	22.7%
No change meat	62.9%	42.8%	31.9%	29.0%	42.3%	32.8%
No change no meat	5.9%	1.6%	9.6%	15.6%	6.4%	7.5%
Wants to increase	0.0%	0.7%	1.9%	4.6%	10.0%	2.0%
Recently increased	0.9%	1.9%	4.0%	9.4%	3.0%	5.1%
"Eating less red and processed meat is better for the environment"						
Strongly agree	19.4%	35.8%	22.5%	48.0%	22.8%	30.5%
Tend to agree	42.1%	29.1%	38.1%	27.5%	31.7%	36.9%
Don't Know	15.9%	17.1%	16.7%	13.5%	25.5%	21.8%
Tend to disagree	11.6%	12.4%	17.7%	5.2%	9.2%	4.2%
Strongly disagree	11.0%	5.6%	5.0%	5.8%	10.8%	6.6%
"Eating less red and processed meat is healthier"						
Strongly agree	21.1%	34.1%	28.1%	41.2%	22.8%	30.5%
Tend to agree	45.9%	40.9%	44.3%	35.4%	31.7%	36.9%

Don't Know	10.9%	10.4%	10.8%	10.3%	25.5%	21.8%
Tend to disagree	14.3%	10.4%	12.8%	5.6%	9.2%	4.2%
Strongly disagree	7.8%	4.2%	4.1%	7.5%	10.8%	6.6%
"My close friends and family would support me if I decided to reduce my meat consumption"						
Strongly agree	20.5%	34.0%	30.1%	34.9%	36,6%	41.3%
Tend to agree	45.3%	39.7%	42.1%	37.8%	31.8%	40.1%
Don't Know	22.9%	17.9%	12.3%	19.6%	24.1%	10.8%
Tend to disagree	7.3%	4.2%	13.3%	4.5%	5.3%	5.7%
Strongly disagree	4.1%	4.2%	2.2%	3.2%	2.2%	2.2%
"My close friends and family influence my food choices"						
Strongly agree	3.3%	1.9%	12.3%	8.1%	8.4%	11.5%
Tend to agree	20.8%	17.8%	30.2%	36.4%	24.9%	28.4%
Don't Know	4.6%	5.4%	8.2%	9.5%	14.5%	3.7%
Tend to disagree	36.0%	30.0%	26.7%	26.7%	33.2%	20.3%
Strongly disagree	35.3%	44.9%	22.7%	19.3%	19.0%	36.1%
"It matters to me to eat similar foods to my close friends and family"						
Strongly agree	3.2%	3.1%	8.3%	9.5%	9.6%	9.3%
Tend to agree	12.3%	13.2%	27.1%	30.9%	21.2%	15.6%
Don't Know	4.0%	6.0%	10.8%	8.7%	17.9%	8.8%
Tend to disagree	40.2%	31.7%	32.4%	29.9%	26.6%	29.1%
Strongly disagree	40.3%	46.0%	21.5%	21.0%	24.6%	37.2%

Table 3. 4 Weighted proportions for meat consumption behaviors, intentions, beliefs, and perceived influence by ethnicity and social grade.

	White		South Asian		Black	
	ABC1 (N=250)	C2DE (N=153)	ABC1 (N=284)	C2DE (N=98)	ABC1 (N=168)	C2DE (N=61)
"Which, if any, of these best describes your usual eating habits?"						
Vegan	3.7%	0.4%	3.1%	1.9%	0.6%	0.9%
Vegetarian	8.1%	6.2%	12.7%	6.0%	2.8%	2.7%
Pescatarian	2.1%	0.0%	9.9%	4.0%	2.3%	7.2%
Flexitarian	13.0%	10.0%	19.5%	13.7%	14.2%	10.8%
Meat Eater	67.6%	81.7%	52.2%	64.1%	68.8%	74.3%
Other	5.5%	1.1%	2.1%	9.7%	11.0%	2.7%
Don't know	0.0%	0.5%	0.4%	0.7%	0.4%	1.4%
"Are you considering decreasing or increasing the amount of meat you eat?"						
Recently decreased	24.4%	22.0%	24.6%	38.1%	28.7%	22.4%
Wants to decrease	11.8%	10.4%	16.4%	22.2%	18.1%	22.0%
No change meat	48.7%	57.6%	29.8%	31.8%	35.9%	39.7%
No change no meat	14.0%	7.4%	17.3%	2.2%	6.8%	7.4%
Wants to increase	0.0%	0.8%	4.7%	0.0%	5.2%	6.8%
Recently increased	1.2%	1.7%	7.2%	5.8%	5.5%	1.7%
"Eating less red and processed meat is better for the environment"						
Strongly agree	30.8%	23.9%	41.7%	23.2%	27.1%	26.7%
Tend to agree	37.8%	32.2%	30.5%	36.9%	36.2%	31.6%
Don't Know	13.6%	20.5%	13.0%	19.2%	19.5%	30.4%
Tend to disagree	13.2%	10.5%	8.2%	17.6%	5.6%	8.1%
Strongly disagree	4.6%	13.0%	6.6%	3.1%	11.6%	3.2%
"Eating less red and processed meat is healthier"						
Strongly agree	28.4%	27.0%	41.4%	21.7%	41.7%	31.8%
Tend to agree	48.7%	36.2%	39.5%	40.2%	27.0%	52.3%
Don't Know	7.9%	14.2%	8.8%	13.9%	9.9%	6.5%
Tend to disagree	10.4%	14.8%	5.3%	16.8%	12.1%	6.1%

Strongly disagree	4.5%	7.8%	5.0%	7.4%	9.3%	3.3%
"My close friends and family would support me if I decided to reduce my meat consumption"						
Strongly agree	29.5%	24.8%	37.0%	23.7%	38.8%	39.7%
Tend to agree	46.9%	36.5%	36.0%	47.5%	40.5%	28.8%
Don't Know	13.5%	29.4%	15.0%	18.0%	10.1%	29.1%
Tend to disagree	6.8%	4.2%	8.8%	8.9%	8.0%	1.1%
Strongly disagree	3.4%	5.1%	3.2%	1.8%	2.6%	1.4%
"My close friends and family influence my food choices"						
Strongly agree	3.4%	1.5%	13.6%	3.4%	12.2%	6.4%
Tend to agree	22.7%	14.7%	32.9%	34.2%	31.6%	18.5%
Don't Know	2.7%	8.0%	6.3%	13.9%	1.8%	20.7%
Tend to disagree	35.2%	35.2%	25.8%	28.4%	29.7%	20.3%
Strongly disagree	36.0%	46.0%	21.4%	20.1%	24.8%	34.1%
"It matters to me to eat similar foods to my close friends and family"						
Strongly agree	4.3%	1.5%	10.8%	5.1%	12/3%	4.4%
Tend to agree	16.4%	7.9%	29.5%	28.2%	19.3%	16.3%
Don't Know	4.4%	5.9%	5.3%	18.4%	6.6%	24.3%
Tend to disagree	40.5%	29.5%	30.8%	31.8%	32.5%	19.9%
Strongly disagree	34.3%	55.2%	23.7%	16.5%	29.2%	35.1%

3.4 Discussion

Minority ethnic groups living in the UK are more likely to follow a low/no meat dietary pattern and have greater awareness of the adverse effects of overconsumption of meat on health than the White population. A quarter to a third of the sample of all ethnicities had recently decreased their meat intake, while a small but notable proportion of respondents of Black and South Asian ethnicity reported that they recently had or intended to increase their meat intake. Compared to White respondents, participants of other ethnicities reported that their eating behaviours were more influenced by family and friends, and that they would want to eat similarly

to their close others. Three-quarters of the whole sample anticipated they would have support from close others if they wanted to reduce their meat intake.

The higher proportion of low/no meat-eating behaviors in the South Asian ethnic population likely reflects the religious restrictions both Hindu and Muslim South Asians may have on their diet. Practicing Hindus restrict almost all their meat intake, but Muslims may also have to limit their meat intake due to inaccessibility of halal meat (Hamlett et al., 2008). In line with a growing body of evidence (Clonan et al., 2016; Maguire & Monsivais, 2015), I also found that women were more likely to follow low/no meat-eating diets and report intentions to reduce their meat consumption compared to men. The differences between genders were most pronounced among White participants, supporting literature that has found wide gender differences in prevalence of vegetarianism in Western countries (Modlinska et al., 2020). In most White ethnic cultures in the UK eating meat is strongly associated with masculinity (de Backer et al., 2020; Graça et al., 2019; Modlinska et al., 2020; Rosenfeld & Tomiyama, 2021). As a result, men may feel more pressure to conform to social norms around meat eating being "masculine", and may expect less support from their social circles if they engaged in a behavior that goes against expected gender roles (Gal & Wilkie, 2010; Modlinska et al., 2020; Rosenfeld & Tomiyama, 2021; Rothgerber, 2013). Indeed, I found that across all ethnic groups, men expected less support from their friends and family to reduce their meat consumption compared to women, although this difference was not statistically significant. This potential social pressure was also reflected in the finding that more men said it was important to them to eat similarly to their close friends and family than women did, although this difference was also not statistically significant.

Among White respondents, more lower SEP individuals followed meat-eating diets than higher SEP ones, although this difference was not statistically significant. This is

in line with previous findings which has shown that in the UK, those in higher occupational roles (e.g. managers) consumed significantly less red meat than those in technical and routine occupations (Clonan et al., 2016). The gap persisted among Black and South Asian ethnic groups, but to a lesser extent. In Western cultures, meat has started to lose its position as a luxury food as it became mass produced and easily accessible. However, meat's symbolic value as a sign of affluence persists in developing countries. The difference in associations of meat and health between Western cultures and cultural heritages associated with South Asian ethnic groups in the UK might be one of the reasons why a greater proportion of South Asian women indicated a desire to increase their meat consumption, while White women were more likely to want to decrease theirs.

In contrast to recent literature, I found that the majority of the participants agreed that eating less red and processed meat is both healthier and better for the environment. The sample came from a pool of self-selected participants, and there was an overrepresentation of individuals with a higher education and income than the UK average, especially in the Black and South Asian ethnic groups. However, lower-SEP respondents were less likely to agree with these statements compared to higher-SEP respondents. This may be because people in higher SEP groups may have more awareness about the negative environmental and health impact of meat consumption, as found in Grummon et al. (2022) and Taillie et al. (2022), which may be due to having had more education, or having more time and resources to access nutrition information (Clonan et al., 2016; Maguire & Monsivais, 2015). Men were also less likely to agree that overconsumption of red meat had a negative impact on the environment compared to women.

I found that both South Asian and Black respondents were statistically significantly more likely than White respondents to agree that they were influenced by and wanted

to eat similarly to friends and family. As discussed in the introduction, the stronger influence of family and friends in minority ethnic groups in the UK may reflect the tradition of communal eating, sharing meals at social gatherings and celebrations and the higher value they place on friends and family (Chowbey & Harrop, 2016) and the characteristics of collectivistic cultures such as conformity and following the majority's behaviors and choices (Hofstede, 2011; Triandis, 2001).

Across all ethnic groups, more higher SEP individuals reported perceived influence of friends and family in their food choices. Individuals with higher SEP might have more flexible work schedules and disposable income to have more occasions to share meals with their friends and family both at home and eating out, creating more opportunities to experience normative influences their close others have on them. Lower SEP occupations are more likely to require disruptive arrangements such as night shifts, isolated work, and limited breaks for food consumption, meaning that individuals with these occupations might choose and consume food away from their friends and family and without their influence.

3.4.1 Strengths and Limitations

The present survey had the advantage of recruiting a large and ethnically diverse sample achieved through quota sampling from a pool of nationally representative respondents. To my knowledge, this survey is one of the first to provide a detailed insight into the norms, attitudes and behaviors around meat consumption for White, South Asian and Black ethnic groups living in the UK.

All measures in the survey relied on self-reports, and actual behaviors of the respondents were not measured. However, since the focus of the study included exploring attitudes and perceptions of social norms (rather that identifying what the real prevalent norms were in society), self-report was an appropriate measure for the

aims of this study. Additionally, the questions analyzed and presented here were asked to respondents as a part of a larger study that included questions about media usage, and sources of information used for food choices, therefore it is unlikely that a social desirability bias that would influence responses was introduced (for other findings from the larger study, see Mroz et al., 2024; Mroz & Painter, 2023). The measures used for beliefs regarding the health and environmental impacts of red and processed meat consumption and those that measured perceived influence and support and desire to be similar to close friends and family were novel items developed for the purposes of this study. While the wording of each item was carefully deliberated on and was decided on after reviewing measures from previous research, it should be noted that they are not previously validated measures.

The respondents were recruited among a pool of people that had already signed up to take part in similar research studies. This self-selection of individuals led to overrepresentation of higher educational attainment and social grade, especially among South Asian and Black respondents (given quotas for education and social grade were not set for these groups), which may impact the generalizability of my findings. I have aimed to account for this by using survey weights in our analysis, however, it should be noted that these weights reflected the YouGov panel, to which respondents are recruited to ensure it is nationally representative, but not the whole UK population.

Due to the hypothesis generating nature of the study on whether there were any differences between ethnic groups in their meat consumption at all, I did not correct the p-value threshold of statistical significance for multiple analyses. Without this correction, it could be suspected that the significance of 1 in 20 results could have occurred solely due to chance. I ran 50 regressions and 22 of them reached statistical significance, which roughly translates to 1 in 2.3 results, and these are unlikely to have

occurred solely due to chance. I have reported the 95% confidence intervals and p-values of each regression to be open for interpretation and I advise that these are taken into account when evaluating the findings.

Finally, for the data analysis, I grouped certain ethnic backgrounds together, which may have led to the disappearance of some nuances between different ethnicities. For example, Pakistani, Bangladeshi and Indian individuals were all analyzed in the South Asian ethnicity group while they may have different religious practices and food habits due to their Muslim-majority and Hindu-majority backgrounds respectively. The participants also differed on whether they were born in Britain or elsewhere. Due to the size of the sample, I was not able to separately analyze those that were born in the UK and those that were not. I also did not collect any data on how strongly individuals identified with the culture of their birth country, which could have moderated their responses.

3.4.2. Conclusion

This study is an important first step in understanding differences in attitudes, beliefs, norms, and behaviors around meat consumption across the three largest ethnic groups in the UK. However, future research with bespoke study design and focused recruitment of specific ethnic, cultural, and religious subgroups is needed to better understand the dynamics of these differences and capture important nuances.

As established in the previous chapters, eating is a social behavior and food choices can be influenced by normative expectations. I have found that different ethnic groups in the UK have different perceptions of social influence from close others when it comes to their food choices. Future research can explore whether these differences translate to variation in responses to social norm-based interventions to change eating behaviors. For example, it can be tested whether social norm based interventions may

be more effective for people who come from cultures that prioritize meal sharing and valuing social coherence more. Culturally tailoring interventions to address the community-specific barriers to and enablers of behaviors could help optimize their effectiveness (Spadea et al., 2018). Future studies can test the effect of cultural tailoring in various contexts and with more diverse populations.

Chapter 4: Testing the effect of a dynamic social norm messaging intervention to reduce meat consumption: a randomized cross-over trial in retail store restaurants

Summary

This chapter details the results of a randomized cross-over intervention study that explored the effects of dynamic social norm messaging in in-store restaurants of a major retail chain in the UK. The intervention aimed to assess whether a dynamic descriptive social norm message intended to encourage increased purchasing of plant-based meal options displayed at three different locations (entrance to the store, entrance to the restaurant, and above the restaurant buffet) in the retail stores increased the percentage of plant-based meals sold at the restaurants. Twenty-two retail store restaurants across the UK participated in the study and recorded their sales of various plant-based and meat-based meals across eight weeks. Following a 4-week baseline period, restaurants were randomly allocated to receive the intervention in the subsequent or final two weeks of the study, with the alternative period defined as the control. There was no evidence that the social norm messaging intervention had an effect on the sales of plant-based meals sold in either group (β = -.022, 95% CIs: [-1.63, 1.58]). There was also no evidence of carry over effects (intervention effect trickling into subsequent control period) or period effects (change in sales due to time passing). Intervention fidelity data suggested that a number of restaurants showed poor adherence to the intervention procedure. However, restricting the analysis only to restaurants with medium or high fidelity found no evidence that the plant-based sales significantly changed from control to intervention periods (β = .003, 95% CIs: -.02 ; 0.033) Nonetheless, instructing retailers to display a dynamic social norm message

intended to encourage consumption of plant-based dishes was an insufficient intervention to increase the proportion of plant-based meals sold in a department store restaurant. Parts of this chapter were published in a peer-reviewed journal article: Çoker et al (2022), Appetite https://doi.org/10.1016/j.appet.2021.105824

4.1 Introduction

Chapter 1 has provided an overview of social norm-based interventions to change eating behaviors, and has highlighted the limited research on how these interventions can target reducing meat consumption in particular. In addition to the paucity of data on social norm interventions to reduce meat intake, it is notable that many of the studies of social norm messaging and eating behaviors have used study designs that were at high risk of bias due to cross-sectional data collection and lack of corresponding control groups (as detailed in Robinson, Thomas, et al., 2014). Most studies have also only measured participants' intentions to change rather than actual shifts in behavior (Aldoh et al., 2021; Carfora et al., 2022; de Groot, 2022; Garcia et al., 2021; Thomas et al., 2017). Finally, the majority of studies recruited adolescents and university students, with little evidence available for groups that are more representative of the general population (Collins et al., 2019; Mollen et al., 2013; Patel et al., 2024; Robinson et al., 2013; Sparkman & Walton, 2017; Stok et al., 2016).

