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A Data-Driven Approach to Evaluating and Improving Scottish Food Environments

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Declaration

I declare that this thesis has been composed by myself and has not been submitted for any other degree or professional qualification. I confirm that all the contents of this thesis are my own work, except where work which has formed part of jointly authored publications has been included. My contribution and those of the other authors to this work have been explicitly mentioned below. I confirm that appropriate credit has been given within this thesis where reference has been made to the work of others.

The work presented in Chapter 2 has been published in *Current Developments in Nutrition*, as “The UK food environment: a systematic review of domains, methodologies and outcomes”, co-authored by Deksha Kapoor, Kirsteen Shields, Christian Reynolds, Martín Del Valle Menendez, and Lindsay M. Jaacks.

The work presented in Chapter 4 has been published in *Preventive Medicine Reports*, as “Characterising the food environment in Scotland and its association with deprivation: A national study”, co-authored by Deksha Kapoor, Joe Kennedy, Kirsteen Shields, Christian Reynolds, Tom Clemens, and Lindsay M. Jaacks.

The work presented in Chapter 5 is under preparation to be submitted to the *British Journal of Nutrition*, to be published as “Consumption of home-prepared, ready-to-eat and out-of-home foods and its association with diet quality in adults living in Scotland”, co-authored by Deksha Kapoor, Ricki Runions, Kirsteen Shields, Christian Reynolds, and Lindsay M. Jaacks.

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The journey of this PhD has been transformational for me, both personally and professionally. Alongside professional learnings, the last four years have reinforced my resilience, adaptability, confidence, and commitment to perform across a spectrum of life scenarios. While the core focus of the PhD has been on academic outcomes of the research, the overall experience of going through this journey has enriched me holistically as a person.

As my previous role spanning over a decade involved implementing research projects, helping clinicians set up clinical trials and population-based surveys, it gave me a first-hand experience of not only working in the field, but also understanding the underlying nuances of primary research. While this experience was extremely valuable for me, it sparked my interest in secondary research, which this PhD has fulfilled to its full potential. This transition pushed me out of my comfort zone, while not only helping me sharpen my skills, but also shaping my perspective on secondary research and its potential.

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Abstract

The persistent rise in the prevalence of diet-related chronic diseases has prompted a shift from traditional individual behaviour change interventions to policies to improve the healthfulness of food environments. The food environment is the interface between people and the wider food system. It encompasses all places where people access food, including retailers, restaurants, pubs/bars, cafés/coffee shops, takeaways, mobile food vans, schools, universities, workplaces, and charities as well as deliveries from these places. Whilst research on food environments in the UK and globally is rapidly expanding, very few studies have been conducted in Scotland. Scotland has disproportionately high rates of diet-related diseases, particularly in socioeconomically deprived areas. To address this, one of the two initial priorities of Scotland's Population Health Framework 2025-2035 is to develop a whole system approach to improve food environments, ensuring a healthy diet is accessible and affordable to all.

The overarching goal of this thesis was to provide evidence to inform data-driven improvements to the Scottish food environment. To achieve this goal, four major aims were developed, each of which forms a chapter in the thesis. The first aim, Chapter 2, was to identify and narratively synthesise recent evidence regarding UK food environments. To accomplish this aim, I conducted a systematic review of 7 databases. After reviewing 31,457 titles and abstracts, I identified 312 articles on the UK food environment published in the past two decades. The majority of articles (32%) focussed on only one of six food environment domains: availability, defined as the presence of specific food items or outlets within a given physical space. Of the remaining domains, 30% of articles assessed product characteristics/quality, 10% assessed promotion, 6% assessed sustainability, 5% assessed affordability and none assessed convenience. With regard to the type of food environment studied, most articles (67%) focussed on food retailers and only 16% assessed restaurants. Finally, obesity was the only health outcome studied extensively. This systematic review highlighted research gaps and laid the foundation for subsequent chapters, each of which addressed a specific gap. Namely, the domain of convenience (Chapter 3) and studies in the geography of Scotland (Chapters 4 and 5) covering the entirety of the food environment, from food retailers to takeaways to full-service restaurants (Chapter 4).

The aim of Chapter 3 was to develop a conceptual model and metric for measuring convenience in food environments. This was done through a

scoping review on whether and how food environment frameworks integrated convenience and in-depth interviews with food environment experts. Convenience was proposed to be objectively measured as the weekly time spent on food-related tasks. Food-related tasks included planning meals, procuring food, cooking, consuming food and cleaning up. The model also included two sub domains within convenience: product and personal characteristics as well as interaction with other food environment domains. Product characteristics encompass the inherent attributes of a food item, such as the level of processing and packaging, which contributes to or hinders its convenience. Personal characteristics (i.e., income, family size, gender, food choices, cultural beliefs and practices) interact with product characteristics and influence time spent on food-related tasks and whether the food environment is perceived as 'convenient.'

The aim of Chapter 4 was to characterise food outlets across Scotland and to assess the association between the food environment and neighbourhood deprivation. Using publicly available food business data from the Food Standards Agency (2024), and a novel approach combining text similarity matching with the GPT-4 large language model, I classified 31,135 food businesses as out-of-home (OOH), including restaurants, pubs, cafés and takeaways; retail, including supermarkets and other establishments that primarily sell non-food products with a limited range of food products such as pharmacies; and other, including mobile caterers, charity organisations and home caterers. Most (60%) of the food outlets were OOH, 28% were retail and 12% were other. The density of OOH outlets (1.9 per km²) was over twice that of retail (0.8 per km²). Glasgow City had the highest OOH density (18.4 per km²), while Argyll and Bute, Western Isles and Highlands had the lowest density for both OOH and retail (≤ 0.03 per km²). Compared to the most deprived neighbourhoods, the least deprived neighbourhoods had more restaurants/cafés (39% versus 23% of food outlets, respectively) and fewer takeaways/sandwich shops (15% versus 23% of food outlets, respectively). This analysis revealed that OOH outlets far outnumber retail in all of Scotland, with takeaways more common in deprived areas and restaurants/cafés in affluent ones. It also highlights unique food environments in different local authorities.

The aim of Chapter 5 was to quantify the consumption of home-prepared, ready-to-eat and OOH foods and its association with diet quality among adults 16+ years living in Scotland. Using 24-hour dietary recall data from the nationally representative Scottish Health Survey (2021), I classified all reported food items as home-prepared, ready-to-eat or OOH. Home-prepared foods were defined as those cooked at home using raw ingredients (such as fruit, milk, flour, etc.); frozen ingredients (including

frozen vegetables or fruit); ingredients obtained from sources like farmer's markets, butchers or fishmongers; and items explicitly designated as home-cooked, home-baked or home-grown. Foods and drinks eaten as-purchased (e.g., biscuits, crisps, breakfast cereals, juice and soft drinks) and pre-prepared convenience foods that only require heating (e.g., frozen and refrigerated ready meals) were classified as ready-to-eat. All food and drinks prepared outside the home including restaurants, pubs and cafés, as well as food prepared outside the home but eaten in the home (e.g., takeaway and delivery food) was defined as OOH.

The results showed that the weighted mean energy contributions from home-prepared and ready-to-eat foods were similar (~45% of daily calories), while the contribution from OOH foods was relatively low (9%). The highest consumption of home-prepared foods was observed in those aged 65–74 years, accounting for weighted mean (SD) 53% (20%) of total calories. Participants aged 16–24 years were the highest consumers of ready-to-eat foods [weighted mean (SD) 51% (21.5%) of total calories]. Those aged 25–34 years were the highest consumers of OOH foods [weighted mean (SD) 13% (20%) of total calories]. Participants in the least deprived areas consumed a higher proportion of energy from home-prepared foods, while those in the most deprived areas obtained more calories from ready-to-eat and OOH foods: weighted mean (SD) intake ranged from 43% (23%) to 50% (20%) for home-prepared foods across the most to least deprived quintiles; and likewise, from 48% (22%) to 43% (19%) for ready-to-eat foods and 9% (18%) to 7% (14%) for OOH foods. Adults with a larger proportion of energy from home-prepared foods were more likely to adhere to the Scottish Dietary Goals, whilst those with a larger proportion of energy from ready-to-eat and OOH foods were less likely to adhere to the Goals.

Overall, the results of this thesis highlight and begin to address research gaps in food environment research in Scotland and provide local evidence essential for understanding Scottish food environments. These findings can inform the development of forthcoming Good Food Nation Plans by local authorities and health boards, as well as national policies to improve food environments in Scotland.

Lay summary

The food environment is how people interact with the wider food system. It includes all places where people access food such as retailers for household shopping or sit-down restaurants/cafés, take-aways or workplaces. It also includes deliveries from these places. People make food related decisions based on their environment which impact their diets and overall health. Understanding food environments helps in improving population health as diet-related chronic diseases such as obesity and cardiovascular diseases are on the rise. Although there is growing research on food environments, there is limited understanding of these environments, particularly for Scotland. Compared to the rest of the UK, Scotland has poor health indicators especially in disadvantaged areas. It is therefore important to study the Scottish food environment.

The overarching goal of this thesis was to provide evidence to inform data-driven improvements to the Scottish food environment. To achieve this goal, four major aims were developed, each of which forms a chapter in the thesis. The first aim, Chapter 2, was to identify and synthesise recent evidence regarding the UK food environments. This review highlighted that most of the research on the UK food environment focused on the presence of specific food items or outlets within a particular area, i.e., availability, with fewer studies on other domains such as quality (e.g., amount of protein in certain foods), promotion (e.g., advertising on the label), affordability (e.g., cost of certain foods) and sustainability (e.g., environmental impact of foods). There were no studies on the domain convenience. With regards to the type of food environment studied, most articles (67%) focused on food retailers and only 16% assessed restaurants. Further, most studies focused on the impact of food environment on obesity. This systematic review highlighted significant research gaps which were addressed in subsequent chapters. Specifically, the domain of convenience (Chapter 3) and studies in the geography of Scotland (Chapters 4 and 5) covering many aspects of the food environment, from food retailers to take-aways to full-service restaurants (Chapter 4).

The aim of Chapter 3 was to develop a conceptual model and metric for measuring convenience in food environments. This was done through a scoping review and qualitative interviews with food environment experts. Convenience was defined as the weekly time spent on food-related tasks. Food-related tasks included planning meals, procuring food, cooking, eating and cleaning up. The model also included two sub domains within convenience: product characteristics such as level of processing and

personal characteristics like education. The model also integrated how other food environment domains interacted with convenience.

Since there was a significant underrepresentation of studies conducted in Scotland, in Chapters 4 and 5, I used analytical approaches on public/national datasets to understand different aspects of the food environment in Scotland. In Chapter 4, I used food business data from the Food Standards Agency (2024), and characterised 31,135 food outlets across Scotland. This was done using a new methodology involving GPT-4. I also explored the association of different types of food outlets with neighbourhood deprivation. Restaurants, pubs, cafés, and takeaways were characterised as out of home (OOH); supermarkets and other establishments that primarily sell non-food products and a limited range of food products such as pharmacies were characterised as retail; and mobile caterers, charity organisations and home caterers were characterised as other. Overall, 60% of food outlets were OOH, 28% were retail and 12% were other. The density of OOH outlets was over twice that of retail. Glasgow City had the highest OOH density while Argyll and Bute, Western Isles and Highlands had the lowest for both OOH and retail. The results from this analysis showed that OOH outlets far outnumber retail in all of Scotland, with takeaways more common in deprived areas and restaurants/cafés in affluent ones. It also highlighted that food environments differ in each of the 32 local authorities in Scotland.

Following this analysis of food availability, Chapter 5 focussed on food consumption in Scotland. I quantified the consumption of home-prepared, ready-to-eat and OOH foods and its association with diet quality using the nationally representative Scottish Health Survey (2021) data. Home-prepared foods were defined as those cooked at home using raw or frozen ingredients as well ingredients obtained from sources like farmer's markets, butchers, or fishmongers or items explicitly designated as home-cooked, home-baked, or home-grown. Foods and drinks eaten as purchased (e.g., biscuits, crisps, breakfast cereals, juice and soft drinks) and pre-prepared convenience foods that only require heating (e.g., frozen and refrigerated ready meals) were classified as ready-to-eat. All food and drinks prepared outside the home including restaurants, pubs and cafés, as well as food prepared outside the home but eaten in the home (e.g., takeaway and delivery food) was defined as OOH. The results showed that the energy contributions from home-prepared and ready-to-eat foods were similar (~45% of daily calories), while the contribution from OOH foods was relatively low (9%). There were differences across sociodemographic groups with older people, females and those residing in the least deprived areas consuming more home-prepared foods compared to younger participants, males and those living in the most

deprived areas, who consumed more RTE and OOH foods. Greater consumption of home-prepared foods was associated with higher adherence to the Scottish Dietary Goals, while greater consumption of ready-to-eat and OOH foods was associated with lower adherence and, consequently, poorer diet quality.

Overall, the results of this thesis highlight research gaps in food environment research in Scotland and provide local evidence essential for understanding Scottish food environments. These findings can inform the development of forthcoming Good Food Nation Plans by local authorities and health boards, as well as national policies to improve food environments in Scotland.

Abbreviations

BMI	Body Mass Index
CI	Confidence Interval
CVD	Cardiovascular Disease
FAO	Food and Agriculture Organization of the United Nations
FSA	Food Standards Agency
FSS	Food Standards Scotland
HFSS	High in fat, salt and sugar
HLPE	High Level Panel of Experts on Food Security and Nutrition
IRR	Incidence Rate Ratio
LMICs	Low- and middle-income countries
NDNS	National Diet and Nutrition Survey
NHS	National Health Service
OOH	Out-of-home
RR	Relative Risk
RTE	Ready-to-eat
SD	Standard deviation
SDG	Scottish Dietary Goals
SHeS	Scottish Health Survey
SIMD	Scottish Index of Multiple Deprivation
UK	United Kingdom

Units

g gram

kcal kilocalorie, equivalent to 1,000 calories or 4.184 kJ

kJ kilojoule, equivalent to 1,000 joules or 0.239006 kcal

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Chapter 1

Introduction

1. Introduction

Over the years, there have been rapid shifts in the ways individuals eat, drink, and interact with their environments. On one hand, transnational food corporations have significantly influenced the global food landscape through aggressive marketing and the pricing of unhealthy products, thereby creating environments that make it increasingly challenging to maintain healthy diets. These practices continue to shift dietary patterns with implications for both human and planetary health. On the other hand, there is growing evidence associating the impact of these environments on diets and health, which have resulted in impactful policy interventions to promote healthier food environments worldwide. Nevertheless, ensuring optimal diets and population health remains a complex global challenge, as countries strive to find balanced solutions that improve well-being without creating unintended consequences. The first step towards this goal is understanding the food environment and identifying which strategies are most effective in each country's unique context. Such insights are crucial for effectively addressing the public health challenges.

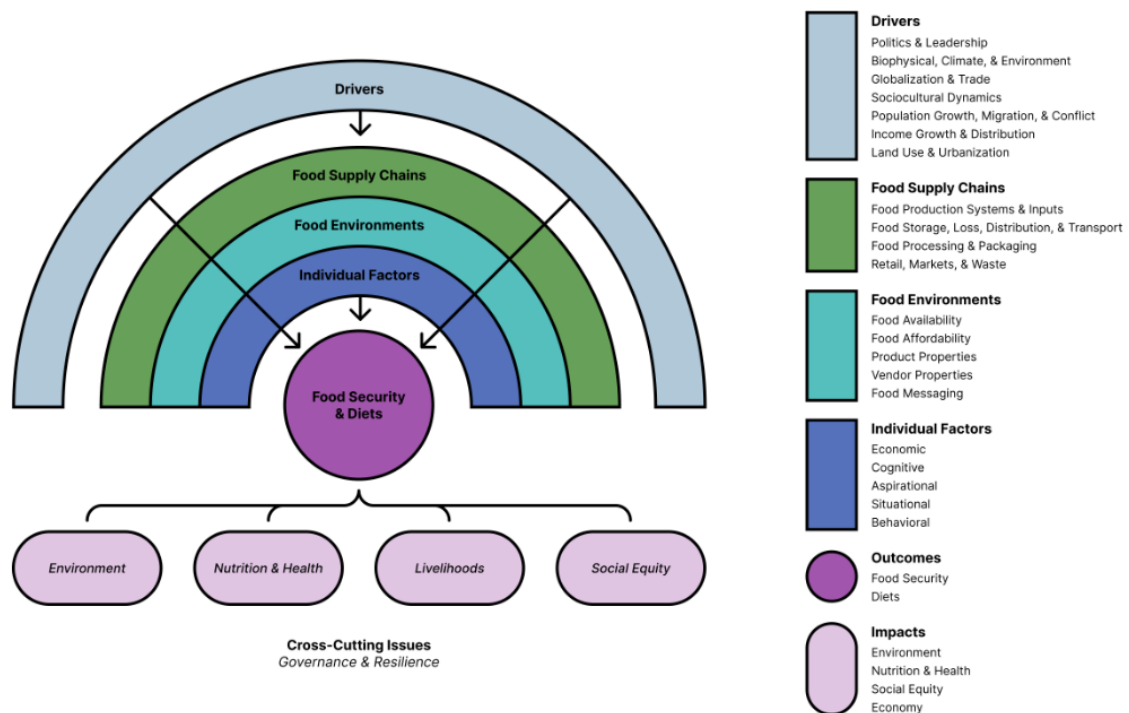
1.1 Public health challenges in the UK and Scotland- from a food systems lens

Food systems encompass the network of individuals, organisations, places, and processes involved in producing, processing, distributing, marketing, and consuming food (1). Within the Food Systems framework (**Error! Reference source not found.**, they are conceptualised as comprising three interconnected components: food supply chains, food

environments, and individual factors, all of which interact to shape diets and broader system outcomes (1). Food supply chains include the activities and actors that move food from production to consumption, while food environments represent the settings in which people acquire and engage with food, including its availability, affordability, quality, and marketing. Individual factors, such as income, knowledge, preferences, and time, mediate how people interact with these environments (1).

Within this framework, food environments occupy a critical intermediary position. They act as the interface where upstream processes in supply chains and wider structural drivers translate into the everyday conditions that shape food choices. Understanding food environments within this broader systems framework is therefore essential for designing policies that address both immediate dietary outcomes and the structural determinants that shape them.

Figure 1.1 Food Systems Framework (GAIN, Johns Hopkins University, FAO, Cornell)



Socioeconomic inequality is a critical driver that shapes food environments and constrains individual food choices. Socioeconomic deprivation, insecure livelihoods, and rising living costs limit people’s ability to access nutritious food, contributing to both food insecurity and obesity.

On our current trajectory, people are projected to live longer but spend more of those years in poor health, meaning illness-free life expectancy is expected to stagnate rather than improve (2). This represents a major public health challenge because it highlights the urgent need to prevent illness earlier in life and support healthier ageing.

Obesity is a major contributor to ill health. The UK has the highest prevalence of obesity in Western Europe and ranks sixth among Organisation for Economic Co-operation and Development (OECD) countries (3). If current trends persist, the proportion of adults with overweight or obesity is projected to rise from 64% in 2019 to 71% by 2040, equivalent to approximately 42.2 million people (20.6 million who are overweight and 21.6 million who are obese) (4).

Scotland's life expectancy is the lowest of all UK countries and remains the lowest in Western Europe (5). Based on the Scottish Burden of Disease study, a 21% increase is projected in the overall burden of disease over the next 20 years (6). The deprivation gap between the least and most deprived groups in England and Scotland is expected to widen by more than 50% by 2040 for people with obesity (4). These inequalities extend to children, with 70% of children in the most deprived areas having a healthy weight compared to 81% of those in the least deprived areas (7).

Commercial determinants of health also play a significant role. Adolescents and adults alike are exposed to pervasive marketing and retail practices that promote unhealthy, ultra-processed foods, both in physical and digital environments (8). These commercial pressures interact with social determinants such as housing, employment, education, and discrimination, compounding the risk of diet related disease (9). As a result, diet related inequalities are widening, with disadvantaged groups experiencing higher rates of obesity, type 2 diabetes, cardiovascular disease, and other chronic conditions (10).

Supply chain disruptions, climate related shocks, welfare reforms, and inflation have driven a sharp rise in household food insecurity, with nearly 15% of UK households experiencing moderate or severe food insecurity in 2024 (11). This insecurity forces families to prioritise affordability over nutrition, often relying on cheap, energy dense foods that undermine long term health. Healthier foods in the UK are nearly three times more expensive than unhealthy options, making nutritionally adequate diets unattainable for many low-income households (12). According to the UK Living Costs and Food Survey, the average cost of a basket of food items rose by 4% in 2024, continuing the trend observed in the year 2023. During this period, lower-income households increasingly either reduced their

consumption or, where possible, switched to lower-cost or lower-quality alternatives (13). In Scotland, 14% of adults reported experiencing food insecurity in 2023, representing an increase from 9% in 2021 and the highest level recorded since 2017 (14).

Furthermore, the UK food environment is under increasing environmental pressure, as current dietary patterns are unsustainable. UK discards an estimated 6.4 million tonnes of edible food annually, highlighting systemic inefficiencies that coexist with widespread unmet nutritional needs (11). High-impact foods, such as meat and dairy, along with food waste in households and retail settings, contribute significantly to climate change and ecosystem degradation (15-17).

Unhealthy diets underlie these worrying public health trends. A poor diet increases the risk of type 2 diabetes, cardiovascular disease, some cancers and other chronic diseases, making it a leading cause of preventable poor health (18, 19). Despite public health efforts over the past decade, there has been little change in people's diets, with a substantial proportion of the population still failing to meet official recommendations. National survey data indicate that most individuals do not meet the UK Government's recommendation to consume at least five portions of a variety of fruits and vegetables per day (20). Similarly, in Scotland, average fruit and vegetable consumption is 265g per day, well below the recommended level of 400g per day (21). Only 4% of adults met the recommendation for fibre in both UK and Scotland, the goal missed by most (14, 20). The recommendation for saturated fats intake was met by less than 30% of the population with most people exceeding recommended intakes (14, 20). Taken together, these challenges illustrate that the UK's burden of disease is not simply the result of individual choices but is produced by the structure and functioning of the food system itself. Addressing public health challenges therefore requires system wide approaches that tackle the economic, social, and commercial drivers of poor diets, rather than relying on individual behaviour change. This includes reshaping food environments, strengthening local and national food policies, and addressing the underlying inequalities that limit access to healthy, sustainable diets. To date, most policies to address unhealthy diets in the UK have focused on individual behaviour change such as awareness campaigns, educational programmes and food labelling (22). However, many have critiqued this approach because it ignores the influence of the complex social and physical contexts in which individual behavioural decisions are made. Such critiques have led to a new focus on improving the healthfulness of food environments (22, 23).

The Transforming UK Food Systems (TUKFS) Programme, funded through UK Research and Innovation and government partners has identified 27 action areas spanning regenerative production, innovation in manufacturing and supply chains, healthier and more sustainable food environments, community empowerment, and strengthened governance (24). Central to this programme is a systems approach that recognises the interdependence of production, distribution, and consumption, and emphasises co-production with citizens, industry, and policymakers, as well as place-based approaches that reflect regional diversity (24).

A multidisciplinary roundtable convened by the British Nutrition Foundation and the Quadram Institute similarly highlighted the need for integrated, system wide action to achieve net zero food systems while maintaining nutritional adequacy, food security, and health equity (25). Although shifts towards more plant rich diets offer clear co benefits, socioeconomic inequalities and food insecurity remain major barriers to change (25). The roundtable emphasised the influential role of industry, retailers, and policymakers in shaping food environments and called for stronger regulation, coordinated cross sector action, and greater accountability to support a just transition to sustainable diets (25).

Particularly in Scotland, policy initiatives such as Good Food Nation and climate commitments underscore the need for food systems that deliver healthier diets while supporting environmental sustainability. Enabling Healthy Living, which includes improving the food environment, has been recognised as one of the five prevention drivers of health and wellbeing in the Scotland's Population Health Framework 2025-2035 (26).

A whole systems perspective reinforces this framing by recognising that dietary behaviours and health outcomes emerge from the complex interplay of social, environmental, commercial, and policy influences (27). Rather than focusing on individual responsibility, this approach highlights the structural constraints, such as socioeconomic deprivation, insecure livelihoods, and rising living costs, that limit people's ability to access nutritious food and contribute to both food insecurity and obesity in the UK (27).

1.2 Food environments- Concepts and frameworks

Table 1.1 provides a summary of definitions and domains of the food environments over time. The development of this section was based on

updating the systematic search of food environment frameworks later detailed in **Chapter 3**.

The concept of 'food environments' was established in the early 2000s. One of the earliest efforts was by Glanz and colleagues (28), who introduced the concept of "nutrition environments" that are related to eating behaviours with emphasis on community and consumer environments. This work led to the development of the Nutrition Environment Measures Survey (NEMS), a tool to evaluate the availability and accessibility of healthy food options in various settings¹. Expanding on their work in 2008, Story, Glanz and colleagues provided an ecological framework depicting multiple factors at individual, social, physical and macro level environment that influence diet, emphasising context and systematic changes needed for healthy behaviour (29).

Next in 2013, the International Network for Food and Obesity/Non-communicable Diseases Research, Monitoring and Action Support (INFORMAS) network, developed a monitoring framework to assess government policies and actions for creating healthy food environments called the Healthy Food Environment Policy Index (Food-EPI) (30). The monitoring framework has been used in over 60 countries, including England (31), but has not yet been applied in Scotland.

Building on the definition by INFORMAS, Herforth's socio cultural food environment framework, expanded the scope of food environments by adding convenience and replacing quality with desirability (32). They also recognised that on-farm and natural or wild food environments constitute important components of the food environment for producers and rural residents.

Next, the frameworks by the Food and Agriculture Organization (FAO) (33) and the High Level Panel of Experts (HLPE) (34) adopted a comprehensive systems approach, emphasising the interlinkages of food systems with behavioural factors shaping dietary outcomes. The framework by the Global Panel on Agriculture and Food Systems for Nutrition (35), focuses on how policies in the food system impact the food environment specially in low- and middle-income countries (LMICs). They provide high level recommendations for policy makers to create healthy food environments.

Recognising both the commonalities among the above definitions and the diversity across domains, Turner and colleagues built upon the Food and Agriculture Organization (FAO) (33) definition by applying socio-

¹ Tools – Penn NEMS. Available at: <https://nems-upenn.org/tools/>

ecological theory to develop a conceptual framework for food environments (36). This framework emphasised on how external and personal domains interface with production, storage, transportation, acquisition, and consumption within the broader food system (36). It provided an important contribution by highlighting LMIC specific food sources such own-production, wild harvested foods, and gifts. Another pioneering contribution was the Downs's Food Environment Typology (37). This was the first framework to introduce a new domain of 'sustainability' to existing domains and provide methodological approaches for measuring these domains. Further, they also expanded on various types of built and natural food environments.

These frameworks proposed by Turner (36) and Downs (37) provided the foundation for subsequent studies in this field. For example, two region-specific food environment frameworks were identified, one based in Africa and another in the Pacific region. The African urban food environment framework (38) developed and validated a socio-ecological framework of 103 factors influencing dietary behaviours in urban African food environments, using literature review, qualitative interviews, and consultation with experts from 27 countries. The factors were ranked, and the following were identified as important: individual, social, physical, and macro-level domains. Second, the typology of food environments specific to the Pacific region was proposed by Bowgard and colleagues (39). Their framework incorporates additional context-specific sub-types, such as kin and community food networks, as well as food aid and services relevant for this geography. It highlights the relationship between acquisition and consumption in the traditional and informal food systems.

Next, Cong and colleagues developed a framework of the online public food environment in China (40). They redefined domains identified in Downs's framework (37), into physical space (availability and accessibility), food attributes (affordability, convenience and food characteristics) and change (sustainability). Focusing on the traditional food environment, in 2023, Gupta and colleagues, a conceptual framework that integrates core dimensions (availability, accessibility, and affordability) with LMIC specific factors such as informal food markets, weak regulatory systems, and the influence of global trade (41).

Specific to the families affected by Human Immunodeficiency Viruses (HIV), in 2024, the Family Dynamics Food Environment Framework (FDF) was developed using best-fit framework analysis (42). This added the family food environment domain to the external and personal domains in Turner's (36) framework, to show the drivers of food choice in the context of families affected by HIV. Lastly, the most recent framework is by

O'Meara et al. (43) which expands the concept of food environments by including women's agency in LMIC contexts. It was guided by a substantial scoping review from 125 countries on multiple eco-social, structural, and individual-level determinants relating to women's agency.

Table 1.1 Summary of food environment frameworks

Name of the Framework and/or Authors, Reference, and year	Definition of Food environment	Domains
Glanz Conceptual model for nutrition environments, (28), 2005	Individual behaviours are shaped by multiple levels of influence, including the community and societal built environments	Community Nutrition environment, Consumer Nutrition environment, Organisational Nutrition environment, Information environment
Healthy Food Environment Policy Index (Food-EPI) (30), 2013	"The combination of physical, economic, policy, and sociocultural opportunities and conditions that shape what people eat and drink, as well as their nutritional status."	Composition, labelling, promotion, provision, retail, prices, and trade and investment
Herforth's socio cultural food environment framework (32), 2015	The availability, affordability, convenience, and desirability of various foods.	Availability, affordability, convenience, and desirability.
Food and Agriculture Organization of the United Nations (FAO) (33), 2016	Described as the "interface" or "link" between food systems and diets.	Access, price, promotion, labelling, quality/ taste
Global Panel on Agriculture and Food Systems for Nutrition, (35), 2016	"The options from which people make decisions about what to eat, circumscribe how income can be spent on food and contribute to shaping people's food preferences, attitudes and beliefs and food cultures more broadly."	Access, price, promotion, labelling, nutrient quality and taste
High Level Panel of Experts (HLPE) food systems framework (34), 2017	"The physical, economic, political and socio-cultural context in which consumers engage with	Availability, physical access (proximity), economic access (affordability), promotion,

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Name of the Framework and/or Authors, Reference, and year	Definition of Food environment	Domains
	the food system to acquire, prepare and consume food". The food environment consists of the physical spaces where food is obtained; the built environment that allows consumers to access these spaces; personal determinants of food choices and the political, social and cultural norms that underlie these interactions.	advertising and information, food quality and safety
Turner's conceptual framework (36), 2018	"The interface where people interact with the wider food system to acquire and consume foods."	The personal domain includes accessibility, affordability, convenience, and desirability. The external domain includes availability, price, vendor and product properties, and marketing and regulation.
Downs's Food Environment Typology (37), 2020	"The consumer interface with the food system"	Availability, affordability, convenience, promotion, quality, and sustainability of foods and beverages in wild, cultivated, and built spaces.
African urban food environment framework (38), 2021	This applies an ecological approach that accounts for the multi-dimensional drivers of dietary behaviours that operate at varying levels of the food environment.	103 factors under individual, social, physical, and macro-level domains.
Bowgard typology of food environments specific to the Pacific region (39), 2021	Kin and community food environment as the network of social relationships through which people acquire food.	Availability, relative price and affordability, promotion, quality, convenience, mode of exchange, and sustainability

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Name of the Framework and/or Authors, Reference, and year	Definition of Food environment	Domains
Cong framework of the online public food environment in China (40), 2022	Food and its physical space are two core elements of the food environment.	Nutrition, healthiness (quality), meal category, and price.
Conceptual framework of food environment using socio-ecological and access theory, LMIC,(41), 2023	“To encompass diverse variables that link people's food acquisition and consumption within the broader food system created by human-built and social environments.”	Availability, affordability, accessibility, global influences, marketing regulation, time-constrained family, and culture sensitive food behaviour.
The Family Dynamics Framework, HIV families (42), 2024	“The food environment, where people procure food, shapes food choices, dietary patterns, and nutrition outcomes”. This is based on Turner's conceptual framework.	Family food environment domain added to personal and external domains in Turner's conceptual framework.
Conceptual framework of women's food environments, LMICs,(43), 2025	“The setting in which individuals acquire food from the wider food system.” Based on the definition by HLPE food systems framework.	The personal food environment includes affordability, accessibility, literacy, preferences social norms, safety perspective, social capital, and convenience. The external food environment includes availability, price, vendor properties, food properties, marketing, policies and regulation.

The evolution of food environment frameworks reflects the shift toward systems-oriented thinking. Early models focused primarily on retail access and consumer choice, whereas more recent frameworks such as those developed by FAO (33), HLPE (34), Turner (36), and Downs (37) explicitly situate food environments within broader food-system structures, governance processes, and sustainability considerations. These frameworks recognise that food environments are shaped by multiple interacting domains, including economic systems, regulatory contexts,

cultural norms, and ecological conditions. This conceptual progression provides the foundation for the framework selected for this thesis.

Downs's Food Environment Typology (37) offers a particularly strong foundation for this thesis (**Figure 1.2 Graphical representation of the Downs's Food Environment Typology (31)**). As stated earlier, it was the first framework to introduce sustainability as a core domain, recognising that food environments are shaped not only by consumer-facing factors but also by ecological pressures, resource use, and long-term food-system resilience. This is very suitable for research on food environments in Scotland, where national policy increasingly emphasises sustainability, equity, and structural determinants of diet through the Good Food Nation Act (44) and the Diet and Healthy Weight: Out of Home Action Plan (45). Scotland's policy landscape recognises that improving population diets requires more than individual behaviour change. It requires transforming the environments in which food is accessed, produced, and consumed. These policies also explicitly link dietary improvement with environmental goals, including reducing food-system emissions, supporting local and sustainable production, and promoting resilient food systems. By incorporating sustainability alongside traditional domains such as availability, affordability, convenience, and desirability, the framework enables an integrated assessment that reflects the holistic ambitions of Scottish food policy.

Next, it explicitly describes each domain providing a methodological structure to measure them. Availability captures whether particular foods are physically present in a given setting, while affordability reflects how food prices compare with income or other benchmarks. Promotion encompasses the ways foods are made appealing or visible through packaging, labelling, and placement. Product characteristics relate to the intrinsic qualities of foods, including their nutrient content, level of processing, freshness, and packaging. Convenience refers to the time required to obtain, prepare, and consume foods, recognising time as a key driver of food choice. Finally, sustainability considers the environmental and social impacts of food consumption. Together, these domains provide a comprehensive framework for understanding how food environments influence dietary behaviours.

In conclusion, the Downs's framework (37) not only situates food environments within the broader food system, similar to frameworks developed by FAO (33), HLPE (34), Turner (36) but also advances the field by explicitly incorporating sustainability and providing clear descriptions for measuring each domain.

Figure 1.2 Graphical representation of the Downs's Food Environment Typology (31)



1.3 Food environments and health outcomes

A substantial body of research demonstrates that food environments are important determinants of dietary behaviours and health outcomes, however, evidence on their long-term health impacts remains limited. Systematic reviews consistently show that greater availability and promotion of energy-dense, nutrient-poor foods is associated with higher consumption of ultra-processed products, increased caloric intake and elevated risk of obesity (46, 47). Exposure to marketing of high-fat, salt and sugar (HFSS) products, particularly among children has been shown to shape food preferences, purchase requests, and consumption patterns, contributing to unhealthy weight gain (48, 49). Broader community level reviews in high income countries provide stronger evidence linking food environments to chronic diseases, particularly diabetes and cardiovascular disease (50). These findings provide strong evidence that commercial determinants of health play a central role in shaping dietary behaviours. Reviews of policy interventions indicate that structural changes, such as food pricing policies, labelling regulations, and product reformulation, can improve dietary behaviours at the population level, with downstream benefits for obesity and chronic disease risk (51).

However, the strength of associations varies considerably across type of environment and study designs. Systematic review of retail food environments, for example, show mixed but suggestive associations with obesity, with results highly dependent on how exposure is measured (e.g., fast food outlet density versus supermarket access) (52). This inconsistency reflects methodological challenges, including heterogeneity in exposure definitions, reliance on measures such as counts or densities of outlets, and limited consideration of individual mobility) (50, 52). A more recent

GPS based systematic review highlighted that daily movement patterns substantially influenced true food environment exposure, with implications for diet quality and cardiometabolic risk (53).

Yet, despite the growing number of systematic reviews demonstrating associations between food environments and health outcomes, the contribution of randomised controlled trials (RCTs) remains relatively limited. Existing RCTs partially address this gap by demonstrating that modifying food environments, particularly in supermarkets and schools, can lead to measurable improvements in dietary behaviours. For example, a large supermarket-based RCT showed that a multicomponent intervention combining in-store guidance and digital tools improved dietary quality (DASH score) over three months, suggesting that retail environments can influence cardiovascular risk factors (54). Similarly, another cluster RCT found that school food environment interventions improved children's food knowledge, wellbeing, and dietary habits, supporting the effectiveness of whole-school approaches (55).

Critically, these trials are short-term and do not assess endpoints such as incident diabetes or cardiovascular disease, the very outcomes identified in systematic reviews as being influenced by food environments. Furthermore, most RCTs involve multicomponent interventions that combine environmental changes with education or behavioural strategies, making it difficult to isolate the independent effect of the food environment itself. As a result, while RCT evidence strengthens causal inference for short-term behavioural outcomes, it remains insufficient to fully substantiate the broader health impacts suggested by observational and review literature.

Collectively, the evidence underscores that food environments are not neutral backdrops but structural drivers of dietary behaviour and health outcomes. At the same time, the field would benefit from stronger experimental and longitudinal evidence to establish the magnitude of their effects on long-term health outcomes. This remains a critical priority for advancing the science of food environments and informing effective policy.

Another key concept in food environment research is food deserts, food swamps, and food oases. These categories are defined by the type and distribution of food outlets within a given area. Food deserts refer to densely populated neighbourhoods where residents experience limited access to affordable and nutritious foods (56). In contrast, food swamps are areas dominated by outlets selling ultra-processed and unhealthy foods relative to those offering healthier options (56). Food oases, on the other hand, are characterised by a greater availability of healthy foods (56). These

are often associated with socioeconomic disparities, as lower-income populations are more likely to live in food deserts with restricted access to fresh fruits and vegetables (57) or food swamps dominated by unhealthy food options (58). Research in this area is valuable because it helps identify communities requiring targeted policy interventions and opportunities for local business development (59). However, while there is growing evidence on addressing socioeconomic barriers and improving supermarket access in the United Kingdom, much of the existing literature remains heavily concentrated on studies conducted in the United States.

1.4 UK policies relating to the food environment

In **Table 1.2** Summary of food environment related policies in the UK by food environment domain, the UK's food environment related policies from the NOURISHING database (60) and the more recent evidence map conducted by Blanchard and colleagues (61), were organised according to the food environment domains outlined in Downs's framework (37).

Within the domain availability, all policies concentrated on four main areas. First, the fruit & vegetable initiatives in schools involves providing a free fruit or vegetable to children up to 6 years in school every day. This initiative is voluntary. However, there are mandatory policies across UK to provide free meals (lunch) to primary school children, particularly those from disadvantaged backgrounds. These extend to meals provided during day care, holidays or during breakfast and are focused to reduce food insecurity. A recent expansion of Free School Meals was announced by the UK government, indicating that September 2026 onwards, all children from families receiving Universal Credit will be eligible for free school meals (62). Each nation also has mandatory nutritional standards for healthy meals served in schools including restrictions on unhealthy food. These policies cover both availability and quality domains.

Third policy focus was on increasing healthier options in stores and out-of-home (OOH) venues. These involved encouraging outlets to switch to healthier ingredients (using more fruit and vegetables), smaller portions, and calorie labelling. Results from an intervention to encourage the adoption of healthier cooking practices among fish and chips shops in London reported decrease in portion size of chips and improvement in caterer's behaviour (63). The fourth focus area was the implementation of takeaway exclusion zones under the National Planning Policy Framework (NPPF), voluntarily adopted by all devolved governments. This involved

restriction on takeaways around certain areas. An evaluation of this initiative in England has demonstrated its effectiveness in reducing the number of new takeaways and reducing obesity levels (64, 65).

Within the domain of promotion, three policy initiatives were introduced regarding labelling: the first mandated the inclusion of information on the amount of energy and select nutrients on all packaged foods, while the second encouraged the voluntary use of traffic light labelling. Studies evaluating mandatory calorie labelling initiative, reported no positive influence on calories purchased by the consumer, possibly as it focuses on individual behaviour change (66). The third policy applies specifically to food products that make a nutrient or health claim. This is a mandatory requirement enforced by the Food Standards Agency (FSA) in the UK and includes food supplements, fortified foods and foods for specific nutritional uses such as baby milk or formula. The fourth focus area was mandatory restrictions on advertising HFSS products to children under 16 years as well as in-store restrictions on placement and multi-buy promotions of these products. Recent evaluation of HFSS product placement restrictions revealed reduction in HFSS sales post this ban across all deprivation levels in England (67).

Under the domain product characteristics/quality, Trans Fat Regulations and the Soft Drinks Industry Levy are mandatory across the UK. Further, a voluntary reformulation of food products to reduce sugar, salt and calories has been adopted by all devolved governments. A voluntary initiative by Jamie's Italian restaurants revealed that a £0.10 levy on sugar-sweetened beverages declined sales in short and medium term, particularly in restaurants with higher baseline sales (68).

Lastly, there are voluntary policies ensuring availability of healthy foods in hospitals for patients, staff and visitors. These also extend to type of products available in vending machines at these healthcare settings.

Table 1.2 Summary of food environment related policies in the UK by food environment domain

Policy Area and Name	Policy brief and status
Food Environment Domain – Availability	
Fruit & vegetable initiatives in schools <ul style="list-style-type: none"> <li>• The Free Fruit in Schools Initiative (Scotland) 	The Free Fruit in Schools Initiative provides one portion of fruit thrice in a week to children up to primary 2 in Scotland. This is implemented at the local authorities' discretion. <i>Status: voluntary.</i>

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Policy Area and Name	Policy brief and status
Food Environment Domain – Availability	
<ul style="list-style-type: none"> The School Fruit and Vegetable Scheme (England) 	<p>Under the School Fruit and Vegetable Scheme, children aged 4-6 years attending state-funded schools in England, are eligible to receive a free piece of fruit or vegetable apart from their school lunch, every day. <i>Status: voluntary.</i></p>
<p>Targeted subsidies for healthy food</p> <ul style="list-style-type: none"> Free Breakfast initiative in Primary Schools (Wales) School Holiday Enrichment Programme (SHEP) (Wales) Free School Meals [under Section 512ZB of the Education Act 1996 in England and Wales; under Education (Scotland) Act 1980 in Scotland and under Northern Ireland legislation in Northern Ireland] The Universal Infant Free School Meals (UIFSM), England 	<p>Free Breakfast in Primary Schools is aimed at providing children with a healthy breakfast to all children attending primary school in Wales. <i>Status: mandatory.</i></p> <p>SHEP is a partnership model involving schools, health professionals and local authorities focussed on providing nutritious food and enrichment activities for children during the summer holidays. The aim is to address food insecurity, holiday learning loss and social exclusion. All the food served during SHEP is required to be compliant with the Healthy Eating in Schools (Nutritional Standards and Requirements) (Wales) Regulations 2013. <i>Status: only some aspects mandatory.</i></p> <p>According to the Free School Meal criteria, children who receive, or whose parents receive, any of the following support payments are eligible to receive free school meals: Income Support, Income-based Jobseeker's Allowance, Income-related Employment and Support Allowance, Support under Part VI of the Immigration and Asylum Act 1999, The guaranteed element of Pension Credit, Child Tax Credit, Working Tax Credit (have an annual gross income of no more than £16,190) and Universal Credit. <i>Status: mandatory</i></p> <p>Under the UIFSM, all children in year 1 and year 2 in government-funded schools receive free meals. These meals should comply with the school food standards (covered under multiple domains).</p> <p>The Scottish Government and local authority partners have an agreement to introduce universal free school lunches for primary 4 and 5 children, along with targeted support for all eligible primary and secondary children, and young people, during school holidays. <i>Status: mandatory</i></p>

Table 1.2 Summary of food environment related to policies in the UK by food environment domain (*cont.*)

Policy Area and Name	Policy brief and status
Food Environment Domain - Availability	
Targeted subsidies for healthy food <ul style="list-style-type: none"> Day Care Food Scheme, Northern Ireland 	All children under 5 years are given one third of a pint of milk free each day under the Day Care Food Scheme , in Northern Ireland. This includes children who attend day care for at least two hours per day. <i>Status: mandatory</i>
Initiatives to increase the availability of healthier food in stores and OOH venues <ul style="list-style-type: none"> The Scottish Grocers Federation Healthy Living Programme (Scotland) Local Authority Healthier Catering awards (England) 	The Healthy Living Programme is aimed at supporting Scottish independent retailers to offer healthy choices, thereby contributing to the goal of achieving a healthy nation. The Scottish Grocers Federation administers this programme, on behalf of Scottish Government. <i>Status: voluntary.</i> Healthier Catering awards. Based on Public Health England's Healthier and more sustainable catering guidance, local councils encourage outlets to focus on reductions in salt, fat and sugar, smaller portions, and inclusion of more fruit and vegetables, along with provision of calorie information. <i>Status: voluntary.</i>
Planning restrictions on food outlets <ul style="list-style-type: none"> Takeaway exclusion zone under the National Planning Policy Framework (NPPF) 	The NPPF enables the local authorities to limit the opening of new hot food takeaways within a 400m zone near schools and areas where evidence suggests over-concentration and high obesity rates. Similar frameworks adopted from the NPPF exist - Scotland has the National Planning Framework 4, Wales has Planning Policy Wales, and Northern Ireland has a Strategic Planning Policy Statement. <i>Status: framework is mandatory, but the adoption of takeaway exclusion zones is based on local authority or council.</i>

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Table 1.2 Summary of food environment related policies in the UK by food environment domain (*cont.*)

Policy Area and Name	Policy brief and status
Food Environment Domain - Promotion	
Nutrient lists on packaged food <ul style="list-style-type: none"> • Food Information Regulations 2014 in Great Britain (England, Wales, Scotland); EU Regulation 1169/2011 in Northern Ireland 	This regulation requires a list of the nutrient content on the back of the packaging of pre-packaged food. These include energy value in both kilojoules (kJ) and kilocalories (kcal); the amounts of fat, saturated fat, carbohydrates, protein, sugars, and salt. <i>Status: mandatory.</i>
Nutrition labelling in prepacked food <ul style="list-style-type: none"> • Multiple Traffic Light (MTL) Front-of-Pack Nutrition Labelling, 2013 	In 2013, UK Health Ministers recommended the multiple traffic light label, a colour-coded system showing whether a product is high (red), medium (amber), or low (green) in fat, saturated fat, salt and sugars, including the total energy (kilocalories and kilojoules). <i>Status: voluntary.</i>
Nutrient and Health claims on labels <ul style="list-style-type: none"> • Nutrition and Health Claims Regulation (NHCR) in Great Britain and Regulation (EC) No. 1924/2006 in Northern Ireland 	“A nutrition claim is any claim that states, suggests or implies that a food has particular beneficial nutritional properties due to the presence, absence, increased or reduced levels of energy or of a particular nutrient or other substance, and includes claims such as source of calcium, low fat, high fibre and reduced salt.” “A health claim is any claim that states, suggests or implies that a relationship exists between a food category, a food or one of its constituents and health.” Foods Standards Agency (FSA) is responsible for its implementation in the UK. <i>Status: mandatory compliance on food products that make nutrition or health claims.</i>

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Table 1.2 Summary of food environment related policies in the UK by food environment domain (*cont.*)

Policy Area and Name	Policy brief and status
Food Environment Domain - Promotion	
<p>Government engages with industry to restrict food marketing to children</p> <ul style="list-style-type: none"> UK Code of Non-broadcast Advertising, Direct & Promotional Marketing (CAP code) 	<p>The CAP Code applies to restrictions on sales promotion and direct marketing to children on non-broadcast media.</p> <p>“Advertisements for high in fat, salt and sugar (HFSS) products must not be targeted at people aged under 16 through the selection of media or the context in which they appear. No medium should be used to advertise HFSS products, if more than 25% of its audience is under 16 years of age”.</p> <p>Further, for content directly targeting children under 12 years, cannot include promotions, or licensed characters or popular celebs. <i>Status: Mandatory; delayed until 2026</i></p>
<p>Initiative to control exposure and marketing of unhealthy products</p> <ul style="list-style-type: none"> HFSS promotions ban 	<p>Restricts promotion and placement of HFSS products. This includes: ban on multi-buy promotions (“buy one get one free”) and restriction on placement at checkouts, aisle ends, store entrances</p> <p>England: placement restrictions (Oct 2022), volume promotions (Oct 2025), advertising restrictions (Oct 2025). Wales & Scotland are planning to implement from 2026. <i>Status: mandatory.</i></p>

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Table 1.2 Summary of food environment related policies in the UK by food environment domain (*cont.*)

Policy Area and Name	Policy brief and status
Food Environment Domain – Product characteristics (Quality)	
<p>Mandatory removal of trans-fats in food products</p> <ul style="list-style-type: none"> Trans Fat Regulations (UK) under the Addition of Vitamins, Minerals and other Substances (Amendment) Regulations 2020 	<p>The Addition of Vitamins, Minerals and Other Substances (Amendment) Regulations of 2020 prohibited the use of trans-fats (other than trans-fat naturally occurring in fat of animal origin) exceeding 2g/100g of fats from 1 April 2021. <i>Status: mandatory.</i></p>
<p>Health-related food taxes</p> <ul style="list-style-type: none"> The Soft Drinks Industry Levy (UK) 	<p>The Soft Drink Industry Levy applies to pre-packaged sugary drinks with at least 5g of sugar per 100ml. Drinks with 5–8g of sugar per 100ml are taxed £0.18 per litre, and those with 8g or more are taxed £0.24 per litre. Milk-based or substitute drinks, pure fruit juices, drinks without added sugar, alcohol substitutes, and certain medicinal drinks are exempted. The levy is applicable on soft drinks produced, packaged and imported in the UK. <i>Status: mandatory.</i></p>
<p>Voluntary reformulation of food products</p> <ul style="list-style-type: none"> Sugar, salt and calorie reduction and reformulation programme (UK) Reformulation for health, Scotland; Making Food Better Programme, Northern Ireland; Healthy Weight: Healthy Wales 	<p>A UK wide voluntary reformulation programme was launched for retailers, manufacturers, and OOH sector to reduce the amount of sugar, salt and calories in commonly consumed foods.</p> <p>The devolved nations adopted this: Scotland has Reformulation for health, Northern Ireland has Making Food Better Programme, Wales adopted the Healthy Weight: Healthy Wales, a whole-systems approach to promote healthy weight, which included reformulation of foods, reducing consumption of HFSS foods, alongside promoting healthier environments <i>Status: voluntary.</i></p>

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Table 1.2 Summary of food environment related policies in the UK by food environment domain (*cont.*)

Policy Area and Name	Policy brief and status
Food Environment Domain – Multiple domains	
<p>Mandatory standards for food available in schools including restrictions on unhealthy food</p> <ul style="list-style-type: none"> • School Food Standards, England • Nutritional Requirements for Food and Drink in Schools (Scotland) Regulations 2020 • Healthy Eating in Schools (Nutritional Standards and Requirements) (Wales) • Food in Schools' policy (Northern Ireland) 	<p>School Food Standards set mandatory requirements to ensure all food provided in schools is nutritious, high quality, supports nutritionally vulnerable pupils, and promotes healthy eating habits. These regulations are applicable to all school meals, vending machines and after-school clubs. This is implemented via School Food Regulations 2014. <i>Status: mandatory. Domains: availability and product characteristics (quality).</i></p> <p>The Nutrition Requirements for food and drink in schools (Scotland) Regulations focuses on increased intake of fruits & vegetables, reduction in sugar, bringing red & red processed meats in adherence with Scottish dietary goals, alongside changing the way secondary school aged pupils are offered food. <i>Status: mandatory. Domains: availability and product characteristics (quality).</i></p> <p>The Healthy Eating in Schools (Nutritional Standards and Requirements) Wales, outlines the types of food and drink that are permitted and prohibited during the school day, as well as the nutrient requirements for school lunches. These regulations must be adhered to by local authorities, governing bodies, or anyone involved in providing food and drink in schools in Wales. <i>Status: mandatory. Domains: availability and product characteristics (quality).</i></p> <p>The Food in Schools Policy in Northern Ireland covers all food provided and consumed in schools along with emphasising healthy eating, lifestyle knowledge and skills. This policy is overseen jointly by the Department of Education and the Department of Health. Along with mandatory components, the policy also contains strongly recommended practices, with schools retaining discretion to adapt these in consultation with pupils, parents, and the community. <i>Status: mandatory. Domains: availability and product characteristics (quality).</i></p>

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Table 1.2 Summary of food environment related policies in the UK by food environment domain (*cont.*)

Policy Area and Name	Policy brief and status
Food Environment Domain – Multiple domains	
<p>Standards in other specific locations (e.g. health facilities)</p> <ul style="list-style-type: none"> National Standards for Healthcare Food and Drink (England) 	<p>National Standards for Healthcare Food and Drink, England. These standards ensure the availability, quality, sustainability of the food and drink available for patients, staff and visitors. <i>Status: voluntary.</i></p> <p><i>Domains: availability and product characteristics (quality).</i></p>
<p>Standards in other specific locations (e.g. health facilities)</p> <ul style="list-style-type: none"> Standards and guidelines for hospital vending machines (Wales and Scotland) 	<p>Vending machines dispensing crisps, chocolate and sugary drinks are prohibited in National Health Service hospitals in Wales. The Welsh government has liaised with major vending providers to identify ways to introduce healthier food and drink options*.</p> <p>The Scottish government issued guidance to chief executives of the NHS on provision of competitively priced fruit and vegetables in hospital settings; removal of all soft drinks with sugar content from vending machines (exemption of unsweetened fruit and vegetable juices); 70% of drinks to comply with the sugar limit of 0.5g per 100ml; vending machines must contain prominently positioned water, unsweetened fruit juice and/or low-fat milk. Further, at least 30% of snacks and 70% of refrigerated food in hospital vending machines must meet the specified criteria with permissible content of fat, saturated fat, sugar and salt/sodium. Further, the Healthcare Retail Standard is a mandatory criterion applied to retail outlets in healthcare settings across Scotland, restricting the promotion of less healthy options and requiring that at least 50% of products offered are healthy. <i>Status: Voluntary. Domains: availability and product characteristics (quality)</i></p>

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Table 1.2 Summary of food environment related policies in the UK by food environment domain (*cont.*)

Policy Area and Name	Policy brief and status
Food Environment Domain – Multiple domains	
Standards in other specific locations (e.g. health facilities) <ul style="list-style-type: none"> <li>• Nutritional Standards for catering in health and social care (HSC) (Northern Ireland) 	Nutritional Standards for Catering in HSC, Northern Ireland: These standards apply to all facilities serving food or beverages to staff and visitors within HSC settings, including catering outlets, privately owned retail units, and vending machines. Unlike in England, the standards do not apply to patient meals. The vending guidelines include recommendations for snacks and confectionery items and require that all beverages offered are sugar-free. Additional measures such as free availability of tap water, absence of salt or sugar on tables, and the removal of all confectionery from till areas. <i>Status: Voluntary. Domains: availability and product characteristics (quality)</i>

* (Health Promoting Hospital Vending Directions and Guide 2008)

For overall improvements in food environments, along with targeted regulations, there is growing acknowledgment of the need for policy coherence. Aligning mutually reinforcing policies across sectors such as agriculture, health and environment is key for food system transformation. GAIN, in collaboration with AKADEMIYA2063, created The Food Systems Policy Coherence Diagnostic Tool, which offers a practical way to assess food systems policy coherence (69). Along with many other countries, results on policy coherence from the UK have been published. Module 1 of the tool focuses on government structures and mechanisms to support coherence and covers five domains: Framework Documents; Political Commitment; Capacity and Implementation; Coordination Structures; Inclusivity, Stakeholder Engagement and Voice; and Monitoring and Accountability (69).

Scotland scored high on Political Commitment, Inclusivity, Stakeholder Engagement and Voice, and moderately on the other three domains (70). The high scoring on these domains was based on the developing framework for integrated food policy, centred on the Good Food Nation (Scotland) Act 2022, as well as the strong public consultation processes. The tool further recommends that details on prioritisation of objectives in the plan and weighted in decision-making from stakeholders would strengthen coherence. The least performing domain in Scotland was

monitoring and accountability. The current regulatory and business impact assessments need a food-systems perspective and specific performance indicators linked to the Good Food Nation objectives. These could be achieved through strengthening evaluation mechanisms, developing key performance indicators, and embedding transparent monitoring and review cycles to ensure sustained policy coherence and accountability across the food system (70).

1.5 Thesis aims and objectives

There is currently significant momentum to improve the healthfulness of food environments in the UK. This thesis (**Figure 1.3**) first aimed to systematically review the literature to understand gaps in the existing literature on food environments in the UK (**Chapter 2**). I identified 31,457 articles and reviewed 3,418 studies published in the past 25 years on the UK food environment. Based on gaps identified in the systematic review, the following three aims were developed.

Aim 1 - Chapter 3. To develop a conceptual model and metric for measuring convenience in food environments

In this chapter, I employ a combination of review and qualitative interviews with food environment experts to build a conceptual model and metric for measuring convenience in food environments. This fills a gap identified in my systematic review (**Chapter 2**) wherein of the six domains of the food environment, convenience had no identified studies.

Aim 2 - Chapter 4. To characterise the food environment across Scotland and explore how the food environment varies by neighbourhood deprivation

My systematic review also found that only 27 studies had been published on the food environment in Scotland, of which 12 were from Glasgow (Scotland's largest city). To address this gap, I used an open-access government data source on registered food businesses (Food Standards Agency, FSA, 2024). The original objective was to identify food deserts and food swamps across Scotland. However, an assessment of existing definitions alongside consultations with a third-sector organisation working on food systems transformation in Scotland, Nourish Scotland², indicated that the available data is insufficient to classify areas as either food deserts or food swamps. I therefore changed my objective to be

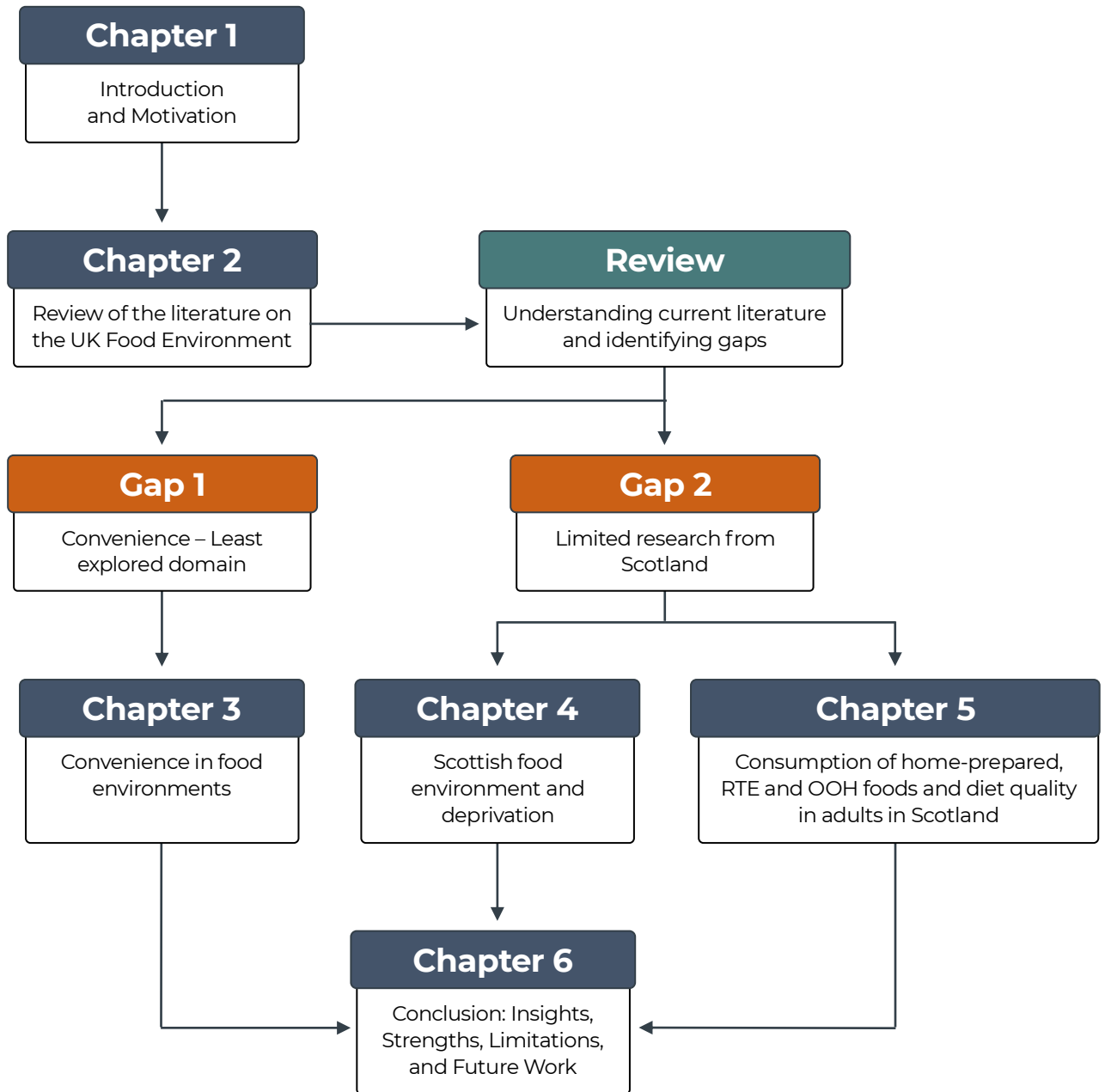
² <https://www.nourishscotland.org/>

broader, describing the distribution of different types of outlets across local authorities and in relation to deprivation.

Aim 3 - Chapter 5. To understand whether greater consumption of home-prepared foods and higher intake of ready-to-eat (RTE) or out-of-home (OOH) foods is linked to poorer adherence to the Scottish Dietary Goals

This chapter brought together ideas from **Chapter 3** on the importance of convenience and **Chapter 4** on the high density of OOH food outlets in Scotland. The aims were developed through informal discussions with Food Standards Scotland (FSS). Using the latest nationally representative dietary intake data from adults (16+ years) living in Scotland (Scottish Health Survey, SHeS, 2021), I analysed the association between the consumption of home-prepared foods, RTE foods, and OOH foods and adherence to the Scottish Dietary Goals as an indicator of overall diet quality.

Figure 1.3 Structure of the thesis



1.6 Products of this PhD research

As a result of my PhD research, I have submitted findings to peer-reviewed journals as well as disseminated results through presentations at domestic and international conferences.

Chapter 2 is now published as: Deksha Kapoor, Kirsteen Shields, Christian Reynolds, Martín Del Valle Menendez, Lindsay M. Jaacks. The UK food environment: a systematic review of domains, methodologies and outcomes. *Current Developments in Nutrition*, 2025.³

Chapter 4 is now published as: Deksha Kapoor, Joe Kennedy, Kirsteen Shields, Christian Reynolds, Tom Clemens, Lindsay M. Jaacks. Characterising the food environment in Scotland and its association with deprivation: A national study. *Preventive Medicine Reports, Volume 59*, 2025⁴ and is also being used on a dashboard for local authorities and health boards to assist them in developing their Good Food Nation Plans.

Chapter 5 is currently under preparation to be submitted to the British Journal of Nutrition: Deksha Kapoor, Ricki Runions, Kirsteen Shields, Christian Reynolds, Lindsay M. Jaacks. Consumption of home-prepared, ready-to-eat and out-of-home foods and its association with diet quality in adults living in Scotland.

I presented this work at the following conferences:

- World Public Health Nutrition Congress, 2024, London. The UK food environment: a systematic review of domains, methodologies and outcomes. Poster Presentation
- World Public Health Nutrition Congress, 2024, London. A conceptual framework for measuring convenience in food environments. Oral Presentation
- International Conference on Diet and Activity Methods, 2025, Toronto. Using public data to describe Scotland's food environment. Poster Presentation. (Finalist for the Poster Presentation Award)
- GAAFS symposium 2025: The Future of Livestock in Global Food Systems, Edinburgh. Characterising the food environment in Scotland and its association with deprivation: a national study. Poster Presentation

³ <https://doi.org/10.1016/j.cdnut.2025.107573>

⁴ <https://doi.org/10.1016/j.pmedr.2025.103254>

Chapter 2

The UK food environment

Background

Improving the healthfulness and sustainability of diets is a key public health priority in the UK, with increasing policy attention directed towards the role of food environments in shaping dietary behaviours. Food environments encompass multiple domains, such as availability, affordability, promotion, product characteristics/quality, convenience, and sustainability that interact to influence food choices. Despite this growing recognition, the extent to which these domains have been studied within the UK context remains unclear.

This chapter addresses this gap by systematically reviewing the literature on food environments in the UK over the past 25 years. While previous reviews have examined specific aspects of food environments, such as retail availability or neighbourhood food access, there has been no comprehensive synthesis that considers the full range of food environment domains and the methodologies used to assess them. To address these limitations, this review was designed to answer two key research questions: (1) which domains of the food environment have been assessed in the UK, and using what methodological approaches; and (2) what types of outcomes, descriptive, dietary, and health have been examined in relation to food environments.

In doing so, the chapter provides a critical overview of the current evidence base and identifies key gaps that limit understanding of how food environments. This chapter forms the foundation for the empirical work presented in the remainder of the thesis.

It is important to note that the initial aim of the review was to focus specifically on Scotland, but preliminary searches revealed a limited number of studies. Hence, the scope was expanded to include the entire United Kingdom, which resulted in a large volume of literature. To address this, the review was restricted to quantitative studies, although qualitative research was also identified.

This Chapter is now published as:

Deksha Kapoor, Kirsteen Shields, Christian Reynolds, Martín Del Valle Menendez, Lindsay M. Jaacks (2025), Review: The UK food environment: a systematic review of domains, methodologies and outcomes. *Current Developments in Nutrition* (<https://doi.org/10.1016/j.cdnut.2025.107573>)

Author	Contributions
Deksha Kapoor	<ul style="list-style-type: none">• Conception of the research question• Developed the extraction template• Screened and extracted data• Collated and analysed data• Wrote the manuscript and subsequent drafts• Submitted the final manuscript
Kirsteen Shields	<ul style="list-style-type: none">• Provided comments on the first draft of the manuscript, particularly on discussion regarding food banks and charities
Christian Reynolds	<ul style="list-style-type: none">• Provided comments on multiple drafts of the manuscript, particularly on geographic variation and results on sustainability
Martín Del Valle Menendez	<ul style="list-style-type: none">• Screened and extracted data• Provided comments on the last draft of the manuscript
Lindsay M. Jaacks	<ul style="list-style-type: none">• Contributed to the study conception, design and methodology• Provided comments on multiple drafts of the manuscript

2. The UK food environment: a systematic review of domains, methodologies and outcomes

2.1 Abstract

Understanding food environments is crucial for developing policies and interventions to enhance the healthfulness and sustainability of UK diets. We systematically reviewed published scientific research to answer two research questions.

First, what types and domains of the food environment have been assessed in the UK using what methodologies? Domains included availability, affordability, promotion, product characteristics/quality, convenience, and sustainability. Second, what outcomes have been assessed in relation to food environments? Outcomes were classified as descriptive (describing the food environment), dietary intake, and health.

Articles published between January 2000 and December 2024 were identified by searching seven databases: CAB Abstracts, CINAHL, EMBASE, Global Health, PubMed, Scopus, and Web of Science. A total of 31,457 articles were identified, 3,418 full texts were reviewed, and 286 articles were included. Another 26 articles were included after screening the references of articles identified in the database search. Thus, data were extracted from a total of 312 articles.

The most common domain studied was availability ($n = 100, 32\%$), followed by product characteristics/quality ($n = 94, 30\%$) and promotion ($n = 33, 10\%$). There was a paucity of research on the domains of sustainability ($n = 19, 6\%$) and affordability ($n = 16, 5\%$), with no articles on the domain of convenience. Only 49 articles (16%) evaluated more than one domain. Most articles were descriptive ($n = 206, 66\%$); 64 (20%) evaluated the association of the food environment with dietary intake and 42 (13%) evaluated the association with health, nearly all with obesity. The current literature on the food environment in the UK focusses largely on availability in the food retail space. More research is needed to understand how different domains of the food environment interact to influence dietary intake and health.

2.2 Introduction

Obesity has surpassed smoking as the leading contributor to death since 2014 in the UK (71). The prevalence of obesity across the UK is high, with 32% of adults in Scotland having obesity (14), and 22% and 26% of adults in Wales (72) and England (73), respectively. By 2035, the prevalence of obesity in adults is predicted to increase by 5 percentage points in Scotland, 8 percentage points in England and 11 percentage points in Wales (74). Similarly worrying trends have been observed in children. From 2019-20 to 2020-21, the prevalence of obesity in children 4-5 years old increased from 9.9% to 14.4% and in children 10-11 years old, it increased from 21.0% to 25.5% (75). Unhealthy diets underlie these worrying trends in obesity. The latest National Diet and Nutrition Survey (2023) found that consumption of fruits and vegetables is well below the 5-A-Day recommendation and mean intake of free sugars exceeds the maximum recommendation in all age groups (76).

While many continue to place the onus of change on individuals, it is increasingly recognised that food environments that encourage the consumption of unhealthy foods are critical drivers of food choice (77). The food environment is the interface between people and the wider food system. It encompasses all places where people access food, including retailers, restaurants, pubs/bars, cafés/coffee shops, takeaways, mobile food vans, schools, universities, workplaces, and charities as well as deliveries from these places (36). The UK food environment has mirrored trends in unhealthy diets and obesity, with most evidence derived from the built environment. From 1980 to 2000, a study in North East England found a 79% increase in the total number of food outlets with a particularly marked increase in 'foods for consumption away from home' outlets, which increased by 259% compared to a 16% increase in 'household shopping' outlets (78). Similar increases in availability of takeaways and grocers/convenience stores were reported around secondary schools in East London from 2001 to 2005 (79). In 2022, there were an estimated 42,341 fast food outlets across the UK (80).

Today, particularly following the Covid-19 pandemic, the way in which people in the UK procure food has diversified, with an increasing number of people ordering food online and using delivery services (e.g., Just Eat, Deliveroo, Uber Eats) (81). According to the Food Standards Agency's "Food and You 2" survey of 5,812 UK participants, conducted between April and July 2024, 75% of respondents reported shopping at large supermarkets while 19% said they used delivery apps such as Just Eat, Deliveroo, or Uber Eats at least once a week (82). When asked about their preferences for

ordering food or drinks online, 60% of respondents reported that they preferred to order from the websites of a restaurant, takeaway or café.

To date, there has not been a comprehensive review of the literature on UK food environments. Previous, multi-country or US-specific reviews do exist, however, and have focussed on the retail food environment (83-85) or specific population subgroups, such as school children (86-88), or specific health outcomes, such as obesity (89-91). There is also some recent interest in understanding the digital food environment given the widespread use of grocery and food delivery services in the UK, but this remains a largely unexplored area of research (92, 93). The aim of this systematic review was to identify and narratively summarise recent evidence regarding the UK food environment and to identify research gaps. The first research question was “what types and domains of food environments have been assessed using which methodologies?” The second was “which outcomes have been assessed in relation to food environments, including descriptive (describing the food environment), dietary intake, and health”. Further, “how these outcomes have been stratified by area deprivation, education, gender, income, ethnicity, and age”. For all research questions, we explored how the number of articles differed by geography (e.g., UK-wide versus England, Scotland, Wales or Northern Ireland).

This systematic review provides an evidence-based understanding of food environment research in the UK, identifying geographical disparities and research gaps, and highlighting a need for bridging various food environment domains to foster cohesive changes and ultimately create healthier and more sustainable food systems.

2.3 Methods

The protocol was registered with PROSPERO⁵ on 8 February 2022. As this was not deemed human subjects’ research, it was exempt from institutional ethics committee review.

2.3.1 Framework and definitions

The review was grounded in the Downs et al. 2020 framework wherein six domains of food environments are defined, including availability, affordability, promotion, product characteristics/quality, convenience, and sustainability (**Table 2.1**) (37). Whilst this framework proposes three types

⁵ ID: CRD42022306066

of food environments – built, cultivated, and natural – in the context of the UK, the built food environment is predominant (37).

Table 2.1 Six domains of food environments as proposed by Downs et al.

Domain	Definition
Availability	The presence of a particular food item in a specific physical space or range
Affordability	The cost of food items in comparison to other foods or to income benchmarks (e.g., % of median income or % of poverty line)
Promotion	Factors that impact on the attractiveness of foods like packaging, labelling (including traffic light labelling) and placement in the store
Product characteristics (Quality)	Features such as food packaging, nutrient and microbial content of foods, processing of foods and freshness of foods
Convenience	Time spent procuring, cooking and consuming foods
Sustainability	The environmental and social impact of food consumption

2.3.2 Search strategy

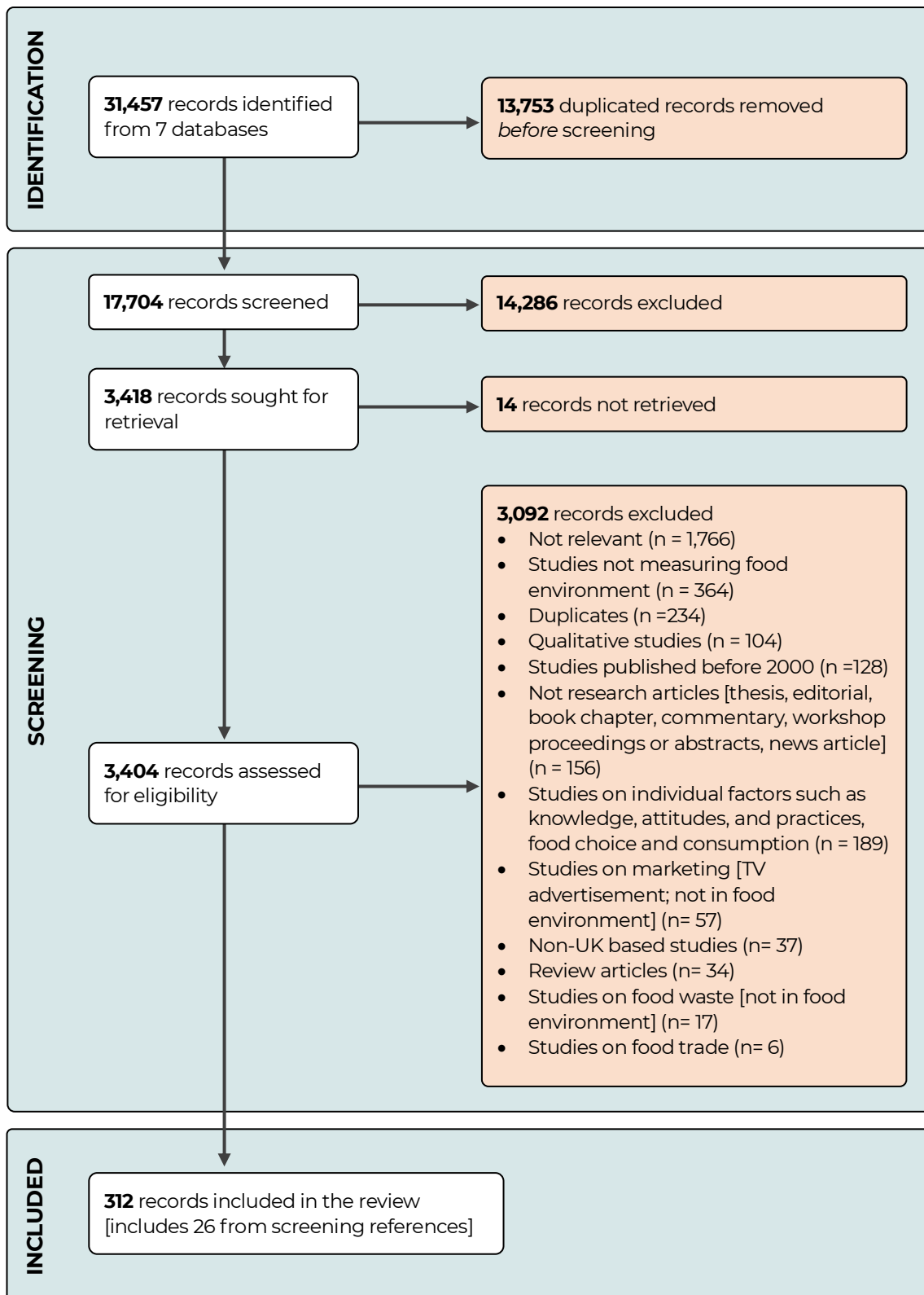
The search strategy was developed by reviewing protocols on the food environment published in PROSPERO. Seven electronic databases were searched from the year 2000 through December 2024: CAB Abstracts, CINAHL, EMBASE, Global Health, PubMed, Scopus, and Web of Science. Searches included key words for domains of the food environment (e.g., “food access*” “supermarket” etc.) AND key words for the geographic area of interest (e.g., “United Kingdom” “UK” etc.). The search terms and results for each database are given in **Table S1**. Searches were duplicated by a second reviewer to check for accuracy. Additional articles were identified after reviewing the references of articles meeting inclusion criteria.

2.3.3 Study selection

The eligibility criteria were as follows: research articles that measured at least one domain of the food environment (availability, affordability, promotion, product characteristics/quality, convenience, or sustainability); conducted in the UK (England, Wales, Scotland, or Northern Ireland); original research using quantitative or mixed methods with no restrictions

on study design; and published from 2000 to December 2024 in English. Only studies published since 2000 were included to better inform local decision-making (policymakers prioritise recent evidence) and subsequent research to address gaps in our understanding of UK food environments. The exclusion criteria were articles on food choices, personal factors such as taste, cultural preferences, knowledge about food, dietary intakes or behaviours without measuring food environments; qualitative articles; articles published in a language other than English; narrative reviews, systematic reviews, opinions, editorials, commentaries, or letters not reporting original research; and articles conducted outside the UK. If the research was conducted outside the UK but measured food environments in the UK, it was included. Articles on the home food environment were excluded. These included articles on marketing such as the impact of TV advertising or time spent on TV viewing in the home/personal food environment. This review only included articles on advertising in the built food environment – i.e., in-store promotions, packaging of foods, etc. Search results were imported into Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia) for screening. The search yielded 31,457 articles, of which 13,753 were duplicates (**Figure 2.1**). DK and MVD independently screened titles and abstracts for eligibility, resulting in the exclusion of 14,286 records. Any discrepancies were resolved through discussion with LMJ. Interrater reliability was assessed using percent agreement (94.2%) and Cohen's kappa ($\kappa=0.83$), indicating substantial agreement between reviewers. Full texts of 3,418 articles were sought for retrieval, of which full text of 14 articles was not available. The full texts of 3,404 articles were then reviewed by DK and MVD. Of these, 3,092 were excluded and 286 were included. Another 26 were included after screening the references of these 286 articles. Thus, the total number of articles included was 312.

Figure 2.1 PRISMA flow diagram for systematic review of food environments in the UK



2.3.4 Data extraction

Data from all eligible articles were extracted into an Excel database. The Excel database was developed by DK with input from LMJ and tested on a subset of included articles, making iterative revisions to the database as necessary. DK and MVD extracted data, with uncertainties discussed and resolved with LMJ. Data were extracted on:

- **Article characteristics.** This included the last name of the first author, year of publication, year of data collection, country study was conducted in (UK-wide, England, Wales, Scotland, or Northern Ireland), study design, sample population, sample size, and source of funding.
- **Type of food environment evaluated.** Lytle's (94) categorisation of the food environment was adapted to define seven types of built food environments:
 1. food store environment, including grocery stores, supermarkets, convenience stores, snack bars, specialty food stores, and farmers' markets;
 2. school food environment, including cafeterias, vending machines, and snack shops in day care settings, schools, colleges, and universities and the areas around them;
 3. worksite food environment, including cafeterias, vending machines, and snack shops in worksites;
 4. neighbourhood food environment, including all places to procure food within a physical region outside residential address;
 5. macro food environment, including national and regional food supply;
 6. public facility food environment, including cafeterias, vending machines, and snack shops in recreation centres, health care facilities, and other public venues, and;
 7. restaurant food environment.
- **Domains of food environment evaluated.** This included availability, affordability, promotion, product characteristics/quality, convenience, and sustainability (**Table 2.1**) (37). For the purposes of this systematic review, articles on food choices, personal factors such as taste,

cultural preferences and knowledge about food were not considered part of the food environment.

- **Methodology used to assess the domains of the food environment.** Any methodology was considered acceptable, including but not limited to instruments such as checklists, interviews or questionnaires; geographic analysis; sales data, nutrient and menu analysis. Lytle (94) methodologies and instruments were adapted to define 12 types of methodologies, detailed in **Table 2.2**. For intervention studies conducted in the food environments, details on type of intervention were extracted.
- **Outcome assessment.** This included information on the type of outcome (descriptive, diet, or health), outcome assessment method, and any stratification by area deprivation, education, gender, income, ethnicity and age.

Details on variables extracted from observational and intervention studies are listed in **Table S2**. This systematic review assessed attributes such as the number of articles measuring the food environment across geographies (i.e., Wales, England, Scotland, Northern Ireland and UK wide); the number of articles assessing the type of measure (e.g., geographical analysis, menu analysis, nutrient fact panel analysis, etc.); and the environment in which the measurement tool was used (e.g., food store, restaurant, school, etc.). No formal risk of bias assessment was done. Details for all included articles in the systematic review (n = 312) are listed in **Table S3**.

Table 2.2 Definitions of methodologies to measure the food environment

Name	Definition and example
Geographic analysis	<p>Analysis of data collected for a specific geographic area. This includes, for example, counts of the number of food stores or restaurants; and distance to the nearest food stores or restaurants.</p> <p>Example: <i>number of fast-food restaurants and convenience stores around home and school neighbourhoods for 3,089 adolescents (95).</i></p>
Menu analysis	<p>Collects standardised information from menus.</p> <p>Example: <i>energy and nutritional content of menu items from 100 restaurants in the UK (96).</i></p>
Market basket survey	<p>Collects standardised information (on food characteristics, price, product placement, availability or including pictures of products) for a pre-defined list of foods via direct observation of the food environment or online. These foods may be based on foods frequently consumed by the population or foods of public health concern. Typically used in food store environments.</p> <p>Example: <i>using a healthy food basket to determine availability and pricing of key items from shops in two localities (97).</i></p>
Sales/ purchase analysis	<p>Use data from sales, cashier receipts, and annotated receipts to assess food purchasing patterns.</p> <p>Example: <i>an experimental study to examine the effect on vegetarian sales by increasing the proportion of vegetarian options available in university cafeterias (98).</i></p>
Nutrient fact panel analysis	<p>The nutrient content of foods available in a food environment is analysed using existing information provided on the product itself (e.g., nutrient fact panel or claims on labelling) or using a nutrient database.</p> <p>Example: <i>comparison of the Nutrition Information Panel content, serving size and package size of children's ready-to-eat breakfast cereals in 5 countries (99).</i></p>

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Table 2.2 Definitions of methodologies to measure the food environment (cont.)

Name	Definition and example
Nutrient analysis	<p>Food samples are collected from a food outlet and analysed in a laboratory for specific nutrients.</p> <p>Example: <i>trans fatty acid content of 62 processed food (pizza, garlic bread, breakfast cereals, quiche, fat spreads, fish and meat products, chips, savoury snacks, confectionery and ice cream) purchased from supermarkets, independent retailers and takeaway outlets (100).</i></p>
Contaminant analysis	<p>Food samples are collected from a food outlet and analysed in a laboratory for contaminants such as pesticides or pathogens.</p> <p>Example: <i>assessment of the microbiological safety of salad vegetables and sauces from kebab takeaway restaurants in the UK (101).</i></p>
Physical measurements	<p>Data collected via physical measurements of stores such as aisle length, shelf length, and placement.</p> <p>Example: <i>association of supermarket size (measured as total aisle length) and national obesity prevalence in England (102).</i></p>
Ecological footprint analysis	<p>Life cycle assessments determine the environmental impact of foods available in food environments.</p> <p>Example: <i>environmental Impact Score of sandwiches and beverages available in 18 university-owned food outlets (103).</i></p>
Policy analysis	<p>Articles analysing policies or recommendations that impact on the domains of food environments such as taxes or food labelling requirements.</p> <p>Example: <i>banning the promotion of foods high in fat, sugar and salt in Scotland has the potential to reduce the number of calories, sugar, saturated fats and sodium for most food groups (104).</i></p>

Continues next page >>

Table 2.2 Definitions of methodologies to measure the food environment (cont.)