As referred to in Chapter 1, at the time the present study was designed and conducted in 2019, the term "dynamic norms" was coined a few years ago and the only evidence for the effectiveness of dynamic descriptive social norm interventions to reduce meat consumption were four studies published by Sparkman and colleagues (Sparkman & Walton, 2017). The initial findings from these studies suggested that referring to new trends in social norms and signaling future shifts in behavior might be an effective way to change behavior when the desired behavior (i.e. reduced meat consumption) is not currently performed by the majority of the population. However, the studies had considerable limitations. Only one of the four studies measured actual food purchasing behavior, but this was done at a single site (university campus café in the US) without a matched control, and with a majority student population.

Aiming to build on these additional findings, and address some of the limitations, the present study was designed in collaboration with a well-known international retail store chain. All 22 in-store restaurants of the chain that are based in the UK were recruited to take part in the study. This offered the unique opportunity to observe the effect on actual purchasing patterns of restaurant-goers representing a diverse demographic across the UK. A randomized cross-over design was implemented for statistical power and robustness. The primary objective of the study was to determine whether the presence of a dynamic, descriptive social norm message about the popularity of plant-based options ("More and more [retail store name] customers are choosing our veggie options") would lead to an increase in the sale of plant-based meals in the in-store restaurants.

I joined this study in October 2020 after the data collection was concluded. My role was to plan and conduct the data analysis and lead the preparation and submission of the manuscript, which has now been published as a peer-reviewed journal article: Çoker et al (2022), Appetite https://doi.org/10.1016/j.appet.2021.105824. While I report the study design and intervention development procedures in this chapter, it should be noted that I did not actively participate in these processes.

4.2 Methods

4.2.1 Setting

All of the retail chain's 22 stores located across the UK (England, Wales, Scotland and Northern Ireland) were included in the study. The in-store restaurants had heavy footfall, attracting about one third of all store-goers and serving millions of meals across the UK each year. The restaurants are branded as affordable, fast-paced, casual and family-friendly, and have a cafeteria-style setting where customers walk through a buffet to make their food choices.

4.2.2 Study Design

A parallel cross-over design was implemented for the study where store restaurants were randomized to the order in which they implemented and removed the intervention. The stores were sorted into geographic clusters, and stores in the same cluster were allocated to the same order condition to control for potential spillover effects of some customers visiting multiple stores and being exposed to different intervention conditions. The study took place between June 17th-July 14th, 2019. Following a 4-week baseline period (May 20th-June 16th, 2019), half of the stores were allocated to an intervention-first condition (social norm message displayed for two consecutive weeks, followed by two weeks of no-message control) and the other half to a control-first condition (no-message control for two consecutive weeks, followed by two weeks of social norm message display). Besides the inclusion or exclusion of the social norm message on digital boards, all other aspects in the in-store restaurant setting, such as meals advertised, branding, images, rotation frequency and duration on the digital screens were unchanged in both intervention and control periods.

4.2.3 Intervention Development

The intervention consisted of the display of a dynamic descriptive social norm message on the digital menu and information screen boards located in three locations across the stores and their restaurants. These screens were typically used to advertise different meals prior to the intervention. The digital boards were located at the entrance of the store, at the entrance of the in-store restaurant, and also on a menu board directly above the buffet. The phrasing of the social norm message was decided following focus group discussions that explored how people's reactions differ to static versus dynamic norms, what constitutes a relevant referent group for the target

population, and which adjectives best describe a plant-based meal option. Clarity, believability and ability to influence were all taken into consideration. The finalized social norm message ("More and more [retail store name] customers are choosing our veggie options") appeared in a green circle on the top right corner of the board and was animated to draw viewers' attention further. The message was displayed alongside a picture of the vegetarian breakfast option in the morning

breakfast hours, and a vegetarian main meal during the lunch hours (Figure 4.1).

Figure 4. 1 The dynamic descriptive social norm message (green circle in upper right corner) displayed alongside available vegetarian meals on a digital screen

4.2.4 Measures

Each of the 22 restaurants reported their sales on a weekly basis, for a total of eight weeks, recording the number of items sold of each breakfast and lunch meal on offer. Meals were categorized as either meat-based or plant-based, and sales were aggregated for each group to calculate the total number of sales of each category within each restaurant. The first four weeks of data constituted the baseline and were averaged to reflect the mean sales of meat and plant-based meals during this period. The following two weeks (hereby "first two weeks") and the last two weeks (hereby "final two weeks") of sales were also averaged in the same manner. In order to account for the fluctuations in overall sales volume across the weeks, the means were then transformed into percentage values to reflect the proportion of meat- and plant-based sales in the three time periods (i.e. baseline, first two weeks, and final two weeks).

4.2.5 Intervention fidelity

Nine out of 22 stores were visited once during the study period for intervention fidelity checks. The restaurants were selected so that each of the geographic clusters were represented. Equal number of visits were intended to be made to restaurants allocated to the intervention-first and control-first conditions, but a miscommunication with the data collector resulted in fidelity checks being performed on six intervention-first and three control-first locations. Adherence to the intervention procedure was checked on six aspects: whether the three screens located at the store entrance, in-store restaurant entrance, and restaurant menu board displayed the social norm message for both breakfast and lunch time. Restaurants were given a fidelity score out of six, with those scoring 5-6 points classified as having high fidelity, 3-4 points as medium fidelity, and 1-2 points as low fidelity.

4.2.6 Data Analysis

The protocol for the statistical analysis plan was written up and pre-registered on OSF before any data analysis was conducted (https://osf.io/3vrqj/). The data analysis was conducted using SPSS version 27 (IBM Corp, 2020). The transformed mean percentage values of meat- and plant-based meal sales across three time periods for each restaurant were checked for normality with histograms, Q-Q plots and Shapiro-Wilk tests. After confirming that the data was distributed normally, the data analysis proceeded with parametric tests.

Prior to exploring the effect of the intervention on plant-based meal sales, preliminary analyses looked at whether there were any baseline differences between restaurants, any carry over effects in intervention-first condition restaurants, and any external chronological effects that could be due to factors such as weather changes, cultural trends, etc. that might alter customers' dietary choices.

Independent samples t-tests were run to check whether there were any differences between the baseline percentage of plant-based meal sales between the restaurants allocated to the two intervention orders (intervention first v. control first).

Another independent samples t-test was run in order to assess whether the intervention period had any effects that lasted beyond the two weeks and into the control period in the intervention-first condition, comparing the difference in percentage of plant-based meal sales between the intervention period and the control period. For the intervention-first condition, this was calculated by subtracting the percentage of plant-based meal sales of the final two weeks of the study period from the first two weeks; and for control-first condition, the percentage of plant-based meal sales from first two weeks were subtracted from that of the final two weeks.

Exploratory analyses conducted during descriptive summary of data had indicated that there was an increase in overall volume of sales over time in the restaurants, regardless of intervention allocation. In order to ensure that this did not statistically significantly affect the percentage of plant-based meal sales, paired samples t-tests looked at the difference between the percentage of plant-based sales in the first and final two-week periods to see if there was a change over time, irrespective of intervention allocation of the restaurants.

The main analysis for predicting the extent of the intervention effect was done with a one-sample t-test followed by a linear regression equation. The difference between intervention and control percentage of plant-based meal sales was calculated for each restaurant. These values were then examined with a one-sample t-test to see if they significantly differed from zero. A regression was run to explore the effect of the intervention and other covariates on the percentage of plant-based meals in the in-store restaurants. The cross-over design was maintained given that there were no carry-over effects. Baseline sales were not entered into the model since there was no baseline differences between groups. Time of sale was also not entered into the model since there was no evidence of a period effect. The percentage of plant-based meal sales was regressed on condition (intervention versus control), intervention sequence (intervention first versus control first), and number of plant-based meal options on display, all entered as dummy variables. Since intervention fidelity data was only available for nine out of 22 restaurants, associated effects were examined in a separate model where previous covariates were maintained, and intervention fidelity was entered as a dummy variable with two levels (low and medium/high).

4.3 Results

4.3.1 Baseline characteristics of stores

There was very little variability in the proportion of plant- and meat-based meal sales across stores (Fig 4.2). There were no significant differences in the mean percentage sales of plant-based meals between the restaurants allocated to the intervention first (M=9.86, SD=1.80) and control first (M=9.09, SD=2.21) orders in the four weeks before the study;(t(21)=.90, p=.379), suggesting the control and intervention stores were well matched in this respect.

4.3.2 Carry-over effects

There was no evidence of carry over effects from the intervention into the control period in the intervention-first condition (Figure 4.3). The t-test returned no significant results between the intervention first (M=-.03, SD=1.01) and control first (M=.18, SD=1.44) conditions; t(21)=-.40, p=.690) suggesting the analysis could proceed as a cross over design.

4.3.3 Period effects

There was no evidence of a trend in sales of plant-based meals over time, with no significant differences in the mean percentage sales of plant-based meals between the first two weeks (M=10.05, SD=2.56) and the second two weeks (M=10.16, SD=2.60) of the study period; (t(21)=-.41, p=.683). (Figure 4.3).

Figure 4. 2 Baseline Percentage of Meat- and Plant-Based Meal Sales in Restaurants

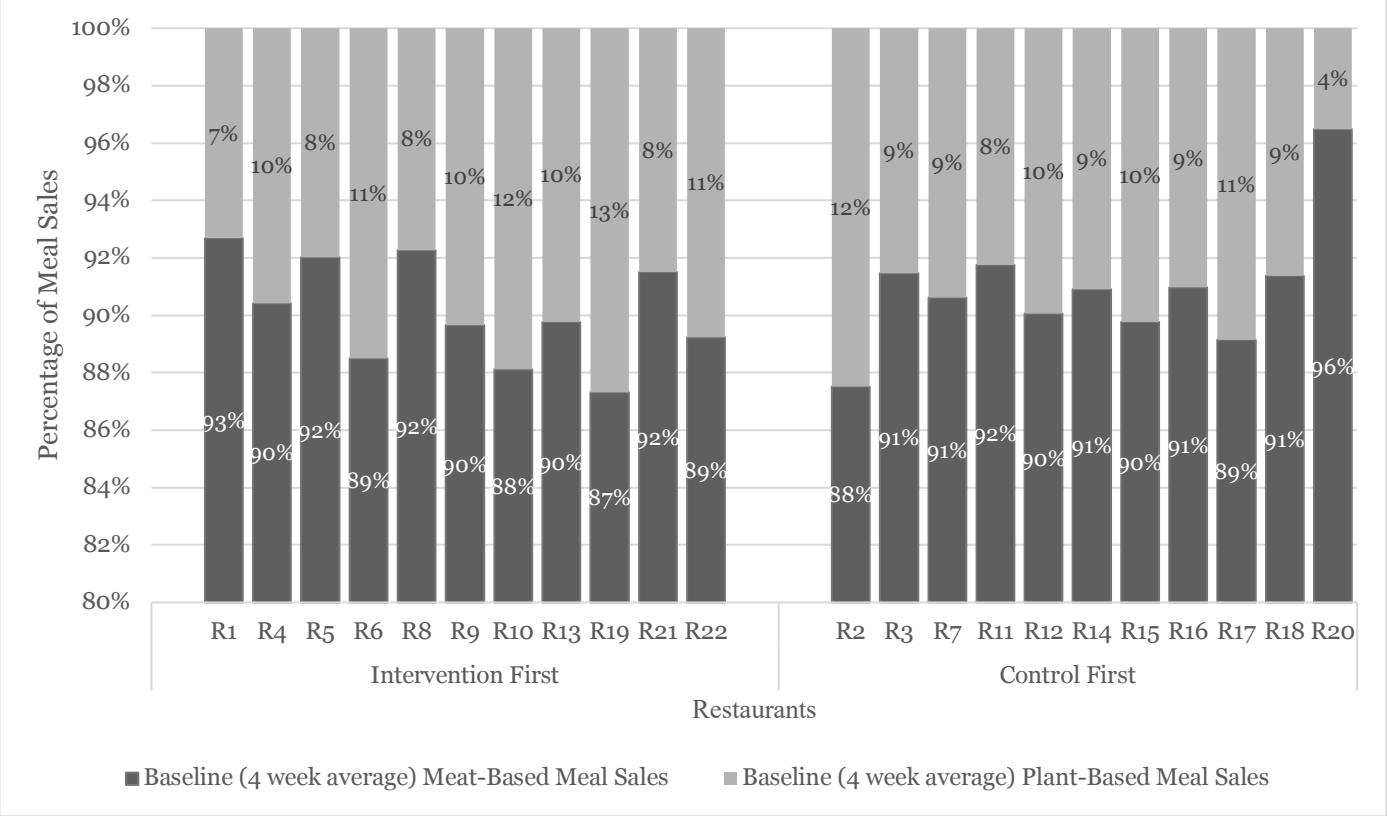
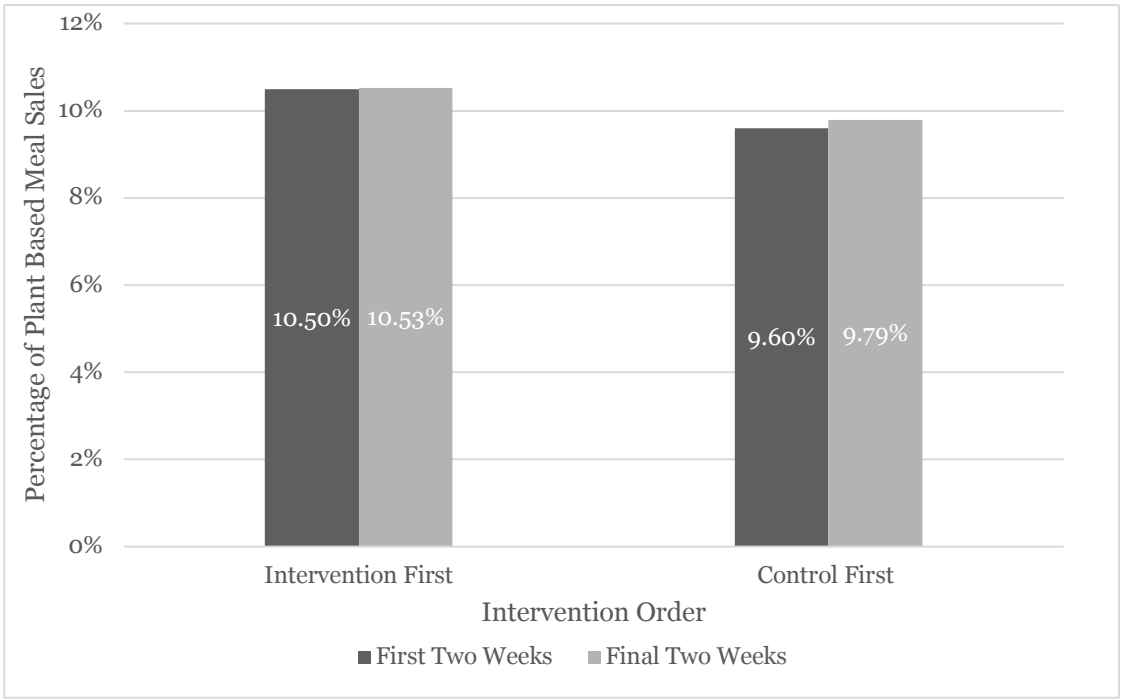


Figure 4. 3 Percentage of plant-based meal sales across time (averaged for 11 restaurants in each condition)



4.3.4 Effect of the intervention

There was no evidence that the change in the percentage of plant-based sales during the intervention or control periods significantly differed from zero ($t(21)=.292$, $p=.773$) Further confirming this, none of the independent variables entered into the regression model except for intervention fidelity had a statistically significant effect on the percentage of plant-based meal sales, and the adjusted R^2 value indicated that the model was not a good fit. The results of the regression analysis therefore did not show any evidence of an effect of the social norm messaging intervention on percentage of plant-based meal sales, controlling for number of meal options available, and having ruled out baseline, carry over, and period effects. (Table 4.1).

4.3.5 Intervention fidelity

Only one out of nine stores scored high on the intervention fidelity scale, three scored medium and five scored low. There was evidence that the difference in percentage of plant-based meal sales between intervention and control periods statistically differed between the medium/high ($M=.003$, $SD=.007$) and the low ($M=-.011$, $SD=.008$) intervention fidelity groups ($t(7)= 2.93$, $p=.040$). However, restricting the analysis only to stores with medium or high fidelity found no evidence that the plant-based sales significantly changed from control ($M= .115$, $SD=.031$, 95% CIs: [0.065, 0.165]) to intervention ($M=.118$, $SD=.033$, 95% CIs: [0.065, 0.171]) periods ($\beta = .003$, 95% CIs: -.027, 0.033), suggesting that despite high adherence to the intervention procedure, the intervention might not have been strong enough to create a statistically significant difference in plant-based sales.

Table 4. 1 Linear Regression Model for percentage of plant-based meal sales

Independent Variables	β (p-value)	[CI] (95%)
Intervention Condition (Ref=Control, 1=Intervention)	-.022(.978)	[-1.63 – 1.58]
Intervention Arm (Ref=Intervention First, 1=Control First)	-.511 (.498)	[-2.18 – 1.08]
No. of plant-based options (Ref=4 options, 1=5 options)	-.097 (.905)	[-1.74 - 1.54]
N = 22, Adj. R^2 = -.063, F_{change} = .156		

4.4 Discussion

Adding a dynamic social norm message to digital boards placed in various locations of a retail chain's in-store restaurants was not effective in shifting customers from meat-based to plant-based meals. Controlling for availability of meat- and plant-based dishes, and with no evidence of baseline differences, carry-over, and period effects, there was no evidence of a statistically significant effect of the intervention on the percentage of plant-based meal sales. However, the fidelity of intervention delivery was sub-optimal.