Name	Definition and example
Food supply analysis	Uses national level data such as food prices, food availability, or food consumption. <i>Example: modelling study to shift current diets to diets that meet dietary recommendations for health, have lower greenhouse gas emissions and are affordable for different income groups (105).</i>

2.4 Results

Key characteristics of articles included in the systematic review are presented in **Table 2.3**. Most articles were from England [n = 120, 38% (63, 64, 78, 79, 89, 92, 95, 97, 98, 103, 106-215)], followed by UK wide articles [n = 87, 28%], Scotland [n = 27, 9% (104, 216-241)], Northern Ireland [n = 9, 3% (242-250)], and Wales [n = 10, 3% (251-260)]. There were 7 articles from Great Britain (261-267) and 21 (6%) multi-country studies (99, 102, 268-286).

We further categorised the number of articles at the regional level in each country, showing clear preferences and paucity of food environment research in some areas (**Figure 2.2**). In England, most articles were from London (n = 27, 26%) and Yorkshire and Humber (n = 18, 15%); in Scotland they were from Glasgow (n = 12, 43%) and in Wales from Cardiff (n = 6, 67%). Within each region, details of urban or rural areas were not provided. Only 19 articles evaluated urban/rural differences (119, 122, 127, 150, 165, 170, 180, 198, 203, 210, 227, 229, 234, 238, 239, 242, 246, 250, 262). After the search and analysis of articles had been conducted, one article retraction was published (287).

Over the past decade, research on food environments has expanded significantly, with 58% of articles (n = 184) published after 2015 and 26% (n = 81) after 2020. However, only 5% [n = 16, (92, 162, 165, 169, 185, 268, 282, 288-296)] of these articles noted data collection occurring post-2020. Most articles (n = 184, 59%) did not focus on any population group such as children or the elderly but on measuring food environment features.

Table 2.3 Key characteristics of articles included in the systematic review of the UK food environment

Characteristic	n (%)
Geography	
UK-wide	87 (28)
England	120 (38)
Scotland	27 (9)
Northern Ireland	9 (3)
Wales	10 (3)
Great Britain	7 (2)
Coastal waters of UK	1 (1)
Scotland and England	3 (1)
Multi-country	21 (7)
Not able to assign	27 (8)
Location	
Not specified	262 (84)
Both rural and urban	18 (6)
Only urban	32 (10)
Year of publication	
2000-2005	23 (7)
2006-2010	30 (10)
2011-2015	75 (24)
2016-2020	103 (33)
Beyond 2020	81 (26)
Year of data collection	
Not reported	76 (24)
≤2000	12 (4)
2001-2005	18 (6)
2006-2010	47 (15)
2011-2015	55 (18)
2016-2020	88 (28)
Beyond 2020	16 (5)

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Table 2.3 Key characteristics of articles included in the systematic review of the UK food environment (*cont.*)

Characteristic	n (%) or range
Population	
Infant	7 (2)
Children	35 (11)
Adolescents	26 (9)
Adults	57 (18)
Elderly	3 (1)
N/A	184 (59)
Study design	
Cross-sectional	242 (78)
Longitudinal	31 (10)
Case study	10 (3)
Modelling	6 (2)
Randomised controlled trial	6 (2)
Intervention	17 (5)
Sample size	
People	115 to 42,838
Store	3 to 8,864
Food samples or products	101 to 68,153
Meals	8 to 2,255,404
Areas	3 to 6,781

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Table 2.3 Key characteristics of articles included in the systematic review of the UK food environment (*cont.*)

Characteristic	n (%)
Type of food(s) evaluated	
Unhealthy foods (fast foods, sweets, cakes, pastries, etc.)	26 (9)
Healthy foods (salads, whole grain cereals, dried fruits, nuts etc.)	11 (4)
Mix of healthy and unhealthy foods (salads and confectionary)	31 (10)
Fruits and vegetables	18 (6)
Meat and seafood	17 (5)
Milk and milk products	13 (4)
Beverages (including alcoholic beverages)	9 (3)
Bread	5 (2)
Baby / infant food	3 (1)
Articles on multiple food groups	9 (3)
Ready-to-eat	34 (11)
Special foods- e.g., low protein, gluten free, meat alternatives	7 (2)
Meals (meals served at schools, restaurants, workplaces, etc.)	32 (10)
Food outlets	97 (31)
Source of Funding	
Government	161 (52)
Charitable NGOs, Foundations, or Professional societies	33 (10)
Intergovernmental bodies	9 (3)
Private charities	5 (2)
Joint funding (Government and Industry)	1 (0)
Joint funding (Government and Private charity)	1 (0)
Not mentioned	63 (20)
None received	39 (13)

Most articles were cross-sectional ($n = 242$, 78%), followed by longitudinal analysis [$n = 31$, 10% (68, 78, 79, 118, 122, 138, 147, 149, 152, 162, 165, 174, 210, 231, 257, 276, 288, 292, 293, 297-308)], intervention studies [$n = 17$, 5% (63, 98, 120, 139, 140, 161, 188, 189, 195, 232, 243, 277, 294, 309-312)], case studies [$n = 10$, 3%

(108, 144, 225, 252-254, 256, 313, 314)] and 2% each (n = 6) were randomised controlled trials (185, 186, 199, 200, 202, 289) and modelling studies (134, 205, 266, 315-317).

Since this review focussed on multiple domains of the food environment, the sample size ranged from 115 to 42,838 people; 3 to 8,864 stores; 101 to 68,153 food samples or products; 8 to 2,255,404 meals, and 3 to 6,781 areas.

Figure 2.2 Geographic distribution of number of articles by country in a systematic review of the UK food environment



On tabulation of articles based on type of food studied, 31% (n = 97) of the articles focussed on type of food outlets instead of focusing on any particular food or food group (64, 78, 79, 96, 102, 108-110, 113, 115-119, 122-124, 126-129, 132, 134, 136, 137, 142-144, 147-154, 157, 162-167, 169, 170, 174-176, 180-182, 191, 192, 194, 195, 198, 203, 213-215, 217, 220-223, 227, 229, 234, 240, 248,

253-255, 261, 262, 265, 270, 279, 281, 282, 292, 297, 302, 314, 318-330). These were followed by articles on ready-to-eat foods [n = 34, 11% (99, 140, 158, 177, 183, 187, 188, 207, 211, 230, 231, 241, 243, 256-258, 260, 263, 275, 280, 331-344)] and articles on meals served at schools, restaurants, or workplaces [n = 32, 10% (63, 98, 112, 120, 135, 139, 145, 146, 159, 160, 172, 185-187, 199-201, 204, 212, 232, 252, 274, 289, 293, 345-352)].

Of 312 articles, 210 (67%) stated their source of funding. Among these, 161 articles (52%) that received government funding, 33 (10%) articles were funded by charitable NGOs, foundations, or professional societies, 9 (3%) articles were funded by intergovernmental bodies like World Health Organisation, and 5 articles (2%) received funding from private charities (149, 182, 188, 191, 353). One article noted joint funding from government and industry (255), while another stated joint funding from government and a private charity (286). A total of 63 articles (20%) did not mention their source of funding and 39 articles (12%) did not receive any funding.

2.4.1 Types of food environments

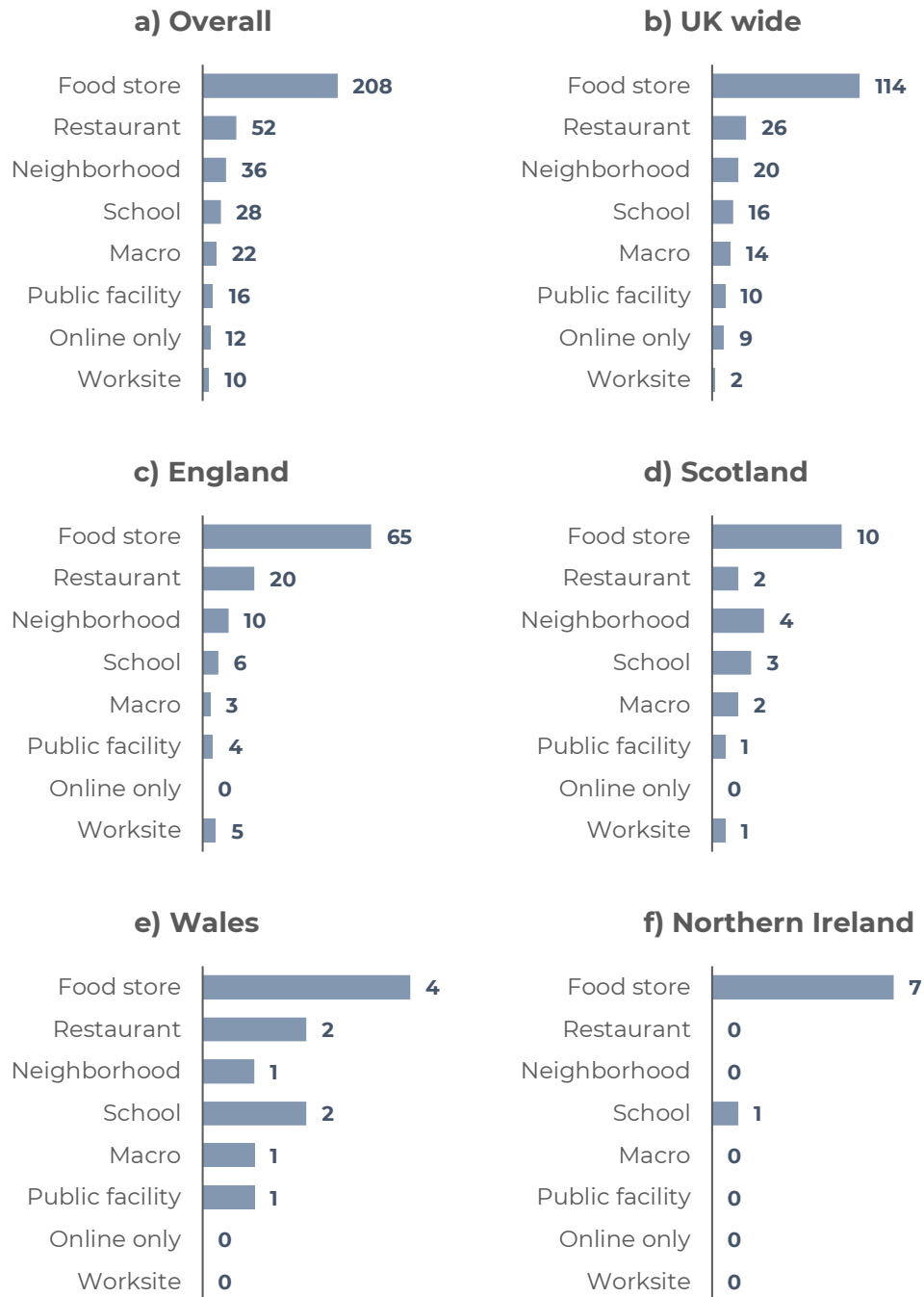
Articles on food store environments were the most common, as seen in **Figure 2.3** [n = 208, 67% (107, 112, 127, 133, 138, 148, 154-156, 181, 188, 205, 207, 213, 215, 216, 231, 233, 249, 261, 266, 270, 271, 278, 284, 287, 294, 295, 299, 300, 305, 308, 310, 312, 317-319, 324, 329, 341, 345, 354-360)]. These included articles on the nutrient content (106, 111, 130, 190, 196, 211, 212, 237, 263, 275, 276, 283, 285, 301, 304, 306, 331, 333, 334, 336-338, 342, 344, 352, 353, 361-371) and microbial content (168, 235, 239, 243-245, 247, 272, 273, 277, 372) of foods sold in UK food stores, availability of healthy foods (117, 136, 202, 218, 219, 228, 246, 253, 254, 298, 303, 310, 373) and access to food stores (104, 114, 115, 126, 134, 143, 180, 184, 209, 210, 214, 222, 224, 225, 242, 262, 265, 324, 374).

The next most prevalent food environment was restaurant food environments [n = 52, 16% (63, 68, 120, 128, 164, 167, 176, 197, 223, 282, 314, 321, 332, 375)] which included articles on nutrient content (96, 146, 159, 185, 191, 274, 281, 289, 292, 325, 327, 328, 330, 346, 348) or microbiological quality (101, 177, 347, 376-378) of meals served at fast food or full service restaurants.

Thirty-six articles evaluated different aspects of neighbourhood (78, 105, 108, 116, 125, 157, 169, 192, 193, 208, 320, 379) such as 20-minute neighbourhood (234) or out-of-home access in deprived neighbourhoods (132, 153, 161, 170, 174, 175, 198, 203, 220, 229, 238, 253, 264, 315, 322, 380). Articles assessing nutritional content of school meals (103, 145, 204, 252, 311, 381) or vending machines (183) at schools were categorised under school food environments [n = 28, 9% (64, 79, 95, 109, 144, 147, 150, 185, 194, 206, 217, 221, 248, 258, 279, 309, 350)]. Twelve articles assessed the online food

environment: eight UK-wide articles (93, 288, 290, 291, 296, 313, 382), three from England (121, 162, 165) and one multi-country study (269). There were 15 articles on hospitals and other public venues categorised as public facility food environment (135, 137, 140, 142, 158, 178, 179, 187, 195, 201, 240, 256, 259, 349, 383); 8 articles on worksite food environment (139, 160, 172, 185, 199, 200, 232, 293) and 19 articles on macro food environment assessing impact of food policies (119, 129, 230, 236, 280, 286, 302, 316, 323, 343, 356, 384-391).

Figure 2.3 Number of articles by type of food environment and country



Note: Categories are non-exclusive, i.e., articles that evaluated more than one type of food environment are counted more than once.

There were 22 (7%) articles that evaluated two types of food environments (110, 122, 124, 148, 251, 260, 335), of which 13 were on food store and restaurant food environment (123, 152, 153, 163, 179, 257, 326, 392). For example, articles evaluating microbial quality of food samples collected from food stores and fast-food restaurants (177, 393). There were no articles

on natural food environments (both wild and cultivated). All of the above were classified as the built food environment.

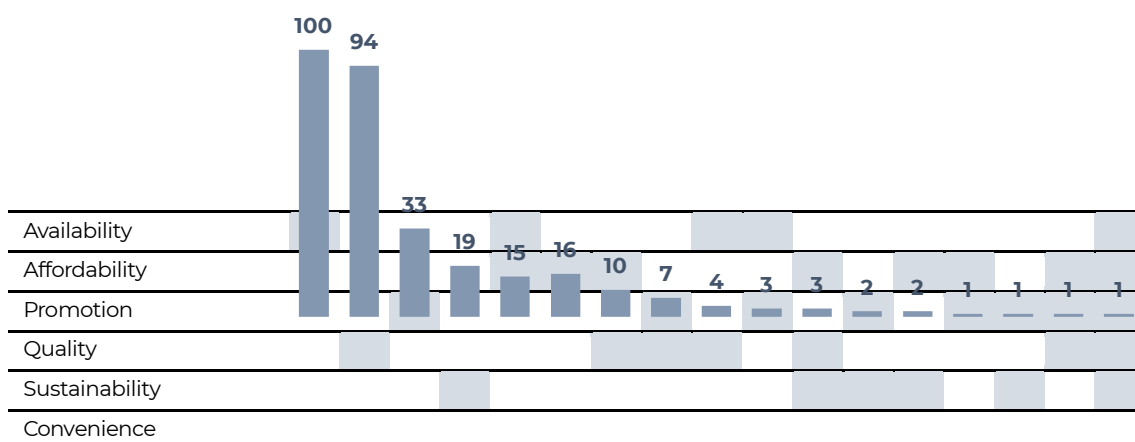
2.4.2 Domains and methodologies

Domains

The most common domain studied was availability [$n = 100$, 32% (64, 78, 79, 92, 95, 102, 108-110, 115, 116, 118, 119, 122-129, 132, 134, 137, 142-144, 147, 148, 150-154, 156-158, 161-167, 169, 170, 174-176, 180, 182, 185-187, 192, 194, 198, 203, 205, 206, 208-210, 214, 215, 217, 219-223, 225, 227, 234, 238, 246, 248, 253-255, 262, 264, 265, 279, 282, 297, 302, 310, 318, 320-324, 343, 373, 375, 380, 394)], followed closely by product characteristics/quality [$n = 94$, 30% (96, 99-101, 106, 111, 130, 133, 135, 146, 159, 160, 168, 172, 177-179, 181, 183, 193, 196, 201, 211, 216, 235, 239, 241, 243-245, 247, 249, 256-260, 263, 272-277, 281, 285, 288, 292, 301, 304, 306, 325, 327, 328, 330, 331, 333-338, 340-342, 344-350, 352, 353, 357, 361-368, 372, 377-379, 382, 393, 395-397)] and promotion [$n = 33$, 10% (93, 138, 141, 149, 156, 188, 197, 199, 200, 202, 213, 230, 231, 233, 240, 251, 261, 268, 270, 280, 284, 295, 296, 308-312, 317, 329, 339, 358, 398)] (**Figure 2.4**).

There was a paucity of research on the domains of sustainability [$n = 19$, 6% (98, 120, 145, 271, 293, 313-316, 319, 332, 351, 356, 384, 386, 387, 389, 399, 400)] and affordability [$n = 16$, 5% (68, 104, 114, 155, 184, 236, 250, 266, 278, 299, 300, 303, 305, 354, 374, 388)]. There were no articles on the domain of convenience. Under the domain availability, most articles focussed on assessing density or proximity of food outlets (118, 297). Others focussed on the type of foods available in food stores (161, 186, 195).

Figure 2.4 Number of articles by domain of food environment



Note: the coloured boxes represent the domains while the number on the bar represents the number of articles in the domains. The presence of multiple, coloured boxes signifies more than one domain.

These included fresh fruits and vegetables, and ready-to-eat and unhealthy foods (e.g., soft drinks, chips, confectionary, etc.).

Under the domain product characteristics/quality, most articles assessed nutrient content [e.g., fatty acids, trans fat, sodium, sugar, etc.] (211, 306, 340) or microbial pathogens in food store or restaurant food environments (101, 378).

Articles on marketing and nutritional claims on food packaging were covered under the promotion domain (268, 339, 398), while those on food prices were most common under the affordability domain (266, 385). Lastly, articles on the environmental impact of food were covered under sustainability (399).

There were 50 articles (16%) that evaluated more than one domain, most common were articles evaluating availability and affordability [n = 15, (97, 114, 117, 121, 131, 136, 173, 218, 228, 229, 232, 242, 253, 255, 326)], and articles assessing affordability and product characteristics/ quality [n = 10, (107, 113, 114, 212, 289, 291, 298, 355, 385, 390)]. One article evaluated all domains except convenience. It was an 11-country study to benchmark the implementation of recommended nutrition policies by national governments using the Healthy Food Environment Policy Index (286). The most studied domain in England, Scotland and Northern Ireland was availability, while in Wales and UK-wide articles it was quality. More details can be found in **Table S3**.

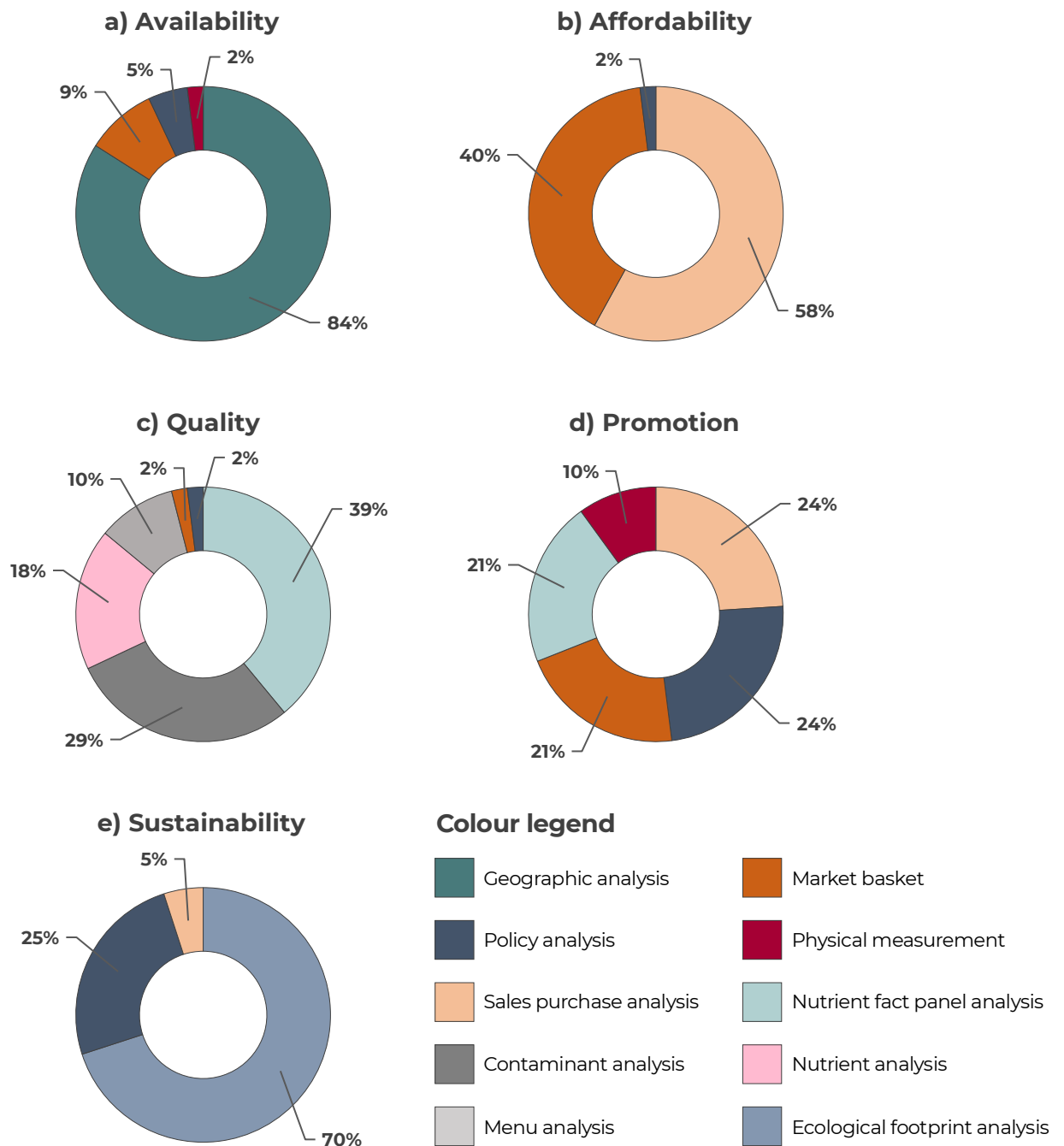
Methodologies

There was a clear preferred methodology to measure each domain (**Figure 2.5**). However, because several articles assessed multiple domains, the categories are not mutually exclusive and therefore have been counted more than once.

Geographic analysis was the most common methodology used to assess availability, applied in 84% (n = 108) of articles on availability (375). This was followed by market basket surveys (n = 10, 9%) (227) policy analysis (n = 5, 5%) (64) and physical measurements (n = 2, 2%) (102).

Assessing food purchase patterns using sales/cashier receipts (n = 23, 58%) (113), market basket surveys (n = 16, 40%) (114) and policy analysis (n = 1, 2%) (286) were the most used methodologies to assess the affordability domain.

Figure 2.5 Type of methodology under each domain of food environment



Note: categories are non-exclusive, i.e., articles that used more than one methodology are counted more than once.

To measure promotion, 7 (24%) articles used sales/ purchase analysis (141) and policy analysis (210) each, 6 articles (21%) used nutrient information available on the package called nutrient fact panel analysis (398) and market basket surveys (149) each, and 3 articles (10%) used physical measurements (240). Nutrient fact panel analysis (n = 44, 39%) (99),

contaminant analysis (n = 33, 29%) (395), articles on food samples tested in a laboratory, called nutrient analysis (n = 21, 18%) (160), menu analysis (n = 12, 10%) (96), market basket surveys (269) and policy analysis (n = 2, 2%) (350) each were methodologies to evaluate the domain on product characteristics/quality.

Lastly, to measure sustainability, ecological footprint analysis (n = 14, 70%), policy analysis (n = 5, 25%) (399) and sales/purchase analysis (n = 1, 5%) (293) were used. It is important to note that within ecological footprint analysis, multiple methodologies were used, such as life cycle analysis (351, 384), reduction in livestock product supply (316), and Water Footprint Impact Indicator estimated as scarcity weighted litres per portion and global hectares per annum (103). This highlights the multi-faceted nature of sustainability definitions and data sources.

2.4.3 Outcomes

Overall, most articles (n = 206, 66%) were descriptive and did not assess any associations between the food environment, 64 (20%) assessed associations with dietary intake (63, 79, 100, 110, 111, 126, 135, 146, 159-161, 173, 181, 183, 186, 190, 191, 193, 197, 199, 200, 204, 208, 211, 212, 217, 241, 281, 292, 298, 299, 301, 303, 304, 306, 310, 328, 330, 331, 333, 334, 336-342, 344, 345, 349, 352, 361-363, 365, 366, 368, 370, 379, 382, 390, 398), and 42 (13%) articles assessed associations with health (102, 116, 122, 124, 125, 127-129, 132, 142, 143, 147, 148, 150-152, 155-157, 169, 172, 176, 198, 205, 206, 209, 210, 214, 265, 266, 288, 297, 302, 315, 320, 322, 323, 343, 375, 380, 387) (**Table 2.4**).

Table 2.4 Outcomes stated in articles included in the systematic review

Country	Outcomes <i>n</i> (%)		
	None-descriptive	Diet	Health
UK wide	108 (54)	50 (79)	24 (58)
England	48 (23)	12 (18)	17 (40)
Scotland	26 (13)	2 (3)	0 (0)
Wales	9 (4)	0 (0)	0 (0)
Northern Ireland	9 (4)	0 (0)	0 (0)
Multiple countries within UK	6 (3)	0 (0)	1 (2)
Total	206	64	42

Of the articles assessing health associations, all focussed on obesity and the impact of food outlet proximity or density on body mass index, except four articles: one analysed links with type 2 diabetes (343), two focussed on cardiovascular disease and cancer (316, 322) and another with type 2 diabetes, cardiovascular disease and cancer (315). No country-wise differences were observed: descriptive articles were most common across all countries (**Table 2.4**).

Most of the articles with outcomes did not present stratified analyses (n = 233, 75%); 64 (20%) articles did stratified analysis by a single variable (64, 97, 104, 105, 109, 114, 115, 117, 121, 132, 136, 137, 143, 144, 149-153, 157, 161, 162, 164, 165, 167, 170, 174, 180, 188, 203, 209, 210, 214, 219, 221-223, 226-230, 233, 234, 237, 238, 242, 253-255, 261, 263, 264, 282, 300, 302, 310, 311, 318, 320, 321, 380, 384, 401) and 15 (5%) articles conducted stratified analysis using two or more variables (110, 119, 148, 156, 164, 175, 194, 198, 205, 206, 294, 322, 323, 356, 386) (**Table S4**). Area deprivation was the most common variable for stratification, for example, articles comparing food outlet density in the least and most deprived neighbourhoods (114, 162).

2.5 Discussion

A comprehensive understanding of the UK food environment requires interdisciplinary research involving public health experts, nutritionists, behavioural scientists, geographers, and complex systems scientists, among others. However, this systematic review found that most research to date has involved only one or a few aspects of the food environment. While more than 250 articles have been published on the UK food environment over the past two decades, most were on a single domain (availability) and in a single type of food environment, food store. Moreover, obesity was the only health outcome studied extensively. Given recent diversification of the way in which people in the UK procure food, with an increasing number of people ordering food and using delivery services (81), and the cost-of-living crisis, climate crisis, EU exit, and other disruptions to the UK food supply, more interdisciplinary work is needed to explore how interactions across multiple domains impact dietary intake and health.

Further, despite evidence that convenience is a key driver of food consumption behaviour in the UK (81) as well as the impact of food systems on climate change (402), this systematic review identified little research on these food environment domains: convenience and sustainability. According to the Food and Agriculture Organization, the processing, packaging, and transport of food have overtaken agriculture

as the largest contributor to food-related greenhouse gas emissions in many high-income countries (403). Similarly, evidence suggests that time spent on home food preparation is an indicator of healthy diets (404) and lack of time is a leading barrier to adopting dietary recommendations (405), yet there were no articles identified under the domain of convenience. Consumer interest in sustainability and convenience are megatrends of the fast-food sector in the UK, evident with nearly half of UK adults buying more locally sourced food and expecting food businesses to play a role in climate change (80). There is also a continued high demand for home food delivery post pandemic (80).

Only about one-fifth of articles identified in this review evaluated more than one domain of the food environment. Valuable insights have come from the few articles identified in this review that looked at multiple domains. For example, the Healthy Food Environment Policy Index, which aimed to assess the extent of implementation of recommended food environment policies by governments, provided a holistic view of the UK's food environment (286). It also identified priority actions to meet implementation gaps (286). Another article evaluating multiple domains identified in this review looked at what dietary changes are required to shift the UK population to diets that meet dietary recommendations for health, have lower greenhouse gas emissions, and are affordable for different income groups (105). To fully comprehend the impact of the food environment on human and planetary health, research is needed that evaluates multiple domains and how these domains interact with each other to influence food choice. For example, ready-to-eat foods are convenient, but are often less affordable, less healthy, come in plastic packaging, and require refrigeration, which impacts their sustainability (406).

With regards to the type of food environment studied, food store environments have been the most researched food environment type by far. More than half of the articles (67%) in this review were on the food store environment, followed by restaurants (16%), neighbourhood food environments (11%), and school food environments (9%). These findings differ slightly from Lytle's systematic review of articles measuring the food environment published between 2007 and 2015, which found that 73% of articles measured the food store environment, 50% measured restaurants, and 15% measured schools (percents do not add to 100 because some articles measured both) (94).

The emphasis on food store environments is appropriate given that 71% of expenditures on food and non-alcoholic drinks in the UK is at stores (with the remaining 29% of expenditures eaten out) (407). However, there is an

increasing need to evaluate the online food environments given the rise in takeaways and deliveries (408), supermarket home delivery, and other forms of home delivery (e.g., vegetable boxes, Hello Fresh and Amazon Fresh) (81). We found only seven articles (2%) that assessed the online food environment in this systematic review, focusing on either availability or labelling of food items in the retail food environment.

About 70% of articles identified in this review were descriptive with no association with dietary intake or health outcomes. Among the few articles that evaluated associations with health outcomes, all but four evaluated the association with obesity. The other four studied type 2 diabetes, cardiovascular disease, and cancer. This is expected as obesity is the leading risk factor for mortality in the UK (71), but other diet-related diseases such as type 2 diabetes, hypertension and heart disease should also be explored.

This systematic review is not without limitations. Firstly, we did not include search terms for food banks or charity shops, which are an increasingly important source of food during the cost-of-living crisis (409). We also did not include search terms explicitly related to cultivated or natural food environments (for example, community gardens), and therefore may have missed literature on these types of food environments. Secondly, grey literature such as third sector or government reports may have been missed. We tried to overcome this by searching seven databases and reviewing the reference list for all included articles but cannot guarantee that a relevant report was not missed. Third, the search terms used for 'convenience' may have contributed to the lack of studies identified for this domain. Future work should consider expanding the search terms and definition to include the time cost of preparing and consuming food as well as personal motivation to plan/prepare meals, availability of ingredients and cooking equipment in the home, and access to transport to procure ingredients.

This study advances understanding of the knowledge gaps that must be filled in order to design evidence-based policies to improve the healthfulness and sustainability of UK diets. At the same time, there is enough evidence for governments to act in order to improve local food environments to achieve healthy diet and weight goals (410). A recently published review of systematic reviews on the effectiveness of food environment policies in improving population diets found that food environment policies targeting the availability of foods in retail and food establishments, food provision in school settings, product reformulation, and the size of portions/packages are effective (51). There are many recent examples of the UK and devolved government actions to improve the

food environment. For example, the ban of single-use plastics in England that was initiated from October 2023 (411) and initiatives to reduce food waste (412, 413) have the potential to improve the sustainability of food environments. Regulations on the promotion of foods and beverages high in fat, sugar and salt in England (414) and under consideration in Scotland (415) and Wales (416) have the potential to improve the healthfulness of food environments across the UK. A data visualisation tool has also been developed to help local authorities explore their food environments (417). There is a need for a comprehensive review of policies across the UK, including non-food policies and monitoring of the impact of these policies on dietary intake, health and food environments. The better we understand the food environment, the easier it will be to create interventions that bring about a positive change in public health and planetary health.

To summarise, the current literature on the food environment in the UK focusses almost exclusively on availability in the food retail space. Though several recent government initiatives aim to improve the healthfulness of food environments in the UK, more research is needed to understand how different domains of the food environment interact to influence dietary intake and health. Moreover, the types of food environments evaluated need to be expanded to include the increasingly relevant digital food environment.

Conclusion

The findings from this systematic review demonstrate that the literature is heavily concentrated on the domain of availability, particularly within retail food environments, with comparatively less attention given to other domains such as sustainability and convenience. The review also reveals that most studies were from England, with limited representation from other countries.

Overall, most research conducted in Scotland was cross-sectional, with the exception of four studies out of all studies conducted in Scotland. One was a feasibility trial evaluating a price-incentivised healthy eating intervention in a worksite canteen. Another was a secondary analysis of household purchasing data, which suggested that policy measures targeting promotions could reduce calorie intake from HFSS foods. The remaining two were case studies based in Glasgow, one found that the relationship between supermarket access and fruit and vegetable consumption varied depending on how access was measured, while the other reported that OOH outlets were more prevalent in more deprived areas. Overall, based on the findings, the authors concluded that access to healthy food is uneven, with more deprived areas having greater exposure to OOH and less healthy outlets in Glasgow, while pricing and promotional policies (e.g., restricting promotions or using price incentives) have the potential to influence purchasing behaviours and reduce consumption of unhealthy foods. Additionally, food quality and safety studies indicated generally low contamination risks, and evidence on affordability showed that although healthy foods may cost more, households still spend more on them, with only minor regional price differences.

This chapter makes a central contribution to the thesis by identifying key gaps in the UK evidence base which formed a rationale for the subsequent research. In particular, the absence of studies on convenience directly motivates the development of a conceptual model and metric for this domain in **Chapter 3**. The limited geographic coverage of existing studies, especially outside Glasgow, informs the national-level analysis of food environments in Scotland presented in **Chapter 4**. Finally, the lack of studies linking food environments to dietary quality underpins the analysis of food consumption patterns and adherence to dietary guidelines in **Chapter 5**.

Overall, this review demonstrates that while there is substantial research on food environments in the UK, it remains fragmented and unevenly distributed across domains and outcomes. Addressing these gaps is essential for developing a more comprehensive understanding of how

food environments influence diet and health, and for informing effective policy interventions. While **Table 1.2** provides a useful overview of UK-wide food environment policies, it is not intended to represent a comprehensive or systematic mapping of policies specific to Scotland. A more comprehensive and structured mapping exercise involving defining the scope of relevant policies using domains outlined in Downs's framework, followed by systematic searches of primary sources, including Scottish Government and local authority websites, legislative databases, and key public bodies such as Food Standards Scotland. These would include both direct and indirect policies influencing the food environment, including those related to planning, advertising and sponsorship, public health, agriculture, trade and retail regulation. Identified policies could be coded against food environment domains to allow analysis of policy coverage, gaps, level of governance, implementation mechanisms, and target populations and overlaps within the Scottish context. Such an approach would extend beyond the descriptive synthesis presented in **Table 1.2** and enable a more detailed assessment of how the policy landscape aligns with current focus of the Scottish Government. It may also reveal how policy levers differ from the wider UK.

Chapter 3

Convenience in food environments

3. A conceptual model and metric for measuring convenience in food environments

3.1 Abstract

There is global consensus that food environments influence what people eat and thus their health. Many frameworks exist describing different domains of food environments, including availability, affordability, promotion, product characteristics/quality, convenience, and sustainability. While certain domains, especially availability and promotion, have been studied widely, convenience –an important driver of food choice– has not been clearly defined in the food environment literature, nor how best to measure it. To address this gap, I conducted a scoping review to understand how food environments integrated convenience and what tools were used to measure it.

Twelve frameworks were identified, of which eight mention convenience while only three defined it. We also summarised the current methodologies for measuring convenience and found none of them objectively measured convenience. Convenience was proposed to be

objectively measured as the weekly time spent on food-related tasks. Food-related tasks included planning meals, procuring food, cooking, consuming and cleaning up. Within convenience, I identified two sub domains: product characteristics and personal characteristics. Product characteristics encompass the inherent attributes of a food item, such as the level of processing and packaging which adds or hinders its convenience. While personal characteristics (i.e., income, family size, gender, food choices, cultural beliefs and practices) interact with product characteristics and influence time spent on food-related tasks and whether the food environment is perceived as ‘convenient.’

Further, I present a conceptual model to measure convenience in food environments, with an understanding that it is highly subjective of what individuals perceive as convenient. The model was updated based on the feedback received from eleven in-depth interviews with food environment experts. While further research is required to validate the model, it highlights an important yet overlooked domain in the food environment.

3.2 Introduction

The ‘food environment’ contains the total scope of options within which consumers make decisions about which foods to acquire and consume (33). Food environments influence what people eat (418) and thus their health (419). Downs et al. proposed that there are six domains that characterise food environments: availability, affordability, convenience, promotion, product characteristics/quality, and sustainability (37). While certain domains like food availability and promotion have been extensively researched and increasingly there has been a focus on affordability and sustainability, convenience remains under-studied. A systematic review of food environment research in the UK identified 311 articles, none of which explicitly evaluated convenience (420) despite evidence that convenience is a key driver of food consumption behaviour in the UK (421).

Research on convenience has been focussed on convenience foods, which have been defined as ‘food products bought and consumed with the objective of saving time and effort’ (422). A review on definitions of convenience food by Scholliers (423), highlighted the definitional complexities of convenience food. He argued that the definition of convenience foods has evolved over time, serving as a potent indicator of societal and technological advancements. From the introduction of sauce jars in the 1910s, to cans featuring two food components in the 1930s,

emergence of TV dinners in the 1950s, frozen peas in the 1960s, and ready-to-heat meals in the 1990s, the trajectory of convenience foods reflects a continuum of innovation. Another literature review on convenience foods also suggested that convenience food is shaped by social and practical factors (424). It highlighted the role of daily routines, technological advancements, and cultural norms in influencing its use. The authors concluded that convenience food succeeds because it fits into consumers' busy lives, aligns with their habits, and is made possible by industry innovations and changes in shopping patterns (424).

Another related research area has been on time scarcity and its association with the consumption of fast foods or RTE foods (425). Time scarcity is the most commonly reported obstacle to maintaining a healthy diet worldwide (426-430). Previous studies have also shown that time constraints for food preparation are associated with poor diet quality (404) and health (431), while lack of time for food procurement has been associated with unhealthy food purchases (432). However, there is insufficient evidence on systematically measuring time on food related activities and even fewer studies which have attempted to characterise convenience within the food environment context.

I fill this gap by proposing an objective metric of convenience and developing a conceptual model to describe convenience in the food environment.

3.3 Defining convenience in food environments – an expanded approach

I first reviewed existing food environment frameworks, extracting information on whether they integrated convenience and how (**Table 3.1**). Twelve frameworks were identified, of which eight frameworks mentioned convenience (32, 33, 36-38, 40) (39, 433) and of those, only three had defined it explicitly (32, 36, 37). These frameworks were identified through a search in PubMed using the search terms “food environment” AND “framework” and through screening references of included articles in March 2025. The search results yielded 236 articles which are presented in **Table S5**.

The most informative and recent framework was by Downs et al. (37) where convenience was defined as “the time cost of obtaining, preparing and consuming a food item.” Additionally, they also identified five tools that have been used to assess convenience. It is important to highlight that the identified tools were differentiated as perceived or objective

measures, where none of the five tools were an objective measure of convenience.

Table 3.1 Food environment frameworks with reference to convenience

Food environment framework	Presence of the domain convenience	Definition/ description of convenience
Glanz's Healthy Nutrition Environments(28)	No	NA
Healthy Food Environment Policy Index (Food-EPI) (30)	No	NA
Herforth's socio cultural food environment framework (32)	Yes Includes convenience of foods as one of the aspects of food environment	Time cost of obtaining food
FAO's Conceptual framework for the links between food systems, food environments and diet quality (33)	Yes Recognises convenience but does not explicitly define it	NA
HLPE Conceptual framework of food systems for diets and nutrition (34)	No	NA
The Global Panel conceptual framework of the food environment (35)	No	NA
Turner's socio-ecological theory driven conceptual framework (36)	Yes Mentioned under personal domain	Relative time and effort of preparing, cooking and consuming food products, time allocation
Downs's Food Environment Typology (37)	Yes Mentioned as one of six domains of the food environment	Time cost of obtaining, preparing and consuming a food item

Continues next page >>

Table 3.1 Food environment frameworks with reference to convenience (cont.)

Food environment Framework	Presence of the domain Convenience	Definition/ description of Convenience
African urban food environment framework (38)	Yes Does not explicitly define convenience; identified as one of the top 10 most important factors influencing dietary behaviours	Time/ effort
Conceptual typology of food environments in the Pacific Region and primary exchange mechanisms (39)	Yes Recognises convenience but does not explicitly define it	NA
Cong's analytical framework of the online public food environment (40)	Yes Does not explicitly define convenience; recognises convenience as an important characteristic of food delivery platforms	Saves time and make consumers' time-use more diverse
Toure's review on Market Food Environment framework in LMICs (433)	Yes Recognises convenience but does not explicitly define it	NA

In contrast for the other domains of food environments, Downs et al. (37) found 22 objective and 3 perceived measures for availability, 16 objective and 3 perceived measures for affordability, 22 objective and 5 perceived measures for promotion and quality, and 2 objective and 1 perceived measure for sustainability. Thus, convenience was the least studied of the domains, lacking tools to quantify it with respect to food environments.

In the framework by Herforth (32), convenience is defined as “the time cost to obtain food.” They highlighted the importance of time scarcity and how it can outweigh the monetary cost of food, especially in certain settings such as women in LMICs or for those who live in food deserts. Regarding measuring convenience, they reported it could be measured either by proximity to food outlets (similar to availability in some

frameworks) or in terms of meal preparation time. Like Downs et al. (37), Herforth (32) provided a comprehensive summary of methodologies used for measuring convenience (**Table 3.2**).

Table 3.2 Summary of methodologies used for measuring convenience by Herforth (32)

Method to measure convenience	Description of method/tool	Source
Consumer Survey	Trained enumerators that probe how convenience or lack of time influence healthy food purchases.	de Menezes et al. 2018 (434)
Participatory Mapping	Maps created by local communities that indicate where they have access and where they procure foods. The maps can be used to assess convenience to vendors and foods.	Pelto et al. 2013 (435)
Photo Elicitation	A visual interview method that uses images to elicit responses. The informants or the interviewer can provide the photos, depending on the objective.	Bignante et al. 2010 (436)
Photovoice	A method used in community-based participatory research to document characteristic of the food environment.	Spencer et al. 2019 (437); Díez et al. 2017 (438)
American Time Use Survey - Eating and Health Module	A tool that collects data on the amount of time people spend doing various activities, including individual decisions about how to use the 24 hours in a day for supporting eating patterns, grocery shopping, and meal preparation.	Beck et al. 2007 (404)

Turner et al. (36) described convenience as a domain under the personal food environment. The personal food environment includes a set of individual level dimensions that has continuous and complex interactions with the external food environment. Convenience is defined as the relative time and effort for preparing, cooking and consuming a food product but how an individual perceives convenience is dependent on external factors.

Other frameworks such as the Toure's Market Food Environment framework (433) in LMICs and FAO's Conceptual Framework for the links between food systems, food environments and diet quality (33) mention convenience, but they do not explicitly define it. Another recent framework, the African Urban Food Environment Framework (38) also recognises convenience as the seventh most important factor influencing dietary behaviours but does not provide a definition. The Cong et al. analytical framework of the online public food environment (40) mentions how convenience of food delivery platforms can save time and make consumers' time-use more flexible, but do not discuss it further. Similarly, the framework by Bowgard (39) on food environments in the Pacific region recognises 'kin and community' as an important food environment which may be closely linked with convenience such as informal food trade in rural areas but, does not explicitly define convenience.

Bowgard also conducted an insightful systematic literature review to determine how convenience is defined and measured but expanded its scope to food environment as well as nutrition research (439). While highlighting the lack of explicit definitions and inconsistencies in measurement across studies, they propose a definition of convenience in relation to the food environment as a "characteristic that results in reduced requirement for resources including time, physical effort, mental effort and skills by the consumer in relation to the planning, acquisition, preparation, storage, transport, consumption or clean-up of food" (439).

Based on this review of how convenience is integrated into existing food environment frameworks and Turner's (36) inclusion of convenience under personal food environment, I proposed a metric to measure convenience objectively as the total time cost of eating which includes time to plan, procure, cook, consume and clean up food relative to an individual's total waking hours in a week (**Equation 1**).

Equation 1

$$\text{Weekly time cost of eating} = \frac{\text{Time to plan + procure + cook + consume + clean up}}{\text{Total waking hours in a week}}$$

In the current metric, I focussed on time requirement and did not include other resources like mental effort, physical effort and skills. Measuring mental effort for a specific task is challenging, as individuals often juggle multiple thoughts simultaneously, making it hard to isolate the effort dedicated to one task. Additionally, perceived mental effort may differ from the actual effort exerted, adding further complexity.

3.4 Development of a conceptual model to measure convenience

An initial conceptual model was developed after a scoping review in PubMed on food environments, previous work published on convenience and an internal brainstorm on indicators. As mentioned previously, details of the review are available in **Table S5**. This was followed by in-depth interviews with eleven experts who have previously published research on food environments.

The qualitative interview guide and protocol were reviewed and approved by the Human (Research) Ethical Review Committee, University of Edinburgh⁶ and all interviewees provided informed consent. Experts were contacted through email addresses available on their professional webpage, and those who expressed an interest in participating were provided with information about the study, which outlined its aim and the draft model. Oral consent was obtained prior to the interview. Electronic notes were taken as the interviews were not recorded. Each interview took approximately 1 hour to complete. At the conclusion of the interview, I inquired whether there are additional experts with whom I should engage.

Expert feedback summarised below, broadly recognised the value of the proposed framework in addressing an important gap in food environment research, while highlighting areas for refinement, measurement, and conceptual clarity.

⁶ Protocol number: HERC_2023_058

1. Experts suggested a few additions such as time spent on clean-up after food preparation, as well as the use of recipe books alongside digital applications. There were also recommendations to broaden contextual relevance by including mobile food vendors, and to consider workplace-related factors that may influence time use. Additionally, experts emphasised the importance of considering interactions between food environment domains.

2. A key theme across feedback was that convenience is inherently complex and difficult to operationalise. Experts highlighted that food-related activities are often non-discrete and overlapping, with individuals frequently multitasking (e.g., cooking while completing other household tasks) or engaging in cognitive planning alongside unrelated activities. This makes it challenging to define and measure “time spent” on food-related tasks in a precise way. Furthermore, convenience was recognised as highly subjective and shaped by personal circumstances, including skills, routines, and preferences. For example, individuals with greater cooking skills may prepare meals more efficiently, suggesting that time use alone may not fully capture convenience.

3. Experts raised several concerns regarding the feasibility of measuring convenience. These included potential recall bias in self-reported time-use data, difficulty capturing secondary or cognitive tasks and challenges in quantifying perceived versus actual time use. To address these issues, a range of methodological approaches were suggested. These included the use of time-use surveys, questionnaires capturing perceptions of convenience, and adaptation of existing tools such as the Food Choice Questionnaire. Experts also emphasised the importance of capturing subjective perceptions, not just objective measures.

4. Experts emphasised that convenience is not experienced uniformly across populations. Its importance and meaning may vary by life stage and context, including among students, working adults, older adults, and retirees. Additionally, product characteristics were noted to be context-dependent, varying by location and mode of consumption (e.g., eating while commuting versus at home).

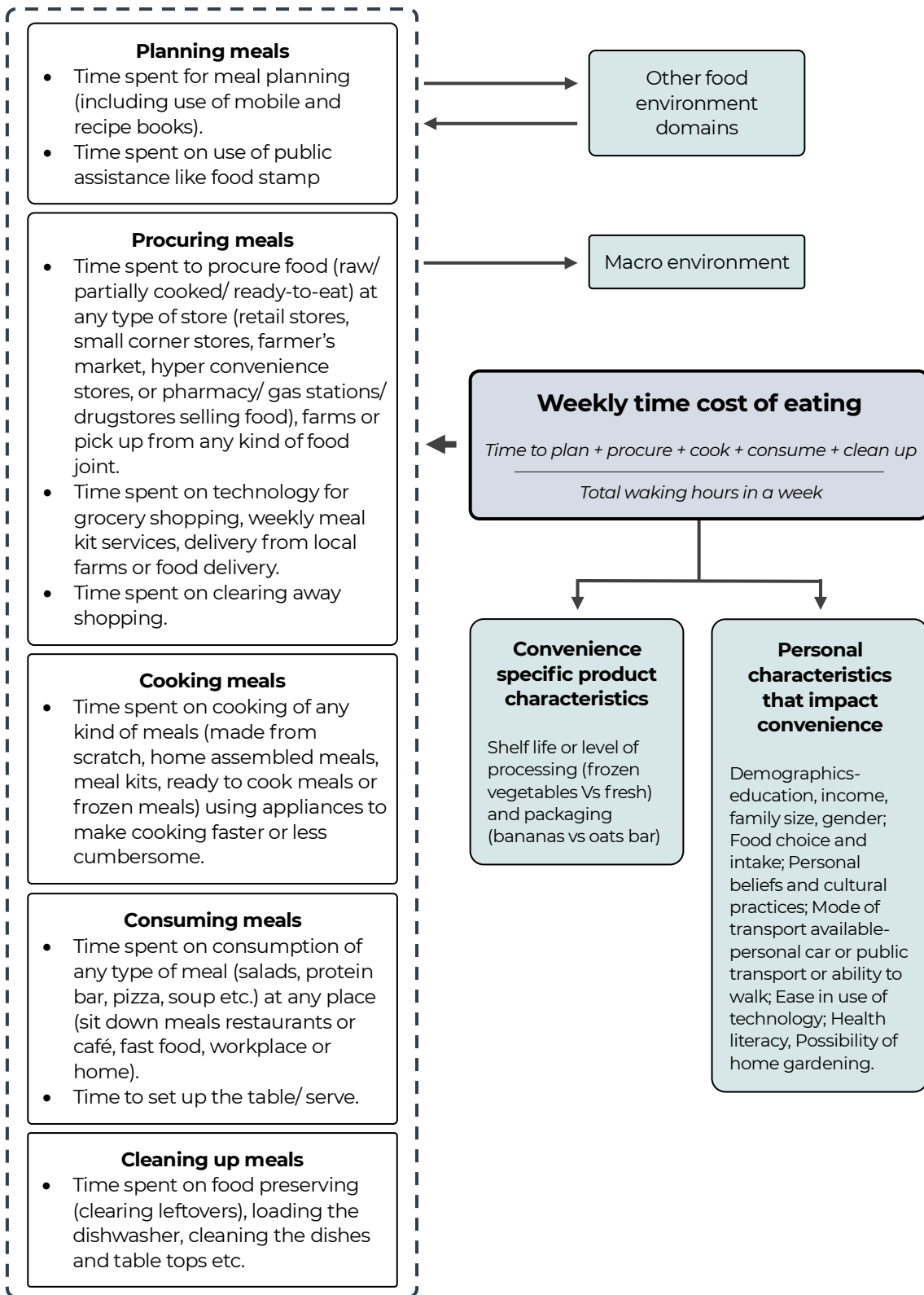
5. While the framework was widely regarded as comprehensive and inclusive, experts noted that it may be too broad to fully operationalise within a single PhD project. As such, there was a recommendation to prioritise theoretical development and conceptual clarity, rather than attempting to measure components empirically.

In summary, expert inputs played a critical role in refining the conceptualisation of convenience, resulting in a model that is grounded and more attuned to real-world complexity. While challenges remain in its

measurement and application, the revised model provides a necessary foundation for advancing research on this overlooked domain of the food environment.

The final model reflected feedback from the experts (**Figure 3.1**). In this model, I break down each step from being hungry to getting something to eat, realising that not everyone may go through the following steps for every eating occasion.

Figure 3.1 Conceptual model for measuring convenience in food environments



- 1. Time to plan.** This includes time spent on meal planning such as selecting what to make and checking home inventory. It could involve time spent on mental planning of recipes as well as use of online food channels or recipe books. This also includes time spent on use of public assistance such as Food Stamp allotments.
- 2. Time to procure.** This includes time spent to obtain food. Foods include raw ingredients, partially cooked or RTE, and OOH, procured from various sources like retail stores, small corner shops, farmer's market, hyper convenience stores, farms, pharmacy/gas stations/drugstores selling food, self-service salad stations/sushi bars at retail stores as well as pick up from restaurants or food joints. This also includes time spent on technology for grocery shopping, food delivery, weekly meal kit services or delivery from local shops or farms as well as clearing away shopping.
- 3. Time to cook.** This refers to time spent on cooking any kind of meals (made from scratch, home assembled meals, meal kits, ready to cook meals or frozen products). Time spent cooking could vary with not only the kind of meal but also the type of cooking appliances used.
- 4. Time to eat.** Time spent on consumption of meals could vary both with the place of eating (sit down meals at restaurants or quick meals at a workplace) and the kind of food (salads, protein bar, pizza, soup etc.). This also includes time to set up the table/serve where relevant.
- 5. Time to clean.** This entails time spent on clearing leftovers, loading the dishwasher, cleaning the dishes and cleaning tabletops, etc.

A previous cross-sectional analysis of the UK Time Use Survey revealed that time spent on food-related tasks such as food preparation or 'set table, wash or put away dishes', declined significantly between 1983 and 2014, mostly for women (440). In that study, the authors concluded that 'lack of time' to prepare food at home may be interpreted as a lack of desire or interest, or a sense of being overwhelmed, rather than a quantitative lack of time women (440). Analysis of the American Time Use Surveys (441) found associations between eating patterns, activities, and Body Mass Index (BMI) groups. Work schedule affects meal prep and exercise, potentially influencing weight. Employed individuals were less likely to shop for groceries or prepare meals, especially if they had children, who were more likely to eat meals at school highlighting time constraints

influence food-related activities (441). However, both the UK and American Time Use Surveys cannot be used to calculate the proposed metric as these did not include time to plan meals and did not explicitly situate the findings within a food environment framework.

3.5 Sub-domains within convenience: product characteristics and personal characteristics

Convenience is person and context specific. What may be convenient to one person in a particular setting, may be inconvenient to another. For example, a person with a car may find a supermarket outside city centre to be convenient because they can buy everything, they need for the week at one shop. A person who must take two buses to get to the same supermarket may not consider it to be convenient. Within convenience, I identified two sub-domains: product characteristics and personal characteristics.

Product characteristics encompass the inherent attributes of a food item, such as the level of processing and packaging that can either enhance or diminish its convenience. For instance, foods like rice or pasta have extended shelf lives, rendering them more convenient with ease of procurement than perishable items like fresh fruits, vegetables and dairy products which need to be bought weekly. Similarly, the packaging of certain products, such as health bars or beverages, contribute to the ease of consumption, while on the other hand, food box delivery schemes may result in more time spent in preparation (442).

Personal characteristics such as income, family size, gender, food choices, cultural beliefs and practices interact with product characteristics, influencing time spent on food-related tasks and whether the food environment is perceived as 'convenient.' For example, households with higher incomes may be able to afford to pay for food delivery, hire cooks, and may have access to personal transport and kitchen appliances such as microwaves and dishwashers, which make planning, procuring, cooking, eating and cleaning more convenient. Individuals with food allergies may require more time to plan, procure and cook foods safely. These interactions with individual traits illustrate how convenience is influenced by personal characteristics.

3.6 Interaction with other food environment domains

Convenience is complex to measure not only because it interacts with personal characteristics, as described above, but also because it interacts with other domains in the food environment. Evaluating the proximity of foods and drinks in a certain area would measure availability as well as, indirectly, convenience (time to procure food). Similarly, there are important trade-offs between convenience and other domains like quality, sustainability and affordability.

Many ultra-processed foods and beverages are convenient (little time needed to plan, cook, eat and clean), but are associated with negative health outcomes thus impacting quality (443). As summarised by Aschemann- Witzel (444), convenience has become one of the key determinants of overconsumption and waste which are challenges to environmental sustainability (445).

On the other hand, more people are now engaging in practices such as purchasing produce direct from farmers, food box deliveries (442), utilising reusable shopping bags, and responsibly managing food waste which may demand additional time, but are sustainable choices. With regards to affordability, convenience often comes at a financial premium, particularly for healthier food choices with nutritious foods more expensive than unhealthy ones (446). On the other end of the spectrum, meal deals available at retail chains could be affordable and convenient but not always healthy.

3.7 Impact of the macro environment

The macro environment caters to policies that exert influence on food supply chains, food economics, food-related marketing, and the broader political landscape, typically profoundly shaped by the governmental structure in place. Many governmental regulations and initiatives can indirectly impact the time cost of eating. For example, subsidies on cleaner cooking fuels like liquefied petroleum gas or electricity can reduce the time spent on cooking as they provide quick ignition and consistent heat over traditional cooking methods. This is especially relevant for rural areas which rely on traditional biomass as cooking fuel (447). There is an increased focus on improving access to electrification and clean cooking in LMICs such as electrical cooking for improving lives and livelihoods as well as reducing greenhouse gas emissions (448). Electric cooking solar powered mini grids are also being explored as an effective, low-cost option

to cooking in remote areas (449). Specific to the UK, the cost of gas influences food choices specially for people experiencing energy poverty (450, 451).

Another example would be the impact of fuel price on time spent in procurement where higher fuel prices may cause individuals to consolidate their shopping trips or opt for bulk purchases to minimise the frequency of trips, thus potentially reducing the time spent in procuring food. In areas that are food deserts where people rely on personal vehicles for procurement, higher fuel costs could be detrimental beyond time spent in procuring food (242).

3.8 Conclusions

Existing frameworks lack a comprehensive definition and a holistic approach to measure convenience. While further research is required to validate the proposed metric, this study serves as a foundational contribution to enrich the existing knowledge base regarding convenience within food environments. Such a model brings attention to an important yet overlooked domain in the food environment.

The metric and model developed are aimed at fostering research and enabling discussions that encompass the entire spectrum of convenience within the food environment. This spectrum begins with product characteristics, personal characteristics such as time constraints and the utilisation of convenience foods, extends to the interplay with various domains within the food environment, and further extends to consider the influence of political and economic factors on convenience. With an aim of this being a universal metric to measure convenience, I have been inclusive of food available through charities or food banks as well as the increasingly relevant digital food environment.

Nonetheless, assessing convenience within food environments presents several methodological challenges. As convenience is inherently multidimensional and context-dependent, shaped by both product characteristics and individual circumstances, this makes it difficult to capture using traditional, objective measures. In particular, the time cost associated with food-related activities is difficult to measure directly and may vary substantially between individuals depending on factors such as household composition, employment status, and cultural practices.

Future research should therefore adopt mixed-methods approaches to more comprehensively assess convenience. Quantitative approaches could include the development of time-use measures or survey instruments to capture time spent on food-related tasks, as well as the use of proxy indicators such as the consumption of RTE or minimally prepared foods. Advances in digital data collection, including smartphone-based time-use diaries or purchasing data, may offer novel opportunities to capture real-time behaviours. Further, how time spent on digital food environment, including social media, food delivery apps, and online recipe platforms impacts one's dietary habits, nutritional choices, and overall health outcomes could be evaluated. These approaches should be complemented by qualitative research to better understand how individuals perceive and prioritise convenience within different social and environmental contexts. It could provide insights important for diet-related interventions and health policies.

Further work is also needed to validate and refine the proposed framework. This could include testing its applicability across different population groups and settings, and assessing its association with dietary behaviours and health outcomes. In particular, it would be helpful to understand whether modifying aspects of convenience within the food environment can lead to meaningful improvements in diet quality. Finally, incorporating convenience into policy-relevant research will be essential. For example, future studies could explore how planning policies, workplace practices, or food retail strategies influence the time cost of eating and, in turn, dietary behaviour. Such work would help bridge the gap between conceptualisation and application, ensuring that the domain of convenience is effectively integrated into efforts to improve food environments.

Though, this work adds to the sparse research reported in the literature on convenience with an attempt to measure it, the key challenge is balancing subjective perceptions of convenience with the need for standardised, comparable measures across studies.

Chapter 4

The food environment in Scotland

Background

This chapter contributes to the overarching aim of this thesis to understand and improve the healthfulness of food environments in the UK, with a specific focus on Scotland. As identified in Chapter 2, there is a limited and geographically uneven evidence base on food environments in Scotland, with a strong concentration of studies in Glasgow and relatively little national-level analysis. This lack of comprehensive spatial evidence constrains the development of effective, place-based policies to improve population diet.

Building on this gap, the present study aims to characterise the distribution of food outlets across Scotland and examine how these vary by neighbourhood deprivation. While the initial objective was to identify “food deserts” and “food swamps,” critical evaluation of existing definitions, alongside consultation with Nourish Scotland, indicated that available administrative data from the Food Standards Agency are not sufficient to robustly classify areas using these constructs. This reflects a broader limitation in the literature, where commonly used concepts may not translate well across different data contexts. Consequently, the study adopts a more descriptive and exploratory approach, focusing on the density of food outlets.

This chapter also builds conceptually on Chapter 3, which highlighted the importance of convenience as an underexplored domain of the food environment. In particular, the prominence of OOH food outlets, such as restaurants, cafés, and takeaways, may represent an important dimension of convenience that shapes dietary behaviour. By quantifying the relative availability of OOH and retail outlets, this study provides an empirical foundation for examining how convenience manifests in real-world food environments.

Research based on food outlets and its association with socio-economic deprivation, show that unhealthy food outlets are more concentrated in deprived areas in the UK. A repeat cross-sectional analysis of area-level deprivation and food outlet density found higher densities of fast-food outlets in more deprived areas across Great Britain and these increased by 36% between 2011 and 2024 (452). Another repeat cross-sectional study on takeaway outlet density and supermarket presence in Norfolk, UK, found similar results with takeaway outlet density significantly higher in more deprived neighbourhoods and socioeconomic inequalities in takeaway availability increased over time (174). Studies that investigate access to supermarkets or healthy food retailers in deprived communities found that around 13.8 million people in the UK have limited access to grocery retail (store or online) with transport, cost, and time constraints

listed as main barriers that influenced access (453, 454). Deprived neighbourhoods often face a 'double burden' with greater exposure to fast-food outlets, and fewer opportunities to access healthier food options. Initiatives like community food projects and social supermarkets which aim at addressing food poverty for low-income households and attempt to bridge gaps in the conventional retail system appear promising(455).

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Joe Kennedy	<ul style="list-style-type: none"> • Wrote the python code for AI to assist with data cleaning • Provided comments on multiple drafts of the manuscript, particularly on use of AI and its justification
Kirsteen Shields	<ul style="list-style-type: none"> • Provided comments on the first draft of the manuscript, particularly discussion on challenges with food access in the rural areas
Christian Reynolds	<ul style="list-style-type: none"> • Assisted with refinement of research question • Provided comments on multiple drafts of the manuscript, particularly discussion on inclusion of delivery-only restaurants
Tom Clemens	<ul style="list-style-type: none"> • Data acquisition and queries • Provided comments on the first draft of the manuscript
Lindsay M. Jaacks	<ul style="list-style-type: none"> • Contributed to the study conception, design and methodology • Code verification • Provided comments on multiple drafts of the manuscript

4. Characterising the food environment in Scotland and its association with deprivation: A national study

4.1 Abstract

Objectives

To characterise food outlets across Scotland and analyse their distribution by neighbourhood deprivation.

Methods

Data from the Food Standards Agency of all registered food businesses in 2024 were categorised as out-of-home (OOH) [including restaurants, pubs, cafés, and takeaways], retail [supermarkets and non-food retailers like pharmacies with limited food items] or other [mobile caterers, charity organisations, and home caterers]. Neighbourhood deprivation was quantified using the Scottish Index of Multiple Deprivation.

Results

Of all food outlets, 59% (n = 18,409) were OOH, 28% (n = 8,757) retail, and 13% (n = 3,969) other. The density of OOH (1.9 per km²) was more than double that of retail (0.8 per km²). Glasgow City had the highest OOH outlet density (18.5 per km²). Argyll and Bute, Western Isles, and Highlands had the lowest density of both OOH and retail (≤ 0.03 per km²).

Compared to the most deprived neighbourhoods, the least deprived neighbourhoods had more restaurants/cafés/canteens (37% versus 23% of food outlets, respectively) and fewer takeaway/sandwich shops (16% versus 24% of food outlets, respectively).

Conclusion

Though OOH outlets far outnumber retail in all of Scotland, unique food environments exist in different local authorities. These insights can inform local development and support targeted strategies to improve food environments.

4.2 Introduction

Scotland has the lowest life expectancy at birth of any Western European country, and it has continued to fall in recent years (5, 456). The gap in time spent living in good health between individuals in the most and least deprived areas is widening, reaching 24 years in 2019 (457). Disparities in healthy weight likely contribute to healthy life expectancy disparities: 39% of adults in Scotland's least deprived areas have a healthy weight compared to 28% of adults in the most deprived areas (458).

A Scotland where everyone eats well and has a healthy weight is a key public health priority (5), and several policies have been adopted in recent years to support this vision. These policies have targeted improvements in food environments recognising their role in influencing what people eat and drink (6). Policies such as taxing unhealthy foods, restricting their promotion, and implementing front-of-pack labelling have been prioritised by governments worldwide including the UK government (7). These policies are generally supported by the public (8), and have led to improvements in diet quality, such as reduction in sugar consumption as a result of the Soft Drinks Levy (9). Several studies in the UK have shown a positive association between proximity (10) and density of fast-food outlets and obesity (11); though not all studies have shown a significant effect (12).

In Scotland, the Good Food Nation (Scotland) Act, passed into Scots Law in 2022, aims to ensure that everyone in Scotland has "ready access to the

healthy, nutritious food they need” and “People who serve and sell food – from schools to hospitals, retailers, cafés and restaurants – are committed to serving and selling good food”. Hence, all foods prepared outside home at establishments such as restaurants, pubs, cafés, and takeaways are considered out-of-home (OOH). Supporting this vision, Public Health Scotland and Food Standards Scotland (FSS) have developed an Eating Out, Eating Well Framework to help the OOH sector provide healthier foods, recognising that OOH food and drink tends to be less healthy (292). According to FSS's latest report on monitoring OOH food and drink purchases in Scotland, 98% of the population visited OOH venues in 2023 (459). Differences in food environments may contribute to health disparities and while government policies aim to improve food environments, no study has comprehensively evaluated the food environment across Scotland.

To date, studies have only been conducted in Glasgow, Scotland’s largest city, and reported a positive association between the density of food outlets and neighbourhood deprivation (223, 224). We, therefore, aimed to: 1) characterise the food environment across Scotland; and 2) explore how the food environment varies by neighbourhood deprivation.

4.3 Methods

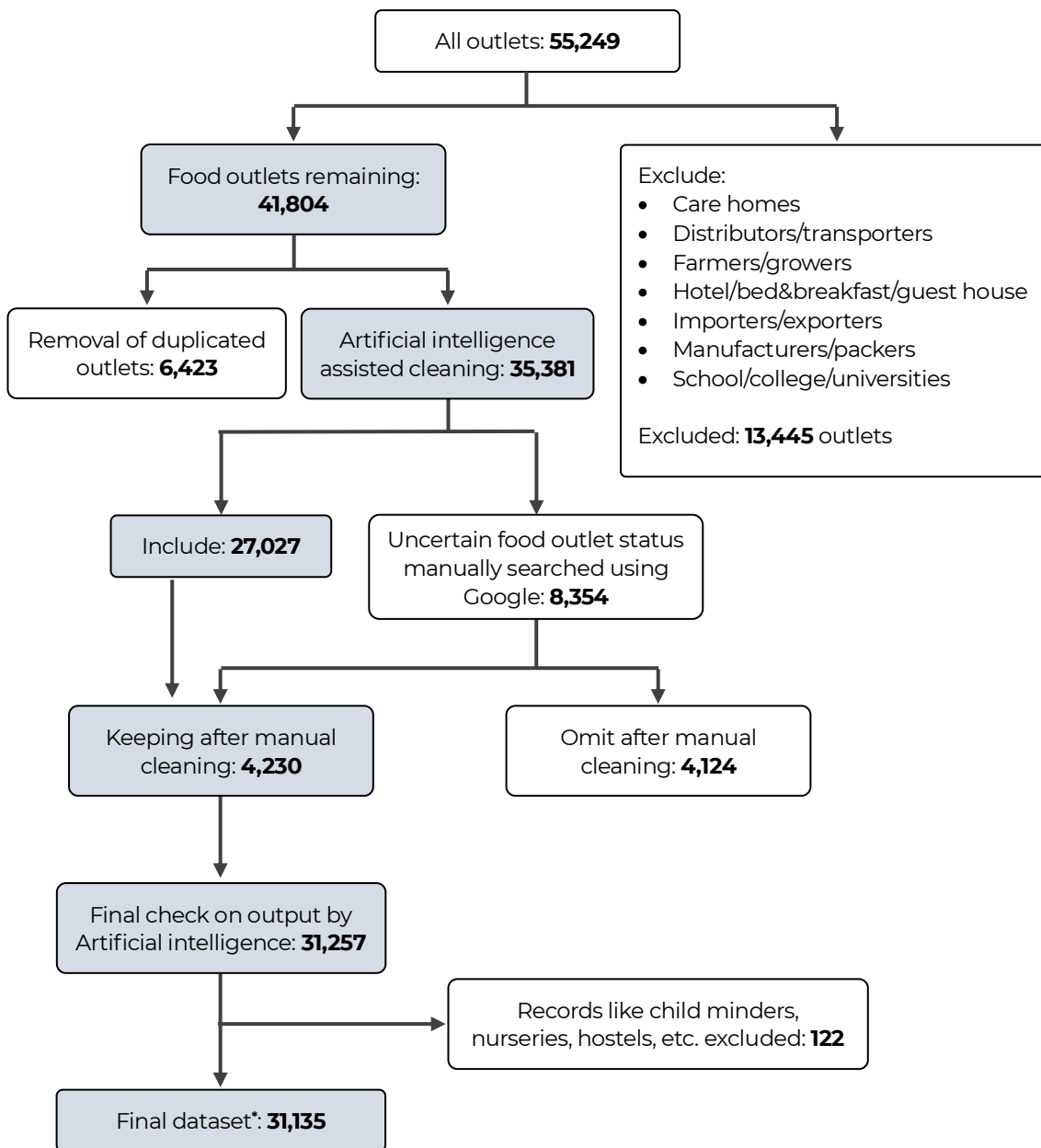
4.3.1 Data source and food outlet classification

Scotland is divided into 32 designated council areas or local authorities. All food outlets must have a food hygiene inspection, undertaken by the local authority under the Food Hygiene Information Scheme rating. We obtained a list of all food outlets from the UK food hygiene rating data (Scotland) in 2024 (n = 55,249), compiled by the Food Standards Agency (FSA)⁷ and downloaded on 1st February 2024.

Data available for each food outlet included business name, address, local authority, geocode, and classification. There were 14 classifications. Seven classifications were excluded from this analysis: care homes, distributors/transporters, farmers/growers, hotel/bed & breakfast/guest house, importers/exporters, manufacturers/packers, and school/college/universities. From the list of 55,249 food businesses, 13,445 (24%) were classified in one of these seven categories and excluded, thus 41,804 (76%) were included in this study (**Figure 4.1**).

⁷ <https://ratings.food.gov.uk/open-data>

Figure 4.1 Flowchart of data cleaning of food businesses in Scotland, 2024



*Outlets with missing postcodes were excluded from Scottish Index of Multiple Deprivation analysis (n = 732)

We categorised outlets using the existing FSA classifications: OOH (including restaurants, pubs, cafés, and takeaways), retail (including supermarkets and other establishments that primarily sell non-food products and a limited range of food products such as pharmacies), or other (mobile caterers, charity organisations, and home caterers) (Table 4.1).

Table 4.1 Definition of food outlets in Scotland, 2024

FSA classification*	FSA description	Categorisation for current analysis
Pub/bar/ nightclub	Commercial establishments that primarily serve alcohol in a public bar. If the establishment has a separate restaurant facility it is recorded under the pub category. <i>Examples: Public Houses, Night clubs/clubs with bars.</i>	Out-of-home
Restaurant/ café/canteen	Establishments whose primary business is to cook/prepare food for customers. <i>Examples: Restaurants, Cafés, Self-service caterer, "Fast food" establishments providing seating, e.g., McDonalds, Burger King, etc. The drive-thru variants of these chains are also included in this category.</i>	
Takeaway/ sandwich shop	Establishments that provide convenience food to customers, primarily for consumption off the premises. Establishments must be immobile and housed in a designated building. These establishments prepare and deliver convenience food directly to the customer. <i>Examples: Fish & chip shops, Takeaway Sandwich shops.</i>	
Retailers - supermarkets/ hypermarkets**	Supermarkets. <i>Examples: Sainsbury, Tesco, Asda, Morrison, Co-op, Marks and Spencer, Waitrose, Aldi, Lidl, etc. that provide a range of food items from more than one grocery sector and from a range of brands. City centre or local variants of larger supermarket groups, e.g., Sainsbury's local, Tesco Metro, Tesco Express, etc. Establishments like Londis and Spar are also included in this category.</i>	Retail

Continues next page >>

Table 4.1 Definition of food outlets in Scotland, 2024 (cont.)

FSA classification*	FSA description	Categorisation for current analysis
Retailers - other	Retail establishments which do not fit into one of the other retailer categories, e.g., establishments that primarily sell non-food products and a very limited range of food products. <i>Examples: Shops where the main business is not food for example a chemist/pharmacy. Smaller-scale food businesses such as Grocers, Confectioners, Butchers (retail only), Fishmongers, Greengrocer/fruiterer, Health food shops, Bakers shops (retail only), Newsagents and Garage minimarkets. Establishments like Costcutter, One-Stop, Nisa, and Premier are also included in this category.</i>	Retail
Other catering premises	Restaurant/catering establishments that do not fit into one of the other restaurants and caterers' categories. <i>Examples: Home caterers such as cake makers selling directly to consumers, village halls, community centres, etc. used by charitable/community organisations.</i>	Other

Continues next page >>

Table 4.1 Definition of food outlets in Scotland, 2024 (cont.)

FSA classification*	FSA description	Categorisation for current analysis
Mobile caterer***	A food establishment that comprises a kitchen or catering facility operating from a mobile unit such as a vehicle, trailer, stall, marquee or other non-permanent structure. Examples: Mobile catering units, Burger vans and other fast-food vans/trailers/stalls.	Other

*The following business classifications were excluded from this analysis: care homes, distributors/transporters, farmers/growers, hotel/bed & breakfast/guest house, importers/exporters, manufacturers/packers, and school/college/universities.

**Cafés in supermarkets are included separately in out-of-home as restaurants/cafés/canteens.

*** Mobile caterers were excluded from the out-of-home category because the address listed in the database reflects the business's registration location, which may differ from the actual site where food is sold.

Since businesses self-selected their classification from the FSA classifications (**Table 4.1**), a consistent definition was not always applied across businesses. If an outlet was categorised in more than one way, it appeared multiple times in the data as different records. For example, Costa Coffee at Edinburgh Airport, was categorised twice as “Restaurant/café/canteen” and “Takeaway/sandwich shop”. The name and address of such outlets were manually reviewed, resulting in removal of 6,423 duplicates. The most recent data entry was retained.

In addition, some businesses that are not traditionally considered part of OOH or retail, for example, banks and schools, were present in the dataset. The process of removing these non-food businesses was facilitated using Open-AI’s GPT-4 large language model (460), by developing an input prompt to identify them based on its domain knowledge and the business description (**Table S6**).

The model identified 8,354 (24%) potential businesses that should be excluded from the list of OOH and retail outlets. Of these, 34 (0.4%) were not in the original list and were “hallucinated” by the model, although in many instances these businesses differed by only minor changes in spelling or punctuation from a business in the original list (**Table S6**).

In addition, this list of potential exclusions contained businesses that could not easily be classified using the name alone such as “A & A Bros” or “1841”. These were manually verified using a Google search. The business name and postcode were searched, typically yielding results such as the outlet's website or its menu on online food delivery platforms. For non-food businesses, details about the company's operations were often displayed.

A total of 4,124 outlets were manually removed following a Google search. A final manual check was carried out on the list of 31,257 outlets flagged as food outlets from GPT-4 assisted cleaning. This resulted in the removal of 122 records (0.4%) incorrectly classified as food businesses, including, for example, childminders, nurseries, hostels, etc. The final dataset for analysis included 31,135 food outlets. This novel approach of combining string similarity matching with GPT-4 saved time, improved efficiency, and was found to be accurate through manual validation (only 0.4% of outlets were misclassified as food outlets).

The “Other catering premises” and “Other retail” contained outlets meeting the definition of other outlet categorisations and so were recategorised accordingly. For example, many outlets with “grill,” “bar,” or “bakes” in the name were recategorised from the “Other catering premises” to “Restaurant/café/canteen”. “Greggs” and outlets with “ice cream” in the name were recategorised to “Takeaway/sandwich shop”. Likewise, outlets like Londis, Morrisons, etc. were recategorised from “Other retail” to “Retailers - supermarkets/hypermarkets”.

This study used publicly available, non-human data and thus does not require ethics approval. Cleaning was done using string matching in R version 4.2 (461).

4.3.2 Data analysis

The density per square kilometre and proportion of OOH, food retail, and other outlets was calculated overall, and by local authority and Scottish Index of Multiple Deprivation (SIMD) quintile. Population density for each local authority was added using 2022 census data (462).

SIMD is a relative measure of deprivation across 6,976 small areas (called data zones), taking into account information across seven domains: income, employment, education, health, access to services, crime, and housing (463). Look-up tables which relate individual postcodes to data zones were used to link SIMD ranks to each food establishment (464).

A total of 732 (2%) food outlets were excluded from the analysis by SIMD as the postcode specified in the FSA database was not available in the

lookup tables. Differences in the proportion of OOH, food retail versus other outlets between quintiles of neighbourhood deprivation, overall and stratified by local authority, were evaluated using chi-square tests. Twenty-one of thirty-two local authorities had fewer than five outlets in a given SIMD quintile and were excluded from the analysis.

To assess the association between deprivation and total outlet density, we employed a Poisson regression model, with SIMD quintile as the independent variable and outlet density as the dependent variable. All analyses were done in R version 4.2 (461).

4.4 Results

Overall, in Scotland, 59% (n = 18,409) of food outlets were OOH, 28% (n = 8,757) retail, and 13% (n = 3,969) other. “Restaurant/café/canteen” was the most common food outlet type (n = 9,248, 30%), followed by “Retailers – other” (n = 6,881, 22%), and “Takeaway/sandwich shops” (n = 5,430, 17%) (**Table S7**). “Retailers - supermarkets/hypermarkets” accounted for only 6% (n = 1,876) of food outlets.

4.4.1 Differences by local authority

The proportion of food outlet types varied by local authority, with densely populated areas having a higher number of outlets as well as outlet density. Glasgow City had the highest number of all types of food outlets (n = 4,977) including 65% OOH and 23% retail. The City of Edinburgh had the highest number of pubs/bars (n = 524, 15% of total outlets) and Highlands had the highest number of home caterers/charities (n = 1,016, 39% of total outlets). Shetland Islands, Comhairle nan Eilean Siar (Western Isles), and Orkney Islands had fewer than 200 total food outlets (**Figure S1**).

Out of 32 local authorities, 30 had more than 50% of their food outlets classified as OOH (**Table S10**). Aberdeenshire and Highlands were the two exceptions where 41% and 27% of food outlets were OOH, respectively. The City of Edinburgh (78%) had the highest proportion of OOH outlets, followed by Argyll and Bute (77%). Shetland Islands (40%) had the highest proportion of retail outlets, followed by Comhairle nan Eilean Siar (Western Isles) (39%), West Dunbartonshire (37%) and Inverclyde and North Ayrshire (both 36%). Highlands was the only local authority with an equally low proportion of both OOH (27%) and retail outlets (28%); a majority of outlets were other (45%).

On average, the OOH outlet density was nearly double that of retail in Scotland: 1.9 OOH outlets per km² versus 0.8 retail outlets per km². Local authorities with a high population density such as Glasgow City, Dundee City, City of Edinburgh, and Aberdeen City had the highest OOH and retail densities (**Table 4.2**). Highlands, Argyll and Bute, Shetland Islands, and Comhairle nan Eilean Siar (Western Isles) had the lowest OOH and retail density of less than one outlet per km².

Table 4.2 Characterisation of Scottish food outlets

Local Authority	Pop. density ^a (people / km ²)	MD Data zones ^b (%)	Outlet density (Outlets / km ²)			
			Outlet density	OOH density	Retail density	Other density ^c
Glasgow City	3,555	45	28.5	18.5	6.4	3.6
Dundee City	2,477	37	16.5	10.2	4.4	1.8
Edinburgh (City of)	1,947	12	13.1	10.3	2.2	0.6
Aberdeen City	1,207	10	7.5	4.6	2.2	0.7
North Lanarkshire	726	34	3.2	1.8	1.1	0.3
Renfrewshire	703	25	3.6	2.2	1.1	0.3
East Dunbartonshire	625	4	2.2	1.3	0.7	0.2
West Dunbartonshire	557	40	2.7	1.6	1	0.1
East Renfrewshire	556	6	1.1	0.6	0.4	0.1
Falkirk	533	16	2.4	1.5	0.8	0.1
Inverclyde	489	45	2.2	1.3	0.8	0.1
West Lothian	424	15	0.9	0.6	0.3	<0.1
Clackmannanshire	325	25	1.9	1	0.6	0.2
Fife	280	20	1.8	1	0.6	0.2
Midlothian	273	9	1.0	0.7	0.3	<0.1
South Lanarkshire	185	20	0.9	0.6	0.3	0.1
East Lothian	165	6	0.7	0.4	0.2	0.1
North Ayrshire	151	40	0.8	0.5	0.3	0.1
East Ayrshire	95	31	0.5	0.3	0.2	<0.1
South Ayrshire	91	18	0.6	0.4	0.2	<0.1

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Table 4.2 Characterisation of Scottish food outlets (*cont.*)

Local Authority	Pop. density ^a (people / km ²)	MD Data zones ^b (%)	Density (Outlets / km ²)			
			Outlet density	OOH density	Retail density	Other density ^c
Angus	52	8	0.3	0.2	0.1	<0.1
Aberdeenshire	42	3	0.2	0.1	0.1	<0.1
Moray	42	3	0.2	0.1	0.1	<0.1
Stirling	42	12	0.2	0.1	0.1	<0.1
Perth and Kinross	29	6	0.1	0.1	<0.1	<0.1
Scottish Borders	25	6	0.1	0.1	<0.1	<0.1
Dumfries and Galloway	23	9	0.1	0.1	<0.1	<0.1
Orkney Islands	22	0	0.2	0.1	0.1	<0.1
Shetland Islands	16	0	0.1	<0.1	<0.1	<0.1
Argyll and Bute	13	10	<0.1	<0.1	<0.1	<0.1
Highlands	9	10	0.1	<0.1	<0.1	<0.1
Comhairle nan Eilean Siar (Western Isles)	9	0	0.1	<0.1	<0.1	<0.1
Average	689	20	0.4	1.9	0.8	0.3

Local authorities are sorted from highest to lowest population density.