There may be several reasons to explain the apparent lack of effectiveness of the intervention. Previous research highlighted the importance of the location, visibility, and target population of dynamic norm messages in their effectiveness (Sparkman & Walton, 2017; Sparkman et al., 2020). Here the dynamic social norm message was presented in a small green circle positioned on the upper right-hand corner of the digital boards with an animated 'jiggle' which appeared only when the plant-based options were being advertised. The non-centric location of the message, its infrequent appearance, and its comparatively small size in relation to the other visual elements on the digital board could have decreased its salience for customers. The customers may also have been distracted by more proximal and immediate cues in the restaurant (such as trays, cutlery, and food items on display on the buffet) rather than the images shown on the digital boards, limiting the visibility of and exposure to the social norm message and decreasing its ability to attract attention and incentivize customers to reflect on the information and motivate them to change their food choices. The dynamic norm message only had a loose referent group of "other customers' and restaurant-goers may not have felt enough of a social connection with fellow customers limiting the perceived importance or desirability of performing the behavior or a need

to preconform to the trend that was communicated. Additionally, the habits and cultural associations the restaurant goers have established with the retail chain might have been too ingrained to be affected by a dynamic social norm message to which they were exposed to for only a short period of time. Most notably, intervention fidelity checks performed on nine out of 22 participating restaurants found that adherence to the correct display of social norm messaging at specified locations was generally low, indicating that restaurant-goers may not have been able to be exposed to the message to the extent that was intended in the original intervention design. The exploratory analysis suggested that low adherence to the intervention procedure may have indeed been associated with lower percentage of plant-based meal sales, however limited data prevents a clear conclusion whether if it was the poor delivery, insufficient salience or the psychological mechanism of the intervention that led to its apparent ineffectiveness.

4.4.1 Strengths and Limitations

A strength of this study is its randomized cross-over design with a dynamic social norm message as the intervention. The majority of the studies on social norms and plant-based eating have used static norm messaging and focused on increasing fruit and vegetable intake rather than encouraging a switch from meat- to plant-based options. Previous studies by Sparkman and Walton (2017) did use dynamic norm messages but assessed its efficacy in single-site settings that were located in and around a university campus, which attracted a limited sub-group of the population, without matching control sites. The present study asked customers to replace meat-based meals with plant-based alternatives, on a much larger scale than any previous study, including all 22 stores of a major and well-known retail chain across the UK. The partnership with the retail chain also enabled access to four weeks of baseline data

that demonstrated customer behavior trends prior to the intervention period clearly and allowed controlling for potential established differences across locations when measuring the efficacy of the intervention.

Working in partnership with a retail chain also added some restrictions to the study design. The availability of plant-based meals at the in-store restaurant was decided by the retail chain and differed between 4-5 options out of 13 items, constituting only 30-38% of dishes on offer. Moreover, only an average of 10% (range 4-13%) of meals consumed during the baseline period were plant-based meals, suggesting that the customer base had a strong preference for meat-based meals when visiting the in-store restaurants. The main limitation of the study design was that not all the intervention sites were visited and checked for intervention fidelity, following assurance from the retail chain partner that the implementation was assured centrally and that there would be very little variability across stores on how the social norm message and other visuals would be displayed on the digital boards. However, the limited findings from the nine out of 22 stores that were visited suggest that intervention fidelity was low on average, but I do not have enough data to fully understand the extent of implementation fidelity impacting effectiveness of the intervention.

4.4.2 Conclusion

At the time it was conducted, the present study was the first to test a dynamic social norm messaging intervention across multiple sites to motivate customers to reduce their meat consumption and choose plant-based alternatives. The study design provided a unique opportunity to test the effectiveness of a dynamic social norm messaging intervention in an ecologically valid setting. While it was not possible to identify and isolate all factors, the study design and data analysis aimed to control for

geographic locations, seasonal and temporal changes, availability of meal options, and intervention fidelity to accurately observe the effect of dynamic social norm messaging on plant-based meal sales. There was no evidence that the intervention led to any change in plant-based meal sales across the participating restaurants, suggesting that simple dynamic social norm messages may not be sufficient to alter eating behaviors in the complex food purchasing environment of the retail chain's in-store restaurants. Better adherence to the intervention procedure and correct display of the message, longer and repeated exposure, increased visibility, attention-drawing design, and more strategic positioning coupled with reference to a closer and more relevant referent group, could all be considered to improve the impact of future dynamic social norm messaging interventions.

Chapter 5: Testing the effect of a dynamic descriptive social norm message on meat-free food selection in worksite cafeterias: a randomized controlled trial

Summary

This chapter builds on findings from three previous studies to develop and test the effectiveness of a social norm messaging intervention to increase meat-free meal selection in worksite cafeterias in the UK. A dynamic descriptive social norm message was developed based on existing theory, communicating a clear change in target behavior, using a relevant and relatable referent group, grounding the desired behavior change in time and place, and including a clear call to action. 25 worksite cafeterias located across England were randomized to either the intervention (N=12) or control (N=13) conditions and the trial lasted for 8 weeks between 03 October 2022 and 10 December 2022. Intervention cafeterias displayed the norm messages on free-standing banners, posters, and floor stickers in various locations and labelled the vegetarian main dish of the day with a star sticker. Regular fidelity checks were conducted and customers in intervention cafeterias were interviewed to assess the salience and perceived credibility of the intervention. Linear mixed effect models to compare the change in weekly percentage of meat-free meal sales between intervention and control cafeterias found no evidence of a difference in meat-free meal sales in the intervention cafeterias compared to the control (-2.22 percentage point change, 95% CIs: [-7.33, 2.90], p=0.378). Baseline percentage sales of meat-free meals

varied by site but there was no evidence this influenced the effectiveness of the intervention (-9.94 percentage point change, 95% CIs: [-19.8, -0.09], 0.048). The intervention was implemented with high fidelity, however, the majority of the customers interviewed reported that they did not remember seeing the intervention materials. This trial aimed to address some of the shortcomings of the previous study that used a crossover design to test a dynamic descriptive norm message in retail store restaurants by implementing a more robust study design, creating a theoretically grounded norm message, and increasing the visibility of the intervention materials by collaborating with the cafeterias' marketing team. Despite these efforts, this study also found no evidence that a dynamic social norm message intended to increase the consumption of meat-free dishes was a sufficient intervention to increase the proportion of meat-free meals sold in worksite cafeterias. This study has been submitted for publication as a peer-reviewed journal article.

5.1 Introduction

This chapter will detail the most ambitious study of the DPhil in terms of its scope and aims as well as my efforts in its conception, development, implementation and evaluation. To the best of my knowledge, this study is the first randomized controlled trial testing the effectiveness of a dynamic descriptive norm message intervention to reduce meat consumption. The trial was conducted in collaboration with a global catering company, recruiting 25 worksite cafeterias across England to implement the intervention. Measuring changes in proportion of plant-based meal sales using data collected from electronic point-of-sale (EPOS) systems, the trial was able to assess the effect of the intervention on actual purchase behaviors of cafeteria customers.

Chapter 4 has given a detailed account of the first randomized cross-over trial testing the effect of a dynamic descriptive norm message in the in-store restaurants of a major retail chain. While the trial benefited from a strong study design, large number of participating sites, and food purchase data from customers of diverse demographic backgrounds, it also had several considerable shortcomings, namely low intervention fidelity, low salience of the norm message, low relevance of the referent group, and a short intervention period. My level of involvement with the trial was also limited, as its design and implementation occurred before I started my DPhil studies.

The limitations of both the randomized cross-over trial and my involvement with it meant that there was room for further evidence generation for the potential effectiveness of dynamic descriptive norm message interventions to reduce meat consumption. In the current study, I aimed to specifically target some of the issues the previous study. First, a more robust RCT design was implemented instead of a cross-over trial. Second, the intervention period was increased from two to eight weeks. Intervention fidelity was prioritized, and frequent checks and close monitoring of the

implementation was ensured. The intervention material was carefully developed with multiple elements that were grounded in social norms theory and their visuals designed in collaboration with the commercial partner's marketing team to ensure increased salience. Lastly, worksite cafeterias were selected as the setting to ensure a large proportion of customers visited them frequently, therefore increasing their exposure to the intervention materials. Recruiting worksite cafeterias for the intervention also had the advantage of using a particular out-of-home (OOH) food setting that only serves a limited subset of customers (i.e. employees of that particular worksite) that are more likely to have varying levels of familiarity and social relationships with each other. This meant that customers of the cafeteria could constitute a more relevant referent group for a social norm messaging intervention compared to the previous study where the customers of the restaurant consisted of shoppers visiting the retail chain store who were unlikely to have any social connections with each other.

The present study also introduced a small qualitative component to assess the salience and perceived credibility of the dynamic descriptive social norm messages. This component has been lacking in previous studies that tested the effectiveness of such messages, leading to the interpretation of their findings to be conjectural. For example, the lack of evidence for the effectiveness of dynamic descriptive social norm messages to reduce meat consumption has been interpreted by different researchers to be due to the wording of the message (Patel et al., 2024), low visibility of the message (Sparkman et al., 2020), ambiguity of the referent group (Aldoh et al., 2021), perception of the target behavior of reduced meat consumption as a "passing trend" rather than a minority behavior that will soon be adopted by the majority (Sparkman & Walton, 2017), and the sociocultural rootedness of meat consumption outweighing

the dynamic norm message (van der Vliet et al., 2024). However, none of these interpretations were supported by any qualitative or quantitative data from the participants of the interventions. Using opportunistic interviews with cafeteria customers, I aimed to provide more detailed and reliable insights into the (in)effectiveness of the present intervention.

Implementing a robust study design and intending to address some of the shortcomings of previous studies, the present study primarily aimed to assess the effect of the presence of dynamic descriptive social norm messages in the workplace cafeteria on the likelihood of cafeteria goers selecting a meat-free meal option. The secondary aim was to assess whether the intervention had any unintended consequences, such as a decrease in revenue, that could affect its acceptability by food retailers.

5.2 Methods

5.2.1 Setting

For this study, I collaborated with a global catering company that has an established relationship with the wider research team I am a part of and that has previously worked with other members of the LEAP team on conducting various experiments. The company is one of the largest contract catering and foodservice companies in the world and is headquartered in the UK. The company is contracted by other companies in various industries (e.g. automotive, telecommunications, postal service) to establish and operate cafeterias in-house at their buildings. Although the offerings of each cafeteria are slightly varied depending on the size, requirements, and customer preferences of each contractor, they have similar menus and prices and use the same branding and marketing materials. Each cafeteria has a manager who reports

to the central management of the company. The sales data from each cafeteria is collected and stored centrally by the catering company.

I liaised with the catering company's Head of Nutrition and Sustainability to pitch the intervention to cafeteria managers and to recruit those interested. Those who registered interest were invited to an online conference call where I outlined the trial design and purpose and intervention materials and encouraged them to take part in the study.

The cafeterias that took part in this study all had a daily two-hour lunch service during which hot main meals and sides, salad bar, sandwiches, wraps, beverages and confectionery were available for purchase. Each cafeteria curated their selection of food based on their customer profiles by choosing from a standard list of recipes provided by the central management of the catering company. The hot meals differed daily, and customers could view a weekly menu in advance. All cafeterias were self-service, with customers walking through each station and choosing what they wanted to eat and paying for it at the tills before sitting down to consume the food. The inclusion criteria required each cafeteria to:

a) be based in the United Kingdom,

b) have EPOS tills operated by the catering company,

c) be able to provide data at a detailed enough level to identify specific meals sold, and

d) offer hot main meal options (in line with the base menu from the catering company).

5.2.2 Study design

I conducted a two-arm, parallel, randomized controlled trial in 25 worksite cafeterias for 8 weeks, starting on 10 October 2022 and ending on 03 December 2022.

The sample size was based on pragmatic factors, rather than a power calculation, including willingness of worksite cafeteria managers to join the trial, the size of worksite they were serving, contracting company, and baseline meat-free meal sales.

After recruitment, worksite cafeterias were randomized with an allocation ratio of 1:1 to one of the following conditions: control (no message) and intervention (social norm messages displayed prominently in the cafeteria). I conducted the randomization via random number assignment using STATA version IC 16.1 (StataCorp, 2020), based on a random seed generated online (https://bit.ly/stata-random) to enable replication. The necessary code for the randomization sequence was written and run on a separate do-file, and I did not view the numbers and conditions assigned to the cafeterias until the complete code was run. There was no stratification or limitation set for the process.

Following randomization, managers whose cafeterias were allocated into the intervention condition were invited to a second online call where I gave detailed information on how to implement the intervention and explained the procedure for fidelity checks.

It was not possible to blind me or worksite cafeteria managers to the intervention allocation due to the nature of its implementation. However, cafeteria customers were not made aware of the research during the trial period and no explicit individual consent of customers were obtained since no personally identifiable information was collected and the data was analyzed at worksite-level only. The catering company obtained verbal consent from the contracting companies where the worksite cafeterias were housed, and from the cafeteria managers that expressed interest in joining the trial. Ethical approval was given by the University of Oxford Central University Research Ethics Committee (Reference: R72710/RE001).

5.2.3 Intervention development

One of the aims I had with this study was to create a social norm message that was grounded in psychological theory and improved on previously used messages in the literature. The intervention message consisted of three main components.

The first component, "More and more of your [company name] colleagues are choosing veggie options", conveyed the dynamic descriptive norm by implying an increased adoption of the target behavior (choice of vegetarian meal option). This phrase was intended to have similarities with the message used in the previous study ("More and more [retail store name] customers are choosing our veggie options").

In line with evidence that higher context specificity increases the potential influence of social norms (Einhorn, 2020), this component also referred to a specific and relevant peer group, i.e. other co-workers of the contracting company in which the worksite cafeteria is located with the phrase "your [company name] colleagues".

The second component, "Join them today!" aimed to reinforce the norm message with a call to action that invites the cafeteria goers to choose a plant-based meal "today", grounding the performance of the normative behavior to a specific time (Chen et al., 2020; Mejtoft et al., 2021).

The final component, "Spotted the star? Look for the star on our most loved veggie options" added an element of gamification that urged customers to identify an easily perceivable feature (the star). It also highlighted the vegetarian dishes as the "most loved" option, which built on previous evidence that suggested drawing attention to plant-based dishes on menus by marking them as "dish of the day" or "chef's recommendation" may increase their likelihood of getting selected (Bacon & Krpan, 2018).

The materials and visual aspects of the intervention were developed in collaboration with a member of the marketing team and the Head of Nutrition and

Sustainability of the catering company over several hours of meetings and reiterations of mock-ups before the materials went into production. The final materials consisted of a large free standing three-sided banner placed at the entrance of the cafeteria, floor stickers that guided the customers from the entrance to the hot main meal buffet, A4 sized posters that were placed next to or above the buffet, and star stickers that were placed next to the vegetarian options on the menu, which were all designed to make the messages as salient as possible by increasing exposure and catching attention (see Figure 5.1).

Figure 5. 1 Photos of the intervention materials displaying a) the large free standing banner, b) floor stickers and c) A4 size posters star sticker marking the vegetarian option on the menu (the company name has been redacted).

a)

b)

c)

5.2.4 Procedure

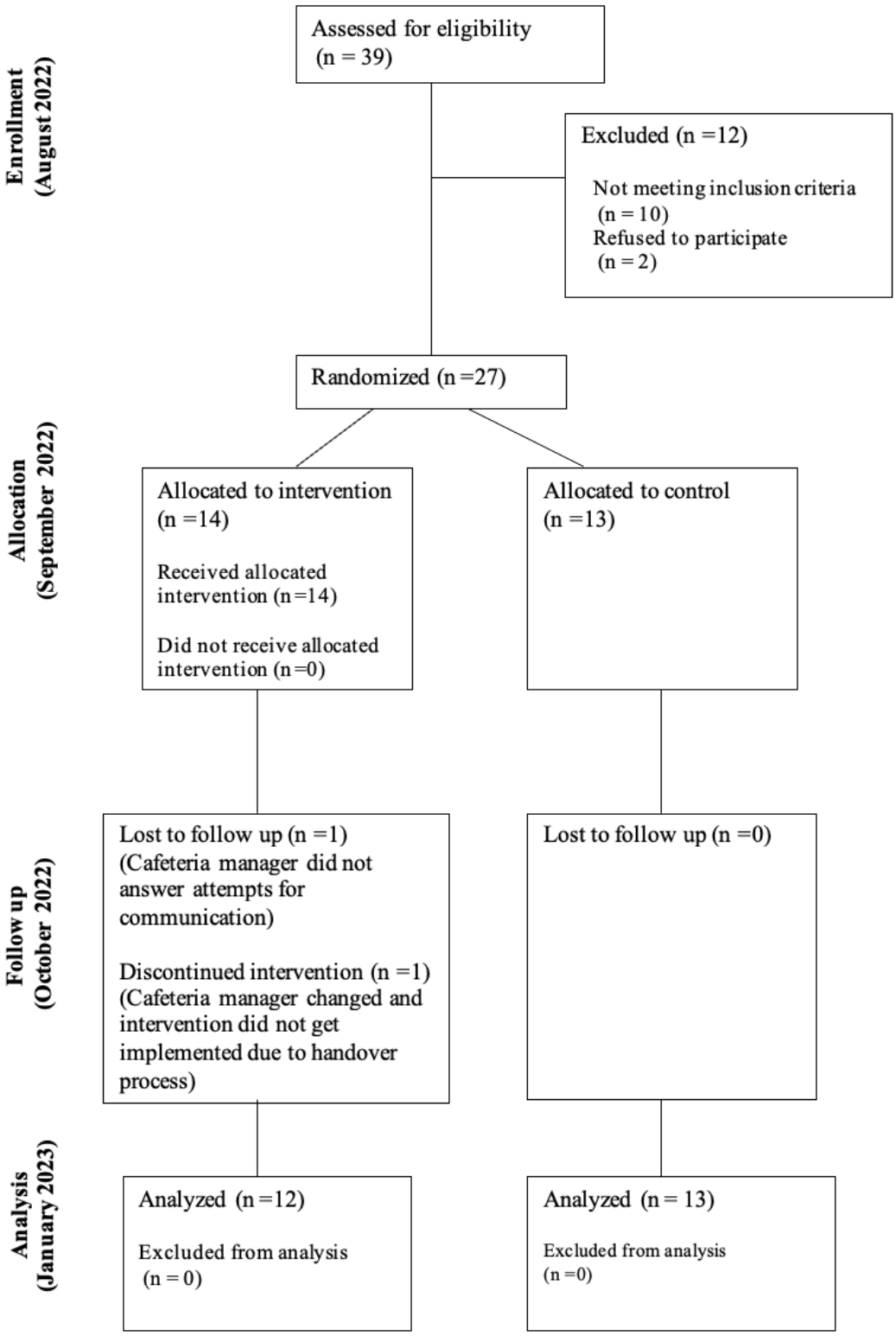
Intervention cafeterias received their materials (i.e. banner, floor stickers, posters, menu star stickers) one week prior to the start of the trial and got guidance on how to place the materials (banners at the entrance, floor stickers leading to hot buffet, and posters at the hot buffet) and marked the daily vegetarian options on their printout menus every day with the star stickers.

All cafeterias, including those in the control condition, received four phone calls over eight weeks from me and two research assistants who volunteered their time to help me. All cafeterias were asked to report any site closures, till malfunctions, promotions and special events, unexpected changes to the preplanned menus, ingredient and supply shortages, or other disruptions and changes to the purchasing environment that could have affected footfall and sales. Intervention cafeterias were additionally asked whether the materials were still intact and on display, whether vegetarian options were being labelled daily, whether the catering staff had any feedback on the intervention, and whether any customers asked questions about the intervention materials. Intervention cafeteria staff were also required to send weekly photographs of the materials and menus to me so I could check that the intervention continued to be implemented correctly. One cafeteria manager was uncontactable, and one cafeteria had a new manager come into the role who did not receive information about the intervention during the handover. These two cafeterias were both part of the intervention condition, and were treated as lost to follow up and excluded from analysis (Figure 5.2).

During the final two weeks of the intervention, 10 out of the 12 intervention cafeterias were visited to observe the implementation in person and receive feedback from catering managers and staff. Two cafeterias could not be visited due to their significant distance from Oxford and difficulties with travel. I personally conducted 6

of those visits, while a research assistant helped me by doing the remaining 4 visits. I trained the research assistant on how to liaise with the catering managers to set up visits, to take pictures of the intervention materials and the displays of food options, to approach customers, and to ask and record answers to questions. I also wrote a script for the questions and ensured that both the research assistant and I had copies of this during each visit (see Appendix 6.1). We arrived at each cafeteria shortly before lunch service and observed the customers' arrival to the cafeteria, their food purchasing patterns, and their interactions during consumption. Opportunistic interviews with willing cafeteria customers were conducted, who were asked whether they noticed the intervention materials, whether they could recall the content of the messages, whether they found this content to be credible and believable, whether they had a positive or negative reaction to the messages and whether they made changes in their consumption pattern as a result.

Figure 5. 2 CONSORT flowchart showing flow of participants (cafeterias) through the stages of the trial.



5.2.5 Measures

Meal Sales. The catering company provided me with sales data that were recorded via EPOS tills throughout the trial. Hot main meals, wraps, salads, soups, sandwiches, savory snacks, starters, and jacket potatoes were coded as either meat-based or meat-free depending on their ingredients using a series of keywords (e.g "chicken", "fish", "lamb" or "Quorn", "plant-based", vegan"). Food items that do not constitute a meal such as confectionery, desserts, beverages, and condiments were excluded from the data. I checked all products manually and individually for potential errors in coding (e.g. coding a meat-including item as meat-free). I contacted the catering managers and asked for clarifications if the contents of a dish were not clear from its name. Following coding, the total number of meals sold every day and every week at each site were calculated, for both the eight-week period that preceded the trial which constituted the baseline, and the eight-week period of the trial itself. The total number of meals was used as a proxy to understand whether there were changes in footfall and overall meal consumption in cafeterias during the intervention period. The proportion of meat-free dish sales were calculated for each day and each week for all participating worksite cafeterias for baseline and trial periods, which was the main outcome of interest.

Baseline meal sales. The catering company provided me with sales data for the eight-week period that preceded the intervention. Baseline meal sales were entered into all regression models as a control variable.

Worksite type. This was used as a proxy to estimate the SES of the cafeteria goers with offices assessed as high and factories/manufacturing as low.

Intervention fidelity. Each site was given a fidelity score based on their adherence to the intervention period based on data gathered from phone calls,

photographs and cafeteria visits. Cafeterias that displayed the materials correctly throughout, answered all phone calls, and provided weekly photos were coded to have high intervention fidelity, whereas those that missed one or more calls or did not send photos each week were coded to have low fidelity, creating a dummy variable.

Cafeteria closures. Any closures or unexpectedly low footfall days due to bank holidays, worker strikes, or worksite specific events were recorded and observations from those days were excluded from the data.

Till malfunctions. Any issues with recording sales using the EPOS devices (e.g. due to internet connection failures or malfunctioning devices) were recorded for each cafeteria and observations from those days were excluded from the data.

5.2.6 Data analysis

The statistical analysis plan specifying the hypotheses and primary and secondary outcomes was pre-registered on OSF before any data cleaning or analysis was conducted (https://osf.io/6wfgu). The analysis was done using STATA version IC 16.1 (StataCorp, 2020). The data received from the catering company were cleaned and discrepancies in records from each cafeteria (e.g. different ways of entering sale dates) were resolved prior to any analysis. Non-meal food items (e.g. confectionery – as explained in the Measures section above) were excluded from the data. Observations from weekends and national holidays were excluded from the data as they only occurred in a small number of sites and had a very low number of observations. Days where cafeterias experienced a till malfunction, closure, or strikes were excluded from the data, and a variable that indicated that the cafeteria had a shorter week was created.

The primary research question was whether the presence of dynamic descriptive social norm messages in the workplace cafeteria changed the likelihood of cafeteria goers selecting a meat-free meal option, when controlling for baseline

percentage of vegetarian main meal sales and length of operational week. Following from this, I also explored whether the effect of the presence of dynamic descriptive social norm messages in the workplace cafeteria varied when interacted with baseline sales, worksite type, and intervention fidelity. To answer these questions, multilevel mixed-effects linear regressions with restricted maximum likelihood and with Kenward-Roger method for degrees of freedom were run with autoregressive (AR) structure of order for within-group errors where the weeks were used as an integer-valued time variable to order the observations within groups and to determine the lags between successive observations. The p-value thresholds for significance were set at 0.05 for the primary, and at 0.01 with a Bonferroni correction for multiple testing for the secondary research question. The weekly percentage of meat-free sales during the intervention period was first regressed on trial arm (control (N=13) versus intervention (N=12)), entering baseline percentage of meat-free meal sales and length of operational week as covariates. Then, another regression model was created adding type of worksite (office versus manufacturing), and baseline percentage of meat-free meal sales as interaction terms, with random effects varying according to each cafeteria. The regressions were repeated with a per-protocol analysis excluding 2 cafeterias from the intervention arm that had low intervention fidelity for a sensitivity analysis.

The secondary research question examined whether the overall sales of meals by the cafeterias changed with the presence of dynamic descriptive social norm messages. For this question, the above regression model was used again, but the dependent variable was replaced with weekly total meal sales during the intervention period and the baseline variable was calculated based on total meal sales. The regression was repeated with a per-protocol analysis excluding 2 cafeterias from the intervention arm that had low intervention fidelity for a sensitivity analysis.

I also explored how cafeteria customers perceived the dynamic descriptive social norm messages in the workplace cafeteria. For this question, opportunistic interviews with cafeteria customers were analyzed for recall of the intervention material and message, believability and perceived credibility of the message, ability of the message to motivate individuals to change their behavior, and priorities of individuals when choosing a meal at their worksite cafeteria (see Appendix 5.1 for a script of the interview questions).

The current analysis deviated from the original statistical analysis plan published on OSF in several aspects. I initially intended to limit the analysis to hot main meal sales in each cafeteria, but due to the low sales of these items and the comparatively high sales of wraps, sandwiches, salads, and pasties in each cafeteria, the scope of the sales data which I analyzed was extended. The original plan also aimed to assess the availability of meat-free hot main meals in each cafeteria and enter this as an interaction variable to predict the effect of the intervention on meat-free sales. However, both due to the inclusion of other food items in the analyzed data, and the lack of consistent information about the content of menus offered at each cafeteria, I decided that it was not possible to meaningfully measure the availability of meat-free items. Finally, the original plan intended to assess the change in the environmental impact of meals sold as a result of the intervention. However, since there was no evidence of a main effect of the intervention on meal sales, I did not go ahead with this analysis.

5.3 Results

5.3.1 Descriptive analyses

Two of 14 intervention cafeterias were excluded from the analysis as they were lost to follow-up. Nine out of remaining 12 intervention cafeterias served offices whereas

three served manufacturing sites. Five out of 13 control cafeterias served offices and eight served manufacturing sites. There was a considerable level of variation across sites in terms of their baseline weekly total meal sales (range: 97.75 – 3282.35) and baseline percentage of weekly meat-free meal sales (range: 9.45% - 42.62%) (Table 5.1).

5.3.2 Effect of the intervention

There was no significant effect of the intervention on the percentage of weekly meat-free meal sales (-2.22 percentage points, 95% CIs: [-7.33, 2.90], p=0.378), controlling for length of operational week and baseline meat-free sales.

Contrary to my hypothesis, there was no evidence that the effectiveness of the intervention varied in relation to the type of worksite (office versus manufacturing: 3.04 percentage point difference, 95% CIs: [-3.35, 9.43], p=0.331) or baseline sales (high versus low baseline vegetarian sales: -9.94 percentage point difference, 95% CIs: [-19.79, -0.09], p=0.048) (Table 5.2).

Table 5. 1 Allocated trial arms, type of worksite served, and baseline weekly total and meat-free meal sales of trial cafeterias.

Cafeterias	Trial Arm	Worksite Type	Baseline Weekly Total Meal Sales (SD)	Baseline Weekly Meat-Free Meal Sales (SD)	Baseline Weekly % of Meat-Free Meal Sales (SD)
Cafeteria A	Intervention	Office	133 (24.10)	25.86 (5.44)	19.48 (2.48)
Cafeteria B	Intervention	Office	250.5 (45.79)	48.5 (14.79)	19.26 (3.69)
Cafeteria C	Intervention	Office	262.13 (33.09)	79.5 (17.36)	30.22 (4.94)
Cafeteria D	Intervention	Manufacturing	689.63 (106.12)	252.13 (54.36)	36.47 (4.61)
Cafeteria E	Intervention	Manufacturing	243.13 (22.44)	71.63 (9.27)	29.59 (3.97)
Cafeteria F	Intervention	Manufacturing	396.75 (75.53)	101.63 (35.75)	25.10 (6.21)
Cafeteria G	Intervention	Manufacturing	165.63 (15.07)	44.00 (8.49)	27.01 (6.74)
Cafeteria H	Intervention	Office	404.25 (71.80)	134.63 (31.34)	33.16 (3.66)
Cafeteria I	Intervention	Office	214.63 (47.87)	63.00 (12.33)	29.59 (2.66)
Cafeteria J	Intervention	Office	275.38 (60.69)	81.00 (21.69)	29.38 (4.48)
Cafeteria K	Intervention	Office	186.50 (27.80)	38.38 (11.08)	20.69 (5.34)
Cafeteria L	Intervention	Office	895.88 (237.62)	294.88 (83.07)	32.78 (2.50)

Cafeteria M	Control	Office	3283.3 (307.32)	1401.25 (196.56)	42.62 (3.83)
Cafeteria N	Control	Manufacturing	193.13 (44.24)	18.87 (14.54)	9.45 (5.52)
Cafeteria O	Control	Office	342.63 (50.26)	72.75 (16.48)	21.21 (3.84)
Cafeteria P	Control	Office	1635.9 (224.55)	390.87 (57.46)	23.96 (2.06)
Cafeteria Q	Control	Manufacturing	226.50 (44.08)	41.50 (8.89)	18.62 (3.88)
Cafeteria R	Control	Manufacturing	160.38 (61.91)	67.25 (28.31)	41.55 (7.63)
Cafeteria S	Control	Manufacturing	506.13 (106.82)	122.87 (25.54)	24.61 (4.67)
Cafeteria T	Control	Office	120.25 (31.14)	39.00 (7.71)	33.67 (8.92)
Cafeteria U	Control	Office	848.50 (138.18)	164.00 (36.75)	19.34 (3.32)
Cafeteria V	Control	Manufacturing	1283.8 (257.43)	274.00 (49.06)	21.51 (1.89)
Cafeteria W	Control	Manufacturing	97.75 (14.36)	26.50 (9.47)	26.74 (6.97)
Cafeteria X	Control	Manufacturing	229.25 (44.98)	30.5 (16.72)	14.22 (10.79)
Cafeteria Y	Control	Manufacturing	391.13 (54.95)	99.13 (8.63)	25.65 (3.32)

Table 5. 2 Mixed-effects regression model results for weekly percentage of meat-free meal sales during the intervention period.

Variables	Model 1					Model 2				
	Model Estimate*	Standard Error	95% CIs	t	p-value	Model Estimate	Standard Error	95% CIs	t	p-value
	Fixed Effects					Fixed Effects				
(Intercept)	22.64	1.65	[19.22 26.05]	13.73	0.000	20.31	1.86	[16.42, 24.20]	10.91	0.000
Trial Arm (ref=Control)	-2.22	2.47	[-7.33, 2.89]	-0.90	0.378	2.54	3.91	[-5.66, 10.73]	0.65	0.525
Length of Week (ref= 5 Days)	-1.24	1.09	[-3.39, .92]	-1.13	0.258	-1.10	1.09	[-3.26, 1.06]	-1.01	0.316
Baseline meat-free sales (ref= Low)	10.62	2.48	[5.47, 15.76]	4.28	0.000	15.52	3.52	[8.16, 22.88]	4.41	0.000
Intervention x High Baseline						-9.94	4.71	[-19.80, -0.09]	-2.11	0.048
Cafeteria Worksite Type (ref=Manufacturing)						3.04	3.05	[-3.35, 9.43]	1.00	0.331
Intervention x Office						-1.68	4.36	[-10.81, 7.46]	-0.38	0.705
	Random Effect					Random Effect				
(Intercept)	27.44	9.27	[14.16, 53.20]			22.49	8.35	[10.86, 46.58]		

*Percentage point change in meat-free meal sales

There was also no evidence of an effect of the intervention on the weekly total number of meal sales across sites, controlling for length of week and baseline total sales (-223 meals, 95% CIs: [-635, 188], p=0.273) (Table 5.3).

Intervention fidelity was high (see Appendix 5.2 for examples of intervention fidelity photos). Only two out of twelve intervention cafeterias rated as low so in place of a regression analysis, I conducted a sensitivity analysis excluding these sites. This did not alter the primary findings (Tables 5.4-6).

Table 5. 3 Mixed-effects regression model results for weekly total meal sales during the intervention period.

Variable	Model Estimate	Standard Error	95% CIs	t	p-value
	Fixed Effects				
(Intercept)	408.84	153.27	[91.00, 726.68]	2.67	0.014
Trial Arm (ref=Control)	-223.25	198.40	[-634.72, 188.22]	-1.13	0.273
Baseline total sales (ref= Low)	1227.85	232.10	[746.51, 1709.18]	5.29	0.000
Length of Week (ref= 5 Days)	-26.39	16.37	[-58.73, 5.96]	-1.61	0.109
	Random Effect				
(Intercept)	238376.7	72047.24	[131736.4, 430980.6]		

Table 5. 4 Sensitivity analysis mixed-effects regression model results for weekly percentage of meat-free meal sales during the intervention period.

Variable	Model Estimate	Standard Error	95% CIs	t	p-value
	Fixed Effects				
(Intercept)	22.60	1.72	[19.00, 26.19]	13.11	0.000
Trial Arm (ref=Control)	-2.10	2.62	[-7.56, 3.36]	-0.80	0.431
Baseline meat-free sales (ref= Low)	10.76	2.66	[5.21, 16.30]	4.05	0.001
Length of Week (ref= 5 Days)	-1.19	1.18	[-3.53, 1.15]	-1.01	0.316
	Random Effect				
(Intercept)	29.84	10.55	[14.92, 59.65]		

Table 5. 5 Sensitivity analysis mixed-effects regression model results for weekly percentage of meat-free meal sales during the intervention period with interactions.

Variable	Model Estimate	Standard Error	95% CIs	t	p-value
	Fixed Effects				
(Intercept)	20.30	1.95	[16.19, 24.41]	10.39	0.000
Trial Arm (ref=Control)	2.66	4.22	[-6.25, 11.58]	0.63	0.537
Length of Week (ref= 5 Days)	-1.05	1.19	[-3.39, 1.30]	-0.88	0.380
Baseline meat-free sales (ref= Low)	15.51	3.69	[7.73, 23.29]	4.21	0.001
Intervention x High Baseline	-10.11	5.11	[-20.90, .68]	-1.98	0.065
Cafeteria Worksite Type (ref= Manufacturing)	3.06	3.20	[-3.69, 9.81]	0.96	0.353
Intervention x Office	-1.85	4.77	[-11.91, 8.21]	-0.39	0.702
	Random Effect				
(Intercept)	24.81	9.70	[11.53, 53.40]		

Table 5. 6 Sensitivity analysis mixed-effects regression model results for weekly total meal sales during the intervention period.