^a <https://www.scotlandscensus.gov.uk/2022-results/scotland-s-census-2022-rounded-population-estimates/>

^b MD: most deprived. <https://www.gov.scot/publications/social-capital-community-wellbeing-scotland/pages/13/>

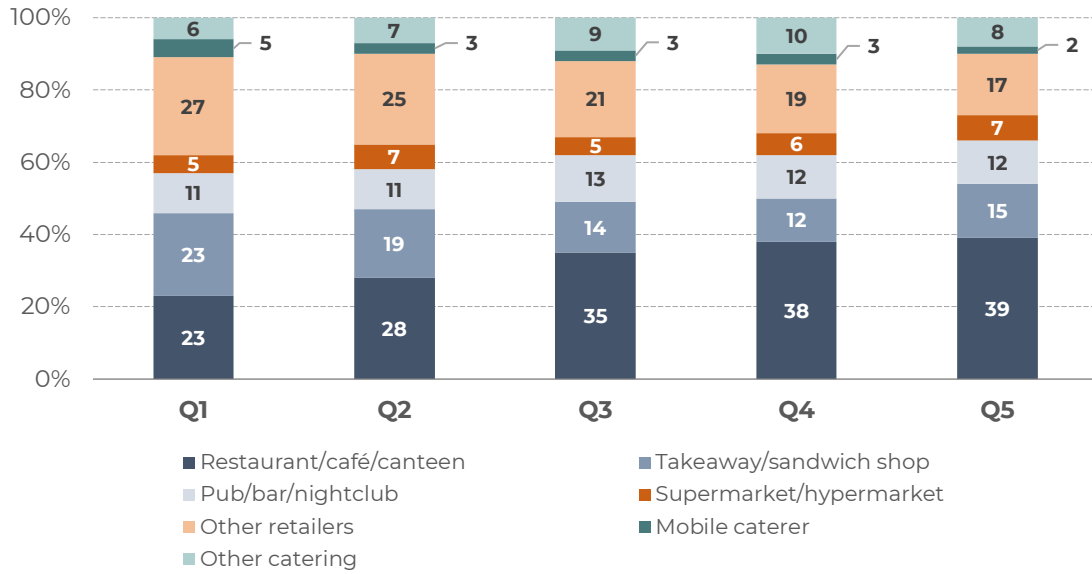
^c "Other" includes home caterers, charitable/community organisations, and mobile caterers.

4.4.2 Differences by neighbourhood deprivation

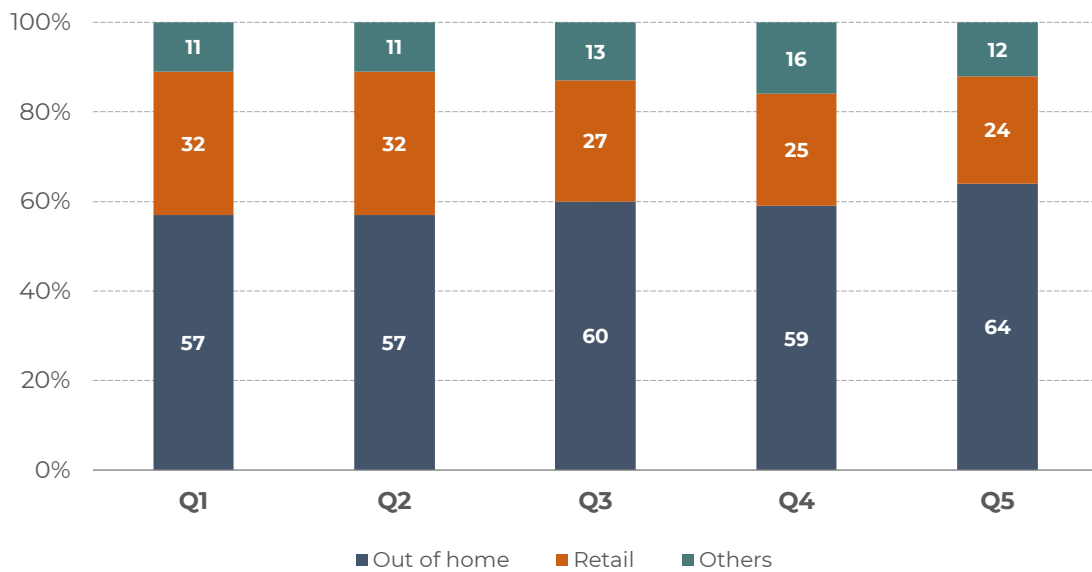
Overall, the most deprived areas had significantly higher total outlet density compared to all other less deprived quintiles (comparing 1st quintile (ref) and 5th SIMD quintile $\beta = -0.31$, SD = 0.01, $p < 0.01$) (**Table S8**). The proportion of OOH outlets was higher in the least deprived neighbourhoods compared to the most deprived (65% versus 58%, $p < 0.01$) (**Figure 4.2, Table S9**).

Figure 4.2 Association of Scottish Index of Multiple Deprivation with classification of food outlets in Scotland, 2024

a) Overall Scotland - all outlets

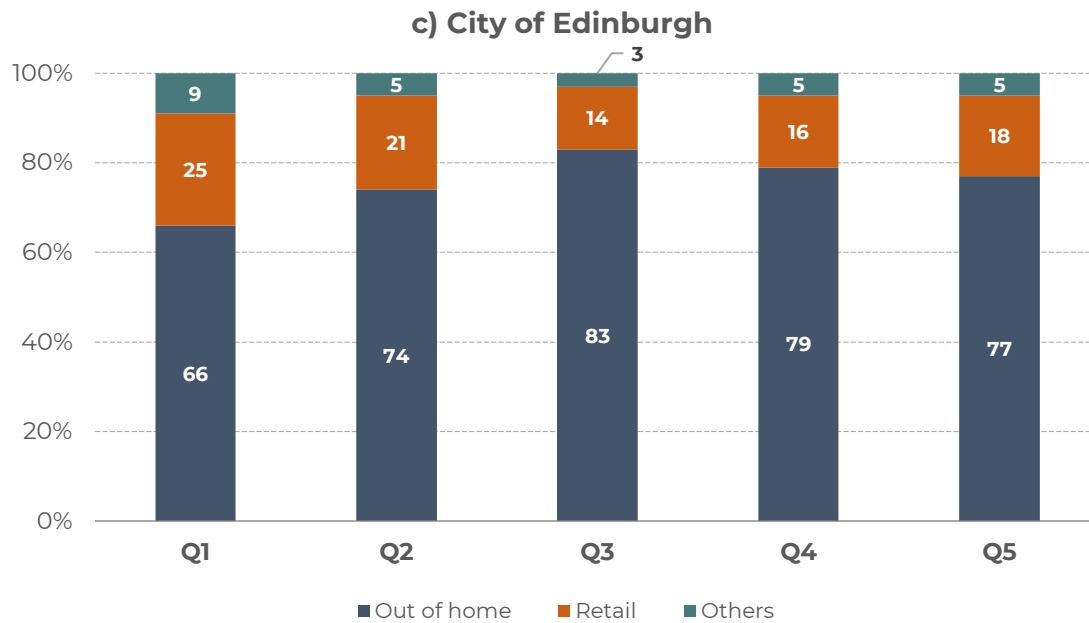


b) Overall Scotland - subcategorized

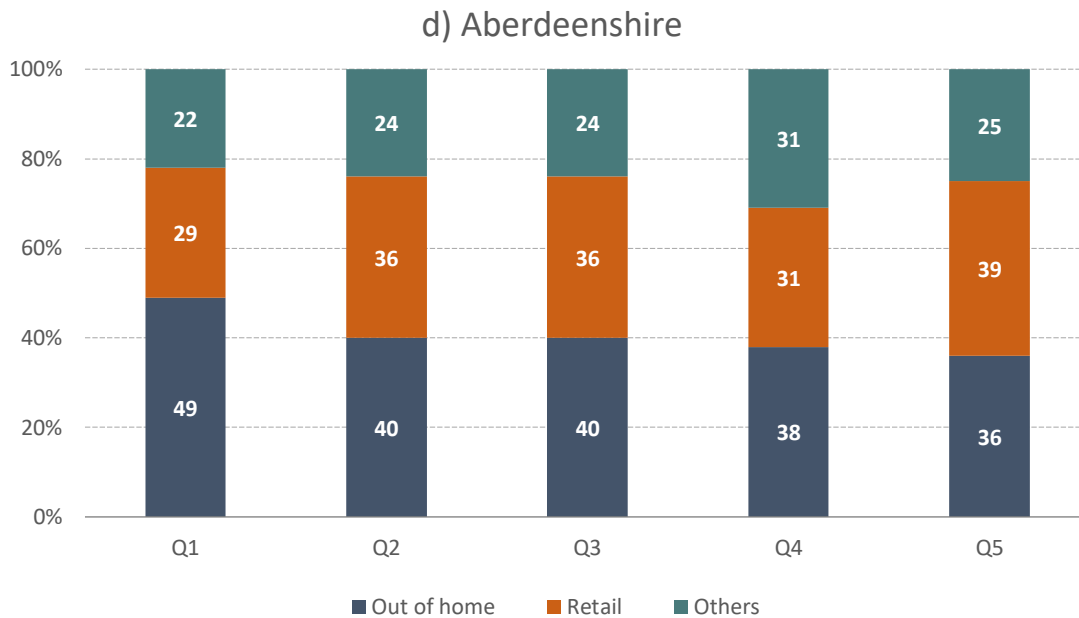


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Figure 4.2 Association of Scottish Index of Multiple Deprivation with classification of food outlets in Scotland, 2024 (cont.)



Note: example of a local authority with higher proportion of Out-of-home in the least deprived neighbourhoods compared to the most deprived and lower proportion of retail outlets in the least deprived neighbourhoods compared to the most deprived



Note: example of a local authority with higher proportion of Out-of-home in the most deprived neighbourhoods and lower proportion of retail outlets in the least deprived neighbourhoods compared to the most deprived neighbourhoods compared to the least deprived

This was driven by a higher proportion of “Restaurant/café/canteen” (37% of total food outlets in the least deprived neighbourhoods versus 23% in the most deprived). In contrast, “Takeaway/sandwich shops” comprised a smaller proportion in the least deprived neighbourhoods (16% versus 24% in the most deprived).

The proportion of food retail outlets was lower in the least deprived neighbourhoods compared to the most deprived (24% versus 32%, respectively, $p < 0.01$) (**Figure 4.2, Table S9**). This was driven by a lower proportion of “Retailers - other” (outlets primarily selling non-food items with a limited food selection, 16% in the least deprived neighbourhoods versus 26% in the most deprived neighbourhoods). In contrast, the proportion of “Retailers - supermarkets/hypermarkets” was higher in the least deprived neighbourhoods compared to the most deprived (7% versus 6%).

Five local authorities, namely, Aberdeen City, Fife, Glasgow City, City of Edinburgh and Stirling followed the same trend as in Scotland overall. However, the opposite was true in Aberdeenshire, Renfrewshire and South Lanarkshire, where the proportion of OOH was higher in the most deprived neighbourhoods and the proportion of retail outlets was lower in the most deprived neighbourhoods. City of Edinburgh and Aberdeenshire shown as examples in **Figure 4.2**, the rest shown in **Table S10**. In Perth and Kinross, the most deprived neighbourhoods had a significantly greater proportion of both OOH and retail outlets than the least deprived neighbourhoods. North Lanarkshire had the same proportion of OOH outlets in the most and least deprived neighbourhoods but a higher proportion of retail outlets in the most deprived neighbourhoods.

4.5 Discussion

This first comprehensive analysis of Scotland’s food environment, covering 31,135 registered food businesses, found that 60% were OOH, with restaurants/café/canteens accounting for half of these outlets. Across all deprivation levels, OOH outlets outnumbered supermarkets and other food retailers, but their makeup varied: takeaways were more common in deprived areas, while restaurants and cafés were more common in affluent ones.

Several local authorities had fewer than one food retail outlet per km², and some of these had a high proportion of “Other” outlets, such as, home caterers and charitable/community organisations, highlighting potentially unique aspects of food environments in these areas of

Scotland where limited food retail access appears to be supplemented by informal or community-based sources.

It is understandable that retail outlets are less numerous than OOH outlets, as the area occupied by a single large supermarket could accommodate several OOH outlets. Nevertheless, these results highlight a significant opportunity to improve public health through the OOH sector, as proposed in the Scottish Government's Eating Out, Eating Well framework. The OOH sector varied by local authority and deprivation. For example, consistent with one previous study (224), we found an especially high density of OOH in Glasgow City. Takeaway/sandwich shops were more prevalent in the most deprived areas compared to the least deprived. This is consistent with a recent analysis in England of the same FSA database which found fast food outlets per 100,000 population in the most deprived decile of lower tier local authorities were double the level in the least deprived decile (465).

Beyond OOH, other aspects of the food environment varied by local authority. In particular, the Highlands was the only local authority where the informal food economy, including home caterers, village halls, and community centres, comprised the largest share (46%) of food outlets. This contrasts with other local authorities such as Dundee City and Glasgow City where 99% of people reside in large urban areas and have a higher number and proportion of both OOH and retail food outlets. These results align with other studies conducted in remote rural areas in Scotland which found that populations access food through various channels, such as crofts, community co-operatives, social enterprises, community gardens, and food banks (466). Grocery provision is limited outside the main towns in these areas (467). Our analysis highlighted that while the Comhairle nan Eilean Siar (Western Isles), Orkney Islands, and Shetland Islands did not have a high proportion of "Other" outlets compared to the Highlands, they had very few outlets overall, which may result in poor food accessibility.

While this is the first study of all registered food businesses in Scotland using the latest FSA data, it has limitations. While we were able to capture some level of specificity within the food sector in terms of business classification, a more granular classification of food outlets (e.g., bakeries, fish and chips) would provide a more complete picture of the food environment. Self-selecting business categories and manual cleaning for others may have introduced some measurement error. Further, OOH may be underestimated by not including mobile caterers. This research does not take into account the digital food environment, including online

delivery options from both OOH and food retail outlets, or “dark kitchens” which rent kitchens to many delivery-only restaurants.

Future studies could include information on whether businesses offer delivery services, as this may impact food access. Data were downloaded on 1st February 2024, but it is possible that some of the food businesses permanently closed or new food businesses have registered since that date. While collecting primary data on food outlets is ideal, such “ground truthing” is resource and time intensive. Thus, secondary data plays a crucial role in quantifying food environments. Some studies have addressed the accuracy and reliability of secondary food outlet data sources in relation to their utility for use in food environment research in the UK and found it useful for surveillance of the food environment (170). An evaluation of the validity and spatial accuracy of the FSA database in England demonstrated high reliability, with a positive predictive value of 95% and a sensitivity of 89% (468), suggesting the results presented herein are likely to be reasonably accurate.

This study highlights improvements to both the OOH and retail food environment are necessary. The Scottish Government proposals to restrict promotion of high fat, sugar, and salt (HFSS) foods in retail and OOH settings aim to tackle this issue, following similar measures introduced in England in 2022 (414, 415, 469). However, early qualitative analysis shows uneven implementation, highlighting the need for complementary policies to improve the accessibility, affordability, and promotion of healthier options (470).

Despite this, the legislation could reduce impulse HFSS purchases creating healthier retail environments for consumers (470). A recent longitudinal analysis found that fast food outlet density has grown faster than supermarkets in Great Britain, especially in deprived areas (452). Changes to neighbourhood planning and licensing of food premises are needed to put food environments on a new trajectory, future proofing further growth in food outlets primarily selling unhealthy food.

Takeaway management zones offer one. An evaluation of local authorities in England who adopted takeaway management zones found 0.83 fewer new outlets opened per local authority than expected without such policies (64) and improve health by reducing obesity and related diseases (65). However, studies also state limitations like such policies may regulate *future* growth but do not address the existing high density of takeaway outlets, particularly in deprived areas (118) or ‘grab and go’ type of foods which are the main form of OOH food in Scotland (459).

Evidence also suggests that they are most effective when implemented as full management zones, compared with time management zones, which only restrict opening hours for new outlets (394). However, restricting access to unhealthy options must be accompanied by parallel efforts to promote and improve access to affordable healthier alternatives. Our study offers insights to inform stakeholder discussions on improving both the OOH and retail sectors across Scotland.

This analysis of Scotland's food environment revealed that though OOH outlets far outnumber retail in all of Scotland, unique food environments exist in different local authorities. These insights can guide local development, and tailored strategies can be proposed to effectively improve the healthfulness of food environments.

4.6 Conclusions

This study provides the first comprehensive national classification of food outlet distribution across Scotland using administrative data from the Food Standards Agency. The findings show that OOH outlets account for the majority of food outlets and are more than twice as dense as retail outlets. Substantial geographic variation was observed, with urban areas such as Glasgow City exhibiting very high outlet densities, while rural and island areas, including Argyll and Bute, Western Isles, and Highlands had low densities. Socioeconomic patterning was also evident, with more deprived neighbourhoods having a higher proportion of takeaway outlets and fewer restaurants, cafés, and canteens.

These findings have important implications for understanding food environments in Scotland. The observed socioeconomic differences in outlet composition suggest that individuals living in more deprived areas may be disproportionately exposed to food environments that facilitate access to takeaway foods, which are often associated with poorer dietary outcomes (471). This provides a plausible pathway linking the structural characteristics of food environments to dietary inequalities.

There were two key novelties in this paper: first, it is the first study to include all registered food businesses in Scotland; second, it integrates AI as a core component of the data cleaning process. The GPT-4 large language model developed by OpenAI was used to assist with the categorisation and cleaning of food outlet data in Scotland for 2024. Specifically, GPT-4 was prompted to review a list of registered businesses and identify outlets that did not directly sell food or drink to consumers. The model was instructed to assess each business and generate a new list containing only those entities that did not meet the inclusion criteria for

food retailers (e.g., village halls, catering companies, or non-food retail businesses). This process was used to support the exclusion of non-relevant businesses from the dataset prior to analysis. As stated in the paper, this process saved time and improved efficiency compared to manual data cleaning. During this process, the model produced a small number of hallucinated outputs (n = 34), meaning business names that were not present in the original dataset. These hallucinations occurred primarily through minor modifications to existing names (e.g., changes in capitalisation, punctuation, or brackets) or through misspellings of original entries. Examples included case alterations (e.g., generating “A And M Catering - Street Trader”), punctuation changes (e.g., converting brackets in business names), and spelling variations (e.g., “Glasgowean Health Shop” instead of “Glaswegian Health Shop”). All outputs generated by GPT-4 were therefore manually checked and validated, and hallucinated entries were removed to ensure the accuracy of the final dataset used in the analysis.

There were also several limitations, some of which have been discussed in the paper. Additionally, although SIMD is widely used to characterise neighbourhood socioeconomic status in studies of food environments in Scotland, it is an area-level measure, reflecting the average deprivation of small geographic units (“data zones”) rather than the circumstances of individuals. Consequently, relationships observed at the area level may be incorrectly attributed to individuals (472). Second, SIMD may obscure within-area heterogeneity, as populations within a single data zone can vary considerably in socioeconomic status. This aggregation can mask pockets of deprivation within otherwise affluent areas (473). Third, the index is known to exhibit urban bias, potentially under-representing deprivation in rural areas where disadvantage is often linked to transport barriers and geographic isolation rather than the social indicators commonly used in deprivation indices (474). Additionally, SIMD represents a relative ranking of deprivation rather than an absolute measure, limiting interpretation of differences between areas (463). Finally, in specific relation to the food access, SIMD is a composite index combining multiple domains and does not identify which specific socioeconomic factors may influence food retail distribution or access. These limitations should be considered when interpreting associations between neighbourhood deprivation and food retail environments.

Overall, this chapter makes a key contribution to the thesis by providing empirical evidence on the structure of food environments across Scotland and identifying clear geographic and socioeconomic inequalities. These findings directly inform Chapter 5, which examines whether food consumption, particularly the consumption of OOH and RTE foods are associated with adherence to the Scottish Dietary Goals. Together, these chapters link the external food environment to individual dietary behaviour, advancing understanding of how environmental factors may shape diet quality in Scotland.

Chapter 5

Consumption of home-prepared, RTE and OOH foods

This chapter is in preparation to be submitted to *British Journal of Nutrition*:

Deksha Kapoor, Ricki Runions, Christian Reynolds, Kirsteen Shields, Lindsay M. Jaacks; Consumption of home-prepared, ready-to-eat and out-of-home foods and its association with diet quality in adults living in Scotland.

Author	Contributions
Deksha Kapoor	<ul style="list-style-type: none">• Conception of the research question• Collated and analysed data• Wrote the manuscript and subsequent drafts
Ricki Runions	<ul style="list-style-type: none">• Review of the statistical analysis plan• Code verification• Review of manuscript
Christian Reynolds	<ul style="list-style-type: none">• Methodology• Review of manuscript
Kirsteen Shields	<ul style="list-style-type: none">• Review of manuscript
Lindsay M. Jaacks	<ul style="list-style-type: none">• Contributed to the study conception, design and methodology• Review of the statistical analysis plan• Code verification• Provided comments on multiple drafts of the manuscript

5. Consumption of home-prepared, ready-to-eat and out-of-home foods and its association with diet quality in adults living in Scotland

5.1 Abstract

We examined associations of consumption of home-prepared foods versus RTE and OOH foods with adherence to the Scottish Dietary Goals (SDG), and explored variations by age, sex, or neighbourhood deprivation. Dietary intake was assessed using up to two days of 24-hour recall from the representative 2021 Scottish Health Survey. The association between quintiles of consumption of home-prepared, RTE and OOH food with Scottish Dietary Goals adherence was estimated using multivariable Poisson regressions, adjusted for education, employment, ethnicity,

income, chronic disease status, family history of cardiovascular disease, and physical activity.

Weighted mean (SD) energy from home-prepared and RTE food was similar [46% (21%) and 45% (20%), respectively], while OOH food contributed less [9% (16%)]. Older adults derived a greater proportion of energy from home-prepared foods and less from RTE and OOH foods compared with younger adults ($p < 0.001$). Females consumed more home-prepared foods ($p = 0.01$) and less RTE ($p < 0.001$) and OOH foods ($p = 0.01$) than males. Participants in the least deprived areas consumed more home-prepared ($p < 0.001$) and less RTE foods ($p = 0.01$) than those in most deprived areas. Participants in the highest quintile of home-prepared food consumption were more likely to meet dietary goals [IRR (95% CI) 1.25 (1.83–1.32)], whereas those with higher consumption of RTE and OOH foods were less likely to adhere [0.87 (0.82–0.92) and 0.83 (0.77–0.89), respectively]. Age, sex and deprivation did not moderate this association. These findings highlight the need for healthier RTE and OOH foods that are better aligned with dietary goals.

5.2 Introduction

There has been an exponential increase in OOH eating globally and these have become a significant component of our diets (475, 476). Changing family dynamics, a decline in home-cooking skills, and evolving social influences have all contributed to this shift in consumption patterns (477). Evidence indicates that eating at food outlets or consuming “on the go” foods is associated with poorer dietary quality and less healthy food choices (478). Similar negative effects on diet quality have also been observed with restaurant and takeaway meals (471, 479, 480).

Scotland is no exception to these global food trends. In 2023, nearly all (98%) of the population visited OOH venues and the number of visits increased by 11% from 2022 (459). Foods ‘on the go’ are the largest share of OOH consumption, comprising more than half (56-59%) of OOH occasions in 2023 (459, 481). OOH food consumed at the place of purchase (38%) or at home (6%) make up a smaller proportion (481). Parallely, obesity continues to be a major challenge in Scotland, with nearly one-third of Scottish adults (32%) living with obesity in 2023, marking the highest level recorded in the time series and up from 24% in 2003 (14). This translates into £772 million spent annually to treat obesity-related conditions by NHS Scotland (482). Further, trends from the Scottish Health survey reveal that the proportion of adults who are obese is consistently higher in the most deprived areas compared to the least deprived areas (483). This combined

with the evidence that takeaway food outlets are more prevalent in deprived communities, add to the diet-related health inequalities (484).

In response to these trends, several policies have been adopted in Scotland in recent years to improve the healthfulness of the OOH food environment. The first proposed National Good Food Nation Plan under the Good Food Nation (Scotland) Act includes reference to a *voluntary framework* for OOH food outlets to increase the availability of healthier options and clearer nutrition labels (485). The plan also commits to monitoring how OOH options change over time (485). However, the plan has been criticised for continuing to emphasise individual behaviour change rather than improvements to the food environment (486, 487). More recently, the Scottish Government and Convention of Scottish Local Authorities have developed a Population Health Framework (26). This framework prioritises improving healthy weight by taking a whole-system approach to food environments, ensuring healthy, balanced diets are accessible and affordable, and supporting better population-level healthy weight outcomes (26).

Globally, several national governments include an emphasis on home-prepared food in their dietary guidelines, including Brazil (488), Canada (489) and Japan (490). Research suggests that individuals who eat more home-prepared food tend to have better dietary outcomes compared to those who rely more on RTE or OOH food (491). Home-prepared food often allows for greater control over ingredients, portion sizes, and cooking methods, which can contribute to a healthier diet (492, 493). One UK-wide cross-sectional analysis of the National Diet and Nutrition Survey (NDNS) found low consumption of home-prepared food and no significant difference in consumption between socio-demographic groups (494). They also observed a modest association between consuming home-prepared food and improved diet quality (494).

A population-based cohort study in Cambridgeshire, England, found that frequent consumption of home-prepared food was associated with better adherence to the Dietary Approaches to Stop Hypertension diet and Mediterranean diet, as well as lower adiposity (495). They also found that the frequency of eating home-prepared food was greater among females, older individuals, and those with higher educational attainment and household income (495). However, there is no evidence from Scotland on the consumption of home-prepared food, nor its association with diet quality.

The first aim of this study was to determine what proportion of energy is derived from home-prepared, RTE and OOH food among adults 16+ years

living in Scotland, and whether this varies by age, sex, and Scottish Index of Multiple Deprivation (SIMD). The second aim was to determine whether the proportion of energy derived from home-prepared, RTE and OOH food is associated with adherence to the Scottish Dietary Goals, and whether this association differs by age, sex, or SIMD.

5.3 Methods

5.3.1 Data source

The Scottish Health Survey (SHeS) is a nationally representative cross-sectional survey that uses a partially clustered, stratified multistage sample design. SHeS aims to evaluate the prevalence of specific health conditions and associated risk factors in Scotland. The survey collects a wide range of information, including biological measurements, health behaviours, physical and mental health, and various socio-economic factors (496). Data used in this analysis were from SHeS 2021, conducted between April and December 2021. SHeS is conducted annually, but 24-hour dietary intake data are collected in three-year cycles. At the time of this thesis, the 2021 dataset was the most recent 24-hour dietary intake dataset available. The next wave of dietary recalls in SHeS was conducted in 2024, and the data were not made public until after the completion of this thesis (released by the UK Data Service in March 2026).

Dietary intake was assessed using Intake24, an online 24-hour dietary recall software⁸. Participants aged ≥ 16 years were invited to complete up to two self-administered dietary recalls. The initial recall was conducted through a link once the participant gave their consent, and the second recall occurred within seven days of the first. For each recall, participants were instructed to log all the food and drinks they consumed the day before. Intake24 automatically assigned food and portion size codes, producing nutrient data at the level of individual food items. Participants also recorded where each meal was sourced. Data were accessed in January 2025.

5.3.2 Classification of foods as home-prepared, RTE and OOH

We defined home-prepared foods as those prepared at home using ingredients (such as fruit, milk, flour, etc.), frozen ingredients (including frozen vegetables or fruit), ingredients obtained from sources like farmers'

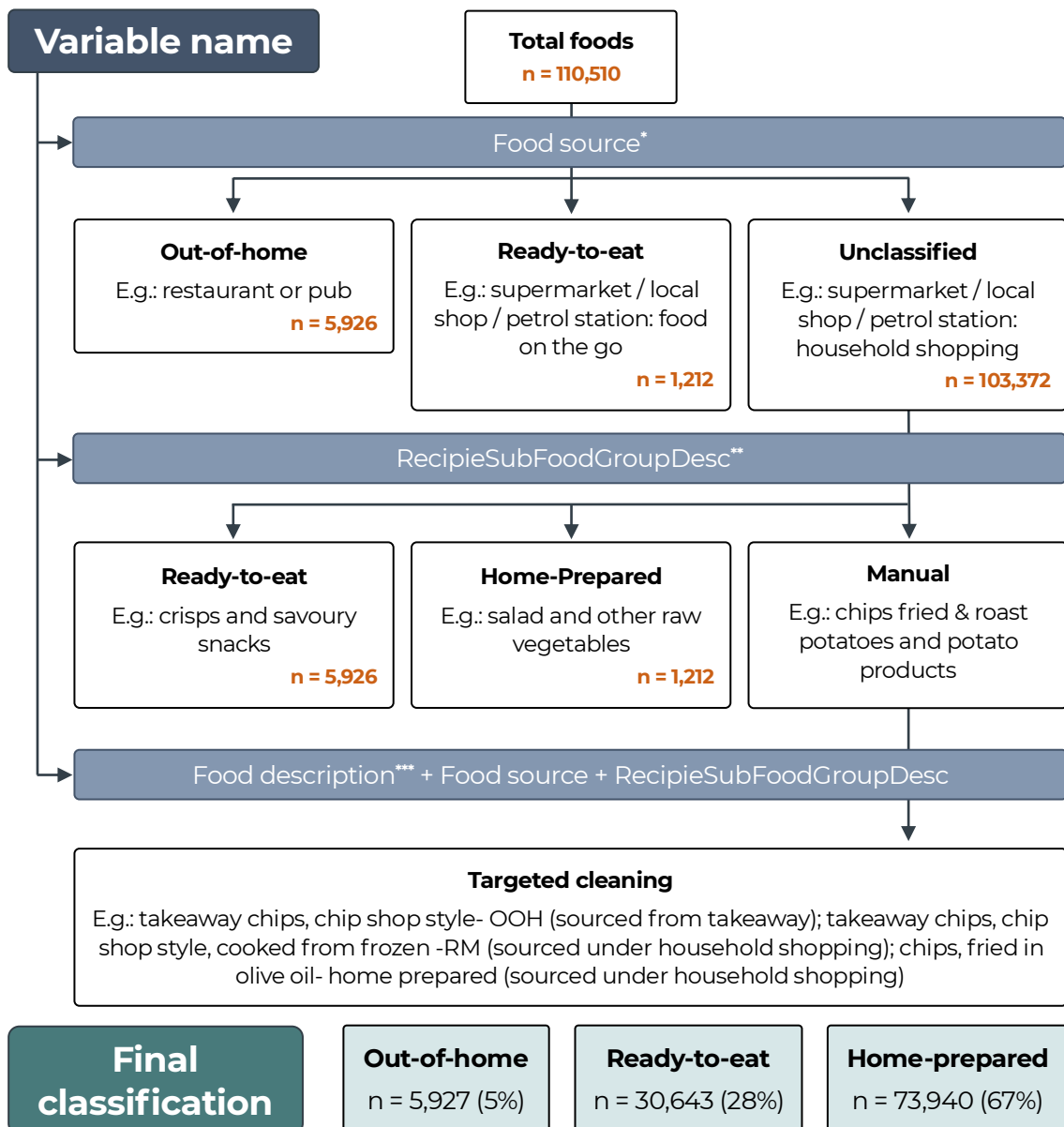
⁸ <https://intake24.org/>

markets, butchers, or fishmongers, or items explicitly designated as home-cooked, home-baked, or home-grown (e.g., from one's own garden or allotment).

Foods and drinks eaten as purchased (e.g., biscuits, crisps, breakfast cereals, juice and soft drinks) and pre-prepared convenience foods that only require heating (e.g., frozen and refrigerated ready meals, canned soups, pasta sauces, instant pot noodles) were classified as RTE. All food and drinks prepared OOH including food prepared OOH but eaten in the home was defined as OOH. Water, alcoholic beverages, and dietary supplements were excluded from the analysis.

The classification of foods as home-prepared, RTE or OOH is summarised in **Figure 5.1**. First, food items were classified by the place they were sourced. The 'food source' variable included 13 options. All food items sourced from the following six options were classified as OOH: 1) Restaurant or pub, 2) café/coffee shop/sandwich bar/deli, 3) fast food/takeaway outlet, 4) Canteen at work or school/university/college, 5) leisure centre/recreation or entertainment venue, and 6) burger, chip or kebab van/street food. All food items sourced from the following two options were classified as RTE: 1) supermarket/local shop/petrol station - food on the go, and 2) vending machine in any location.

Figure 5.1 Flow diagram for classification of foods



* Examples listed are drop down options available to the participant in the Intake24 dataset

** Examples listed are sub food groups allocated by the Intake24 software

*** Examples listed are food names added by the participants or the closest match of that food available in the Intake24 database

For the remaining food items, classification as home-prepared, RTE or OOH required further details from the food item's description. For example, food items sourced from 'Asda' could be classified as home-prepared (e.g., milk, butter, etc.) or RTE (e.g., biscuits, bars etc.). Within each sub-food group, food descriptions were manually reviewed and assigned to either home-prepared or RTE. In instances where food items could not be definitively classified as home-prepared or RTE within a sub-food group based on the food description alone, the entire food item observation was reviewed to determine the most accurate categorisation.

The proportion of energy from home-prepared, RTE and OOH was calculated for each participant by separately summing the energy from these sources on each day and dividing them by the participant's energy intake that day. For participants who completed two recalls, the average percent of energy from home-prepared, RTE and OOH from the two days was used.

5.3.3 Adherence to the Scottish Dietary Goals

The Scottish Dietary Goals outline the nutritional targets aimed at improving and maintaining the health of the Scottish population (497). Adherence to each dietary Goal was calculated by summing daily nutrient or food intakes for each participant. For those who completed two recalls, the mean intake was used. We created a binary variable for each of the 10 Goals, to indicate whether a participant met the recommendation or not (**Table S11**). To derive a composite score, each participant was assigned a value of 1 if they adhered to the Goal and 0 if they did not adhere. Thus, a participant that adhered to all 10 Goals received a composite score of 10, and if they adhered to none of the Goals, they received a score of 0. The overall score ranged between 0 and 10, with higher scores indicating a diet with greater adherence to the Goals and hence better diet quality.

5.3.4 Socio-demographic characteristics

Potential confounders were identified using a Directed Acyclic Graph (DAG) (**Figure S2**) constructed from prior evidence on the relationships between the exposure (proportion of energy from home-prepared, RTE and OOH foods), the outcome (adherence to dietary Goals), and related variables. Age was categorised as 16-34 years (reference group), 35-44 years and 55+ years, and sex as male or female (reference group). SIMD is a relative measure of deprivation across 6,976 small areas (called data zones), taking into account information across seven domains: income, employment, education, health, access to services, crime, and housing (463). Highest educational qualification was categorised as Primary level

or none, Secondary, University degree, or don't know. Annual income was categorised as <£23,400, £23,401–41,600, £41,601–90,000, >£90,000, or don't know. Employment was categorised as employed or unemployed. Ethnicity was categorised as White or Other. Family history of cardiovascular disease (CVD) was self-reported by the participant answering whether either parent had heart disease or stroke before age 60, using a binary variable (yes/no). Chronic disease status was recoded as a binary variable (yes/no). A response of 'yes' was assigned to participants who reported ever being diagnosed with any of the following conditions: high blood pressure, angina, myocardial infarction, stroke, diabetes, cardiac arrhythmia, heart murmur, or chronic obstructive pulmonary disease. Participants' self-reported physical activity was categorised as meets recommendations, some activity, or low/very low activity.

5.3.5 Statistical analyses

Analyses accounted for survey design and sampling weights to ensure estimates are representative of the age and sex distribution of those living in Scotland (496). Descriptive statistics (frequencies, percentages, mean and SD) were generated by crosstabulation and were utilised to describe the distribution of proportion of energy derived from home-prepared, RTE and OOH foods across socio-demographic characteristics. The differences between groups were tested using Kruskal-Wallis tests. We conducted a complete case analysis. A total of 6,157 respondents completed SHeS in 2021, from which 3,447 (56%) completed at least one dietary recall. Of these, 405 (12%) completed one dietary recall and 3,042 (88%) completed two dietary recalls. For the current analysis, we used data from participants who had at least one dietary recall (3,447). There was no missing data for age, sex or SIMD. There were less than 2% missing data (including 'don't know' or 'refused') for all socio-demographic characteristics except income. For income, 9% of participants (n = 296) selected 'don't know' or 'refused.' To avoid excluding these individuals, we retained them by creating a separate category for these responses.

Linear regression was used to assess the association between the proportion of energy from home-prepared, RTE and OOH food and age, sex and SIMD. Poisson regression models with robust standard errors were used to evaluate the association between quintiles of proportion of energy from home-prepared, RTE and OOH food (as separate models) and: 1) adherence to individual dietary Goals [binary variable, adheres vs. does not adhere, reported as relative risks (RR) and 95% confidence intervals (CI)], and 2) the composite dietary score [discrete count variable, range 0-10, reported as an incidence rate ratios (IRR) and 95% CIs]. Interaction terms were introduced with age, sex and SIMD to assess effect

modification. All regressions were adjusted for education, income, ethnicity, family history of cardiovascular disease, and chronic disease status. A sensitivity analysis was conducted wherein the independent variables (proportion of energy from home-prepared, RTE and OOH foods) were modelled continuously instead of as quintiles.

The analysis plan was preregistered⁹ and was followed with two minor deviations. First, the primary exposure was quintiles of the proportion of energy from home-prepared, RTE and OOH foods, with continuous proportions presented as sensitivity analyses. This improved interpretability of the findings. Second, age was categorised into three groups rather than seven. All analyses were conducted in R version 4.2 (461).

5.4 Results

Most participants with two dietary recalls consumed home-prepared (94%) and RTE (94%) foods on both days (**Table S12**). OOH foods were less frequently consumed: 26% of participants with two dietary recalls reported consuming them on one day, and just 7% consumed them on both days; 67% did not report consuming OOH food on either day. The most frequently reported home-prepared foods were tea/coffee (22% of all home-prepared food items reported), semi skimmed milk (12%), fruit (10%), and vegetables [including frozen vegetables and canned beans and pulses] (7%). The most frequently reported RTE foods were biscuits (13% of all RTE food items reported), soft drinks (10%), high fibre breakfast cereals (8%), and sugars [including preserves, jam conserves and sweet spreads] (6%). The most frequently reported OOH foods were tea/coffee (13% of all OOH food items reported), cooked vegetable dishes [e.g., onions rings, pakoras, curries, etc.] (3%), and takeaway chips (6%).

5.4.1 Consumption of home-prepared, RTE and OOH foods and differences by age, sex and SIMD

The weighted mean (SD) proportions of energy from home-prepared and RTE food were similar [46.5% (21.0%) and 44.9% (20.3%), respectively], while energy from OOH was much lower [8.6% (16.3%)]. The highest quintile of proportion of energy from home-prepared food ranged from 66% to 100% whereas the lowest quintile ranged from 0% to 31% (**Table S13**). The highest quintile of proportion of energy from RTE food ranged from 60% to 100% whereas the lowest quintile ranged from 0% to 27%. The highest

⁹ <https://osf.io/3p7qg/>

quintile of proportion of energy from OOH ranged from 34% to 100% whereas the second lowest quintile ranged from 0% to 14%. To account for the large number of non-consumers of OOH (n = 2,397), the lowest quintile was set to 0%.

Older adults, females and those living in less deprived areas had a significantly larger proportion of energy from home-prepared foods (**Table 5.1**). For example, comparing those aged 16-34 years and those aged 55 years or more, the mean (SD) was 39.5% (20.9%) versus 51% (19.8%). The mean (SD) was 47.7% (20.6%) for females, compared to 45.1% (21.5%) for males. Comparing those in the most and least deprived areas, the mean (SD) was 42.8% (22.7%) versus 49.6% (20.0%).

Younger adults, males and those living in more deprived areas had a significantly larger proportion of energy from RTE foods (**Table 5.1**). Comparing those aged 16-34 years and those aged 55 years or more, the mean (SD) was 48.2% (21.8%) versus 43.1% (19%). By sex, the mean (SD) was 46.6% (20.6%) for males and 43.2% (19.8%) for females. For the most versus least deprived areas, the mean (SD) was 48.2% (22.5%) and 43.2% (18.9%), respectively.

Younger adults and, to a lesser extent, females had a significantly larger proportion of energy from OOH foods (**Table 5.1**). The mean (SD) was 12.3% (19.6%) in those aged 16-34 years versus 5.8% (12.5%) in those aged 55 years or more, and 9.0% (16.3%) for females versus 8.2% (16.3%) for males.

In multivariable linear regression, wherein age, sex and SIMD were modelled together, adjusting for confounders, similar socio-demographic trends were observed. Older adults, females and those living in less deprived areas had a larger proportion of energy from home-prepared foods (**Table S14**). Conversely, older adults, females and those living in less deprived areas had a significantly smaller proportion of energy from RTE foods. Finally, older adults had a significantly smaller proportion of energy from OOH foods compared to younger adults.

Table 5.1 Weighted proportion of energy derived from food source type by age, sex and Scottish Index of Multiple Deprivation

	n	Home-prepared			RTE			OOH		
		Mean	SD	p-v*	Mean	SD	p-v*	Mean	SD	p-v*
Overall	3,447	46.5	21.0		44.9	20.3		8.6	16.3	
Age										
16-34 years	969	39.5	20.9		48.2	21.8		12.3	19.6	
25-54 years	1,100	47.1	21	<0.001	44.1	20.2	<0.001	8.8	16.8	<0.001
55+ years	1,378	51.0	19.8		43.1	19.0		5.8	12.5	
Sex										
Male	1,664	45.1	21.5	0.01	46.6	20.6	<0.001	8.2	16.3	0.04
Female	1,783	47.8	20.6		43.2	19.8		9.0	16.3	
SIMD										
Q1**	637	42.8	22.7	<0.001	48.2	22.5	0.01	9.1	17.8	0.80
Q2	686	44.8	21.0		45.6	21.0		9.7	17.6	
Q3	652	46.4	20.5		44.5	19.4		9.1	16.8	
Q4	732	48.5	20.5		43.4	19.5		8.2	15.5	
Q5***	739	49.6	20.0		43.2	18.9		7.2	14.0	

* p-value, design based Kruskal-Wallis test

** 1st quartile, most deprived

*** 5th quartile, least deprived

5.4.2 Association of consumption of home-prepared, RTE and OOH foods with adherence to the Scottish Dietary Goals

Higher consumption of home-prepared foods was associated with significantly better adherence to several of the Scottish Dietary Goals. Compared to participants in the lowest quintile, participants in the highest quintile of home-prepared food consumption were more likely to meet the dietary Goals for energy density [RR (95% CI) 5.46 (4.02–7.58)], saturated fat [1.41 (1.12–1.77)], fibre [1.81 (1.12–3.01)], free sugars [3.12 (2.40–4.10)], salt [1.19 (1.04–1.36)], and fruit and vegetables [3.57 (2.67–4.87)], after adjusting for confounders (Table 5.2).

Table 5.2 Association of quintiles of proportion of energy from home-prepared food with adherence to the Scottish Dietary Goals*

Scottish Dietary Goals	Q2	Q3	Q4	Q5
	Q1 (Ref.) - RR (95% CI)			
Energy (<125kcal/100g)	1.57 (1.10–2.28)	2.38 (1.71–3.38)	3.48 (2.54–4.88)	5.46 (4.02–7.58)
Carbohydrates (\leq 50% total energy)	0.91 (0.78–1.06)	0.92 (0.79–1.08)	0.8 (0.68–0.94)	0.61 (0.51–0.73)
Total Fat (\leq 35% food energy)	1.05 (0.88–1.25)	1.18 (0.99–1.40)	1.18 (0.99–1.40)	1.18 (0.99–1.41)
Saturated Fat (\leq 11% food energy)	1.01 (0.79–1.28)	1.01 (0.79–1.28)	1.08 (0.85–1.37)	1.41 (1.12–1.77)
Trans Fat (<1% food energy)	1.00 (0.88–1.12)	0.99 (0.88–1.11)	0.97 (0.86–1.09)	0.92 (0.81–1.04)
Fibre (\geq 18g/day)	1.03 (0.60–1.80)	1.79 (1.11–2.97)	2.13 (1.35–3.49)	1.81 (1.12–3.01)
Fruit & Vegetables (>400g/day)	1.93 (1.41–2.68)	2.72 (2.02–3.73)	3.47 (2.59–4.71)	3.57 (2.67–4.87)
Red & Processed meat (<70g/day)	1.05 (0.92–1.21)	1.09 (0.95–1.25)	1.06 (0.92–1.21)	1.05 (0.92–1.21)
Salt (\leq 6g/day)	1.09 (0.95–1.25)	1.07 (0.94–1.22)	1.10 (0.96–1.26)	1.19 (1.04–1.36)
Free Sugars (\leq 11% total energy)	1.12 (0.82–1.54)	1.46 (1.09–1.98)	2.03 (1.54–2.70)	3.12 (2.40–4.10)
Composite adherence score (IRR (95% CI))	1.05 (0.99–1.12)	1.13 (1.07–1.19)	1.18 (1.11–1.25)	1.25 (1.18–1.32)

*Estimates are from multivariable Poisson regression, adjusted for education, employment, physical activity, income, ethnicity, family history of cardiovascular disease and chronic disease status.

Overall, participants in the highest quintile of home-prepared food consumption had a composite dietary Goal adherence rate 1.25 (95% CI 1.18–1.32) times the adherence rate for those in the lowest quintile, after adjusting for confounders (Table 5.2). Results were consistent when the proportion of energy from home-prepared food was modelled continuously (Table S15).

Conversely, participants in the highest quintile of RTE food consumption were less likely to meet the dietary Goals for energy density [RR (95% CI) 0.26 (0.19–0.35)], saturated fat [(0.78 (0.62–0.99)], free sugars [0.32 (0.24–

0.42)], salt [0.87 (0.76–0.99)], and fruit and vegetables [0.45 (0.33–0.59)] than those in the lowest quintile, after adjusting for confounders (**Table 5.3**).

Table 5.3 Association of quintiles of proportion of energy from ready-to-eat food with adherence to the Scottish Dietary Goals*

Scottish Dietary Goals	Q2	Q3	Q4	Q5
	Q1 (Ref.) - RR (95% CI)			
Energy (<125kcal/100g)	0.24 (0.16–0.36)	0.80 (0.65–0.97)	0.65 (0.53–0.79)	0.44 (0.35–0.56)
Carbohydrates (≤50% total energy)	1.22 (1.02–1.46)	1.40 (1.18–1.68)	1.51 (1.27–1.80)	1.61 (1.35–1.92)
Total Fat (≤35% food energy)	0.99 (0.84–1.18)	1.05 (0.89–1.24)	1.07 (0.91–1.27)	0.96 (0.81–1.14)
Saturated Fat (≤11% food energy)	0.91 (0.74–1.13)	0.87 (0.70–1.08)	0.79 (0.63–0.99)	0.78 (0.62–0.99)
Trans Fat (<1% food energy)	1.06 (0.94–1.19)	1.08 (0.96–1.22)	1.08 (0.96–1.22)	1.10 (0.97–1.24)
Fibre (≥18g/day)	1.37 (0.89–2.12)	1.41 (0.92–2.18)	1.3 (0.84–2.04)	0.92 (0.56–1.52)
Fruit & Vegetables (>400g/day)	1.07 (0.87–1.31)	1.02 (0.83–1.26)	0.88 (0.71–1.10)	0.45 (0.33–0.59)
Red & Processed meat (<70g/day)	0.99 (0.86–1.13)	1.0 (0.88–1.14)	1.03 (0.90–1.17)	0.96 (0.84–1.11)
Salt (≤6g/day)	0.95 (0.84–1.07)	0.94 (0.83–1.06)	0.90 (0.79–1.02)	0.87 (0.76–0.99)
Free Sugars (≤11% total energy)	0.66 (0.54–0.81)	0.54 (0.43–0.66)	0.41 (0.32–0.52)	0.32 (0.24–0.42)
Composite adherence score (IRR (95% CI))	0.97 (0.92–1.03)	0.97 (0.92–1.02)	0.94 (0.89–0.99)	0.87 (0.82–0.92)

*Estimates are from multivariable Poisson regression, adjusted for education, employment, physical activity, income, ethnicity, family history of cardiovascular disease and chronic disease status.

Overall, participants in the highest quintile of RTE food consumption had a composite dietary Goal adherence rate 0.87 (95% CI 0.82–0.92) times the adherence rate for those in the lowest quintile, after adjusting for confounders (**Table 5.3**). Results were consistent when the proportion of energy from RTE food was modelled continuously (**Table S15**).

Participants in the highest quintile of OOH food consumption were less likely to meet the dietary Goals for energy density [RR (95% CI) 0.37 (0.23–0.56)], fat [0.69 (0.53–0.87)], fibre [0.29 (0.10–0.64)], and fruit and vegetables [0.30 (0.18–0.46)] than those in the lowest quintile, after adjusting for confounders (**Table 5.4**).

Table 5.4 Association of quintiles of proportion of energy from out-of-home food with adherence to the Scottish Dietary Goals*

Scottish Dietary Goals	Q2	Q3	Q4	Q5
	Q1 (Ref.) - RR (95% CI)			
Energy (<125kcal/100g)	0.87 (0.66–1.12)	0.72 (0.53–0.95)	0.56 (0.40–0.77)	0.38 (0.24–0.58)
Carbohydrates (\leq 50% total energy)	0.95 (0.78–1.15)	1.04 (0.86–1.24)	1.11 (0.92–1.33)	0.86 (0.68–1.07)
Total Fat (\leq 35% food energy)	0.91 (0.74–1.10)	0.86 (0.70–1.04)	0.86(0.70–1.05)	0.69 (0.53–0.87)
Saturated Fat (\leq 11% food energy)	0.58 (0.41–0.79)	1.01 (0.77–1.29)	0.92 (0.70–1.19)	0.85 (0.62–1.14)
Trans Fat (<1% food energy)	0.98 (0.85–1.12)	1.00 (0.87–1.15)	0.99 (0.86–1.13)	1.01 (0.87–1.17)
Fibre (\geq 18g/day)	0.87 (0.52–1.36)	0.45 (0.22–0.81)	0.65 (0.36–1.08)	0.29 (0.10–0.64)
Fruit & Vegetables (>400g/day)	0.94 (0.73–1.20)	0.71 (0.53–0.93)	0.68 (0.50–0.89)	0.30 (0.18–0.46)
Red & Processed meat (<70g/day)	1.06 (0.91–1.23)	1.01 (0.86–1.17)	1.01 (0.86–1.17)	0.93 (0.78–1.11)
Salt (\leq 6g/day)	0.97 (0.83–1.12)	0.99 (0.85–1.15)	1.05 (0.90–1.21)	0.94 (0.79–1.11)
Free Sugars (\leq 11% total energy)	0.76 (0.55–1.01)	0.68 (0.49–0.93)	0.67 (0.48–0.91)	0.98 (0.71–1.30)
Composite adherence score (IRR (95% CI))	0.93 (0.88–0.99)	0.93 (0.87–0.99)	0.93 (0.87–0.99)	0.83 (0.77–0.89)

*Estimates are from multivariable Poisson regression, adjusted for education, employment, physical activity, income, ethnicity, family history of cardiovascular disease and chronic disease status.

Overall, participants in the highest quintile of OOH food consumption had a composite dietary Goal adherence rate 0.83 (95% CI 0.77–0.89) times the adherence rate for those in the lowest quintile, after adjusting for

confounders (**Table 5.4**). Results were consistent when the proportion of energy from OOH food was modelled continuously (**Table S15**).

Interaction terms between age group, sex and SIMD quintiles with quintiles of home-prepared food consumption were close to 1.0 across all categories, indicating little variation in dietary adherence by these factors (**Table S16**). None of the associations were statistically significant. Similar interaction patterns and non-significant associations were observed for RTE and OOH (**Table S16**). Overall, age, sex and SIMD did not appear to moderate the association between consumption of home-prepared, RTE and OOH and adherence to dietary Goals.

5.5 Discussion

To our knowledge, this study is the first population-based analysis to describe the consumption of home-prepared, RTE and OOH foods within the Scottish population, while also examining variation across socio-demographic characteristics.

The majority of participants (94%) consumed home-prepared and RTE foods on both days of dietary recalls, with approximately 92% of their energy coming from these sources. This indicates a significant reliance on RTE foods in daily meals. Relatively lower consumption of OOH foods was observed, with 33% of participants consuming OOH foods on either or both of their dietary recalls, which accounted for 9% of their total energy intake. Higher consumption of home-prepared foods was observed in older participants, females and those living in the least deprived areas, whereas higher consumption of RTE and OOH foods was observed in younger participants and those living in the most deprived areas. Adults with a larger proportion of energy from home-prepared foods and smaller proportion from RTE and OOH foods were more likely to adhere to the Scottish Dietary Goals. This was true across all age, sex and SIMD groups. These findings emphasise the importance of improving the nutritional profile of RTE foods in order to increase adherence to the Scottish Dietary Goals.

Participants aged 16–34 years obtained nearly 50% of their energy from RTE foods, making them the highest consumers in this category. In line with the findings from this analysis and another prospective cohort study in the UK (498) on socio-demographic associations, another study reported that the consumption of ready meals and takeaways peaked among individuals aged 19–29; adults from higher social classes were more likely to eat out, whereas children from less affluent households consumed takeaways more frequently on a weekly basis (499). Even

studies on online food delivery services show that households with lower social grade are more likely to use takeaway food delivery apps compared with households in the highest grade who used it more for grocery delivery (500).

Along with addressing an important research gap, the findings from this study are supported by previous studies conducted in other parts of the world including the UK. Similar to the findings reported from the Fenland study (495), another study based in the United States found a positive association between cooking frequency and Healthy Eating Index-2015 (491). There is also opposing evidence suggesting that home-prepared food is not a prerequisite for a high-quality diet (501). This study used NDNS data (2008–2016) and compared individuals with low versus high consumption of home-prepared food (501). However, their definition of home-prepared foods excluded items without a recipe, such as pieces of fruit, cereal, toast, and sandwiches, as well as foods that could be eaten on their own or used in prepared dishes, such as milk, cheese, and certain vegetables so the results are not directly comparable. Understandably, the evidence is pretty consistent regarding the association of RTE and OOH with poor diet quality. These tend to be high in calories, total and saturated fats, sugar, and sodium, while being low in fruits, vegetables, and essential micronutrients (212, 502). Further, most RTE foods are classified as ultra-processed (503, 504) and have been linked to several health outcomes such as all-cause mortality, cardiovascular diseases, metabolic syndrome and cancer (505, 506).

Previous research suggests that many factors have contributed to the rise in reliance on RTE and OOH foods, suggesting there are many opportunities to intervene. Qualitative studies highlight that time scarcity, lower cost of take-out and frozen meals, lack of cooking skills, more working women and single person households are key drivers (507, 508) for increased RTE and OOH consumption. Similarly, for the increased use of online services, participants reported motivations to seek comfort food, time and cost considerations, price promotions, low delivery fee and appealing food images as main factors (509). Therefore, policy actions such as restricting promotion of foods high in fat, sugar or salt and product reformulations (510) targeting younger adults and those residing in deprived areas would be needed to improve diet quality at population levels. Longitudinal studies evaluating impact of reformulations demonstrate that these measures are successful (511). Modelling studies show a 20% reduction in fat content of RTE and OOH foods could substantially lower population energy intake, obesity prevalence, and incidence of type 2 diabetes and cardiovascular disease in the UK (512). However, other policies promoting home-prepared food would need to go

hand in hand to improve overall diets. This would require measures to increase affordability of basic ingredients and making minimally processed foods more accessible. Very recently, this has been acknowledged by the UK government as a response to the report “Food, Diet and Obesity Committee’s report 'Recipe for health: a plan to fix our broken food system’” in a policy paper (513). Additionally, it is also important to promote sustainable cooking methods as well as appliances to achieve benefits that have a positive environmental impact (514). The results from this study further confirm policy action in terms of improving diet quality in the Scottish context and are particularly helpful for the Eating Out, Eating Well Framework (45) and Scotland’s Population Health Framework 2025-2035 (26) where one of the focus areas is to enable healthy living by improving diets in Scotland specifically in the deprived areas.

There are some limitations to our study. Although this study is based on the latest nationally representative dietary intake data, it is a cross-sectional analysis and is 4 years old. An analysis of subsequent waves of the SHeS survey would be valuable in determining trends in population subgroups. The data may have been influenced by COVID-19-related restrictions, which could have altered food consumption patterns, including increased home cooking and reduced OOH eating (496). Another challenge was distinguishing between home-prepared and RTE foods based on the current granularity of data collected in Intake24. For example, sandwiches, may be purchased ready-made from retail outlets, assembled at home using store-bought bread, or prepared entirely from scratch by baking bread at home. So, clear-cut distinctions are not always possible. Although these categorizations are commonly used, achieving conceptually clear or mutually exclusive definitions is challenging. Terms such as “home-prepared food” and “cooking” are not universally defined in the academic literature (515). There is ongoing debate over what constitutes cooking, for example, whether applying heat qualifies, or if additional preparation steps such as chopping and mixing are required. These concepts are also subject to individual interpretation, with participants differing in how they classify foods based on personal perceptions (516). Foods prepared at home can vary widely in the degree of preparation involved, ranging from meals cooked entirely from raw ingredients to simply heating pre-prepared or ultra-processed products (504). These perceptions are further influenced by cultural norms, cooking skills, and household circumstances (495). These challenges are deepened by changes in the contemporary food environment, including the increased availability of convenience foods, meal kits, and food delivery services, which blur the traditional boundaries between home and OOH food provision (499, 517). As such, the category of “home-prepared” does

not necessarily equate to healthier or less processed food. Similarly, there is no consensus in defining OOH foods. A systematic review on eating OOH and its association with dietary intake notes that different studies use different classifications (518). This heterogeneity in definitions is a limitation in understanding and comparing the nutritional impacts of OOH eating.

Further, misreporting in self-measured dietary instruments is a well-documented limitation (519, 520). Specifically, foods eaten outside the home are more prone to being under reported (521). However, the use of the multiple-pass method in this study is likely to have mitigated some of this bias (522). Further, although our analyses adjusted for several relevant potential confounding factors, residual confounding is always possible. We did not consider cost of home-prepared versus RTE and OOH foods. This is an important consideration before home-prepared food could be promoted. Some studies have shown that home-prepared food can be costlier when time and energy cost is added (523-525). For people experiencing energy poverty, or not using energy-efficient appliances, may increase energy costs unnecessarily (451, 514).

Additionally, future work could incorporate other factors that impact diet quality such as cooking skills (171), time (526) and food availability (163). It would also be helpful in the future to better understand the high use of RTE foods, as they not only have low nutritional value but have high environmental impacts (406, 527).

This study also has several advantages. This is the first account of consumption patterns of home-prepared, RTE, and OOH foods in Scotland. As this analysis is based on food consumption data rather than purchase records or measures of cooking frequency, it offers a better estimate of dietary exposure. Individuals may acquire or prepare foods without consuming them and likewise may consume foods not procured or prepared by themselves. Further, in addition to utilising the meal sourcing questions embedded within Intake24, we applied a manual categorisation procedure to classify foods as home-prepared, RTE or OOH, thereby ensuring greater precision and consistency in the classification process. Lastly, we examined energy contributions from all food sources—home-prepared, RTE, and OOH—providing a holistic view. Astbury et al. focused only on home-prepared foods and suggested that other components, such as RTE and OOH, should also be considered to improve overall diet quality (494).

5.6 Conclusions

This study highlights that the majority of participants relied on a mix of home-prepared and RTE foods, with over ninety percent of their daily energy intake derived from these sources. Notably, RTE and OOH consumption was high among younger individuals, males and those living in more deprived areas. People who consume more RTE and OOH foods were less likely to adhere to the Scottish Dietary Goals. In contrast, greater consumption of home-prepared foods was linked to better diet quality.

These findings underscore the need for interventions to reduce overconsumption of RTE and OOH foods, particularly among younger adults and those in deprived areas as well as innovations to improve the nutritional quality of RTE foods, given that their consumption is likely to persist. These insights are especially timely for informing and supporting other national efforts to improve dietary outcomes in Scotland.

Chapter 6

Conclusion

6. Conclusion

Understanding food environments is crucial because they directly shape what people eat, their nutrition, and their overall health. More so now as the narrative has shifted from 'responsible consumer choices' to the food environment approach. This approach recognises that the choices one makes about food are shaped by the contexts within which they are made. Hence, these environments become an important point of intervention towards achieving a healthy population. Current food environments are not making healthy food choices easy. We need systematic changes to create food environments that make healthy eating the default choice, while limiting the availability and promotion of unhealthy foods.

This thesis ultimately sought to provide evidence to inform data-driven improvements to the Scottish food environment. This was driven by a systematic review of the literature on UK food environments which identified a key gap in terms of studies in Scotland, as well as informal consultations with stakeholders in Scotland, e.g., FSS and Nourish Scotland. The insights generated from this research are timely, aligning with the Scottish Government's commitment to improving food environments through initiatives such as the Good Food Nation Act (44) and the Population Health Framework 2025–2035 (26).

6.1 Insights generated from this work

This work resulted in four key insights.

First, current food environment research primarily focuses on food availability and food store environments, with the main emphasis on their association with obesity. Specific to Scotland, most research identified was conducted in Glasgow. Five articles that examined multiple areas, all focussed on the availability domain. Additionally, two policy analyses were identified: one assessing the impact of voluntary sodium reduction targets in processed foods, and another evaluating the Universal Infant Free School Meal initiative. A narrow evidence base creates blind spots. It means that policies may be designed around the needs of urban populations, or around a single domain (availability), rather than the full set of factors that shape dietary behaviour. More research is needed that focusses on multiple domains and across multiple geographies to provide a wide-ranging understanding of the UK food environment and to support the development of Scotland's Good Food Nation Plans. A more comprehensive evidence base is essential for understanding how food environments differ across Scotland's 32 local authorities, identifying where inequalities are most rooted, supporting local authorities to design tailored interventions, thereby enabling national monitoring of progress toward dietary and sustainability goals.

Second, while numerous frameworks describe the various domains of food environments, research has largely focussed on availability, promotion, and, more recently, sustainability. In contrast, the domain of convenience remains poorly defined, highlighting a critical gap in the literature. Convenience can be objectively measured as the weekly time spent on food-related tasks (planning meals, procuring food, cooking, consuming and cleaning up). Within convenience, personal characteristics (i.e., income, family size, gender, food choices, cultural beliefs and practices) interact with product characteristics (level of processing and packaging) and influence time spent on food-related tasks and whether the food environment is perceived as 'convenient.' This work highlights a critical conceptual and methodological gap in the literature and provides a foundation for future empirical research. Ignoring time scarcity risks designing policies that are unrealistic for time poor households. Understanding it could support interventions that reduce the time burden of healthy eating such as healthier RTE options. This insight opens a new research area, positioning convenience as a measurable, actionable domain.

Third, food environments influence diet quality which in turn could contribute to health inequalities. Analysis of food businesses in Scotland revealed that OOH outlets far outnumber retail in all of Scotland, with takeaways more common in deprived areas and restaurants and cafes in affluent ones. It also highlighted unique food environments in different local authorities. These findings reveal distinct local food environments across Scotland and indicate that national policies must be adapted to local contexts. This insight underscores the need for targeted interventions in high takeaway density areas and place-based strategies tailored to each local authority's food environment

Fourth, analysis of food consumption data revealed that the majority of adults consumed both home-prepared and RTE foods daily, with more than 90% of their total calories from these sources. Greater consumption of home-prepared foods and lower consumption of RTE and OOH was linked to higher adherence to Scottish Dietary goals. Unhealthy food consumption, including both RTE and OOH foods, was disproportionately higher among younger individuals, males, and those living in more deprived areas, emphasising the need for interventions to enhance the healthfulness of such foods as well as to address dietary inequalities. These findings highlight both the nutritional implications of food sourcing and the socioeconomic inequalities inherent within them. It also highlights the need to improve the healthfulness of RTE and OOH foods, given their central role in Scottish diets.

Taken together, these insights reinforce the need for system level changes in support of healthier food environments in Scotland. The *EAT-Lancet* report also echoes that governments must implement policies to make healthy food the norm (528). Among its many recommendations are restrictions on promotions of unhealthy products, subsidies to make nutritious foods more affordable, and measures to enhance the purchasing power of low-income households (528). This underpins the need to expand food environment research to domains other than availability. The cost of food or affordability has been reported as the most common factor preventing people from adopting healthier diets, highlighting that financial and resource limitations can override knowledge or intent (9, 529). Nourish Scotland, under the Our Right to Food initiative, is developing an indicator to monitor the ability of those most at risk of rights violations to access a healthy, sustainable, and culturally appropriate diet (530). This work is guided by creating healthy shopping baskets for typical households in Scotland and measure its affordability over time. Further, as highlighted in **Chapter 4** and **Chapter 5**, improvements in both retail and OOH are needed. Food retail has been recognised as one of the seven entry points for creating enabling food

environments by EU Food Policy Coalition (531). They recommend policy actions such as improved store layouts promoting plant-based foods and removal of nutritionally poor foods.

The evidence generated in this thesis provides essential local insight to inform these policy directions and supports the development of forthcoming Good Food Nation Plans by local authorities, health boards, and national policymakers. Below listed are actionable, food system-based pathways for strengthening Scotland's food environment policies:

1. The systematic review revealed that UK food environment research remains heavily concentrated on availability, obesity, and a small number of geographic areas. This narrow evidence base reflects a system in which certain domains are easier to measure and align with existing policy structures, while others remain overlooked despite their importance for dietary behaviour. It would be helpful to invest in developing a national food environment monitoring system that captures all domains, availability, affordability, promotion, convenience, and sustainability across all local authorities. This system should be supportive of local authorities to conduct their own assessments, ensuring rural, island, and remote communities are not excluded from Good Food Nation planning. Further, investing in policy evaluation will be essential as regular feedback loops strengthen learning and adaptation.

2. Narrow research focus limits policy action. By broadening the evidence base on rural and more deprived SIMD areas, policy makers can better identify leverage points within the food system and design interventions that reflect local realities.

3. It would be helpful to incorporate the convenience metric into national dietary monitoring, as a subsection to the Scottish Health Survey or UK time use surveys, recognising time as a structural determinant of diet. This could help in designing policies that reduce the time burden of healthy eating such as subsidising healthy RTE options, supporting community kitchens, or incentivising retailers to offer healthier convenience foods. This would require engaging industry in reformulating healthier convenience products (532).

4. The mapping of food outlets across Scotland revealed economic inequality, commercial concentration, and planning decisions that reinforce poor diet quality in disadvantaged communities. There are policies limit the proliferation of unhealthy outlets but these are voluntary. Strengthening planning in deprived areas along with creating an equity metrics into Good Food Nation Plans, that requires local authorities to

report on disparities in access to healthy vs. unhealthy outlets could be useful (533).

5. Analysis of Scottish Health Survey data showed that younger adults and those in deprived areas consumed more RTE and OOH foods and were less likely to meet dietary goals. These patterns reflect structural constraints such as income, retail access, and marketing exposure rather than individual choice. Using consumption data to inform pricing policies, including subsidies for healthy foods or levies on nutritionally poor RTE/OOH products would be useful. This would require multi-level, system wide action and strengthen national efforts like calorie labelling, portion size guidance, and reformulation targets.

By embedding food environment policy within a broader systems framework, Scotland can move beyond focusing solely on individual behaviour change and instead create the structural conditions needed for healthier, more equitable, and sustainable diets. Existing policies and frameworks can be leveraged to support this approach. For example, the Good Food Nation (Scotland) Act 2022 (44) requires national and local Good Food Nation Plans, but these plans would benefit from a broader evidence base encompassing all food environment domains, equity indicators, and convenience considerations. Similarly, the Population Health Framework 2025–2035 (26) identifies “Enabling Healthy Living” as a priority, yet currently lacks comprehensive food environment metrics. The Diet and Healthy Weight Delivery Plan (2018) (534) highlights reducing inequalities but does not include tools to assess time-related barriers. The Right to Food (530) commitment should explicitly consider affordability, convenience, and accessibility as structural determinants. Finally, the Out of Home Action Plan (45), which seeks to improve the healthfulness of out-of-home foods, could be strengthened by integrating considerations of convenience and pricing.

6.2 Strengths of the research approach

The biggest strength of this research is that it is the product of a systematic process through which gaps were identified and methods chosen and applied to fill those gaps. The informal consultation of key stakeholders in Scotland also strengthened the research approach. Together, these steps ensured that the evidence generated by this thesis addresses unmet research needs and supports the translation of knowledge into policy. **Chapter 3** adds to the understanding of convenience in food environments and is a product of insightful conversations with many food environment experts.

Next, in **Chapter 4** and **Chapter 5** of this thesis, I have utilised the most recent nationally representative open-source data that is routinely collected by the Scottish Government, which strengthens the credibility of the findings and their potential uptake by policymakers. This approach resonates with the perspective shared by Abimbola (2021), who recommends caution while equating rigour with universal validity or standardisation, and instead lays emphasis on generating contextual, locally meaningful knowledge that may lead to equitable action within specific settings (535). Specifically, in **Chapter 4**, the research integrated various government datasets to analyse and present evidence of socioeconomic and geographic disparities. And therefore, provides a comprehensive understanding by combining data on population density, area density, outlet density and SIMD. Similarly, the analysis in **Chapter 5** is centred around Scottish Dietary Goals assuring that it is aligned with national priorities, facilitating its policy relevance. An additional strength of this work is its strong alignment with FSS's current focus on OOH food consumption. **Chapter 4** and **Chapter 5** together provide a comprehensive view of the food environment by addressing two crucial aspects: the availability of food outlets and the consumption patterns from these sources.

Further, this research is also methodologically strong and reproducible. The systematic review drew on seven databases to identify relevant articles. The food business dataset was developed using novel AI-assisted methods combined with detailed manual data classification. For **Chapter 5**, survey-weighted 24-hour dietary recall data were used to reduce potential biases arising from the survey's sampling design and from differential non-response among participants. All code and underlying data used in the thesis including the data extraction database from **Chapter 2** is publicly and freely available without restriction at Figshare, while the dataset, R script, and python notebook used in this thesis are available on GitHub which will facilitate use of this approach in similar future studies.

This thesis sets up a strong foundation for future research. The Good Food Nation Dashboard for local authorities and health boards integrates various national datasets and will integrate the food business dataset I generated in **Chapter 4**. It is also going to be used on a FSS funded project, focussed on understanding OOH intake and behaviours among adults living in Scotland. Overall, this research presents a comprehensive, policy relevant body of work to produce timely insights that can be used to improve population health which is especially critical as Scotland continues to have the lowest life expectancy in the UK and Western

Europe (5), alongside a projected 21% rise in disease burden over the next two decades (536).

6.3 Limitations of the research approach

A major limitation of this thesis, across all aims except **Chapter 3**, is the lack of consideration of the increasingly relevant digital food environment. The rise of food aggregator apps used for both food and grocery delivery and 'dark kitchens' has altered food access. Another important aspect of the food environment that wasn't considered was food insecurity and food bank use, both of which are important in the context of the current cost-of-living crisis. In **Chapter 4**, I found a high proportion of charity /community organisations in the Highlands. Qualitative research was not included in this thesis, though such approaches can offer valuable insights into the lived realities of individuals. For example, experiences may differ substantially between urban areas such as Glasgow and rural regions, or even between island contexts- such as the Highlands, which benefit from substantial tourist infrastructure, versus the more remote Western Isles. A deeper understanding of the food environment from people's perspectives will facilitate the development of more effective interventions to promote positive changes in public health.

Apart from those mentioned above, limitations specific to each aim are summarised below. In **Chapter 2**, search terms relating to food banks, charities, and cultivated or natural food environments were not included. In addition, many publications from third-sector organisations and government reports may have been overlooked, as grey literature was not referenced. In **Chapter 4**, the initial classification of food outlet type relied on the owner's discretion, as they self-selected their outlet category, which may have led to misclassification. With reference to **Chapter 5**, although latest available data from the SHeS survey was used, the insights represented are four years old. Though NDNS data suggests that there aren't many differences in diet over short periods (20). Another operational challenge was with the granularity of data collected in Intake24, grey areas often arise when distinguishing between home-prepared and RTE foods. For example, sandwiches, may be purchased ready-made from retail outlets, assembled at home using store-bought bread, or prepared entirely from scratch by baking bread at home. Such variability makes strict categorisation challenging, as clear-cut distinctions are not always possible.

6.4 Future work

If the work presented in this thesis were to be repeated, I would begin by revising the search terms more comprehensively to ensure that all aspects of the food environment are captured. I would also include reports and publications from government organisations such as FSS, PHS, the Scottish Government Good Food Nation team, and Zero Waste Scotland, as well as from independent organisations that collaborate with government and advocate on various aspects of the Scottish food environment. These include Nourish Scotland, the Scottish Food Coalition¹⁰, Slow Food Scotland¹¹, and the Scottish Obesity Alliance¹².

Future research on the conceptual model of convenience could focus on testing a metric that estimates the time-cost burden of food-related tasks among Scottish individuals. A useful starting point may be the citizen science cooking survey, which collected data on household cooking habits—including cooking time and method—across 10 countries, including the UK (537). This could be complemented with qualitative research to explore how convenience is perceived, including the role of time spent engaging with the digital food environment across different population groups.

Next, in addition to the dataset used in **Chapter 4** which combined FSA outlet data with population density and SIMD, I would also explore ways to integrate the SHeS dataset. That would provide holistic insights about consumption, disease prevalence and outlet availability at both local authority level and deprivation level. This dataset could also facilitate more robust analyses of longitudinal trends. Other variables available in the FSA dataset like geocodes, could also be explored for a more granular understanding. Incorporating information on whether a food business offers delivery, or is listed on platforms such as Uber Eats, Deliveroo or Just Eat, would be very valuable for understanding access beyond the density of outlets.

Substantial work is being led by FSS to improve various aspects of the food environment across Scotland, and the findings from this thesis could serve as a valuable foundation for many of these interventions and actions. For example, FSS, in partnership with the Scottish Food Enforcement Liaison Committee and the Diet, Nutrition and Health Working Group, piloted MenuCal—a web-based tool designed to help food businesses

¹⁰ <https://foodcoalition.scot/>

¹¹ <https://www.slowfood.org.uk/slow-food-scotland/>

¹² <https://www.scottishobesityalliance.org/>

calculate calorie and allergen information (538). The pilot demonstrated that the tool not only supported compliance but also encouraged some product reformulation and portion size adjustments. Building on to the dataset analysed in **Chapter 4**, this initiative could be scaled up to include all food businesses in Scotland, providing a strong platform to monitor and evaluate the uptake of voluntary reformulation efforts within the OOH sector.

Overall, the findings of this thesis, combined with the broader systems thinking perspective, highlight several important avenues for future research:

1. How can future systematic reviews better capture the full breadth of food environment domains including convenience, affordability, promotion, and sustainability through improved search strategies and inclusion of grey literature?
2. What insights emerge when government and third sector reports (e.g., FSS, PHS, Good Food Nation team, Zero Waste Scotland, Nourish Scotland, Scottish Food Coalition) are systematically integrated into food environment evidence reviews?
3. How can Scotland develop a comprehensive, multi domain food environment monitoring system that aligns with Good Food Nation ambitions and supports local authority planning?
4. How valid and reliable is the proposed “weekly time cost burden” metric for measuring convenience among Scottish households?
5. How do different population groups in Scotland perceive convenience, and how do these perceptions interact with time, income, digital food environments, and cultural norms? How does engagement with digital food environments (e.g., delivery apps, online grocery shopping, recipe platforms) shape perceptions of convenience and influence dietary behaviours?
6. How can FSA outlet data, Scottish Health Survey (SHeS) or other national dietary intake data, and SIMD be integrated to examine relationships between outlet availability, consumption patterns, and health outcomes at local authority and neighbourhood levels?
7. What longitudinal trends in food outlet distribution, dietary behaviours, and health outcomes can be identified through linked datasets?

8. How does the availability of delivery services (e.g., Uber Eats, Deliveroo, Just Eat) reshape access to food, particularly in deprived or rural areas?

These provide a clear roadmap for researchers, policymakers, and practitioners seeking to build on the foundations laid by this thesis.

Further, successful policies and initiatives implemented in other countries could also serve as a valuable foundation for pilot testing and adaptation within the Scottish context. The Mexican government has implemented a ban on the sale of ultra-processed foods, sugary drinks, and products carrying warning labels in schools to promote healthier eating habits (539). Building on Scotland's existing Nutritional Requirements for Food and Drink in Schools (Scotland) Regulations, which set mandatory standards and limit the provision of HFSS products, a similar ban on the sale of such items could be highly beneficial. This would be particularly valuable in for secondary schools, as high energy density and calories from free sugars have been reported in the national dietary survey for children in Scotland (540). Evaluations of England's HFSS product placement policy revealed a spill-over effect in Scotland, with reduced sales of HFSS products, indicating that comparable measures could yield positive outcomes in Scotland (67).

Similarly, the UK Code of Non-broadcast Advertising, Direct and Promotional Marketing restricts advertisements for HFSS products aimed at audiences under 16 years of age; however, adherence to this code is self-regulatory rather than mandatory. In contrast, Chile has implemented a comprehensive "daytime" ban on advertising such products across all television channels between 6 a.m. and 10 p.m. (541). This strict regulation has led to a 73% reduction in children's exposure to unhealthy food advertising on television and a 64% decrease in overall advertising of these products (541). While similar restrictions were initially set to take effect in January 2023 under the UK Health and Care Act (2022), their implementation has been delayed until 2026 (542). Learning from these successes, similar regulatory approaches could be beneficial in Scotland to reduce children's exposure to unhealthy food marketing. Colombia has introduced a gradually increasing tax on ultra-processed foods, starting at 10% and rising to 20% by 2025, to curb obesity and related diseases while addressing its fiscal deficit. The tax targets foods high in salt, saturated fat, and processed ingredients. Authorities hope that, over time, healthier consumer and vendor choices will make revenue from the tax minimal (543). The same tax is being deliberated in the UK (544).

Further, in lines with the transformation towards sustainable food systems Denmark developed the world's first national action plan for plant-based foods in 2023 (545). This national action plan aligns with the Nordic Nutrition Guidelines, and with Denmark's Climate Programme, which identify plant-based diets as essential for both health and climate mitigation (545). Many cross-sector initiatives are proposed for strengthening the green transition and reducing greenhouse gas emissions which could also be adopted for Scotland.

Another crucial consideration is understanding why, despite numerous policies and initiatives to improve diets, success remains limited. To enhance both effectiveness and equity, policymakers must take into account how people actually live, the trade-offs they face, the values that guide their choices, and the constraints that shape their options (546). Policies should therefore be designed, implemented, and evaluated with this full picture in mind, rather than relying on one-dimensional interventions. The full picture tool is especially important when addressing dietary inequalities, as people in more deprived areas often experience overlapping barriers that reduce the impact of simple policy levers unless these complex realities are fully considered (546).

Another initiative that fulfils addressing multiple domains in the food environment is the concept of public dining. Nourish Scotland has been gathering evidence to reintroduction of this concept positioning access to good food as a state responsibility comparable to the provision of public hospitals, libraries, and parks (547). These are government supported restaurants that provide healthy, low cost, and sustainable meals to people. Historically, in the post-World War II period, the UK government operated many subsidised civic restaurants which provides a precedent for such an approach (548). As a model, these dining spaces address multiple key domains such as affordability (through govt subsidies), quality (offering healthy, nutritious meals), availability (providing access to healthy meals in an OOH setting) and sustainability (through local sourcing, reduced carbon emissions and food waste) (547).

6.5 Personal reflections on the research process and findings

This period of research significantly deepened my understanding of food environments and how they shape dietary behaviours and health inequalities in Scotland. Working across multiple methodologies, from systematic review to conceptual model development, spatial analysis, and dietary assessment, allowed me to appreciate the complexity of the food

system in a way I had not fully grasped before. What began as an exploration of discrete domains of food environment, evolved into a broader recognition that food choices are embedded within interconnected social, economic, political, and commercial systems.

Broadly, this research strengthened my appreciation of systems thinking. It reinforced that improving diets requires far more than targeting individual behaviour; it requires coordinated, system level changes across planning, retail, public health, social policy, and commercial regulation. Engaging with policy frameworks such as the Good Food Nation agenda showed me how research can directly inform real world policy, but also how gaps in evidence can limit policy effectiveness. For example, the absence of research on convenience, the limited geographic coverage of Scottish food environment studies, and the lack of integrated datasets all represent barriers to designing equitable and context sensitive interventions. Seeing these gaps first hand, strengthened my belief in the value of rigorous, policy relevant research that is attentive to context and equity.

My previous professional experience in implementation research gave me a strong grounding in primary research. That work provided invaluable field experience and helped me understand the nuances of data collection, community engagement, and operational challenges. However, it also sparked a growing interest in secondary research, which this PhD has allowed me to explore to its full potential. Transitioning from implementation to analysis pushed me out of my comfort zone and helped me sharpen my skills in evidence synthesis, conceptual thinking, and data interpretation. It also reshaped my perspective on the power of secondary research to generate insights that can guide policy and systems change.

After spending the first two years of my PhD in India, it felt opportune to finally move to Scotland and experience the food environment in person. This transition was particularly meaningful because the food environments in India and Scotland are profoundly different. India's food landscape is characterised by a vast network of unorganised retail, informal markets, street vendors, and small family-run shops. These settings create a dynamic, highly accessible, and often hyper-local food system. In contrast, Scotland's food environment is far more structured, regulated, and dominated by formal retail and OOH sectors. Experiencing these differences first hand enriched my understanding of how food environments are shaped by cultural, economic, and regulatory contexts. It also helped me appreciate why policy solutions cannot be transplanted across countries without considering the underlying systems that sustain

them. Being physically present in the context I was studying added depth and nuance to my understanding. It allowed me to observe the lived realities of affordability and access. Given my background in implementation research, being able to experience the context of my thesis was vital, it grounded the analysis in real world conditions and strengthened the relevance of my findings.

Throughout this journey, I developed a wide range of practical research skills. Conducting a systematic review taught me how to navigate large bodies of literature and critically summarise evidence. Developing a conceptual model of convenience required integrating theoretical frameworks with qualitative insights from expert interviews. Working with large datasets, from the Food Standards Agency and SHeS enhanced my analytical skills and deepened my understanding of how to translate raw data into meaningful public health insights. Across all chapters, I learned how to identify gaps, frame research questions, and translate findings into actionable policy recommendations.

Perhaps most importantly, this work highlighted the importance of equity focused and context sensitive approaches to both research and policy in Scotland. The clear socioeconomic gradients in outlet distribution, consumption, and access to healthy food underscored the need for interventions that address structural inequalities rather than individual behaviours alone. It also reinforced the importance of understanding local contexts- urban, rural, islands and highlands, and everything in between, when designing food environment policies.

Overall, this research journey has shaped not only my understanding of food environments but also my perspective on public health more broadly. It has shown me the value of interdisciplinary thinking, the importance of grounding policy in robust evidence, and the need to centre equity in all efforts to improve population diets. It has been both challenging and deeply rewarding, and it has strengthened my commitment to contributing to healthier, fairer, and more sustainable food systems in Scotland.

6.6 Conclusion

We are living in a world today, where old challenges like malnutrition haven't been resolved and new challenges like climate crisis or unsustainable food systems are becoming an increasing concern. As public health advocates, we need to find balanced solutions that improve population health without creating unintended consequences. This brings us to creating a world where healthy eating is the default choice,

people are mindful of food waste, there's respect for those who grow food, and overall eating healthy is easy- accessible and affordable to everyone. If we reshape the context in which people make food decisions to support health, we can achieve both healthier populations and a healthier planet. This, at its core, is what food environments are about.

The results presented in this thesis clearly highlight the research gaps in food environment research in Scotland. They also show the value of examining multiple domains of the food environment simultaneously, highlighting both the trade-offs and synergies between them. Moreover, using national datasets offered crucial local evidence for understanding Scottish food environments. This ensures that the insights are both relevant and reliable, supporting local authorities and health boards in shaping Good Food Nation Plans, while also contributing to the development of national policies that aim to improve food environments across Scotland.