Variable	Model Estimate	Standard Error	95% CIs	t	p-value
	Fixed Effects				
(Intercept)	361.88	157.11	[34.18, 689.58]	2.30	0.032
Trial Arm (ref=Control)	-162.20	212.87	[-606.24, 281.84]	-0.76	0.455
Baseline total sales (ref= Low)	1373.19	255.84	[839.51, 1906.87]	5.37	0.000
Length of Week (ref= 5 Days)	-13.84	17.34	[-48.17, 20.48]	-0.80	0.426
	Random Effect				
(Intercept)	238376.7	72047.24	[131736.4, 430980.6]		

5.3.3 Customer perceptions

Across 10 sites, 155 cafeteria customers participated in opportunistic interviews. Most (n = 88, 57%) customers did not recall seeing the intervention materials, and could not recall the message in the materials. Of those who could recall seeing the materials (N=67), only three people were able recall the dynamic norm message. Around a quarter (28.4%) of those who saw the materials recalled it contained the message "Spotted the star?" and a similar proportion (26.9%) recalled it contained information about vegetarian options. Only five people recalled that the

message both referred to a star and vegetarian options. The component that was recalled the most were the star stickers that were placed next to the meat-free options on the physical menus on display on the hot meal buffet. The majority of the customers who recalled seeing the messages found them to be credible and believable and mentioned they have observed their colleagues choosing more meat-free options in the recent past. When asked why they may not have noticed the intervention materials, the majority of the customers reported that they focus on the visual appearance and appeal of the food items that are on display and that they "tune out" promotional materials and posters. The majority of the customers listed taste and visual appeal as their priorities when choosing their lunch options at the cafeteria. Value for money was mentioned occasionally, while health was mentioned rarely and sustainability not at all as an important factor in food choices.

5.4 Discussion

I conducted a randomized controlled trial testing the effects of a theoretically informed dynamic descriptive norm message intervention on the selection of meat-free meal choices in worksite cafeterias in the UK and found no evidence of an effect of the intervention.

This trial adds to the small, but growing body of literature that was discussed at length in Chapter 1 that have found that dynamic descriptive norm interventions might not be sufficient to change meat reduction intentions and behaviors (Çoker, Pechey, et al., 2022; Patel et al., 2024; Sparkman et al., 2020 (studies 2 and 4 only); van der Vliet et al., 2024; Weikertova & Urban, 2023; Zumthurm & Stämpfli, 2024). Here, I sought to overcome limitations of previous trials but despite the efforts made to formulate the dynamic descriptive norm message in line with existing social psychology theory and to make the intervention materials highly visible and salient in this trial, most

customers who were interviewed did not recall seeing the materials. Interventions that attempt to relay normative information through text-based communication depend heavily on individuals to spend time and cognitive effort on reading, understanding, internalizing, and acting on the information. In fast-paced decision-making food purchasing settings, few individuals have the opportunity to pause, notice, and reflect on the intervention message. The short-term messaging interventions could also have been insufficient to challenge existing norms that repeat customers of the cafeterias have formed through multiple observations of colleagues' food choices over long periods (i.e. years) of time.

The relative ineffectiveness of social norm interventions to change meat-eating behavior compared to some other dietary habits may also be because meat consumption is more complex and socially and culturally charged than other food consumption behaviors. Meat has historically been associated with ideas of masculinity (Ruby & Heine, 2011), affluence (Fiddes, 1994), natural hierarchy (Piazza et al., 2015), religiosity (Chiles & Fitzgerald, 2018), and kinship (Swatland, 2010). The symbolic values assigned to meat consumption make it a particularly challenging behavior to change through communicating normative information, unlike other food behaviors such as increasing fruit and vegetable intake or choosing healthier snacks that have been successfully changed with norm based interventions (Collins et al., 2019; Huitink et al., 2020; Mollen et al., 2013).

The trial design also accounted for a number of factors that could have impacted the effectiveness of the intervention. While the intervention message provided normative information about others' behaviors, I anticipated that this could be either supported or hindered by which types of dishes cafeteria goers observed their colleagues choose in real life (Thomas et al., 2017). I therefore collected data on sales of meat-free meals for the eight-week period prior to the intervention and found that

baseline sales did not impact the effect of the intervention. The study featured in Chapter 4 had issues with intervention fidelity (Çoker, Pechey, et al., 2022). I therefore made it a priority to measure intervention fidelity of each site at various time points and found that only two out of 12 sites had imperfect implementation. Excluding these two sites from the analysis did not change the outcome of the trial. Previous research has found that people who have lower socioeconomic status are more likely to overconsume meat, while those with higher socioeconomic status are more likely to have tried and/or consumed meat alternatives (Clark et al., 2021). I used type of worksite as a proxy for socio-economic status to explore whether implementing the intervention in cafeterias that mainly served office workers or in those that mainly served manufacturing workers made a difference in its effectiveness and found no differences between the two worksite types. Finally, I prioritized making the trial duration as long as possible and negotiated with the catering company to have an eight-week intervention period. Compared to previous field studies (Çoker, Pechey, et al., 2022; Patel et al., 2024; Sparkman et al., 2020) this period was considerably longer and addressed the potential risk of customers not noticing intervention materials due to a short time of exposure and provided an opportunity for the impact of the intervention to develop over time.

5.4.1 Strengths and Limitations

For this study, I collaborated with a global catering company that operates a large number of cafeterias in the UK, to test a social norm messaging intervention to reduce meat sales in a real world setting, targeting a range of worksites (both office-based and manufacturing) located across England. I tested the intervention using a robust RCT design and was able to objectively measure meat consumption behavior through food purchasing data. Additionally, I developed the creative aspects of message delivery (i.e

the visual design, size, positioning, and material and the wording of the social norm message) in consultation with the catering company's nutrition and marketing teams, drawing from their consumer insights, commercial expertise, and data-based knowledge of food purchasing trends across their worksites. Through this collaboration, the study contributed to meeting a need demonstrated by previous research for cooperation between psychology and nutrition science research and input from the food industry and retailers (Graham & Abrahamse, 2017).

The study also had a few limitations. First, I was unable to assess any individual level differences in cafeteria customers. Therefore, it is not possible to know whether the intervention had an effect on some individuals such that it increased their selection of meat-free meals, and whether it backfired on others such that they showed a reactance to the intervention and selected more meat-based meals, resulting in an overall lack of an effect. Secondly, I followed a non-stratified randomization strategy, which resulted in office cafeterias being slightly overrepresented in the intervention condition. Linked to this, there were also discrepancies between cafeterias in terms of the proportion of the workforce who came into work in person and used the cafeteria regularly, and who worked in a hybrid model and only used the cafeteria once or twice per week. The intervention also took place during a period where a number of worksites went through closures due to industry strikes, which meant that the cafeterias of these worksites were operational for fewer days. I predicted that this could have potentially created differences in the frequency and duration of exposure to intervention materials. This was accounted for the analyses but no change was found in the effect of the intervention. Thirdly, while the cafeterias were operated by the same catering company and had comparable menu offerings, pricing, and marketing policies, they also served different companies and organizations. This meant that cafeterias differed not only in size and layout, but also in terms of the clientele they

serve and the company culture they exist in, evidenced by very different baseline uptakes of meat-free options and volume of overall sales.

5.4.2. Conclusion

While dynamic descriptive social norm message based interventions may not be effective on their own for reducing meat consumption, we cannot exclude the possibility that they could be effective when combined with other interventions that implicitly indicate what other consumers prefer, such as increasing the availability of meat-free meal options (Garnett et al., 2019; Pechey, Bateman, Cook, et al., 2022b), making meat-free options the default choice (Meier et al., 2022), or placing these options in more prominent positions (Piernas et al., 2021; Trewern et al., 2022). Future research can explore whether adding a norm message to these other proven interventions can amplify their effects and motivate greater reductions in meat consumption.

Chapter 6: Discussion

Summary

The following chapter provides an overview of the key findings of the four studies included in this thesis, which are placed in the context of wider and recent relevant literature. Strength and limitations of the methodologies used are discussed at length. Reflections on academic and commercial collaborations, logistic and project management issues, and lessons learned for future research are shared. Recommendations for better understanding of the complexity of meat consumption behaviors, designing more effective interventions to reduce meat consumption, and improving the quality, diversity, and robustness of research in the field are made.

6.1 Key findings

This thesis has addressed the pressing need to reduce meat consumption for planetary health. Research in this field is relatively new, with most studies testing interventions to reduce meat consumption being published after the second half of the last decade. While interventions to reduce meat consumption have used a variety of behavior change techniques including information provision, economic incentives, naming and labelling, and changing food purchasing microenvironments, there has been a lack of studies focused on leveraging social norms. Previous literature showed that social norm-based interventions could be successful in changing eating behaviors such as increasing fruit and vegetable intake or selection of healthier snacks. These findings suggested that these interventions could potentially also be effective in reducing meat consumption. The four studies included in this thesis aimed to generate robust evidence for better understanding the role of social norms in food choices and meat consumption and for testing the effectiveness of norm-based interventions in reducing said consumption.

Chapters 2 and 3 reported two online studies that aimed to offer a deeper understanding of perceptions of social norms around healthy and sustainable food choices and how they are shaped by the demographic characteristics of individuals and by the social group the normative information refers to. Chapter 4 presented findings from a randomized parallel cross-over field study that tested dynamic descriptive social norm messaging intervention to reduce meat consumption that was led by the commercial partner and took place in the in-store restaurants of a major retail store chain. Chapter 5 built on this previous study and tested a theoretically informed intervention in a randomized controlled trial across worksite cafeterias and reflected

on how study design, intervention fidelity, and trial settings could have contributed to the ineffectiveness of the interventions.

Altogether, these studies led to the key finding that dynamic descriptive social norm messaging interventions showed no evidence of effectiveness in reducing meat consumption and/or increasing plant-based food consumption, which is discussed below, along with possible explanations why, in the context of other emerging literature.

The findings of this thesis are part of a larger, growing body of evidence generated in the past four years since the start of my DPhil in late 2020 that dynamic descriptive norm messaging interventions are not an effective method to reduce meat consumption (Aldoh et al., 2021; Malta et al., 2024; Patel et al., 2024; van der Vliet et al., 2024; Weikertova & Urban, 2023; Zumthurm & Stämpfli, 2024). These findings have been in contrast with initial studies that have tested these interventions that have found mixed evidence for their effectiveness (de Groot, 2022; Sparkman & Walton, 2017; Sparkman et al., 2020). When taken together with the established evidence that eating is a normative behavior and is influenced by social norms, these findings raise the question whether messaging-based interventions are the best method to leverage social norms. Text-based messaging interventions that aim to provide normative information rely on higher-order cognitive processing (Mollen et al., 2021), and might not be effective unless the target population perceives them to be credible and believable (Granfield, 2002; Miller & Prentice, 2016). Conveying norms through actual demonstration and observation of behavior where individuals can see others select and consume more plant-based foods in a variety of food settings may be more effective than messages (Derricks et al., 2023; Einhorn, 2020).

Another factor to consider for improving social norm interventions would be the selection of the food consumption setting. Interventions in the out-of-home (OOH)

food settings (e.g. restaurants, cafeterias) are easier to implement as they take place in public spaces where a large number of consumers are making food choices, and well suited to research as data can often be collected without requiring collection of personal information and therefore individual consent. Eating outside of the home is also a very social behavior, and people often list "socializing with others" as the main reason for going out to eat (Biermann & Rau, 2020; Fechner et al., 2024), meaning there might be room for normative influences to be leveraged in these settings. However, it must be kept in mind that not all OOH food settings are equal, and while most restaurants, pubs, and cafes might be frequented for the social aspect of eating, workplace cafeterias might be visited solely due to convenience and habit and food purchased in those settings might often be consumed alone. This difference was clearly illustrated in the RCT detailed in Chapter 5 where visits to the worksite cafeterias where the social norm intervention took place revealed that a considerable number of customers preferred to eat their lunches alone or get their food to go and consume it at their work stations.

Even in the OOH food settings where social interactions are a priority, the present social referent groups might not be the most relevant ones for exerting normative influence. The experimental online supermarket shopping task in Chapter 2 found that individuals selected healthier and more sustainable food products if they perceived people they regularly shared their meals with to be prioritizing health and sustainability in their food choices. However, there was no association between their food selection and their perception of healthy and sustainable food choices of other people in the UK. The survey study in Chapter 3 found that despite differences across ethnic groups, considerable proportions of respondents reported that they were influenced by the food choices of their friends and family and expressed a desire to consume similar foods to these referent groups. These findings are in line with other

literature in the field. For example, qualitative studies have found evidence that family norms matter more than peer or friend norms for meat consumption, and that meat reducers were more likely to consume meat when with family members that are omnivores (Ostermann et al., 2024; Salmivaara et al., 2022). Complementing this, an analysis of NDNS diet diary data has found that the amount of meat eaten with family was significantly more than when eating alone or with others (Horgan et al., 2019). The evidence that family norms seem to be more influential on food choices and meat consumption than other referent groups can be interpreted through the lens of Social Identity Theory introduced in Chapter 1, which suggests that the level of social identification with a reference group is positively associated with converging towards the behaviors of that group (Tajfel, 1974; Verhallen & Post, 2020).

Although this was not an intended research question for the thesis, the studies also generated some evidence that suggests people have differing levels of awareness of and concerns about the health versus environmental impact of their food choices. In Chapter 2, participants were more likely to report perceiving others to be making healthier food choices more than sustainable ones. In Chapter 3, regardless of ethnic background, participants were more likely to agree that overconsumption of red and processed meat was bad for health than for the environment. In Chapter 5, opportunistic interviews revealed that while a very small number of cafeteria goers prioritized health while making their work lunch choices, and none brought up issues around sustainability or environment. These findings are complementary to previous literature introduced in Chapter 1 which has found that people's knowledge on the environmental impact of meat production is still limited. They also bring up the question of whether individuals perceive their diet and food choices to have a direct and significant impact for their health, but do not make the same association with the environment. Indeed, previous research has found when asked to rank six food related

decisions (such as reducing food waste and minimizing the purchase of packaged products), eating less meat was considered one of the least impactful measures to reduce damage to the environment (McBey et al., 2024).

6.2 Strengths and limitations

6.2.1. Strengths

The most significant strength of this thesis is its use of a mixed methods approach including online and field studies, and of quantitative and qualitative methodologies. While online studies were particularly suitable for measuring individual differences and performing meaningful subgroup analyses based on demographic characteristics, field studies were appropriate for testing interventions aimed at whole populations rather than individuals, and for observing behavioral changes at a group level. Being able to run both online and field studies also meant that the shortcomings of each were counterbalanced to some extent, which will be discussed in the limitations section.

Using online studies brought the advantages of being time and cost-efficient, with straightforward ethical approval processes, quick recruitment timeframes, and only requiring making payments to participants, without additional expenses. Collaborating with market research companies Dynata and YouGov enabled the recruitment of diverse and nationally representative samples and quick collection and access to data, which would have taken considerable time and resources if a similar sample was to be recruited through offline methods. Conducting the surveys online instead of face-to-face also prevented potential interviewer effects where the demographic characteristics, tone of voice, non-verbal cues of the interviewer, or the way in which they probe, follow up, or respond can influence the way a participant responds to the questions (Bogner & Landrock, 2016). Further ensuring the quality of

the collected data, the time participants take to respond to the survey was monitored, and respondents who were "speeders" (i.e. those who take an unreasonably short time to complete the study) were dropped from the analyses.

On the other hand, conducting field studies enabled the measurement of real-life behaviors (in the case of this thesis, food purchasing), as opposed to hypothetical behaviors or reported intentions. This has provided considerable "ecological validity" to the two studies, i.e. how generalizable their findings were to the real world. This validity helped produce robust evidence about the effectiveness of the intervention being tested and allowed for the interpretation of the results for informing future research and policy to be done with more confidence. Collaborating with commercial partners to conduct the two field studies in this thesis allowed for the interventions to be tested on non-student samples, in locations that were spread across the UK. These collaborations also meant that a large number of sites were recruited to each study, making it possible to collect hundreds to thousands of data points each day, and allowing for statistically well-powered analyses to be conducted afterwards. This was a very unusual and fortuitous opportunity, especially for a DPhil thesis, given that most doctoral students often have to conduct studies with university students and/or within the proximity of their home institution due to constraints in budget, time, and other resources.

The studies that constituted this thesis mainly used quantitative methodologies for data measurement and analysis, but also employed qualitative methods to provide a deeper understanding of the outcomes. RCTs, which are defined as the "gold-standard" of intervention effectiveness research, are less open to subjectivity and can generate more robust evidence, especially when isolating the causal relationship between the interventions and the outcomes. Qualitative methods such as semi-structured interviews can help understand nuances and explain behaviors in a way

that cannot be captured by quantitative data, for example by providing insights into the cognitive and emotional reasonings of participants that led to their decision-making. The benefits of mixed methods research were best illustrated in Chapter 5, where the null findings of the RCT testing a social norm intervention contradicted both my formal hypotheses and the informal expectations of my supervisory team and our commercial partners. However, once I conducted interviews with the customers of the cafeteria, it became clear that customers did not pay attention to the advertisements and informational material in the cafeteria (including those of the intervention), and their priorities for food choice were about taste and visual appeal, while the intervention messages targeted norm conformity. The objective, statistically robust findings of the quantitative data analysis combined with the descriptive and reflective input from the interviews allowed a well-rounded evaluation of the intervention and offered a clearer pathway for how future research could improve on it. Future research could benefit from incorporating qualitative methods more systematically into study design to generate richer, more in-depth insights into individuals' reasonings and priorities when making food choices in different settings that was beyond the scope of this population-level intervention.