References

1. The Food Systems Dashboard [Internet]. 2025 [cited 12/03/2026]. Available from: <https://www.foodsystemsdashboard.org/information/about-food-systems>.
2. The Health Foundation Health in 2040: projected patterns of illness in England: The Health Foundation; 2025 [Available from: <https://reader.health.org.uk/projected-patterns-of-illness-in-england/projections-of-ill-health-overall-levels-of-ill-health-in-england-over-the-next-20-years#demographic-changes-drive-the-projected-growth-of-ill-health>].
3. OECD. Health at a Glance 2017: OECD Indicators. 2017.
4. Nick Payne KBea. Adult Overweight and Obesity Prevalence Projections. Cancer Research UK; 2022.
5. Scottish Government Life Expectancy in Scotland 2020-2022 Provisional Figures. In: Scotland NRo, editor. Scotland2023.
6. Public Health Scotland Scottish Burden of Disease study-Forecasting the future burden of disease: Incorporating the impact of demographic transition over the next 20 years. Scotland: Public Health Scotland; 2022 November 2022.
7. Public Health Scotland Primary 1 Body Mass Index (BMI) statistics Scotland: Public Health Scotland; 2022 [Available from: <https://publichealthscotland.scot/publications/primary-1-body-mass-index-bmi-statistics-scotland/primary-1-body-mass-index-bmi-statistics-scotland-school-year-2021-to-2022/#:~:text=Marked%20socioeconomic%20inequalities%20in%20child,in%20the%20least%20deprived%20areas>].
8. Chavez-Ugalde Y, De Vocht F, Jago R, White M, Toumpakari Z. Using group model building to frame the commercial determinants of dietary behaviour in adolescence - findings from online system mapping workshops with adolescents, policymakers and public health practitioners in the Southwest of England. BMC Public Health. 2025;25(1):144.
9. Wagstaff C, Pettinger C, Relton C, Psarikidou K, Swan E, Methven L, et al. Addressing food system determinants of health inequalities in urban environments: learnings from the FoodSEqual and FoodSEqual-Health projects. Philos Trans R Soc Lond B Biol Sci. 2025;380(1935):20240150.
10. UK Parliament Diet-related health inequalities In: Technology TPOoSa, editor. Westminster, London UK Parliament; 2022.
11. Moore HLaN, H. . Food in the UK: Addressing Food Insecurity in the 21st Century. . London: Institute for Global Prosperity, UCL.; 2025.
12. Johnstone AM, Lonnie M, team FIOFp. Tackling diet inequalities in the UK food system: is food insecurity driving the obesity epidemic? (The FIO Food project). Proc Nutr Soc. 2024;83(3):133-41.

13. Office for National Statistics (ONS), ONS website, statistical bulletin, . Family spending in the UK: April 2023 to March 2024 2025 [updated 10 September 2025]. Available from: <https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/expenditure/bulletins/familyspendingintheuk/april2023tomarch2024#cite-this-statistical-bulletin>.
14. Deakin E WV, Birtwistle S, McClelland R, Fox J, Biggs H, Minty S. The Scottish Health Survey Main Report. In: Research SCfS, editor. 2023.
15. Scarborough P, Clark M, Cobiaci L, Papier K, Knuppel A, Lynch J, et al. Vegans, vegetarians, fish-eaters and meat-eaters in the UK show discrepant environmental impacts. *Nat Food*. 2023;4(7):565-74.
16. Tonini D, Albizzati PF, Astrup TF. Environmental impacts of food waste: Learnings and challenges from a case study on UK. *Waste Manag*. 2018;76:744-66.
17. Garvey A NJ, Owen A, Barrett J. Towards net zero nutrition: The contribution of demand-side change to mitigating UK food emissions,. *Journal of Cleaner Production*. 2021;290.
18. (IHME) IfHMaE. Global Burden of Disease Results Tool (GBD 2019) In: Washington Uo, editor. Seattle, WA2024.
19. Schulze MB, Martinez-Gonzalez MA, Fung TT, Lichtenstein AH, Forouhi NG. Food based dietary patterns and chronic disease prevention. *BMJ*. 2018;361:k2396.
20. Caireen Roberts KJ, David Collins and Polly Page, Beverley Bates, Gillian Swan and Jo Nicholas. National Diet and Nutrition Survey 2019 to 2023: report. In: Disparities OfHI, editor. 2025.
21. Food Standards Scotland Estimation of food and nutrient intakes from food purchase data in Scotland between 2001 and 2018. Scotland: Food Standards Scotland 2022 2 February 2022.
22. Theis DRZ, White M. Is Obesity Policy in England Fit for Purpose? Analysis of Government Strategies and Policies, 1992-2020. *Milbank Q*. 2021;99(1):126-70.
23. Booth KM, Pinkston MM, Poston WS. Obesity and the built environment. *J Am Diet Assoc*. 2005;105(5 Suppl 1):S110-7.
24. Bridle S, Parsons K, Poppy G, Duncombe T, Dicks LV, Doherty B, et al. Key action areas for transforming the UK food system: insights from the Transforming UK Food Systems (TUKFS) Programme project portfolio. *Philos Trans R Soc Lond B Biol Sci*. 2025;380(1935):20240166.
25. Spiro A, Bardon L, Fanzo J, Hill Z, Stanner S, Traka MH. Every Person Counts in a Fair Transition to Net Zero: A UK Food Lens Towards Safeguarding Against Nutritional Vulnerability. *Nutr Bull*. 2025;50(4):683-702.
26. (COSLA) SGaCoSLA. Scotland's Population Health Framework 2025-2035. Scotland; 2025.
27. Breslin G, Fakoya O, Wills W, Lloyd N, Bontoft C, Wellings A, et al. Whole systems approaches to diet and healthy weight: A scoping review of reviews. *PLoS One*. 2024;19(3):e0292945.
28. Glanz K, Sallis JF, Saelens BE, Frank LD. Healthy nutrition environments: concepts and measures. *Am J Health Promot*. 2005;19(5):330-3, ii.

29. Story M, Kaphingst KM, Robinson-O'Brien R, Glanz K. Creating healthy food and eating environments: policy and environmental approaches. *Annu Rev Public Health.* 2008;29:253-72.
30. Swinburn B, Vandevijvere S, Kraak V, Sacks G, Snowdon W, Hawkes C, et al. Monitoring and benchmarking government policies and actions to improve the healthiness of food environments: a proposed Government Healthy Food Environment Policy Index. *Obes Rev.* 2013;14 Suppl 1:24-37.
31. The Food Foundation Food Environment Policy Index (Food-Epi) for England The Food Foundation 2017.
32. Herforth A, Ahmed S. The food environment, its effects on dietary consumption, and potential for measurement within agriculture-nutrition interventions. *Food Secur.* 2015;7(3):505-20.
33. Nations FaAOotU. Influencing food environments for healthy diets. Rome 2016.
34. (HLPE) HLPoEoFSaN. Nutrition and food systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.; 2017 September 2017.
35. NUTRITION GPOAAFSF. Improving nutrition through enhanced food environments. 2017 May 2017.
36. Turner C, Aggarwal A, Walls H, Herforth A, Drewnowski A, Coates J, et al. Concepts and critical perspectives for food environment research: A global framework with implications for action in low- and middle-income countries. *Global Food Security-Agriculture Policy Economics and Environment.* 2018;18:93-101.
37. Downs SM, Ahmed S, Fanzo J, Herforth A. Food Environment Typology: Advancing an Expanded Definition, Framework, and Methodological Approach for Improved Characterization of Wild, Cultivated, and Built Food Environments toward Sustainable Diets. *Foods.* 2020;9(4).
38. Osei-Kwasi HA, Laar A, Zotor F, Pradeilles R, Aryeetey R, Green M, et al. The African urban food environment framework for creating healthy nutrition policy and interventions in urban Africa. *PLoS One.* 2021;16(4):e0249621.
39. Bogard JR, Andrew NL, Farrell P, Herrero M, Sharp MK, Tutuo J. A Typology of Food Environments in the Pacific Region and Their Relationship to Diet Quality in Solomon Islands. *Foods.* 2021;10(11).
40. Cong N, Zhao A, Kwan MP, Yang J, Gong P. An Indicator Measuring the Influence of the Online Public Food Environment: An Analytical Framework and Case Study. *Front Nutr.* 2022;9(Front Nutr. 2022; 9: 818374.):818374.
41. Gupta N, Deshmukh V, Verma S, Puri S, Tandon N, Arora NK. Food environment framework in low- and middle-income countries- An integrative review. *Global Food Security-Agriculture Policy Economics and Environment.* 2023;39.
42. Ambikapathi R, Boncyk M, Gunaratna NS, Fawzi W, Leyna G, Kadiyala S, Patil CL. Expanding the food environment framework to include family dynamics: A systematic synthesis of qualitative evidence using HIV as a case study. *Glob Food Sec.* 2024;42:100788.
43. O'Meara L, de Bruyn J, Hope T, Fajo-Pascual M, Hodge R, Turner C, et al. Conceptual framework of women's food environments and determinants of food

acquisition and dietary intake in low- and middle-income countries: a scoping review. *Lancet Planet Health*. 2025;9(8):101280.

44. Scottish Government Good Food Nation (Scotland) Act 2022. 2022.
45. Scottish Government Diet and healthy weight: out of home action plan. 2021.
46. Caspi CE, Sorensen G, Subramanian SV, Kawachi I. The local food environment and diet: a systematic review. *Health Place*. 2012;18(5):1172-87.
47. Cobb LK, Appel LJ, Franco M, Jones-Smith JC, Nur A, Anderson CA. The relationship of the local food environment with obesity: A systematic review of methods, study quality, and results. *Obesity (Silver Spring)*. 2015;23(7):1331-44.
48. Boyland EJ, Nolan S, Kelly B, Tudur-Smith C, Jones A, Halford JC, Robinson E. Advertising as a cue to consume: a systematic review and meta-analysis of the effects of acute exposure to unhealthy food and nonalcoholic beverage advertising on intake in children and adults. *Am J Clin Nutr*. 2016;103(2):519-33.
49. World Health Organization Report of the commission on ending childhood obesity. 2016 21 January 2016.
50. Gebremariam AD, Kent K, Charlton K. The Association between Community Food Environments and Health Outcomes in High-Income Countries: A Systematic Literature Review. *Curr Nutr Rep*. 2025;14(1):74.
51. Hansen KL, Golubovic S, Eriksen CU, Jorgensen T, Toft U. Effectiveness of food environment policies in improving population diets: a review of systematic reviews. *Eur J Clin Nutr*. 2022;76(5):637-46.
52. Pineda E, Stockton J, Scholes S, Lassale C, Mindell JS. Food environment and obesity: a systematic review and meta-analysis. *BMJ Nutr Prev Health*. 2024;7(1):204-11.
53. Siddiqui NZ, Wei L, Mackenbach JD, Pinho MGM, Helbich M, Schoonmade LJ, Beulens JWJ. Global positioning system-based food environment exposures, diet-related, and cardiometabolic health outcomes: a systematic review and research agenda. *Int J Health Geogr*. 2024;23(1):3.
54. Steen DL, Helsley RN, Bhatt DL, King EC, Summer SS, Fenchel M, et al. Efficacy of supermarket and web-based interventions for improving dietary quality: a randomized, controlled trial. *Nat Med*. 2022;28(12):2530-6.
55. Brennan SF, Lavelle F, Moore SE, Dean M, McKinley MC, McCole P, et al. Food environment intervention improves food knowledge, wellbeing and dietary habits in primary school children: Project Daire, a randomised-controlled, factorial design cluster trial. *Int J Behav Nutr Phys Act*. 2021;18(1):23.
56. Franca FCO, Zandonadi RP, Moreira IMA, da Silva ICR, Akutsu R. Deserts, Swamps and Food Oases: Mapping around the Schools in Bahia, Brazil and Implications for Ensuring Food and Nutritional Security. *Nutrients*. 2024;16(1).
57. Corfe S. What are the barriers to eating healthily in the UK? London: The Social Market Foundation; 2018.
58. Hager ER, Cockerham A, O'Reilly N, Harrington D, Harding J, Hurley KM, Black MM. Food swamps and food deserts in Baltimore City, MD, USA: associations with dietary behaviours among urban adolescent girls. *Public Health Nutr*. 2017;20(14):2598-607.

59. Yang M, Wang HL, Qiu F. Neighbourhood food environments revisited: When food deserts meet food swamps. *Canadian Geographies-Geographies Canadiennes*. 2020;64(1):135-54.
60. NOURISHING policy database [Internet]. 2015. Available from: <https://policydatabase.wcrf.org/>.
61. Blanchard L, Ray S, Law C, Vega-Salas MJ, Rutter H, Egan M, et al. Inequalities in Research on Food Environment Policies: An Evidence Map of Global Evidence from 2010-2020. *Adv Nutr*. 2024;15(11):100306.
62. The Education Hub DfE, GOV.UK ., Expanding free school meals: what parents need to know [Internet]2025. [cited 13/10/2025]. Available from: <https://educationhub.blog.gov.uk/2025/06/expanding-free-school-meals-what-parents-need-to-know/>.
63. Al-alawy Khamis KF. Top Tips on Chips: Can Local Fast Food Caterers in England Adopt Healthier Cooking Practices? *Food and Public Health* 2014;4(2):54-9.
64. Rahilly J, Amies-Cull B, Chang M, Cummins S, Derbyshire D, Hassan S, et al. Changes in the number of new takeaway food outlets associated with adoption of management zones around schools: A natural experimental evaluation in England. *SSM Popul Health*. 2024;26:101646.
65. Rogers NT, Amies-Cull B, Adams J, Chang M, Cummins S, Derbyshire D, et al. Health impacts of takeaway management zones around schools in six different local authorities across England: a public health modelling study using PRIMETIME. *BMC Med*. 2024;22(1):545.
66. Polden M, Jones A, Essman M, Adams J, Bishop TRP, Burgoine T, et al. Evaluating the association between the introduction of mandatory calorie labelling and energy consumed using observational data from the out-of-home food sector in England. *Nat Hum Behav*. 2025;9(2):277-86.
67. Kininmonth AR, Stone, R. A., Jenneson, V., Naisbitt, R., Wilkins, E.L., Van, D.T.T., Johnstone, A., & Fildes, A., Morris, M. A. Restricting less healthy foods in retail environments: Evidence-based recommendations for policy impact. 2025 September 2025.
68. Cornelsen L, Mytton OT, Adams J, Gasparini A, Iskander D, Knai C, et al. Change in non-alcoholic beverage sales following a 10-pence levy on sugar-sweetened beverages within a national chain of restaurants in the UK: interrupted time series analysis of a natural experiment. *J Epidemiol Community Health*. 2017;71(11):1107-12.
69. AKADEMIYA2063 G. Diagnosing Policy Coherence for Food Systems: Toolkit – Modules 1 & 2 Geneva; 2025.
70. S. KNaN. Mechanisms supporting Policy Coherence in UK Food Strategies - Working Paper #57. Switzerland: Global Alliance for Improved Nutrition (GAIN); 2025 2025.
71. Ho FK, Celis-Morales C, Petermann-Rocha F, Parra-Soto SL, Lewsey J, Mackay D, Pell JP. Changes over 15 years in the contribution of adiposity and smoking to deaths in England and Scotland. *BMC Public Health*. 2021;21(1):169.
72. Hannah V WA, Rich L, Jenkins B, Jesurasa A. The primary care needs of people living with overweight and obesity in Wales: Summary. In: Wales PH, editor. 2021.

73. Office for Health Improvement & Disparities Official Statistics Obesity Profile: short statistical commentary UK Government; 2024 [Available from: <https://www.gov.uk/government/statistics/update-to-the-obesity-profile-on-fingertips/obesity-profile-short-statistical-commentary-may-2024>].
74. Keaver L, Xu B, Jaccard A, Webber L. Morbid obesity in the UK: A modelling projection study to 2035. *Scand J Public Health*. 2020;48(4):422-7.
75. NHS Digital Significant increase in obesity rates among primary-aged children, latest statistics show. 2021.
76. Office for Health Improvement & Disparities National Diet and Nutrition Survey 2019 to 2023: report. UK2025.
77. Constantinides SV, Turner C, Frongillo EA, Bhandari S, Reyes L, Blake CE. Using a global food environment framework to understand relationships with food choice in diverse low- and middle-income countries. *Global Food Security-Agriculture Policy Economics and Environment*. 2021;29(100511).
78. Burgoine T, Lake AA, Stamp E, Alvanides S, Mathers JC, Adamson AJ. Changing foodscapes 1980-2000, using the ASH30 Study. *Appetite*. 2009;53(2):157-65.
79. Smith D, Cummins S, Clark C, Stansfeld S. Does the local food environment around schools affect diet? Longitudinal associations in adolescents attending secondary schools in East London. *BMC Public Health*. 2013;13:70.
80. Lumina Intelligence The market and consumer trends shaping the future for UK quick service restaurants. 2022 March 2022.
81. Camilla A GR, Draper A, Guthrie S. Food consumption in the UK: Trends, attitudes and drivers.; 2020.
82. Food Standards Agency F&Y2 Wave 7: Executive summary. Food Standards Agency 2024.
83. Titis E, Procter R, Walasek L. Assessing physical access to healthy food across United Kingdom: A systematic review of measures and findings. *Obes Sci Pract*. 2022;8(2):233-46.
84. Turner G, Green R, Alae-Carew C, Dangour AD. The association of dimensions of fruit and vegetable access in the retail food environment with consumption; a systematic review. *Glob Food Sec*. 2021;29:100528.
85. Needham C, Sacks G, Orellana L, Robinson E, Allender S, Strugnell C. A systematic review of the Australian food retail environment: Characteristics, variation by geographic area, socioeconomic position and associations with diet and obesity. *Obes Rev*. 2020;21(2):e12941.
86. Turbutt C, Richardson J, Pettinger C. The impact of hot food takeaways near schools in the UK on childhood obesity: a systematic review of the evidence. *J Public Health (Oxf)*. 2019;41(2):231-9.
87. Williams J, Scarborough P, Matthews A, Cowburn G, Foster C, Roberts N, Rayner M. A systematic review of the influence of the retail food environment around schools on obesity-related outcomes. *Obes Rev*. 2014;15(5):359-74.
88. Capper TE, Brennan SF, Woodside JV, McKinley MC. What makes interventions aimed at improving dietary behaviours successful in the secondary school environment? A systematic review of systematic reviews. *Public Health Nutr*. 2022;25(9):2448-64.

89. Lam TM, Vaartjes I, Grobbee DE, Karssenberg D, Lakerveld J. Associations between the built environment and obesity: an umbrella review. *Int J Health Geogr.* 2021;20(1):7.
90. Townshend T, Lake A. Obesogenic environments: current evidence of the built and food environments. *Perspect Public Health.* 2017;137(1):38-44.
91. Wilkins E, Radley D, Morris M, Hobbs M, Christensen A, Marwa WL, et al. A systematic review employing the GeoFERN framework to examine methods, reporting quality and associations between the retail food environment and obesity. *Health Place.* 2019;57:186-99.
92. Rinaldi C, D'Aguilar M, Egan M. Understanding the Online Environment for the Delivery of Food, Alcohol and Tobacco: An Exploratory Analysis of 'Dark Kitchens' and Rapid Grocery Delivery Services. *Int J Environ Res Public Health.* 2022;19(9).
93. Goodman MK, Jaworska S. Mapping digital foodscapes: Digital food influencers and the grammars of good food. *Geoforum.* 2020;117:183-93.
94. Lytle LA, Sokol RL. Measures of the food environment: A systematic review of the field, 2007-2015. *Health Place.* 2017;44:18-34.
95. Shareck M, Lewis D, Smith NR, Clary C, Cummins S. Associations between home and school neighbourhood food environments and adolescents' fast-food and sugar-sweetened beverage intakes: findings from the Olympic Regeneration in East London (ORiEL) Study. *Public Health Nutr.* 2018;21(15):2842-51.
96. Theis DRZ, Adams J. Differences in energy and nutritional content of menu items served by popular UK chain restaurants with versus without voluntary menu labelling: A cross-sectional study. *PLoS ONE.* 2019;14(10) (no pagination).
97. Lloyd S, Lawton J, Caraher M, Singh G, Horsley K, Mussa F. A tale of two localities: Healthy eating on a restricted income. *Health Education Journal.* 2011;70(1):48-56.
98. Garnett EE, Marteau TM, Sandbrook C, Pilling MA, Balmford A. Order of meals at the counter and distance between options affect student cafeteria vegetarian sales. *Nat Food.* 2020;1(8):485-8.
99. Chepulis L, Everson N, Ndanuko R, Mearns G. The nutritional content of children's breakfast cereals: a cross-sectional analysis of New Zealand, Australia, the UK, Canada and the USA. *Public Health Nutr.* 2020;23(9):1589-98.
100. Roe M, Pinchen H, Church S, Elahi S, Walker M, Farron-Wilson M, et al. Trans fatty acids in a range of UK processed foods. *Food Chem.* 2013;140(3):427-31.
101. Meldrum RJ, Little CL, Sagoo S, Mithani V, McLauchlin J, de Pinna E. Assessment of the microbiological safety of salad vegetables and sauces from kebab take-away restaurants in the United Kingdom. *Food Microbiol.* 2009;26(6):573-7.
102. Cameron A, Waterlander WE, Svastisalee CM. The correlation between supermarket size and national obesity prevalence. *BMC Obesity.* 2014;1(1):1-4.
103. Graham F, Russell J, Holdsworth M, Menon M, Barker M. Exploring the Relationship between Environmental Impact and Nutrient Content of Sandwiches and Beverages Available in Cafes in a UK University. *Sustainability.* 2019;11(11).
104. Revoredo-Giha C, McNamee P, Norwood P, Akaichi F, Dogbe W. Expenditure and Nutritional Impact of Banning the Promotion of Foods High in Fat, Sugar and Salt in Scotland. *Front Nutr.* 2022;9:874018.

105. Reynolds CJ, Horgan GW, Whybrow S, Macdiarmid JI. Healthy and sustainable diets that meet greenhouse gas emission reduction targets and are affordable for different income groups in the UK. *Public Health Nutr.* 2019;22(8):1503-17.
106. Alessandrini R, Brown MK, Pombo-Rodrigues S, Bhageerutty S, He FJ, MacGregor GA. Nutritional Quality of Plant-Based Meat Products Available in the UK: A Cross-Sectional Survey. *Nutrients.* 2021;13(12).
107. Angood KM, Wood JD, Nute GR, Whittington FM, Hughes SI, Sheard PR. A comparison of organic and conventionally-produced lamb purchased from three major UK supermarkets: Price, eating quality and fatty acid composition. *Meat Sci.* 2008;78(3):176-84.
108. Bagwell S. The role of independent fast-food outlets in obesogenic environments: a case study of East London in the UK. *Environment and Planning A-Economy and Space.* 2011;43(9):2217-36.
109. Baniukiewicz M, Dick ZL, Giabbanelli PJ. Capturing the fast-food landscape in England using large-scale network analysis. *EPJ Data Sci.* 2018;7(1):39.
110. Barrett M, Crozier S, Lewis D, Godfrey K, Robinson S, Cooper C, et al. Greater access to healthy food outlets in the home and school environment is associated with better dietary quality in young children. *Public Health Nutr.* 2017;20(18):3316-25.
111. Bath SC, Hill S, Infante HG, Elghul S, Neziyana CJ, Rayman MP. Iodine concentration of milk-alternative drinks available in the UK in comparison with cows' milk. *Br J Nutr.* 2017;118(7):525-32.
112. Berill Takacs JAS, Anastasia Z. Kalea, Aiduan Borrion. Comparison of environmental impacts of individual meals - Does it really make a difference to choose plant-based meals instead of meat-based ones? *Journal of Cleaner Production.* 2022;379.
113. Bhatnagar P, Scarborough P, Kaur A, Dikmen D, Adhikari V, Harrington R. Are food and drink available in online and physical supermarkets the same? A comparison of product availability, price, price promotions and nutritional information. *Public Health Nutr.* 2021;24(5):819-25.
114. Black C, Ntani G, Inskip H, Cooper C, Cummins S, Moon G, Baird J. Measuring the healthfulness of food retail stores: variations by store type and neighbourhood deprivation. *Int J Behav Nutr Phys Act.* 2014;11:69.
115. Black C, Ntani G, Kenny R, Tinati T, Jarman M, Lawrence W, et al. Variety and quality of healthy foods differ according to neighbourhood deprivation. *Health Place.* 2012;18(6):1292-9.
116. Bodicoat DH, Carter P, Comber A, Edwardson C, Gray LJ, Hill S, et al. Is the number of fast-food outlets in the neighbourhood related to screen-detected type 2 diabetes mellitus and associated risk factors? *Public Health Nutr.* 2015;18(9):1698-705.
117. Bowyer S, Caraher M, Eilbert K, Carr-Hill R. Shopping for food: lessons from a London borough. *British Food Journal.* 2009;111(4-5):452-74.
118. Brown H, Kirkman S, Albani V, Goffe L, Akhter N, Hollingsworth B, et al. The impact of school exclusion zone planning guidance on the number and type of food outlets in an English local authority: A longitudinal analysis. *Health Place.* 2021;70:102600.

119. Brown H, Xiang H, Albani V, Goffe L, Akhter N, Lake A, et al. No new fast-food outlets allowed! Evaluating the effect of planning policy on the local food environment in the North East of England. *Soc Sci Med.* 2022;306:115126.
120. Buratto A, Lotti L. Encouraging sustainable food consumption through nudges: An experiment with menu labels. *Ecological Economics.* 2024;216.
121. Burden M, Mooney PD, Blanshard RJ, White WL, Cambray-Deakin DR, Sanders DS. Cost and availability of gluten-free food in the UK: in store and online. *Postgrad Med J.* 2015;91(1081):622-6.
122. Burgoine T, Alvanides S, Lake AA. Assessing the obesogenic environment of North East England. *Health Place.* 2011;17(3):738-47.
123. Burgoine T, Alvanides S, Lake AA. Creating 'obesogenic realities'; do our methodological choices make a difference when measuring the food environment? *Int J Health Geogr.* 2013;12:33.
124. Burgoine T, Forouhi NG, Griffin SJ, Brage S, Wareham NJ, Monsivais P. Does neighborhood fast-food outlet exposure amplify inequalities in diet and obesity? A cross-sectional study. *Am J Clin Nutr.* 2016;103(6):1540-7.
125. Burgoine T, Forouhi NG, Griffin SJ, Wareham NJ, Monsivais P. Associations between exposure to takeaway food outlets, takeaway food consumption, and body weight in Cambridgeshire, UK: population based, cross sectional study. *BMJ.* 2014;348:g1464.
126. Burgoine T, Gallis JA, T LP, Monsivais P, Benjamin Neelon SE. Association between distance to nearest supermarket and provision of fruits and vegetables in English nurseries. *Health Place.* 2017;46:229-33.
127. Burgoine T, Mackenbach JD, Lakerveld J, Forouhi NG, Griffin SJ, Brage S, et al. Interplay of Socioeconomic Status and Supermarket Distance Is Associated with Excess Obesity Risk: A UK Cross-Sectional Study. *Int J Environ Res Public Health.* 2017;14(11).
128. Burgoine T, Monsivais P, Sharp SJ, Forouhi NG, Wareham NJ. Independent and combined associations between fast-food outlet exposure and genetic risk for obesity: a population-based, cross-sectional study in the UK. *BMC Med.* 2021;19(1):49.
129. Burgoine T, Sarker C, Webster CJ, Monsivais P. Examining the interaction of fast-food outlet exposure and income on diet and obesity: evidence from 51,361 UK Biobank participants. *Int J Behav Nutr Phys Act.* 2018;15(1):71.
130. Butler G, Stergiadis S, Seal C, Eyre M, Leifert C. Fat composition of organic and conventional retail milk in northeast England. *J Dairy Sci.* 2011;94(1):24-36.
131. Caraher M, Lloyd S, Lawton J, Singh G, Horsley K, Mussa F. A tale of two cities: A study of access to food, lessons for public health practice. *Health Education Journal.* 2010;69(2):200-10.
132. Cetateanu A, Jones A. Understanding the relationship between food environments, deprivation and childhood overweight and obesity: evidence from a cross sectional England-wide study. *Health Place.* 2014;27(100):68-76.
133. Chan L, Mehra A, Saikat S, Lynch P. Human exposure assessment of fluoride from tea (*Camellia sinensis* L.): A UK based issue? *Food Research International.* 2013;51(2):564-70.

134. Clarke G EH, Guy C. Deriving Indicators of Access to Food Retail Provision in British Cities: Studies of Cardiff, Leeds and Bradford. *Urban Studies*. 2002;39:2041–60.
135. Davies IG, Blackham T, Jaworowska A, Taylor C, Ashton M, Stevenson L. Saturated and trans-fatty acids in UK takeaway food. *Int J Food Sci Nutr*. 2016;67(3):217-24.
136. Donkin AJ, Dowler EA, Stevenson SJ, Turner SA. Mapping access to food in a deprived area: the development of price and availability indices. *Public Health Nutr*. 2000;3(1):31-8.
137. Edwards KL, Clarke GP, Ransley JK, Cade J. The neighbourhood matters: studying exposures relevant to childhood obesity and the policy implications in Leeds, UK. *J Epidemiol Community Health*. 2010;64(3):194-201.
138. Ejlerskov KT, Sharp SJ, Stead M, Adamson AJ, White M, Adams J. Supermarket policies on less-healthy food at checkouts: Natural experimental evaluation using interrupted time series analyses of purchases. *PLoS Med*. 2018;15(12):e1002712.
139. Emma E. Garnett AB, Theresa M. Marteau, Mark A. Pilling, Chris Sandbrook. Price of change: Does a small alteration to the price of meat and vegetarian options affect their sales? *Journal of Environmental Psychology*. 2021;75.
140. Evans CE, Worth S, White R, Strachan EK. Evaluation of an experiment to increase availability of healthier snack foods in vending machines situated within English sports facilities. *Public Health Nutr*. 2023;26(12):3088-99.
141. Fildes A, Lally P, Morris MA, Dalton A, Croker H. Impact on purchasing behaviour of implementing 'junk free checkouts': A pre-post study. *Nutr Bull*. 2022;47(3):333-45.
142. Fraser LK, Edwards KL. The association between the geography of fast food outlets and childhood obesity rates in Leeds, UK. *Health Place*. 2010;16(6):1124-8.
143. Fraser LK, Edwards KL, Tominitz M, Clarke GP, Hill AJ. Food outlet availability, deprivation and obesity in a multi-ethnic sample of pregnant women in Bradford, UK. *Soc Sci Med*. 2012;75(6):1048-56.
144. G. Gallo R, Barrett L, A. Lake A. The food environment within the primary school fringe. *British Food Journal*. 2014;116(8):1259-75.
145. Garnett EE, Balmford A, Sandbrook C, Pilling MA, Marteau TM. Impact of increasing vegetarian availability on meal selection and sales in cafeterias. *Proc Natl Acad Sci U S A*. 2019;116(42):20923-9.
146. Glynn Davies I, Stevenson L, Ashton M, Taylor C, Long R, M. Blackham T, Jaworowska A. Nutritional composition of takeaway food in the UK. *Nutrition & Food Science*. 2014;44(5):414-30.
147. Green MA, Radley D, Lomax N, Morris MA, Griffiths C. Is adolescent body mass index and waist circumference associated with the food environments surrounding schools and homes? A longitudinal analysis. *BMC Public Health*. 2018;18(1):482.
148. Griffiths C, Frearson A, Taylor A, Radley D, Cooke C. A cross sectional study investigating the association between exposure to food outlets and childhood obesity in Leeds, UK. *Int J Behav Nutr Phys Act*. 2014;11:138.
149. Harmer G, Jebb SA, Ntani G, Vogel C, Piernas C. Capturing the Healthfulness of the In-store Environments of United Kingdom Supermarket Stores Over 5 Months (January-May 2019). *Am J Prev Med*. 2021;61(4):e171-e9.

150. Harrison F, Jones AP, van Sluijs EM, Cassidy A, Bentham G, Griffin SJ. Environmental correlates of adiposity in 9-10 year old children: considering home and school neighbourhoods and routes to school. *Soc Sci Med*. 2011;72(9):1411-9.
151. Hobbs M, Green M, Roberts K, Griffiths C, McKenna J. Reconsidering the relationship between fast-food outlets, area-level deprivation, diet quality and body mass index: an exploratory structural equation modelling approach. *J Epidemiol Community Health*. 2019;73(9):861-6.
152. Hobbs M, Green MA, Wilkins E, Lamb KE, McKenna J, Griffiths C. Associations between food environment typologies and body mass index: Evidence from Yorkshire, England. *Soc Sci Med*. 2019;239:112528.
153. Hobbs M, Griffiths C, Green MA, Jordan H, Saunders J, Christensen A, McKenna J. Fast-food outlet availability and obesity: Considering variation by age and methodological diversity in 22,889 Yorkshire Health Study participants. *Spat Spatiotemporal Epidemiol*. 2019;28:43-53.
154. Horsley JA, Absalom KA, Akiens EM, Dunk RJ, Ferguson AM. The proportion of unhealthy foodstuffs children are exposed to at the checkout of convenience supermarkets. *Public Health Nutr*. 2014;17(11):2453-8.
155. Howard Wilsher S, Harrison F, Fearn A, Jones A. Food Sales and Adult Weight Status: Results of a Cross-Sectional Study in England. *Nutrients*. 2022;14(9).
156. Howard Wilsher S, Harrison F, Yamoah F, Fearn A, Jones A. The relationship between unhealthy food sales, socio-economic deprivation and childhood weight status: results of a cross-sectional study in England. *Int J Behav Nutr Phys Act*. 2016;13:21.
157. Ilyankou I, Newing A, Hood N. Supermarket Store Locations as a Proxy for Neighbourhood Health, Wellbeing, and Wealth. *Sustainability*. 2023;15(15).
158. James A, Birch L, Fletcher P, Pearson S, Boyce C, Ness AR, et al. Are food and drink retailers within NHS venues adhering to NICE Quality standard 94 guidance on childhood obesity? A cross-sectional study of two large secondary care NHS hospitals in England. *BMJ Open*. 2017;7(11):e018214.
159. Jaworowska A, Blackham T, Stevenson L, Davies IG. Determination of salt content in hot takeaway meals in the United Kingdom. *Appetite*. 2012;59(2):517-22.
160. Jaworowska A, Rotaru G, Christides T. Nutritional Quality of Lunches Served in South East England Hospital Staff Canteens. *Nutrients*. 2018;10(12).
161. Jennings A, Cassidy A, Winters T, Barnes S, Lipp A, Holland R, Welch A. Positive effect of a targeted intervention to improve access and availability of fruit and vegetables in an area of deprivation. *Health Place*. 2012;18(5):1074-8.
162. Kalbus A, Ballatore A, Cornelsen L, Greener R, Cummins S. Associations between area deprivation and changes in the digital food environment during the COVID-19 pandemic: Longitudinal analysis of three online food delivery platforms. *Health Place*. 2023;80:102976.
163. Kalbus A, Cornelsen L, Ballatore A, Cummins S. Associations between the food environment and food and drink purchasing using large-scale commercial purchasing data: a cross-sectional study. *BMC Public Health*. 2023;23(1):72.

164. Keeble M, Adams J, Bishop TRP, Burgoine T. Socioeconomic inequalities in food outlet access through an online food delivery service in England: A cross-sectional descriptive analysis. *Appl Geogr.* 2021;133:None.
165. Keeble M, Adams J, Burgoine T. Changes in Online Food Access During the COVID-19 Pandemic and Associations With Deprivation: Longitudinal Analysis. *JMIR Public Health Surveill.* 2023;9:e41822.
166. Keeble M, Adams J, Sacks G, Vanderlee L, White CM, Hammond D, Burgoine T. Use of Online Food Delivery Services to Order Food Prepared Away-From-Home and Associated Sociodemographic Characteristics: A Cross-Sectional, Multi-Country Analysis. *Int J Environ Res Public Health.* 2020;17(14).
167. Keeble M, Adams J, Vanderlee L, Hammond D, Burgoine T. Associations between online food outlet access and online food delivery service use amongst adults in the UK: a cross-sectional analysis of linked data. *BMC Public Health.* 2021;21(1):1968.
168. Kliem KE, Shingfield KJ, Livingstone KM, Givens DI. Seasonal variation in the fatty acid composition of milk available at retail in the United Kingdom and implications for dietary intake. *Food Chem.* 2013;141(1):274-81.
169. Krenz K, Dhanani A, McEachan RRC, Sohal K, Wright J, Vaughan L. Linking the Urban Environment and Health: An Innovative Methodology for Measuring Individual-Level Environmental Exposures. *Int J Environ Res Public Health.* 2023;20(3).
170. Lake AA, Burgoine T, Stamp E, Grieve R. The foodscape: classification and field validation of secondary data sources across urban/rural and socio-economic classifications in England. *Int J Behav Nutr Phys Act.* 2012;9:37.
171. Lam MCL, Adams J. Association between home food preparation skills and behaviour, and consumption of ultra-processed foods: Cross-sectional analysis of the UK National Diet and nutrition survey (2008-2009). *Int J Behav Nutr Phys Act.* 2017;14(1):68.
172. Little CL, Barrett NJ, Grant K, McLauchlin J. Microbiological safety of sandwiches from hospitals and other health care establishments in the United Kingdom with a focus on *Listeria monocytogenes* and other *Listeria* species. *J Food Prot.* 2008;71(2):309-18.
173. Mackenbach JD, Burgoine T, Lakerveld J, Forouhi NG, Griffin SJ, Wareham NJ, Monsivais P. Accessibility and Affordability of Supermarkets: Associations With the DASH Diet. *Am J Prev Med.* 2017;53(1):55-62.
174. Maguire ER, Burgoine T, Monsivais P. Area deprivation and the food environment over time: A repeated cross-sectional study on takeaway outlet density and supermarket presence in Norfolk, UK, 1990-2008. *Health Place.* 2015;33:142-7.
175. Maguire ER, Burgoine T, Penney TL, Forouhi NG, Monsivais P. Does exposure to the food environment differ by socioeconomic position? Comparing area-based and person-centred metrics in the Fenland Study, UK. *Int J Health Geogr.* 2017;16(1):33.
176. Mason KE, Pearce N, Cummins S. Geographical heterogeneity across England in associations between the neighbourhood built environment and body mass index. *Health Place.* 2021;71:102645.
177. Mc LJ, Jorgensen F, Aird H, Charlett A, Elviss N, Fenelon D, et al. An assessment of the microbiological quality of liver-based pate in England 2012-13: comparison of

samples collected at retail and from catering businesses. *Epidemiol Infect.* 2017;145(8):1545-56.

178. McLauchlin J, Aird H, Charlett A, Chattaway M, Elviss N, Hartman H, et al. Imported edible leaves collected at retail sale in England during 2017 with an emphasis on betel and curry leaves: microbiological quality with respect to Salmonella, Shiga-toxin-producing *E. coli* (STEC) and levels of *Escherichia coli*. *J Appl Microbiol.* 2018;125(4):1175-85.

179. McLauchlin J, Aird H, Charlett A, Elviss N, Jorgensen F, Willis C. Microbiological Quality of Cooked Chicken: Results of Monitoring in England (2013-17). *J Food Prot.* 2020;83(11):1989-97.

180. Molaodi OR, Leyland AH, Ellaway A, Kearns A, Harding S. Neighbourhood food and physical activity environments in England, UK: does ethnic density matter? *Int J Behav Nutr Phys Act.* 2012;9:75.

181. Mulrooney HM, Bell J. Does the food retail environment reflect UK public health recommendations for healthy eating? *Public Health.* 2016;134:114-6.

182. Nowak M, Jeanes Y, Reeves S. The food environment in leisure centres and health clubs: how appropriate is it for children? *Nutrition & Food Science.* 2012;42(5):307-14.

183. Park H, Papadaki A. Nutritional value of foods sold in vending machines in a UK University: Formative, cross-sectional research to inform an environmental intervention. *Appetite.* 2016;96:517-25.

184. Patterson R, Risby A, Chan MY. Consumption of takeaway and fast food in a deprived inner London Borough: are they associated with childhood obesity? *BMJ Open.* 2012;2(3).

185. Pechey R, Bateman PA, Cook B, Potter C, Clark M, Stewart C, et al. Testing the effectiveness of ecolabels to reduce the environmental impact of food purchases in worksite cafeterias: A randomised controlled trial. *Appetite.* 2022;179:106277.

186. Pechey R, Cartwright E, Pilling M, Hollands GJ, Vasiljevic M, Jebb SA, Marteau TM. Impact of increasing the proportion of healthier foods available on energy purchased in worksite cafeterias: A stepped wedge randomized controlled pilot trial. *Appetite.* 2019;133:286-96.

187. Pechey R, Jenkins H, Cartwright E, Marteau TM. Altering the availability of healthier vs. less healthy items in UK hospital vending machines: a multiple treatment reversal design. *Int J Behav Nutr Phys Act.* 2019;16(1):114.

188. Piernas C, Harmer G, Jebb SA. Removing seasonal confectionery from prominent store locations and purchasing behaviour within a major UK supermarket: Evaluation of a nonrandomised controlled intervention study. *PLoS Med.* 2022;19(3):e1003951.

189. Piernas C, Harmer G, Jebb SA. Testing availability, positioning, promotions, and signage of healthier food options and purchasing behaviour within major UK supermarkets: Evaluation of 6 nonrandomised controlled intervention studies. *PLoS Med.* 2022;19(3):e1003952.

190. Pombo-Rodrigues S, Hashem KM, Tan M, Davies Z, He FJ, MacGregor GA. Nutrition Profile of Products with Cartoon Animations on the Packaging: A UK Cross-Sectional Survey of Foods and Drinks. *Nutrients.* 2020;12(3).