Another strength of this thesis is its inclusion of two large scale, multi-site field studies. In addition to knowledge of research methodology and study design, field studies require well refined project management and interpersonal communication skills to be able to quickly and creatively solve problems that arise during different stages of the trial. Due to the extensive time, effort, and resources they require, field studies are rather uncommon in social psychology research, especially for doctoral level work. Specifically in the area of dynamic social norms and meat consumption, only four other field studies were conducted by two groups of researchers (Patel et al., 2024; Sparkman et al., 2020). Three of the studies were single site, while one was

conducted in three different cafeterias within the same university campus, and three out of four were done in university cafeterias, while one was done at a restaurant near a university campus. This meant that the samples of these studies were significantly biased towards a student population and were not representative of the general population. Testing the interventions in only one site without the presence of matched controls and/or other intervention sites introduced numerous confounding factors specific to the characteristics of that one site, greatly limiting the external validity of these studies. Conducting two field studies in different settings (department store restaurants and worksite cafeterias), across multiple sites spread across the UK that attracted customers of different demographics meant that this thesis was able to produce rigorous evidence with considerable external validity.

The studies in this thesis have also addressed important gaps in the meat consumption literature by addressing novel research questions with robust study designs. To my knowledge, the online survey study detailed in Chapter 3 is the first nationally representative (in terms of age, gender, and SEP) survey of three largest ethnic groups in the UK for meat consumption behaviors, attitudes and norms. At the time of submission, the field study detailed in Chapter 5 was the first RCT testing dynamic descriptive social norms to reduce meat consumption in worksite cafeterias.

6.2.2. Limitations

Online survey studies run the risk of being conducted in too 'sterilized' settings that do not mimic real-world decision-making environments, jeopardizing their external validity. Contrastingly, field studies can be 'contaminated' by myriad factors that happen in the real world that the researchers cannot prevent or control. This might mean that the findings of the experiment may not be solely caused by the effect of the intervention being tested, limiting its internal validity. Further elaboration of how

these limitations presented themselves in the studies included in this thesis is made below.

Online studies are restricted in their external validity because they often take place in a more isolated, sterile environment than the actual behavior or decision-making process. Participants are often alone when they participate in online studies, and are able to better focus on the stimuli on the screen which are presented neatly with limited distractions. The nature of online studies also puts them at a higher risk of response biases. One of these biases is "satisficing" where participants who do not want to exert cognitive effort in their responses might apply time and effort saving strategies such as choosing the first answer available, choosing the neutral/no opinion answer instead of expressing agreement or disagreement, choosing an answer at random, or choosing the answer that aligns with the argument made by the question (Krosnick, 1991). Another response bias is "socially desirable responding", where participants may give responses in a study in a way that they think the researchers want or expect them to, rather than responding in the way they normally would in the outside world. (Bogner & Landrock, 2016).

In addition to being conducted online, survey studies have limitations of their own. Although quota sampling techniques are applied to ensure national representativeness in terms of age, gender and SEP, it must not be neglected that participants still self-select into research platforms and panels where these samples are often recruited from. Even knowing about the existence of such research platforms and having the online literacy to be able to sign up on them means that these participants are not fully representative of the population at large.

The surveys included in this thesis were designed to be suitable for quantitative analysis, and used questions with quantifiable response options such as Likert scales instead of open-ended ones. Meat consumption behaviors are influenced by culture,

social networks, habits, experiences, religious or traditional practices, and countless other factors. A quantitative survey with a limited number of questions is unlikely to be able to fully capture the complexity behind these behaviors and address all these factors. While the survey studies of this thesis provide valuable first insights, they need to be complemented by qualitative studies that generate rich, in-depth data.

Field interventions that take place in various real-world food purchasing settings have a number of limitations. First, the interventions could only be present in one of the countless food purchasing environments individuals find themselves in on a given day. In the case of the RCT detailed in Chapter 5, individuals only saw the intervention materials when they visited their worksite cafeteria for lunch. In addition to having their weekday breakfasts and dinners and their weekend meals elsewhere, interviews with cafeteria goers also revealed they also frequently pack their lunches, go outside to other shops, or work from home and visit the cafeteria an average of 2-3 times a week. In the randomized crossover trial in Chapter 4, the intervention took place at in-store restaurants of a retail store that sold a specific range of items, which suggests that customers would only eat at the restaurant when they visit the store to make a particular purchase, which could be once every few months or even less frequently. This limited exposure to intervention materials can limit their effectiveness, not allowing enough time for individuals to notice, read, understand, reflect, and act on the information being communicated.

Even when presented in a specific food purchasing setting, the normative messaging intervention materials in the two field trials were in conflict with other elements of the purchasing environment that implicitly suggested choosing meat-based dishes were the norm in these settings. The in-store restaurants in Chapter 4 were particularly known for a specialty meat-based dish that was very popular among customers, and sales data showed that this dish regularly sold 4-5 times more than any

other item on the menu. This popularity meant that customers visiting the restaurant were more likely to observe others eating meat-based dishes, and inferring that the norm in that restaurant was to choose a meat-based option. This observed majority behavior could then have been in conflict with the information on the intervention materials, which suggested that an increasing number of people were choosing plant-based options. In the worksite cafeterias in Chapter 5, while hot main dishes had a minimum of one meat and one vegetarian option, the majority of sandwiches, wraps, soups, even salad toppings that were on offer included meat products. This relative high availability of meat-based options might have led cafeteria goers to think that the catering company was responding to demand from other customers, inferring again that the norm was to choose meat-based options. During site visits, while interviewees gave anecdotes about their colleagues reducing or eliminating meat in their diets, observations of cafeteria goers' plates showed that most chose meat-based dishes, again contradicting the information on the intervention materials. Trying to change behaviors using dynamic normative messages that attempt to communicate that a trend is emerging which is opposite of the present, observable, and engrained norm is not unlike swimming against the current, especially when implicit cues like availability, popularity, and actual behaviors of others do not support the message.

Beyond this, all norm-based interventions require more time and repeated exposure to create any meaningful change. Social norms often serve as the unwritten rules of society and require either considerably large momentum or gradual and collective action to change. For example, consider the case of social distancing and mask wearing practices during the COVID-19 outbreak. If the perception of widespread and imminent threat to public health was not present to create a sense of urgency and momentum, populations would not have had changed their behaviors so quickly or created new norms around distancing and masking. On the other end,

consider the example of tobacco use in the UK. While until early 21st century, the majority of the adult population were smokers and smoking indoors was common practice, this changed slowly from 2006 onwards when smoking bans were introduced in enclosed spaces. A combination of top-down government action and increased level of awareness about negative health impacts of smoking, led to less approval of smoking among individuals and gradually reduced the amount of smokers, making non-smoking the new norm. Neither the sudden and immense threat of COVID-19 nor the government's policymaking efforts and decades of evidence generation and communication regarding negative health impacts of tobacco use are present in the case of meat consumption. There is still a lack of knowledge and conviction when it comes to the human health impacts of overconsumption of meat, there is still considerable support for meat production and provision from the government, and the countless risks climate change poses on planetary health are often ignored and not regarded as time-sensitive by the majority of the world's population. In this context, the potential of norm-based interventions to reduce meat consumption as implemented separately by individual institutions that target a very specific subpopulation and a very small number of food purchasing settings are extremely limited.

The unique and often contrasting limitations of the research methodologies also meant that the findings from the online studies were not able directly inform and influence the field studies. While both studies from Chapter 2 and 3 found support for the theory that socially close others such as friends and family are more relevant and influential normative referents compared to more ambiguous, or general social groups, it was not possible to design the field intervention materials to refer to these close others. Since both interventions in Chapters 4 and 5 took place in OOH food purchasing settings where people dined with other shop goers or colleagues, it was not

logically possible to devise normative messages that would refer to the food choices of people's friends or family. Further, each study recruited its samples from different platforms and subpopulations. While this helped with the generalizability of the study findings, it also meant that some of the findings from the online studies could not directly inform and improve the intervention design of the field studies.

6.3 Additional reflections

In this section, I will discuss some of the challenges and issues that have arose in each study that have not been included in the published manuscripts or the study chapters as they involve logistic and interpersonal details but nevertheless are important to reflect on for better demonstrating the research experience I have gained through my DPhil studies. In addition to the challenges mentioned in this section, I also had to suspend my studies for a term due to circumstances concerning my health. These are outlined in Appendix 6.1.

The online studies detailed in Chapters 2 and 3 were conducted in collaboration with other researchers, which meant that as the most junior researcher involved in the project, I had to adapt to the timelines of the more senior members of the group. To be able to launch the studies on the dates set by my colleagues, I had to prepare my study materials in a matter of weeks. I also had to refine and limit my research questions and make sure I selected measures that were reliable and valid due to the restriction on how many items each researcher could add to the survey study. This was because we joined resources to recruit the participants together but wanted to collect different data for different research questions of interest, while ensuring that we avoided participant fatigue and attrition. Interdepartmental collaboration also meant that some things were lost in translation. As my colleagues were from a humanities

field and did not usually employ quantitative methods, they did not notice an error with the recruitment of the sample whereby White participants were considerably older than the national average, and told the market research company they were happy with the data collection and that they could stop recruiting. I then realized this mistake weeks later as I was getting ready for my data analysis, and had to re-establish contact with the market research company and do another round of recruitment in order to ensure the sample was nationally representative. Managing delicate professional relationships and respecting the time and generosity of my collaborators while making sure I was taking the necessary steps for conducting robust and accurate quantitative research was a challenge and a learning experience.

The study detailed in Chapter 4 was chronologically the first piece of work I completed for this thesis, and required me to take over the data analysis and manuscript writing of a trial that was already conducted. The project had run into issues with receiving the data from the commercial partner, and we were granted access to it over a year after the completion of the trial. This meant that the details of the research protocol, intervention design, and fidelity checks were not quite fresh in my co-authors' memories who had since moved on to other projects. Some of the co-authors of the study had also left their position within my larger research team, which meant that communication was not always seamless, and the timeframes for receiving feedback and input were extended significantly. As this was my first project as a DPhil student, I was learning a lot about the "dos and don'ts" of study design and intervention implementation, and had to ask a lot of questions to a lot of different co-authors to feel assured that I understood everything about the trial and was coming up with the right analysis plan and was writing the manuscript accurately. While this was daunting, I also felt truly supported by my supervisors and the rest of the research

team, and felt honored that I was trusted with seeing this important field study through and getting it published.

For the study in Chapter 5, conducting a multi-site RCT with 25 locations spread across England and collaborating with catering managers of each site as well as the central management of the catering company put my logistic management and communication skills to the test and taught me some important lessons. First, I learned that compromise on some elements of intervention implementation was necessary when collaborating with a commercial partner. For example, the launch of the intervention was dependent on the schedule and availability of the catering company, and all the intervention materials had to be designed in only two months to be able to meet their deadlines and start the trial on time. I was also restricted on the duration of the intervention, as the catering company was able to launch the study in October but wanted it to end in December to be able to offer customers their Christmas menus, meaning the trial could only run for a maximum of 8 weeks. I also learned that while writing a detailed statistical analysis plan and trying to account for confounding factors was very important for transparent and rigorous research, unexpected and uncontrollable external factors still occur in field studies. After we launched the intervention, some of the worksites' employees went on collective strikes for multiple days during which their cafeterias were shut down, and I found out that some of the other worksites had hybrid working procedures which meant the number of customers using the cafeteria fluctuated considerably across different days of the week. These had unintended impacts on footfall, which may have in turn affected the exposure of cafeteria customers to the intervention materials. I aimed to control for these in my analyses as detailed in Chapter 5, however, it is possible that this was not enough to fully capture the disruption in exposure to intervention materials. Finally, while I prioritized fidelity checks and being in frequent contact with all intervention cafeteria

managers, I learned that limits in budget and time while conducting a multi-site trial meant that these checks could not be done perfectly. In the end, I was not able to visit two out of the twelve cafeterias due to their distance from Oxford. I aimed to compensate for this by collecting more photographic evidence from these cafeterias ensuring the correct implementation of the intervention, but being unable to observe how cafeteria goers interacted with the intervention materials in these two sites in person and not being able to collect qualitative data via interviews means that I may have missed some information and nuance that were particular to these sites. Having successfully designed, conducted, analyzed, and disseminated this field trial, I believe that I have truly honed my research design, project management, and interpersonal communication skills which have prepared me for future work.

Dynamic descriptive norm-based messaging interventions are created based on the assumptions that people place importance on how others behave in a given context and have a disposition to "pre-conform" to emerging trends and new ways of behaving. They rely on the individuals to notice, read, and critically engage with the message, and are unable to account for other priorities individuals may have when making a decision. For the study detailed in Chapter 5, when I visited the intervention cafeterias, especially the ones that served manufacturing or other manual labor sites, I realized the intervention had completely neglected how physically and mentally depleted employees are by the time they arrive to the cafeteria for their lunch break. I saw people with tired and dejected faces, people taking power naps with their heads resting on the dining tables, people trying to sort out errands like doctor's appointments or plumbers' visits on the phone, and people grabbing a sandwich or salad bowl with lightning speed and rushing back to their desks. None of these individuals had the "capability, opportunity, or motivation" behavioral theories (Michie et al., 2011) claim are crucial for change to occur to engage with the intervention material and consider

choosing a vegetarian option for their lunch. They did not have the cognitive capacity, they did not have interest, and they did not have the time to read, reflect, and react to the dynamic descriptive social norm message I had spent weeks putting together. Additionally, having spent years being part of a healthcare department and a sustainable food consumption research team, I had created the intervention with the underlying assumption that eating a nutritionally balanced and healthy meal for lunch would be a priority for the majority of the cafeteria customers. However, my conversations quickly revealed that for almost all customers, work lunches were about eating something that was subjectively appetizing in appearance and delicious in taste that would satisfy more hedonistic needs, rather than something that was going to be beneficial for their health. Out of 155 participants, only four brought up calorie content or nutritional makeup of dishes or general health concerns as their priorities when choosing their lunch.

It is irrefutably key for any scholarly work, in particular a DPhil thesis, to ground research in established theory and existing literature. However, this might also mean the research risks being trapped in the "ivory tower" and not pay enough attention to the nuances of the setting and the sample of the studies. In retrospect, I can criticize the creation of the social norm intervention for taking place in a vacuum, by a team consisting of a DPhil student, an associate professor supervisor, and a head of sustainability at a catering company with a postgraduate degree and a background in nutrition. Our extensive knowledge about and focus on healthy and sustainable diets, combined with our limited understanding of the oversaturation of worksite cafeterias with advertisements and informational posters and our lack of insights into the mindset and priorities of the customers, meant that we were not able to fully appreciate and predict what might have worked better in the field. During my time as a DPhil student, I have had the opportunity to learn more about co-design methods

and patient and public involvement and engagement processes and have come to appreciate how important this kind of input is for effective intervention design and implementation. However, given that I had around two months to design the intervention, integrating these approaches was regrettably not a possibility for my study.

Throughout my DPhil degree, I prioritized gaining relevant academic experiences to complement the studies that make up this thesis in order to share and apply some of the lessons I've learned from the challenges described above. These included supervising and tutoring students, public engagement and science communication efforts, conference attendances, and collaborations with other researchers, and are detailed in Appendix 6.2.

6.4 Recommendations for future research and policy

6.4.1. Towards a more complex understanding of meat consumption

The studies in this thesis have focused on the social aspects of food (and in particular, meat) consumption, and have attempted to leverage social norms and their potential influence to promote the selection of more plant-based options. However, there are a number of other psychological mechanisms and behavioral drivers of meat consumption that future research would benefit from factoring in when designing interventions.

One such mechanism is Graça and colleagues' construct of "meat attachment", which encapsulates to what degree individuals are nutritionally dependent on, feel biologically and hierarchically entitled to, gain hedonistic pleasure from, and experience repulsion by meat consumption (Graça et al., 2015, 2016; Williams et al., 2023). There is evidence that this construct may be able to explain behavioral variance

over and above other theoretically established predictors such as attitudes, perception of social norms, and perception of behavioral control for meat consumption. Supporting this, a systematic review lists the reasons meat-eaters most commonly state as their reasons for meat consumption as follows: “meat an essential component of a healthy diet, they enjoy eating meat, they feel that meat is a part of their traditions, and they believe they lack the knowledge and cooking skills to prepare an adequate meal without meat” (Valli et al., 2019).

Meat attachment appears to map on to certain demographic characteristics. A recent survey study with a quasi-nationally representative sample of 1222 UK adults found that older people, men, and those with no higher education have higher meat attachment than younger people, women, and those with higher education respectively (Laffan & Howard, 2024), which may explain the reluctance of these subgroups to reduce their meat consumption. Understanding meat attachment and how it presents in different individuals may be a helpful tool in tailoring and improving behavioral interventions.

Hedonistic motivations are a big driver of meat consumption, and there is considerable evidence that taste is often the most important deciding factor for people when making food choices (Ardebili & Rickertsen, 2024; Fechner et al., 2024). Future interventions need to consider the priorities of individuals when making food choices (which sometimes might be different than what researchers heavily involved in health and sustainability issues assume they are), as well as keeping in mind that these priorities might change based on the eating setting. For example, a survey study in Germany found that while taste was selected as the most important factor for choosing a dish at a restaurant by 74% of respondents, only 31% of respondents said this was their number one concern when deciding what to cook at home. Contrastingly, while 36% of respondents valued health the most when eating at home, only 9% ranked it as

a top concern when dining at a restaurant (Biermann & Rau, 2020). Appreciating this context dependent variation in priorities when making food choices can increase the effectiveness of interventions to reduce meat consumption by making sure they appeal to the right factors in the right settings.

Another important factor for meat consumption is price. Cost of food has always been an important driver for purchase decisions, but this has become even more apparent following the period of unprecedented inflation, unemployment and increased cost of living following the COVID-19 pandemic (Bisoffi et al., 2021). Past literature has generated evidence that suggests consumers in the UK and Europe tend to perceive sustainable and plant-based foods as more expensive than their meat counterparts (Michel et al., 2021; Williams et al., 2023), might not want to consume sustainable foods due to their perceived higher price (Verain et al., 2012), and might be motivated by a price incentive to switch to meat substitutes (Carlsson et al., 2022a). These perceptions are in contrast with findings from modelling studies that vegetarian and vegan diets that are rich in legumes and whole grains and limit or completely restrict meat and dairy products can be about a quarter cheaper than the cost of current diets (Springmann et al., 2021). This discrepancy between perceptions and actual cost of plant-based options could be due to a lack of information or awareness about prices of ingredients that vegetarian and vegan diets can be composed of. Alternatively, a distorted perception of a difference in price between meat and plant-based dishes could be created by how the OOH food sector prices dishes by factoring in other costs beyond those of just the ingredients themselves (e.g. labor, overheads, profits). For example, in the worksite cafeterias that provided the setting for the RCT detailed in Chapter 5, main dishes were often the same price (or had a 5 to 10p price difference) regardless of being meat or plant-based. Given that meat is often perceived as more filling and more delicious than plant-based options (Jahn et al., 2021; Michel

et al., 2021), customers may have felt that they were getting more 'value for their money' when spending the same amount on a meat rather than a plant-based dish.

6.4.2. Towards more effective interventions to reduce meat consumption

While eating behaviors in general and meat consumption in particular are indeed influenced by social norms, evidence indicates that interventions that alter the food purchasing microenvironment have a greater effect than those that target decision-making processes. Out of all the "nudge"-type interventions that restructure the microenvironment without limiting choices, making plant-based options the default appears to be the most effective strategy across a variety of contexts (for systematic reviews, see Reinders et al., 2024; Zhang et al., 2024) and deserve more attention in future research and policymaking efforts.

However, another approach that might be effective is multimodal interventions that combine changes to the microenvironment with targeting cognitive processes (Chang et al., 2023). For example, a default intervention where a plant-based meal is pre-selected can be complemented with a social norm message that reinforces the idea that the normal and expected behavior in that setting is to choose the plant-based meal. If successful, this type of intervention could start a 'virtuous cycle', where the default intervention makes fewer people opt out and ask for a meat option, therefore creating a setting where individuals can actually observe more plant-based options being consumed, and that in turn can increase the credibility and boost the effect of the social norm message that highlights eating plant-based is the normal behavior.

The importance of socially close and relevant referent groups for normative influence has been discussed throughout this thesis. Future interventions leveraging social norms might consider possibilities for targeting at-home food choices, where

people are most likely to share a meal with their most relevant referent group, i.e. their family, recruiting participants as household clusters. This might be considerably more challenging from ethical and logistic aspects compared to an intervention taking place at an OOH setting but might provide useful insights into where and with whom normative influence is strongest for meat consumption.

Finally, as discussed in the introduction of this thesis in Chapter 1, there is still a considerable lack of awareness and as well as a lack of appreciation of the impacts of the food system on climate change and health (Steinitz et al., 2024), which affects the motivation people might have to change their eating habits and consider reducing their meat consumption. To illustrate, a recent survey of 1590 adults living in Scotland showed that people didn't think there is a need for them to change their meat consumption, and 47% of the respondents said they did not know of any health consequences of eating too much meat (McBey et al., 2024). Future interventions can target determinants of meat consumption such as taste, attachment, and price which were discussed in the subsection above, rather than focusing on health and sustainability to achieve more effective behavior change.

6.4.3. Towards more robust methodology and evidence generation

The small body of evidence around social norms and meat consumption is saturated by online experiments and studies that measure intentions or self-reported behavior rather than actual food purchase or consumption. A recent systematic review of social norm interventions to reduce meat consumption and/or increase plant-based food consumption published until 2023 identified only eight field studies testing dynamic descriptive social norms (Pollicino et al., 2024). Out of these eight studies, one was the retail store restaurant intervention I have detailed in Chapter 4, and the

other was a masters' thesis project that focused on university college cafeteria interventions that I co-supervised (Biggs, 2022). The remaining six came from two papers written by the same group of authors that have introduced the concept of dynamic social norms to the literature (Sparkman & Walton, 2017; Sparkman et al., 2020).

Filling the gap in the literature with pre-registered, robust, multi-site field interventions that generate evidence with a low risk of bias has been one of the primary aims of this DPhil thesis and my additional relevant work, which is much needed in an area of study where the culture of 'publish or perish' is considerably present and on occasion leads to the production and dissemination of research that is not upheld to the highest standards (Rawat & Meena, 2014).

Another problem associated with the pressures to publish quickly and frequently is the lack of dialogue and collaboration between social psychology and behavioral science researchers. This lack of communication may lead to the inefficient spending of time, effort, and material resources in trialing very similar interventions in equally similar settings and populations. To illustrate, during my time as a DPhil student, I have met three other postgraduate researchers at different institutions testing dynamic descriptive norms to reduce meat consumption, all with null findings. If there was more increased sharing of knowledge between us and our research teams, we may have been able to either differentiate our research questions or hypotheses further, or collaborate and conduct more complex, international, and novel experiments. Some efforts have been made to consolidate findings from intervention trials and behavioral science research, such as the "Operating Conditions Framework" (Rothman & Sheeran, 2021), which focuses on an intervention's ability to target a behavioral mechanism and how that mechanism in turn is able to initiate behavioral change, and the "Behavior Change Technique Ontology" (Michie et al., 2020), which

attempts to formally classify and define all aspects of behavioral science (e.g. interventions, populations, settings) and their relationships with one another to serve as a tool for a holistic understanding of human behavior.

These frameworks and ontologies, although promising to be useful, are built on research that is published and publicly available, and can only be as good as the data provided by these works, and will regrettably reflect their limitations and biases. As discussed in Chapter 1, social psychology and behavioral science research still struggle with a serious lack of diversity in recruitment of subjects. In the particular case of the small but growing field of meat consumption research, a considerable number of studies are run online with small, female-dominant, non-representative samples that often come from university student populations. Additionally, the majority of these studies are from the UK and the USA, while China, India, Brazil and Russia along with the USA generate half the world's emissions from food consumption (Steinitz et al., 2024), but are yet to be home to interventions that promote meat reduction. While there is evident value in proof-of-concept studies and interventions that are trialed locally or nationally, efforts to replicate promising findings in meat reduction internationally are crucial in meeting climate change mitigation targets as set by global organizations.

6.5 Conclusion

This thesis has aimed to apply social psychology and behavioral science theory and methodology to explore the role of social norms in reducing meat consumption. Two field studies found no evidence that dynamic descriptive social norm messaging interventions were effective in decreasing meat consumption, while two survey studies and an online shopping task highlighted the importance of social referent groups and demographic characteristics such as ethnicity, gender, and SEP in perception of social

norms around meat consumption. Identifying effective strategies to reduce meat consumption is crucial for mitigating climate change and alleviating pressures in the public healthcare system caused by non-communicable diseases. The studies that constitute this thesis have applied robust, transparent, and representative research methodology to generate findings that are generalizable and applicable, and that can help future researchers and policy makers prioritize strategies other than dynamic descriptive social norm-based messaging interventions to achieve a shift to healthier and more sustainable diets.

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Appendices

Appendix 2.1 Recruitment text

Survey topic: Health, Survey length: 30 minutes, Reward: *Dynata* incentive

Hi [Name],

We have a new study available for you.

This study is being carried out by the University of Oxford and may therefore look a little different to surveys you've taken part in before. Rest assured, you will not be asked for any information that could identify you.

This study aims to investigate how food labels impact the choices we make in a supermarket context. Before undertaking the task, you will be asked to read an information sheet, to confirm you are eligible to participate, and confirm your consent to participate.

For further information and to take part go to [link to survey page (PIS and consent) and shopping website].

SCREENING QUESTIONS (Pre-shopping)

1. Age
   - Under 18 years old
   - 18 years old or over

2. Do you currently reside in the UK?
   - Yes
   - No

3. Are you fluent in English?
   - Yes
   - No

4. Are you vegetarian or vegan?
   - Yes
   - No

5. How hungry are you right now?
   - Scale: not at all – extremely

6. How full are you right now?
   - Scale: not at all – extremely

Appendix 2.2 Participant Information Sheet and Consent Form

Food Labelling and Online Shopping: Study 3

Our research team at the University of Oxford is interested in how food labels impact choice in a supermarket setting. The results from this study will help inform a larger project, funded by the Wellcome Trust, looking at how the food we eat affects our health and the environment.

Why have I been invited?
You have been invited to participate because you are an adult (aged 18+) living in the UK and are not vegetarian or vegan.

Do I have to take part?
Please note that your participation is voluntary. You may withdraw at any point during the online study for any reason, before submitting your answers, by pressing the 'Exit' button/closing the browser. However, we are only able to reimburse participants who complete the full survey.

What is involved?
You will be asked to complete an online shopping task using an experimental shopping platform. This study should take around 30 minutes to complete but can take up to 45 minutes depending the individual. During the shopping task, you will be asked to 'purchase' 10 items from a shopping list, but you will not be spending your own money and you will not receive any of the foods you "purchase". If you do agree to participate, you may withdraw at any time by simply closing your browser window.

As a panel member, you will be offered reimbursement for your time though the *Dynata* incentive system. **Please pay careful attention to the instructions listed on the shopping platform before clicking "Checkout".**

What will happen to the data I provide? All data collected during this study will be kept entirely confidential to the research team and your responses will be completely anonymous. All research data and records will be stored securely on secure University of Oxford servers for up to 10 years and then deleted. The University of Oxford will not store your IP address. *Dynata* is the data controller with respect to your personal data and, as such, will determine how your personal data is used. *Dynata* will share only fully anonymised data with the University of Oxford, for the purposes of research. This project was reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee (reference number).

What happens to the results/findings?
The results may be published in scientific journals or presented at research meetings. Members of the University of Oxford may be given access to data for monitoring and/or audit of the study to ensure that the research is complying with applicable regulations. Your individual data will never be shared, however the main results from this study may be shared with collaborators on this project for research purposes.

Who is organising and funding the research?

This research was funded by the Wellcome Trust, Our Planet Our Health (Livestock, Environment and People –LEAP) award number 205212/Z/16/Z.

Who do I contact if I have a concern about the study or wish to complain?

If you have a concern about any aspect of this project, please speak to the researcher [Christina Potter, email: Christina.Potter@phc.ox.ac.uk, Tel: (+44)01865 289592] or their supervisor [Brian Cook, email: Brian.Cook@phc.ox.ac.uk, Tel: (+44)01865 289592], who will do their best to answer your query. The researcher should acknowledge your concern within 10 working days and give you an indication of how they intend to deal with it. If you remain unhappy or wish to make a formal complaint, please contact the Chair of the Medical Sciences Interdivisional Research Ethics Committee at the University of Oxford: Email: ethics@medsci.ox.ac.uk; Address: Research Services, University of Oxford, Wellington Square, Oxford OX1 2JD.

If you decide to take part in this study, you agree that you may not otherwise reproduce, modify, copy or distribute or use for commercial purposes any of the materials or content on the Site without written permission from the University of Oxford. If you wish to take part in this study and confirm that you are aged 18 years or older, please tick the box below.

☐

Appendix 2.3 Post-experiment survey questions

1. Demographic characteristics
    1) Gender: o Male o Female o Other o Prefer not to say
    2) Age (years): Drop down menu(range of 18-99) o Prefer not to say

2. Household size – "How many people live at your house, including you?

3. Individual income per year
    1) Less than £15,000
    2) £15,000 - £24,999
    3) £25,000 - £39,999
    4) £40,000 - £75,000
    5) Over £75,000
    6) Prefer not to say

4. What is the highest educational qualification you have achieved?
    - None
    - Up to 4 GCSE's (Including 1-4 O Levels/CSE/GCSEs (any grades), Foundation Diploma, NVQ level 1, Foundation GNVQ or equivalents)
    - 5 or more GCSE's or 1 A-level (Including 5+ GCSEs (Grades A*-C),1 A Level/ 2-3 AS Levels, NVQ level 2, Intermediate GNVQ, City and Guilds Craft, BTEC First/General Diploma, RSA Diploma, Apprenticeship or equivalents)
    - 2 or more A-levels (Including 2+ A Levels, 4+ AS Levels, NVQ Level 3, Advanced GNVQ, City and Guilds Advanced Craft, ONC, OND, BTEC National, RSA Advanced Diploma or equivalents)
    - Bachelor's degree (Including BA, BSc, NVQ Level 4-5, HNC, HND, RSA Higher Diploma, BTEC Higher level or equivalents)
    - Post-Graduate degree or qualification (Including Higher Degrees e.g. MA, PhD, PGCE, Professional qualifications e.g. teaching, nursing, accountancy or equivalents)
    - Prefer not to say

5. "How often do you look at the front of package nutrition labels when doing your usual grocery shop?"
    - Always
    - Often
    - Sometimes
    - Rarely
    - Never

6. Now we would like to know a little about your eating habits. Please think only of what you ate *yesterday* when answering the following questions. "Did you eat any meat or poultry yesterday? (Think about curry, stirfry, sandwiches, pie fillings, sausages/burgers, liver, pâté or mince.)" No / Yes

   6a. If YES, "How much of each type of meat listed below did you eat yesterday?"

Meat	**Amount**	**None**	**1**	**2**	**3**	**4**	**5+**
Sausage	Each						
Beef (e.g. roast, steak, mince, curry, burger)	Serving						
Pork (e.g. roast, chops, sweet and sour)	Serving						
Lamb or mutton (e.g. roast, chops, stew, burger)	Serving						
Chicken or turkey in breadcrumbs or deep fried (e.g. nuggets, KFC)	Serving						
Chicken or turkey (e.g. roast, drumsticks, curry)	Serving						
Bacon	Rasher						
Ham, Parma ham, salami, pastrami, cured meats	Slice						
Liver or liver pâté	Serving						
Other (e.g. duck, goose, kidney)	Serving						

7. "Did you eat any fish or seafood yesterday?" No / Yes

   10a. If YES – "How much of each type of fish listed below did you eat yesterday?"

Fish	**Amount**	**None**	**1**	**2**	**3**	**4**	**5+**
Tinned tuna	Serving						
Oily fish (e.g. salmon, tinned salmon, herring, mackerel, sardines, fresh tuna steak)	Serving						
Breaded fish (e.g. fish fingers) or fish cakes	Serving						
Battered fish	Serving						
White fish (e.g. cod, haddock, fish pie)	Serving						
Prawns	Serving						
Lobster or crab	Serving						

Shellfish (e.g. mussels, scallops)	Serving						
Other	Serving						

8. Meat knowledge: "The following statement best reflects my beliefs regarding the impact of producing meat and meat products on the environment:"
   1) I believe that producing meat and meat products has a harmful effect on the environment.
   2) I do not know how producing meat and meat products affects the environment.
   3) I believe that producing meat and meat products has no effect on the environment.
   4) I believe that producing meat and meat products has a beneficial effect on the environment.

9. Meat reduction: "Have you considered reducing the amount of meat that you eat?"
   1) Yes, I've reduced the amount of meat I eat in the past 5 years.
   2) Yes, I would like to reduce the amount of meat I eat, but haven't yet.
   3) No, I'm happy with the amount of meat I eat / don't eat.
   4) No, I would like to eat more meat.

10. "Most people in the UK will try to choose the food items that are better for the environment."
*Responses on a Likert scale.

11. "Most people in the UK will try to choose the food items that are better for their health."
*Responses on a Likert scale.

12. "People who I share my meals with will try to choose the food items that are better for the environment."
*Responses on a Likert scale.

13. "People who I share my meals with will try to choose the food items that are better for their health."
*Responses on a Likert scale.

Appendix 3.1 Recruitment Text

This survey is about your eating habits and how you access news, and the results will be used to inform our client.

Your YouGov Account will be credited with 50 points for completing the survey.

We have tested the survey and found that, on average it takes around 8-10 minutes to complete. This time may vary depending on factors such as your Internet connection speed and the answers you give.

Please click the forward button below to continue.

Appendix 3.2 Survey Questions

Question 1

What ethnic group best describes you? Please select one option only. (We ask the question in this way so that it is consistent with Census definitions.)

White

- ◯ English / Welsh / Scottish / Northern Irish / British
- ◯ Irish
- ◯ Gypsy or Irish Traveller
- ◯ Any other White background

Mixed / Multiple ethnic groups

- ◯ White and Black Caribbean
- ◯ White and Black African
- ◯ White and Asian
- ◯ Any other Mixed / Multiple ethnic background

Asian / Asian British

- ◯ Indian
- ◯ Pakistani
- ◯ Bangladeshi
- ◯ Chinese
- ◯ Any other Asian background

Black / African / Caribbean / Black British

- ◯ African
- ◯ Caribbean
- ◯ Any other Black / African / Caribbean background

Other ethnic group

- ◯ Arab
- ◯ Any other ethnic group
- ◯ Prefer not to say

Question 2

Which, if any, of these best describes your usual eating habits?

- ○ Vegan (do not eat dairy products, eggs, or any other animal product)
- ○ Vegetarian (do not eat any meat, poultry, game, fish or shellfish)
- ○ Pescatarian (eat fish but do not eat meat or poultry)
- ○ Meat eater (eat meat and/or poultry)
- ○ Flexitarian (Follow a diet of vegetarian-only days, and then mixed diet the rest of the time)
- ○ Other
- ○ Don't know

Question 3

You previously said that you are pescaterian.

In your opinion, which, if any, of the following sources have influenced the way you have described your eating habits the most? (Please select up to 3 options)

- ☐ Charities and activism groups (e.g. WWF)
- ☐ Family
- ☐ Schools
- ☐ Supermarkets
- ☐ Social media
- ☐ Scientists/ academics
- ☐ Doctors and health professionals

- [ ] TV News (e.g. Sky News, CNN, BBC News etc.)
- [ ] Cookery books/ cookery magazines
- [ ] Friends and peers
- [ ] Printed Newspapers / Magazines
- [ ] Celebrities and athletes
- [ ] Politicians
- [ ] Food bloggers
- [ ] TV programmes (other than cookery programmes)
- [ ] TV cookery programmes
- [ ] Online news media (e.g. BBC News website, Buzzfeed news etc)
- [ ] Other
  (please specify) _____
- [ ] Not applicable – my diet has not been influenced by anything
- [ ] Don't know

Question 4a.

You previously said that social media has influenced your eating habits.

Which, if any, of the following specific social media have influenced your eating habits? (Please select all that apply)

- [ ] Snapchat
- [ ] Telegram
- [ ] LinkedIn
- [ ] WhatsApp
- [ ] Viber
- [ ] WeChat
- [ ] YouTube
- [ ] Facebook
- [ ] TikTok
- [ ] Nextdoor
- [ ] Reddit
- [ ] Pinterest
- [ ] Line
- [ ] Twitter
- [ ] Facebook Messenger
- [ ] Instagram
- [ ] Other (please specify) _____
- [ ] Don't know

Question 4b.

You previously said that TV News has influenced your eating habits.

Which, if any, of the following specific TV News stations/ programmes have influenced your eating habits? (Please select all that apply)

- [ ] Channel 4 News (C4 News)
- [ ] CNN
- [ ] BBC TV News
- [ ] Other news TV programme from outside the United Kingdom
- [ ] Other regional or local news TV programme
- [ ] Channel 5 News (C5 News)
- [ ] Sky News
- [ ] ITV News
- [ ] Other1 (please specify) _____
- [ ] Other2 (please specify) _____
- [ ] Don't know

Question 4c.

You previously said that printed newspapers/ magazines have influenced your eating habits.

Which, if any, of the following specific printed newspapers/ magazines have influenced your eating habits? (Please select all that apply)

- [ ] Daily Mail / Mail on Sunday
- [ ] The Times / Sunday Times
- [ ] The Sun / Sun on Sunday
- [ ] The Daily Telegraph / Sunday Telegraph
- [ ] The Financial Times
- [ ] Metro
- [ ] The 'i' newspaper
- [ ] The Guardian / Observer
- [ ] Daily Star / Star Sunday
- [ ] Economist
- [ ] The Express / Sunday Express
- [ ] Daily Mirror / Sunday Mirror / Sunday People
- [ ] A regional or local newspaper
- [ ] Other newspapers or broadcast news channels from outside the United Kingdom
- [ ] Other1 (please specify) _____
- [ ] Other2 (please specify) _____
- [ ] Don't know

Question 5

Which ONE of the following statements BEST describes how you may be increasing or decreasing the amount of meat you eat? (If you don't plan on changing the amount of meat, if any, that you eat, please select the relevant "Not applicable" option)

- ○ I have recently increased the amount of meat I eat
- ○ I am considering increasing the amount of meat I eat, but have **not** done so yet
- ○ I am considering decreasing the amount of meat I eat, but have **not** done so yet
- ○ I have recently decreased the amount of meat I eat
- ○ Not applicable – I eat meat and don't plan on changing the amount of meat I eat
- ○ Not applicable – I don't eat meat and don't plan on changing this
- ○ Don't know

Question 6

For the following question, please think about your close friends/ family. For each of the following, please think about your close friends/ family as a whole.

Which ONE of the following statements BEST describes how MOST of your close friends/ family may be increasing or decreasing the amount of meat they eat? (Please select one option on each column. If they don't plan on changing the amount of meat, if any, that they eat, please select the relevant "Not applicable" option)

	Family members	Close friends
They have already increased the amount of meat they eat	○	○
They have already decreased the amount of meat they eat	○	○
They are considering decreasing the amount of meat they eat, but have **not** done so yet	○	○
They are considering increasing the amount of meat they eat, but have **not** done so yet	○	○
Not applicable – they don't plan on changing the amount of meat they eat	○	○
Not applicable – they don't eat meat and don't plan on changing this	○	○
Don't know	○	○

Question 7

To what extent do you agree or disagree with each of the following statements?

	Strongly agree	Tend to agree	Tend to disagree	Strongly disagree	Don't know
Eating less red and processed meat is better for the environment	◯	◯	◯	◯	◯
Eating less red and processed meat is healthier	◯	◯	◯	◯	◯

Question 8

For the following question, please think about your close friends/ family. For each of the following, please think about your close friends/ family as a whole.

To what extent do you think each of the following people agree or disagree with each the following statement?

Eating less red and processed meat is better for the environment

	Strongly agree	Tend to agree	Tend to disagree	Strongly disagree	Don't know
Most of my family members	◯	◯	◯	◯	◯
Most of my close friends	◯	◯	◯	◯	◯

Question 9

For the following question, please think about your close friends/ family. For each of the following, please think about your close friends/ family as a whole.

To what extent do you think each of the following people agree or disagree with each the following statement?

Eating less red and processed meat is healthier

	Strongly agree	Tend to agree	Tend to disagree	Strongly disagree	Don't know
Most of my family members	◯	◯	◯	◯	◯
Most of my close friends	◯	◯	◯	◯	◯

Question 10

To what extent do you agree or disagree with each of the following statements?

	Strongly agree	Tend to agree	Tend to disagree	Strongly disagree	Don't know
My close friends and family would support me if I decided to reduce my meat consumption	◯	◯	◯	◯	◯
It matters to me to eat similar foods to close friends and family	◯	◯	◯	◯	◯
My close friends and family influence my food choices	◯	◯	◯	◯	◯

Appendix 5.1 Script for opportunistic interviews with cafeteria customers

1. Have you noticed any new informative messages in the cafeteria in the past two months?
    a. Yes

    b. No

2. If yes, what did the message say?

3. Did this message have an effect on your lunchtime meal choices?
    a. Yes, please say what effect this message had on your choices

    b. No, please say why this message didn't affect your choices

4. Did you find the informative message to be believable?
    a. Yes

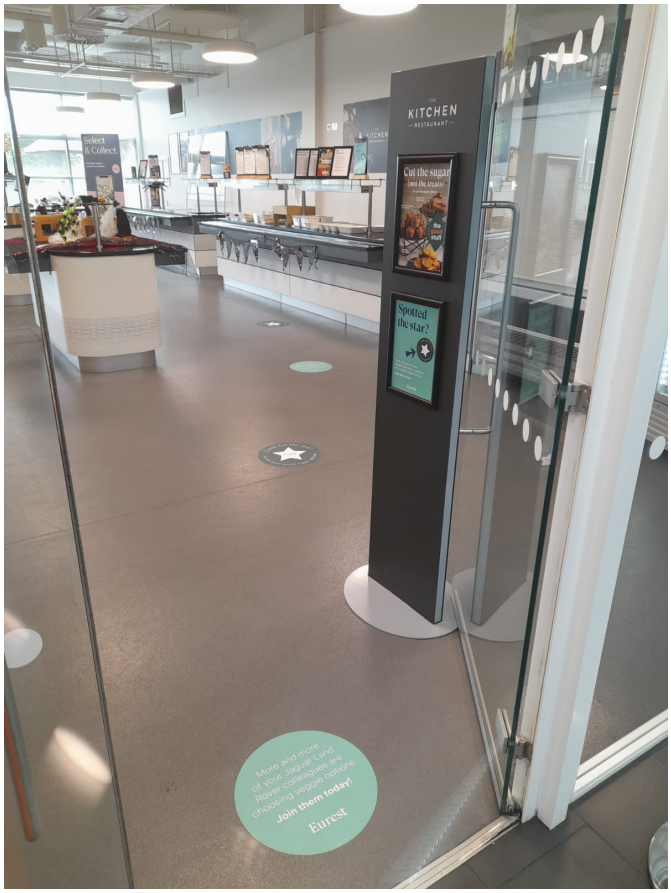
    b. No

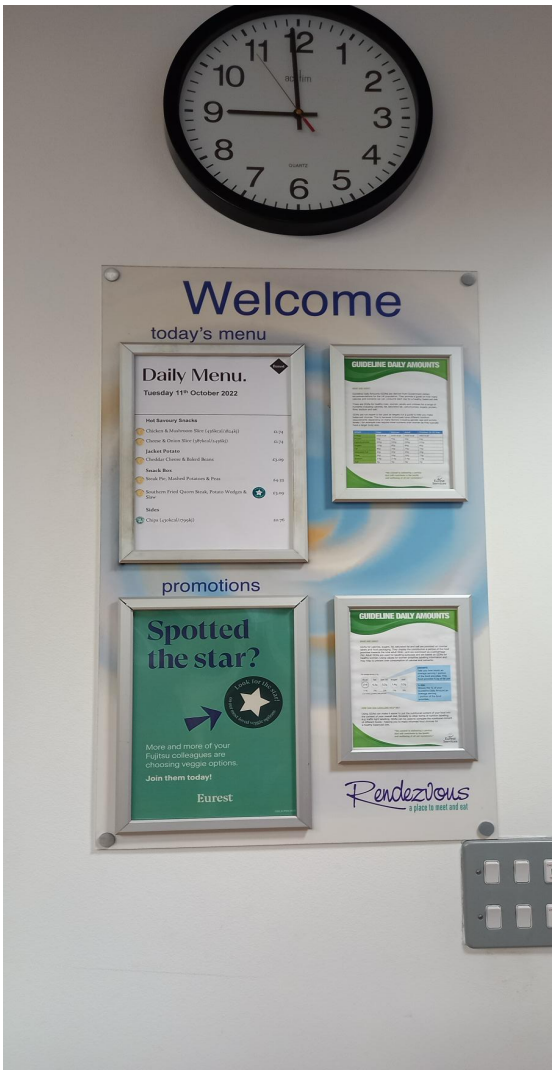
5. Why/ why not?

Additional questions to consider asking if the customer is engaged:

6. Why do you think you have not noticed the messages?
7. What do you focus on visually when you are at the cafeteria?
8. What are your priorities when making lunch choices at the cafeteria?
9. Have you observed your colleagues making more vegetarian choices?

Appendix 5.2 Examples of intervention fidelity photos from intervention cafeterias


KITCHEN
RESTAURANT
Select & Collect
Cut the sugar
Spotted the star?
More and more of your colleagues are choosing veggie options.
Join them today!
Eurest


Welcome
today's menu
Daily Menu.
Tuesday 11th October 2022
GUIDELINE DAILY AMOUNTS
promotions
Spotted the star?
More and more of your Fujitsu colleagues are choosing veggie options.
Join them today!
Eurest
GUIDELINE DAILY AMOUNTS
Rendezvous
a place to meet and eat


Spotted the star?
Look for the star!
More and more of your colleagues are choosing veggie options.
Join them today!
Eurest

Appendix 6.1 Disruption of Studies

Adult ADHD diagnosis. I had a history of diagnosed anxiety and depression before starting my degree, and started struggling with my mental health again in Hilary Term 2022. I suspected I might be neurodivergent and sought help from the University of Oxford's Disability Advisory Service (DAS) and my GP practice. Following their advice, I got a preliminary diagnostic assessment from the DAS on March 2022 that strongly suggested the presence of Attention Deficit and Hyperactivity Disorder (ADHD) and I was recommended to get a full psychiatric assessment. Due to long waiting times, I was only able to get an official adult ADHD diagnosis on November 2022 from a private practice. I was then started on medication for my symptoms, and on April 2023 my psychiatrist advised the titration period was sufficient and my care could be transferred back to my GP. This diagnostic process lasted over a year, and came at a great financial, emotional, and mental cost that was disruptive to my studies. However, with the support of my supervisors, I decided to continue my degree while decreasing my workload through periods of increased stress until Trinity Term 2024.

Suspension of status. Following a UK-wide shortage of ADHD medications in early 2024, I struggled with focusing on my studies. This was further exacerbated when my GP made the serious mistake of prescribing me a different medication without adjusting the dosage properly despite my protests and warnings, causing me to experience a number of physiological side effects that disrupted my ability to do my day-to-day tasks and function normally in May 2024. Upon careful consideration, and conversations with my supervisors, the Director of Graduate Studies at my department, the Dean of Welfare at my college, my therapist, and my psychiatrist, I decided to retroactively suspend my status for Trinity Term 2024. I returned to my studies at the beginning of Michaelmas Term 2024 to finish and submit my thesis.

Appendix 6.2 Additional academic work and engagement

Supervision and tutoring. I have co-supervised an MBiol (Masters of Biology) student who ran a field study testing the effect of dynamic descriptive norm messages with different referent groups on meat-free meal selection in Oxford college cafeterias. Her work won the prestigious Southern Fields Studies Prize for best field study and thesis in Final Honours in Biological Sciences at the University of Oxford[1]. The manuscript detailing the work has been accepted for publication at a peer-reviewed journal. I have also co-supervised a Bachelor's in Human Sciences dissertation on how anthropological methodologies can inform public health research and policy for reducing meat consumption. Additionally, I have worked as a tutor on a Year 3 Undergraduate Human Sciences module entitled 'Health and Disease' and both of my students received a first-class honors on this module. Finally, I have worked as a Psychology teacher for Oxbridge Academic Programs, a summer program designed for high school juniors and seniors where I designed my own curriculum, delivered all lectures, administered and evaluated assessments.

Public engagement and science communication. I have been invited to give a talk on how social norms influence food choices as part of the "Science Short Talks" series at the Oxford University Natural History Museum on March 2021[2]. Following this, I was invited to be featured as a guest on the Oxford Sparks Big Questions Podcast on December 2022 to talk about meat consumption during festive celebrations such as Christmas where indulgent meals become the norm[3]. More recently, I was asked to feature in an introductory video showcasing the research conducted as part of the

[1] Biggs, E. (2022). Field Studies Evaluating the Efficacy of Behavioural Interventions to Reduce Meat Consumption in UK University Canteens.
[2] https://youtu.be/ENT_7GXi474
[3] https://www.oxfordsparks.ox.ac.uk/podcasts/should-i-feel-guilty-eating-turkey-at-my-christmas-dinner/

Livestock, Environment, and People project (LEAP) on April 2024[4]. Additionally, I have participated in public engagement events for LEAP including their "Meat Your Persona"[5] tour designed to engage the general public with meat production and consumption in the UK, and the "Meat the Future"[6] exhibition at the Oxford University Natural History Museum. Through these experiences, I have learned to tailor content to different audiences with ease, considering their age, previous exposure to the material, knowledge of related subjects, and motivations to engage with the topics at hand.

Conferences. I have presented my work through four oral presentations and through being an invited speaker at three symposia at national and international conferences including the European Health Psychology Society Annual Conference, the American Psychology Association Annual Convention, the International Conference on Environmental Psychology, UK Society for Behavioral Medicine Annual Scientific Meeting, British Feeding and Drinking Group Annual Meeting, Society for Personality and Social Psychology Sustainability Preconference, and the LEAP Conference. I have built a strong network of researchers and scholars that are involved in behavior change and promoting healthy and sustainable diets and have sought opportunities to collaborate and exchange ideas wherever possible.

Collaborations. I have been involved in three additional projects outside of my DPhil studies that supported my research interests in social norms and reducing meat consumption. The first project was a collaboration with colleagues from London School of Economics and Canadian University Dubai on understanding the role of social norms and referent groups on attitudes, beliefs, and intentions around meat

[4] https://leap.web.ox.ac.uk/article/motivating-people-to-more-sustainable-diets-a-leap-video
[5] https://leap.web.ox.ac.uk/article/meat-your-persona-the-national-tour
[6] https://leap.web.ox.ac.uk/article/meat-the-future-exhibition

consumption in individuals living in the Gulf Cooperation Council countries[7]. The second project is an ongoing collaboration with Dr Emma Garnett, a fellow researcher in the Sustainable and Healthy Food Group (SHFG) on whether matching meat and plant-based meals lead to a higher selection of plant-based options in an online hypothetical meal choice task[8]. The third project is another ongoing collaboration within SHFG led by my supervisor Dr Rachel Pechey on exploring the impact of static and dynamic descriptive norm labels on the selection of healthy and sustainable foods in an online experimental supermarket shopping task. Collaborating with colleagues both in and outside of my home institution has enabled me to explore more research questions that were outside of the scope of my DPhil, exposed me to different methodologies and study designs, and helped me gain experience working with different team dynamics and management styles.

[7] Contu, D., Shreedhar, G., Mourato, S., Takshe, A., Carfora, V., & Çoker, E. N. (2024). *Understanding preferences for low carbon diets and policies to address climate change in the Gulf Cooperation Council and Arab world* (LSE Middle East Centre Paper Series, Issue.

[8] https://osf.io/wxzhu