191. Reeves S, Wake Y, Zick A. Nutrition labeling and portion size information on children's menus in fast-food and table-service chain restaurants in London, UK. *J Nutr Educ Behav.* 2011;43(6):543-7.
192. Rex D, Blair A. Unjust des(s)erts: food retailing and neighbourhood health in Sandwell. *International Journal of Retail & Distribution Management.* 2003;31(9):459-65.
193. Saunders P, Saunders A, Middleton J. Living in a 'fat swamp': exposure to multiple sources of accessible, cheap, energy-dense fast foods in a deprived community. *Br J Nutr.* 2015;113(11):1828-34.
194. Shoari N, Beevers S, Brauer M, Blangiardo M. Towards healthy school neighbourhoods: A baseline analysis in Greater London. *Environ Int.* 2022;165:107286.
195. Simpson N, Bartley A, Davies A, Perman S, Rodger AJ. Getting the balance right-tackling the obesogenic environment by reducing unhealthy options in a hospital shop without affecting profit. *J Public Health (Oxf).* 2018;40(4):e545-e51.
196. Tan M, He FJ, Ding J, Li Y, Zhang P, MacGregor GA. Salt content of sauces in the UK and China: cross-sectional surveys. *BMJ Open.* 2019;9(9):e025623.
197. Thomas JM, Ursell A, Robinson EL, Aveyard P, Jebb SA, Herman CP, Higgs S. Using a descriptive social norm to increase vegetable selection in workplace restaurant settings. *Health Psychol.* 2017;36(11):1026-33.
198. Titis E, Di Salvatore J, Procter R. Socio-economic correlates of childhood obesity in urban and rural England. *Public Health Nutr.* 2023;26(9):1815-27.
199. Vasiljevic M, Cartwright E, Pilling M, Lee MM, Bignardi G, Pechey R, et al. Impact of calorie labelling in worksite cafeterias: a stepped wedge randomised controlled pilot trial. *Int J Behav Nutr Phys Act.* 2018;15(1):41.
200. Vasiljevic M, Fuller G, Pilling M, Hollands GJ, Pechey R, Jebb SA, Marteau TM. What is the impact of increasing the prominence of calorie labelling? A stepped wedge randomised controlled pilot trial in worksite cafeterias. *Appetite.* 2019;141:104304.
201. Vitale M, Crossland S, Shinwell J, Stretesky PB, Defeyer MA, Brownlee IA. The Nutritional Quality of Food Provision at UK Government-Funded Holiday Clubs: A Cross-Sectional Analysis of Energy and Nutrient Content. *Nutrients.* 2023;15(8).
202. Vogel C, Crozier S, Penn-Newman D, Ball K, Moon G, Lord J, et al. Altering product placement to create a healthier layout in supermarkets: Outcomes on store sales, customer purchasing, and diet in a prospective matched controlled cluster study. *PLoS Med.* 2021;18(9):e1003729.
203. Vogel C, Lewis D, Ntani G, Cummins S, Cooper C, Moon G, Baird J. The relationship between dietary quality and the local food environment differs according to level of educational attainment: A cross-sectional study. *PLoS One.* 2017;12(8):e0183700.
204. Wickramasinghe K, Rayner M, Goldacre M, Townsend N, Scarborough P. Environmental and nutrition impact of achieving new School Food Plan recommendations in the primary school meals sector in England. *BMJ Open.* 2017;7(4):e013840.
205. Wilkins E, Morris M, Radley D, Griffiths C. Methods of measuring associations between the Retail Food Environment and weight status: Importance of classifications and metrics. *SSM Popul Health.* 2019;8:100404.

206. Williams J, Scarborough P, Townsend N, Matthews A, Burgoine T, Mumtaz L, Rayner M. Associations between Food Outlets around Schools and BMI among Primary Students in England: A Cross-Classified Multi-Level Analysis. *PLoS One*. 2015;10(7):e0132930.
207. Wright J, Kamp E, White M, Adams J, Sowden S. Food at checkouts in non-food stores: a cross-sectional study of a large indoor shopping mall. *Public Health Nutr*. 2015;18(15):2786-93.
208. Wrigley N, Warm D, Margetts B. Deprivation, diet, and food-retail access: findings from the Leeds 'food deserts' study. *Environ Plann A*. 2003;35(1):151-88.
209. Wu YT, Kingston A, Houlden V, Franklin R. The longitudinal associations between proximity to local grocery shops and functional ability in the very old living with and without multimorbidity: Results from the Newcastle 85+ study. *Arch Gerontol Geriatr*. 2022;101:104703.
210. Xiang H, Goffe L, Albani V, Akhter N, Lake AA, Brown H. Planning policies to restrict fast food and inequalities in child weight in England: a quasi-experimental analysis. *Obesity (Silver Spring)*. 2024;32(12):2345-53.
211. Yip YL, Ensaff H. Breakfast on the go: Evaluating the nutritional content of supermarket products. *Nutrition*. 2021;84:111098.
212. Remnant J, Adams J. The nutritional content and cost of supermarket ready-meals. Cross-sectional analysis. *Appetite*. 2015;92:36-42.
213. Lam CCV, Ejlerskov KT, White M, Adams J. Voluntary policies on checkout foods and healthfulness of foods displayed at, or near, supermarket checkout areas: a cross-sectional survey. *Public Health Nutr*. 2018;21(18):3462-8.
214. Titis E. Quantifying the Impact of Supermarket Distance on Childhood Obesity in Greater London, United Kingdom: Exploring Different Access Measures and Modification Effects of Transportation. *Child Obes*. 2023;19(7):479-88.
215. Vogel C, Abbott G, Ntani G, Barker M, Cooper C, Moon G, et al. Examination of how food environment and psychological factors interact in their relationship with dietary behaviours: test of a cross-sectional model. *Int J Behav Nutr Phys Act*. 2019;16(1):12.
216. Candlish AAG, Pearson SM, Aidoo KE, Smith JE, Kelly B, Irvine H. A survey of ethnic foods for microbial quality and aflatoxin content. *Food Addit Contam*. 2001;18(2):129-36.
217. Crawford F, Mackison D, Mooney JD, Ellaway A. Observation and assessment of the nutritional quality of 'out of school' foods popular with secondary school pupils at lunchtime. *BMC Public Health*. 2017;17(1):887.
218. Cummins S, Macintyre S. A systematic study of an urban foodscape: The price and availability of food in Greater Glasgow. *Urban Studies*. 2002;39(11):2115-30.
219. Cummins S, Macintyre S. Are secondary data sources on the neighbourhood food environment accurate? Case-study in Glasgow, UK. *Prev Med*. 2009;49(6):527-8.
220. Macintyre S, McKay L, Cummins S, Burns C. Out-of-home food outlets and area deprivation: case study in Glasgow, UK. *Int J Behav Nutr Phys Act*. 2005;2:16.
221. Ellaway A, Macdonald L, Lamb K, Thornton L, Day P, Pearce J. Do obesity-promoting food environments cluster around socially disadvantaged schools in Glasgow, Scotland? *Health Place*. 2012;18(6):1335-40.

222. Macdonald L, Ellaway A, Macintyre S. The food retail environment and area deprivation in Glasgow City, UK. *Int J Behav Nutr Phys Act.* 2009;6:52.
223. Macdonald L, Olsen JR, Shortt NK, Ellaway A. Do 'environmental bads' such as alcohol, fast food, tobacco, and gambling outlets cluster and co-locate in more deprived areas in Glasgow City, Scotland? *Health Place.* 2018;51:224-31.
224. Sauveplane-Stirling V, Crichton D, Tessier S, Parrett A, Garcia AL. The food retail environment and its use in a deprived, urban area of Scotland. *Public Health.* 2014;128(4):360-6.
225. Thornton LE, Pearce JR, Macdonald L, Lamb KE, Ellaway A. Does the choice of neighbourhood supermarket access measure influence associations with individual-level fruit and vegetable consumption? A case study from Glasgow. *Int J Health Geogr.* 2012;11:29.
226. Macintyre S, Macdonald L, Ellaway A. Do poorer people have poorer access to local resources and facilities? The distribution of local resources by area deprivation in Glasgow, Scotland. *Soc Sci Med.* 2008;67(6):900-14.
227. Cummins S, Smith DM, Taylor M, Dawson J, Marshall D, Sparks L, Anderson AS. Variations in fresh fruit and vegetable quality by store type, urban-rural setting and neighbourhood deprivation in Scotland. *Public Health Nutr.* 2009;12(11):2044-50.
228. Cummins S, Smith DM, Aitken Z, Dawson J, Marshall D, Sparks L, Anderson AS. Neighbourhood deprivation and the price and availability of fruit and vegetables in Scotland. *J Hum Nutr Diet.* 2010;23(5):494-501.
229. Dawson J, Marshall D, Taylor M, Cummins S, Sparks L, Anderson AS. Accessing healthy food: availability and price of a healthy food basket in Scotland. *Journal of Marketing Management.* 2008;24(9-10):893-913.
230. Dogbe W, Revoredo-Giha C. Industry levy versus banning promotion on soft drinks in Scotland: A distributional analysis. *Food Policy.* 2022;106.
231. Kopasker D, Ejebu OZ, Norwood P, Ludbrook A. Longitudinal study of the effects of price and promotion incentives on purchases of unhealthy foods: evidence for restricting food promotions. *BMJ Nutr Prev Health.* 2022;5(1):62-71.
232. Mackison D, Mooney J, Macleod M, Anderson AS. Lessons learnt from a feasibility study on price incentivised healthy eating promotions in workplace catering establishments. *J Hum Nutr Diet.* 2016;29(1):86-94.
233. Amarachi Nneli CR-G, Wisdom Dogbe. Could taxes on foods high in fat, sugar and salt (HFSS) improve climate health and nutrition in Scotland? *Journal of Cleaner Production.* 2023;421.
234. Olsen JR, Caryl F, Nicholls N, Smith M, McCrorie P, Mitchell R. Inequalities in neighbourhood features within children's 20-minute neighbourhoods and variation in time spent locally, measured using GPS. *Wellbeing Space Soc.* 2023;5:100174.
235. Plaza J, Damek F, Villena I, Innes EA, Katzer F, Hamilton CM. Detection of *Toxoplasma gondii* in retail meat samples in Scotland. *Food Waterborne Parasitol.* 2020;20:e00086.
236. Revoredo-Giha C, Lamprinopoulou-Kranis, Toma C, Luiza, et al Bread consumption models; Scotland; Food prices. The 83rd Annual Conference of the Agricultural Economics Society Dublin 2009.

237. Revoredo-Giha C, Russo C. Food Expensiveness in Scotland's Remote Areas: An Analysis of Household Food Purchases☆. *Rural Sociology*. 2022;88(1):32-70.
238. Smith DM, Cummins S, Taylor M, Dawson J, Marshall D, Sparks L, Anderson AS. Neighbourhood food environment and area deprivation: spatial accessibility to grocery stores selling fresh fruit and vegetables in urban and rural settings. *Int J Epidemiol*. 2010;39(1):277-84.
239. Solecki O, MacRae M, Ogden I, Strachan N. Can the high levels of human verocytotoxigenic *Escherichia coli* O157 infection in rural areas of NE Scotland be explained by consumption of contaminated meat? *J Appl Microbiol*. 2007;103(6):2616-21.
240. Stead M, Eadie D, McKell J, Sparks L, MacGregor A, Anderson AS. Making hospital shops healthier: evaluating the implementation of a mandatory standard for limiting food products and promotions in hospital retail outlets. *BMC Public Health*. 2020;20(1):132.
241. Garcia AL, Ronquillo JD, Morillo-Santander G, Mazariegos CV, Lopez-Donado L, Vargas-Garcia EJ, et al. Sugar Content and Nutritional Quality of Child Orientated Ready to Eat Cereals and Yoghurts in the UK and Latin America; Does Food Policy Matter? *Nutrients*. 2020;12(3).
242. Furey S, Strugnell C, McIlveen MH. An investigation of the potential existence of "food deserts" in rural and urban areas of Northern Ireland. *Agriculture and Human Values*. 2001;18(4):447-57.
243. Moore JE, Wilson TS, Wareing DR, Humphrey TJ, Murphy PG. Prevalence of thermophilic *Campylobacter* spp. in ready-to-eat foods and raw poultry in Northern Ireland. *J Food Prot*. 2002;65(8):1326-8.
244. Scullion R, Harrington CS, Madden RH. A comparison of three methods for the isolation of *Arcobacter* spp. from retail raw poultry in Northern Ireland. *J Food Prot*. 2004;67(4):799-804.
245. Scullion R, Harrington CS, Madden RH. Prevalence of *Arcobacter* spp. in raw milk and retail raw meats in Northern Ireland. *J Food Prot*. 2006;69(8):1986-90.
246. Shaw M, Nugent AP, McNulty BA, Walton J, McHugh M, Kane A, et al. What is the availability of iodised salt in supermarkets on the Island of Ireland? *Eur J Clin Nutr*. 2019;73(12):1636-8.
247. Soutos N, Koidis P, Madden RH. Presence of *Listeria* and *Salmonella* spp. in retail chicken in Northern Ireland. *Lett Appl Microbiol*. 2003;37(5):421-3.
248. Williams JL. Spaces between home and school: The effect of eating location on adolescent nutrition. *Ecol Food Nutr*. 2016;55(1):65-86.
249. Wilson IG. *Salmonella* and *campylobacter* contamination of raw retail chickens from different producers: a six year survey. *Epidemiol Infect*. 2002;129(3):635-45.
250. Furey S, Farley H, Strugnell C. An investigation into the availability and economic accessibility of food items in rural and urban areas of Northern Ireland. *International Journal of Consumer Studies*. 2002;26(4):313-21.
251. Aljawad A, Morgan MZ, Rees JS, Fairchild R. The availability of novelty sweets within high school localities. *Br Dent J*. 2016;220(11):575-9.

252. Fairchild R, Collins A. Serving up Healthy and Sustainable School Meals? An Analysis of School Meal Provision in Cardiff (UK). *Journal of Environmental Policy & Planning*. 2011;13(3):209-29.
253. Guy C. Neighbourhood retailing and food poverty: a case study in Cardiff. *International Journal of Retail & Distribution Management*. 2004;32(12):577-81.
254. E CGGCH. Food retail change and the growth of food deserts: a case study of Cardiff. *International Journal of Retail & Distribution Management* 2004;32(2):72-88.
255. Guy CM, David G. Measuring physical access to 'healthy foods' in areas of social deprivation: a case study in Cardiff. *International Journal of Consumer Studies*. 2004;28(3):222-34.
256. Kibblewhite S, Bowker S, Jenkins HR. Vending machines in hospitals – are they healthy? *Nutrition & Food Science*. 2010;40(1):26-8.
257. Meldrum RJ, Garside J, Mannion P, Charles D, Ellis P. Variation in the annual unsatisfactory rates of selected pathogens and indicators in ready-to-eat food sampled from the point of sale or service in Wales, United Kingdom. *J Food Prot*. 2012;75(12):2238-40.
258. Meldrum RJ, Mannion PT, Garside J, Welsh Food Microbiological F. Microbiological quality of ready-to-eat food served in schools in Wales, United Kingdom. *J Food Prot*. 2009;72(1):197-201.
259. Meldrum RJ, Smith RM. Occurrence of *Listeria monocytogenes* in sandwiches available to hospital patients in Wales, United Kingdom. *J Food Prot*. 2007;70(8):1958-60.
260. Meldrum RJ, Smith RM, Ellis P, Garside J, Welsh Food Microbiological F. Microbiological quality of randomly selected ready-to-eat foods sampled between 2003 and 2005 in Wales, UK. *Int J Food Microbiol*. 2006;108(3):397-400.
261. Nakamura R, Suhrcke M, Jebb SA, Pechey R, Almiron-Roig E, Marteau TM. Price promotions on healthier compared with less healthy foods: a hierarchical regression analysis of the impact on sales and social patterning of responses to promotions in Great Britain. *Am J Clin Nutr*. 2015;101(4):808-16.
262. Newing A, Hood N, Videira F, Lewis J. 'Sorry we do not deliver to your area': geographical inequalities in online groceries provision. *The International Review of Retail, Distribution and Consumer Research*. 2021;32(1):80-99.
263. Eyles H, Webster J, Jebb S, Capelin C, Neal B, Ni Mhurchu C. Impact of the UK voluntary sodium reduction targets on the sodium content of processed foods from 2006 to 2011: analysis of household consumer panel data. *Prev Med*. 2013;57(5):555-60.
264. Hawkesworth S, Silverwood RJ, Armstrong B, Pliakas T, Nanchahal K, Sartini C, et al. Investigating the importance of the local food environment for fruit and vegetable intake in older men and women in 20 UK towns: a cross-sectional analysis of two national cohorts using novel methods. *Int J Behav Nutr Phys Act*. 2017;14(1):128.
265. Dolton PJ, Tafesse W. Childhood obesity, is fast food exposure a factor? *Econ Hum Biol*. 2022;46:101153.
266. Scheelbeek PFD, Cornelsen L, Marteau TM, Jebb SA, Smith RD. Potential impact on prevalence of obesity in the UK of a 20% price increase in high sugar snacks: modelling study. *BMJ*. 2019;366:l4786.

267. Mason KE, Pearce N, Cummins S. Do neighbourhood characteristics act together to influence BMI? A cross-sectional study of urban parks and takeaway/fast-food stores as modifiers of the effect of physical activity facilities. *Soc Sci Med*. 2020;261:113242.
268. Bassetti E, Khosravi A, Pries AM. Prevalence of Front-of-Pack Warning Signs among Commercial Complementary Foods in Seven High and Upper Middle-Income Countries. *Nutrients*. 2023;15(7).
269. Bridge G, Lomazzi M, Santoso CMA, Bedi R. Analysis of the labelling of a sample of commercial foods for infants and young children in 13 countries. *J Public Health Policy*. 2021;42(3):390-401.
270. Charlton EL, Kahkonen LA, Sacks G, Cameron AJ. Supermarkets and unhealthy food marketing: An international comparison of the content of supermarket catalogues/circulars. *Prev Med*. 2015;81:168-73.
271. Clark M, Springmann M, Rayner M, Scarborough P, Hill J, Tilman D, et al. Estimating the environmental impacts of 57,000 food products. *Proc Natl Acad Sci U S A*. 2022;119(33):e2120584119.
272. Cook N, Williams L, D'Agostino M. Prevalence of Norovirus in produce sold at retail in the United Kingdom. *Food Microbiol*. 2019;79:85-9.
273. Davis R, Boyd CE, Wakefield J, Shatova O, McNevin A, Harris B, Davis DA. Trace element concentrations in white leg shrimp *Litopenaeus vannamei* from retail stores in the EU, UK, and USA and the ability to discern country of origin with classification models. *Curr Res Food Sci*. 2021;4:655-61.
274. Dunford E, Webster J, Woodward M, Czernichow S, Yuan WL, Jenner K, et al. The variability of reported salt levels in fast foods across six countries: opportunities for salt reduction. *CMAJ*. 2012;184(9):1023-8.
275. Dunford EK, Ni Mhurchu C, Huang L, Vandevijvere S, Swinburn B, Pravst I, et al. A comparison of the healthiness of packaged foods and beverages from 12 countries using the Health Star Rating nutrient profiling system, 2013-2018. *Obes Rev*. 2019;20 Suppl 2:107-15.
276. Ellis KA, Innocent G, Grove-White D, Cripps P, McLean WG, Howard CV, Mihm M. Comparing the fatty acid composition of organic and conventional milk. *J Dairy Sci*. 2006;89(6):1938-50.
277. Food Standards Agency UK-wide Survey of Salmonella and Campylobacter Contamination of Fresh and Frozen Chicken on Retail Sale. 2003.
278. Grashuis J, Hakelius K. Pricing strategies of corporations and consumer co-operatives in the food retail sector: Evidence from England, Sweden, and the Netherlands. *Journal of Co-Operative Organization and Management*. 2023;11(1).
279. Heroux M, Iannotti RJ, Currie D, Pickett W, Janssen I. The food retail environment in school neighborhoods and its relation to lunchtime eating behaviors in youth from three countries. *Health Place*. 2012;18(6):1240-7.
280. Hieke S, Kuljanic N, Pravst I, Miklavec K, Kaur A, Brown KA, et al. Prevalence of Nutrition and Health-Related Claims on Pre-Packaged Foods: A Five-Country Study in Europe. *Nutrients*. 2016;8(3):137.

281. Hobin E, White C, Li Y, Chiu M, O'Brien MF, Hammond D. Nutritional quality of food items on fast-food 'kids' menus: comparisons across countries and companies. *Public Health Nutr.* 2014;17(10):2263-9.
282. Hoenink JC, Huang Y, Keeble M, Mackenbach JD, Pinho MG, Burgoine T, Adams J. Socioeconomic distribution of food outlet availability through online food delivery services in seven European countries: A cross-sectional study. *Health Place.* 2023;84:103135.
283. Kaur A, Scarborough P, Hieke S, Kusar A, Pravst I, Raats M, Rayner M. The nutritional quality of foods carrying health-related claims in Germany, The Netherlands, Spain, Slovenia and the United Kingdom. *Eur J Clin Nutr.* 2016;70(12):1388-95.
284. Thornton LE, Cameron AJ, McNaughton SA, Waterlander WE, Sodergren M, Svastisalee C, et al. Does the availability of snack foods in supermarkets vary internationally? *Int J Behav Nutr Phys Act.* 2013;10:56.
285. Trichterborn J, Harzer G, Kunz C. Nutrient profiling and food label claims: evaluation of dairy products in three major European countries. *Eur J Clin Nutr.* 2011;65(9):1032-8.
286. Vandevijvere S, Barquera S, Caceres G, Corvalan C, Karupaiah T, Kroker-Lobos MF, et al. An 11-country study to benchmark the implementation of recommended nutrition policies by national governments using the Healthy Food Environment Policy Index, 2015-2018. *Obes Rev.* 2019;20 Suppl 2:57-66.
287. Potter C, Pechey R, Clark M, Frie K, Bateman PA, Cook B, et al. Effects of environmental impact labels on the sustainability of food purchases: Two randomised controlled trials in an experimental online supermarket. *PLoS One.* 2022;17(11):e0272800.
288. Bandy LK, Hollowell S, Jebb SA, Scarborough P. Changes in the salt content of packaged foods sold in supermarkets between 2015-2020 in the United Kingdom: A repeated cross-sectional study. *PLoS Med.* 2022;19(10):e1004114.
289. Bianchi F, Luick M, Bandy L, Bone J, Kelly S, Farrington J, et al. The impact of altering restaurant and menu option position on food selected from an experimental food delivery platform: a randomised controlled trial. *Int J Behav Nutr Phys Act.* 2023;20(1):60.
290. De-loyde K, Pilling MA, Munafò MR, Attwood A, Maynard OM. How are milk substitutes labelled in the UK? Should the term 'milk' be added to milk substitute labelling? *Behavioural Public Policy.* 2023;10(1):110-26.
291. Glover A, Hayes HE, Ni H, Raikos V. A comparison of the nutritional content and price between dairy and non-dairy milks and cheeses in UK supermarkets: A cross sectional analysis. *Nutr Health.* 2024;30(1):157-65.
292. Huang YR, Theis DRZ, Burgoine T, Adams J. Trends in energy and nutrient content of menu items served by large UK chain restaurants from 2018 to 2020: an observational study. *Bmj Open.* 2021;11(12):e054804.
293. McPhedran R, Zhuo S, Zamperetti L, Gold N. The effects of Veganuary on meal choices in workplace cafeterias: an interrupted time series analysis. *Behavioural Public Policy.* 2023;10(1):90-109.

294. Thomas M, Moore JB, Onuseleogu DA, Dalton A, Rains T, Lowry E, et al. Supermarket top-up of Healthy Start vouchers increases fruit and vegetable purchases in low-income households. *Nutr Bull.* 2023;48(3):353-64.
295. Trewern J, Chenoweth J, Christie I, Halevy S. Does promoting plant-based products in Veganuary lead to increased sales, and a reduction in meat sales? A natural experiment in a supermarket setting. *Public Health Nutr.* 2022;25(11):3204-14.
296. Wallis LW, Moore SG. Product promotions in online supermarkets: prevalence of 'High Fat Sugar Salt' (HFSS) products and labelling characteristics. *Public Health Nutr.* 2023;26(11):2607-18.
297. Alonge O, Shiode S, Shiode N. The Impact of Fast-Food Density on Obesity during the COVID-19 Lockdown in the UK: A Multi-Timepoint Study on British Cohort Data. *Sustainability.* 2023;15(11).
298. Bandy LK, Hollowell S, Harrington R, Scarborough P, Jebb S, Rayner M. Assessing the healthiness of UK food companies' product portfolios using food sales and nutrient composition data. *PLoS One.* 2021;16(8):e0254833.
299. Bandy LK, Scarborough P, Harrington RA, Rayner M, Jebb SA. The sugar content of foods in the UK by category and company: A repeated cross-sectional study, 2015-2018. *PLoS Med.* 2021;18(5):e1003647.
300. Beatty TKM. Do the Poor Pay More for Food? Evidence from the United Kingdom. *American Journal of Agricultural Economics.* 2010;92(3):608-21.
301. Brinsden HC, He FJ, Jenner KH, Macgregor GA. Surveys of the salt content in UK bread: progress made and further reductions possible. *BMJ Open.* 2013;3(6).
302. Green MA, Hobbs M, Ding D, Widener M, Murray J, Reece L, Singleton A. The Association between Fast Food Outlets and Overweight in Adolescents Is Confounded by Neighbourhood Deprivation: A Longitudinal Analysis of the Millennium Cohort Study. *Int J Environ Res Public Health.* 2021;18(24).
303. Jones NR, Conklin AI, Suhrcke M, Monsivais P. The growing price gap between more and less healthy foods: analysis of a novel longitudinal UK dataset. *PLoS One.* 2014;9(10):e109343.
304. Pombo-Rodrigues S, Hashem KM, He FJ, MacGregor GA. Salt and sugars content of breakfast cereals in the UK from 1992 to 2015. *Public Health Nutr.* 2017;20(8):1500-12.
305. Revoredo-Giha C, Renwick A. Retailers Price Behavior in the UK Fresh Fruit and Vegetable Market. *Agribusiness.* 2012;28(4):451-68.
306. Scarborough P, Adhikari V, Harrington RA, Elhussein A, Briggs A, Rayner M, et al. Impact of the announcement and implementation of the UK Soft Drinks Industry Levy on sugar content, price, product size and number of available soft drinks in the UK, 2015-19: A controlled interrupted time series analysis. *PLoS Med.* 2020;17(2):e1003025.
307. Smith D. Does the local food environment around schools affect diet? Longitudinal associations in adolescents attending secondary schools in East London. *BMC Public Health.* 2013.
308. Van Camp D, de Souza Monteiro DM, Hooker NH. Stop or go? How is the UK food industry responding to front-of-pack nutrition labels? *European Review of Agricultural Economics.* 2011;39(5):821-42.

309. Nikolaou CK, Lean ME, Hankey CR. Calorie-labelling in catering outlets: acceptability and impacts on food sales. *Prev Med.* 2014;67:160-5.
310. Piernas C, Cook B, Stevens R, Stewart C, Hollowell J, Scarborough P, Jebb SA. Estimating the effect of moving meat-free products to the meat aisle on sales of meat and meat-free products: A non-randomised controlled intervention study in a large UK supermarket chain. *PLoS Med.* 2021;18(7):e1003715.
311. Spence S, Matthews JNS, McSweeney L, Adamson AJ, Bradley J. The Effect of a Product Placement Intervention on Pupil's Food and Drink Purchases in Two Secondary Schools: An Exploratory Study. *Nutrients.* 2022;14(13).
312. Ejlerskov KT, Stead M, Adamson A, White M, Adams J. The nature of UK supermarkets' policies on checkout food and associations with healthfulness and type of food displayed: cross-sectional study. *Int J Behav Nutr Phys Act.* 2018;15(1):52.
313. Baker N, Popay S, Bennett J, Kneafsey M. Net yield efficiency: Comparing salad and vegetable waste between community supported agriculture and supermarkets in the UK. *J Agric Food Syst Co.* 2019;8(4):179-92.
314. Filimonau V, Nghiem VN, Wang LE. Food waste management in ethnic food restaurants. *International Journal of Hospitality Management.* 2021;92.
315. Milner J, Green R, Dangour AD, Haines A, Chalabi Z, Spadaro J, et al. Health effects of adopting low greenhouse gas emission diets in the UK. *BMJ Open.* 2015;5(4):e007364.
316. Scarborough P, Allender S, Clarke D, Wickramasinghe K, Rayner M. Modelling the health impact of environmentally sustainable dietary scenarios in the UK. *Eur J Clin Nutr.* 2012;66(6):710-5.
317. Wu Q, Honhon D. Don't waste that free lettuce! Impact of BOGOF promotions on retail profit and food waste. *Production and Operations Management.* 2023;32(2):501-23.
318. Cummins SC, McKay L, MacIntyre S. McDonald's restaurants and neighborhood deprivation in Scotland and England. *Am J Prev Med.* 2005;29(4):308-10.
319. Dixon-Hardy DW, Curran BA. Types of packaging waste from secondary sources (supermarkets)--the situation in the UK. *Waste Manag.* 2009;29(3):1198-207.
320. Libuy N, Church D, Ploubidis G, Fitzsimons E. Fast food proximity and weight gain in childhood and adolescence: Evidence from Great Britain. *Health Econ.* 2024;33(3):449-65.
321. Macdonald L, Cummins S, Macintyre S. Neighbourhood fast food environment and area deprivation--substitution or concentration? *Appetite.* 2007;49(1):251-4.
322. Mason K, Pearce N, Cummins S. Neighbourhood built environments, socioeconomic position, and hospital admissions for cardiovascular disease: a prospective study using UK Biobank. *medrxiv preprint.* 2023.
323. Mason KE, Palla L, Pearce N, Phelan J, Cummins S. Genetic risk of obesity as a modifier of associations between neighbourhood environment and body mass index: an observational study of 335 046 UK Biobank participants. *BMJ Nutr Prev Health.* 2020;3(2):247-55.
324. Mason KE, Pearce N, Cummins S. Associations between fast food and physical activity environments and adiposity in mid-life: cross-sectional, observational evidence from UK Biobank. *Lancet Public Health.* 2018;3(1):e24-e33.

325. Jones M FE, Hennessy-Priest K, Costa J.S. . A Systematic Cross-Sectional Analysis of British Based Celebrity Chefs' Recipes: Is There Cause for Public Health Concern? *Food and Public Health*. 2013;3(2):100-10.
326. Penney TL, Burgoine T, Monsivais P. Relative Density of Away from Home Food Establishments and Food Spend for 24,047 Households in England: A Cross-Sectional Study. *Int J Environ Res Public Health*. 2018;15(12).
327. Robinson E, Burton S, Gough T, Jones A, Haynes A. Point of choice kilocalorie labelling in the UK eating out of home sector: a descriptive study of major chains. *BMC Public Health*. 2019;19(1):649.
328. Robinson E, Jones A, Whitelock V, Mead BR, Haynes A. (Over)eating out at major UK restaurant chains: observational study of energy content of main meals. *BMJ*. 2018;363:k4982.
329. Stones C. Online food nutrition labelling in the UK: how consistent are supermarkets in their presentation of nutrition labels online? *Public Health Nutr*. 2016;19(12):2175-84.
330. Young M, Coppinger T, Reeves S. The Nutritional Value of Children's Menus in Chain Restaurants in the United Kingdom and Ireland. *J Nutr Educ Behav*. 2019;51(7):817-25.
331. Chu BTY, Irigaray CP, Hillier SE, Clegg ME. The sugar content of children's and lunchbox beverages sold in the UK before and after the soft drink industry levy. *Eur J Clin Nutr*. 2020;74(4):598-603.
332. Espinoza-Orias N, Azapagic A. Understanding the impact on climate change of convenience food: Carbon footprint of sandwiches. *Sustainable Production and Consumption*. 2018;15:1-15.
333. Garcia AL, Curtin L, Ronquillo JD, Parrett A, Wright CM. Changes in the UK baby food market surveyed in 2013 and 2019: the rise of baby snacks and sweet/savoury foods. *Arch Dis Child*. 2020;105(12):1162-6.
334. Garcia AL, Raza S, Parrett A, Wright CM. Nutritional content of infant commercial weaning foods in the UK. *Arch Dis Child*. 2013;98(10):793-7.
335. Gillespie I, Little C, Mitchell R. Microbiological examination of cold ready-to-eat sliced meats from catering establishments in the United Kingdom. *J Appl Microbiol*. 2000;88(3):467-74.
336. Hashem KM, He FJ, Alderton SA, MacGregor GA. Cross-sectional survey of the amount of sugar and energy in cakes and biscuits on sale in the UK for the evaluation of the sugar-reduction programme. *BMJ Open*. 2018;8(7):e019075.
337. Hashem KM, He FJ, Jenner KH, MacGregor GA. Cross-sectional survey of the amount of free sugars and calories in carbonated sugar-sweetened beverages on sale in the UK. *BMJ Open*. 2016;6(11):e010874.
338. Hashem KM, He FJ, MacGregor GA. Cross-sectional surveys of the amount of sugar, energy and caffeine in sugar-sweetened drinks marketed and consumed as energy drinks in the UK between 2015 and 2017: monitoring reformulation progress. *BMJ Open*. 2017;7(12):e018136.
339. Hashem KM, He FJ, MacGregor GA. Labelling changes in response to a tax on sugar-sweetened beverages, United Kingdom of Great Britain and Northern Ireland. *Bull World Health Organ*. 2019;97(12):818-27.

340. Marty L, Evans R, Sheen F, Humphreys G, Jones A, Boyland E, Robinson E. The energy and nutritional content of snacks sold at supermarkets and coffee shops in the UK. *J Hum Nutr Diet*. 2021;34(6):1035-41.
341. Moore JB, Horti A, Fielding BA. Evaluation of the nutrient content of yogurts: a comprehensive survey of yogurt products in the major UK supermarkets. *BMJ Open*. 2018;8(8):e021387.
342. Moore JB, Sutton EH, Hancock N. Sugar Reduction in Yogurt Products Sold in the UK between 2016 and 2019. *Nutrients*. 2020;12(1).
343. Sarkar C, Webster C, Gallacher J. Are exposures to ready-to-eat food environments associated with type 2 diabetes? A cross-sectional study of 347 551 UK Biobank adult participants. *Lancet Planet Health*. 2018;2(10):e438-e50.
344. Zand N, Chowdhry BZ, Wray DS, Pullen FS, Snowden MJ. Elemental content of commercial 'ready to-feed' poultry and fish based infant foods in the UK. *Food Chem*. 2012;135(4):2796-801.
345. Howard S, Adams J, White M. Nutritional content of supermarket ready meals and recipes by television chefs in the United Kingdom: cross sectional study. *BMJ*. 2012;345:e7607.
346. Huang Y, Burgoine T, Theis DR, Adams J. Differences in energy and nutrient content of menu items served by large chain restaurants in the USA and the UK in 2018. *Public Health Nutr*. 2022;25(10):1-9.
347. Little CL, Gillespie IA, Mitchell RT, Local Authority Co-ordinating body on F, Trading S, Public Health Laboratory S. Microbiological examination of ready-to-eat burgers sampled anonymously at the point of sale in the United Kingdom. *Commun Dis Public Health*. 2001;4(4):293-9.
348. Muc M, Jones A, Roberts C, Sheen F, Haynes A, Robinson E. A bit or a lot on the side? Observational study of the energy content of starters, sides and desserts in major UK restaurant chains. *BMJ Open*. 2019;9(10):e029679.
349. Nikolaou CK, Hankey CR, Lean ME. Nutritional adequacy of meals from an independent catering facility versus chain restaurants for young adults. *Nutr Health*. 2017;23(1):51-6.
350. Parnham JC, Millett C, Vamos EP. School meals in the UK: ultra-processed, unequal and inadequate. *Public Health Nutr*. 2023;26(1):297-301.
351. Takacs B SJA, Kalea Z.A, Borrion A. Comparison of environmental impacts of individual meals - Does it really make a difference to choose plant-based meals instead of meat-based ones? *Journal of Cleaner Production*. 2022;379.
352. Zand N, Chowdhry BZ, Pollard LV, Pullen FS, Snowden MJ, Zotor FB. Commercial 'ready-to-feed' infant foods in the UK: macro-nutrient content and composition. *Matern Child Nutr*. 2015;11(2):202-14.
353. Coyne KJ, Baldrige AS, Huffman MD, Jenner K, Xavier D, Dunford EK. Differences in the sodium content of bread products in the USA and UK: implications for policy. *Public Health Nutr*. 2018;21(3):632-6.
354. Bandy LK, Scarborough P, Harrington RA, Rayner M, Jebb SA. Reductions in sugar sales from soft drinks in the UK from 2015 to 2018. *BMC Med*. 2020;18(1):20.
355. Coffey AA, Lillywhite R, Oyebode O. Meat versus meat alternatives: which is better for the environment and health? A nutritional and environmental analysis of

animal-based products compared with their plant-based alternatives. *J Hum Nutr Diet.* 2023;36(6):2147-56.

356. Scarborough P, Appleby PN, Mizdrak A, Briggs AD, Travis RC, Bradbury KE, Key TJ. Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the UK. *Clim Change.* 2014;125(2):179-92.

357. Neumann NJ, Eichner G, Fasshauer M. Flavour, emulsifiers and colour are the most frequent markers to detect food ultra-processing in a UK food market analysis. *Public Health Nutr.* 2023;26(12):3303-10.

358. Nakamura R, Pechey R, Suhrcke M, Jebb SA, Marteau TM. Sales impact of displaying alcoholic and non-alcoholic beverages in end-of-aisle locations: an observational study. *Soc Sci Med.* 2014;108(100):68-73.

359. Jones P, Comfort D, Hillier DJ, editors. *Interpretations of the Concept of Sustainability Amongst the UK's Leading Food and Drink Wholesalers 2016.*

360. Dicken SJ, Batterham RL, Brown A. Nutrients or processing? An analysis of food and drink items from the UK National Diet and Nutrition Survey based on nutrient content, the NOVA classification and front of package traffic light labelling. *Br J Nutr.* 2024;131(9):1619-32.

361. Cooper S, Nelson M. 'Economy' line foods from four supermarkets and brand name equivalents: a comparison of their nutrient contents and costs. *J Hum Nutr Diet.* 2003;16(5):339-47.

362. Zand N, Chowdhry BZ, Zotor FB, Wray DS, Amuna P, Pullen FS. Essential and trace elements content of commercial infant foods in the UK. *Food Chem.* 2011;128(1):123-8.

363. Wood G, Evans S, Pointon-Bell K, Rocha JC, MacDonald A. Special Low Protein Foods in the UK: An Examination of Their Macronutrient Composition in Comparison to Regular Foods. *Nutrients.* 2020;12(6).

364. Bath SC, Button S, Rayman MP. Iodine concentration of organic and conventional milk: implications for iodine intake. *Br J Nutr.* 2012;107(7):935-40.

365. Dalziel CJ, Kliem KE, Givens DI. Fat and fatty acid composition of cooked meat from UK retail chickens labelled as from organic and non-organic production systems. *Food Chem.* 2015;179:103-8.

366. Fry L, Madden AM, Fallaize R. An investigation into the nutritional composition and cost of gluten-free versus regular food products in the UK. *J Hum Nutr Diet.* 2018;31(1):108-20.

367. Ghodsian B, Madden AM. Evaluating the $\leq 10:1$ wholegrain criterion in identifying nutrient quality and health implications of UK breads and breakfast cereals. *Public Health Nutr.* 2018;21(6):1186-93.

368. Hashem KM, He FJ, Jenner KH, MacGregor GA. Cross-sectional survey of salt content in cheese: a major contributor to salt intake in the UK. *BMJ Open.* 2014;4(8):e005051.

369. Kaur A, Scarborough P, Matthews A, Payne S, Mizdrak A, Rayner M. How many foods in the UK carry health and nutrition claims, and are they healthier than those that do not? *Public Health Nutr.* 2016;19(6):988-97.

370. Khehra R, Fairchild RM, Morgan MZ. UK children's breakfast cereals - an oral health perspective. *Br Dent J.* 2018;225(2):164-9.

371. Ogundijo DA, Tas AA, Onarinde BA. An assessment of nutrition information on front of pack labels and healthiness of foods in the United Kingdom retail market. *BMC Public Health*. 2021;21(1):220.
372. Brereton N. Survey of metals in commercial infant foods, infant formula and non-infant specific foods- Report for the UK Food Standards Agency (FS102048). The Food and Environment Research Agency; 2014 March 2014.
373. Bath SC, Button S, Rayman MP. Availability of iodised table salt in the UK - is it likely to influence population iodine intake? *Public Health Nutr*. 2014;17(2):450-4.
374. Lan H, Dobson PW. Healthy Competition to Support Healthy Eating? An Investigation of Fruit and Vegetable Pricing in UK Supermarkets. *Journal of Agricultural Economics*. 2017;68(3):881-900.
375. Albalawi A, Hambly C, Speakman J. Associations of Food Outlet Densities with Obesity Measures Identify Fish and Chip Shops as a Uniquely Important Problem. *Nutrients*. 2020;12(4):1-68.
376. Sagoo SK, Little CL, Mitchell RT. The microbiological examination of ready-to-eat organic vegetables from retail establishments in the United Kingdom. *Lett Appl Microbiol*. 2001;33(6):434-9.
377. Wang Y, Lehane C, Ghebremeskel K, Crawford MA. Modern organic and broiler chickens sold for human consumption provide more energy from fat than protein. *Public Health Nutr*. 2010;13(3):400-8.
378. Gormley FJ, Little CL, Murphy N, de Pinna E, McLauchlin J. Pooling raw shell eggs: Salmonella contamination and high risk practices in the United Kingdom food service sector. *J Food Prot*. 2010;73(3):574-8.
379. Ni Mhurchu C, Capelin C, Dunford EK, Webster JL, Neal BC, Jebb SA. Sodium content of processed foods in the United Kingdom: analysis of 44,000 foods purchased by 21,000 households. *Am J Clin Nutr*. 2011;93(3):594-600.
380. Shaw H. Food access, diet and health in the UK: an empirical study of Birmingham. *British Food Journal*. 2012;114(4-5):598-616.
381. Wickramasinghe KK, Rayner M, Goldacre M, Townsend N, Scarborough P. Contribution of healthy and unhealthy primary school meals to greenhouse gas emissions in England: linking nutritional data and greenhouse gas emission data of diets. *Eur J Clin Nutr*. 2016;70(10):1162-7.
382. Bouga M, Combet E. Emergence of Seaweed and Seaweed-Containing Foods in the UK: Focus on Labeling, Iodine Content, Toxicity and Nutrition. *Foods*. 2015;4(2):240-53.
383. Prowse R, Lawlor N, Powell R, Neumann EM. Creating healthy food environments in recreation and sport settings using choice architecture: a scoping review. *Health Promot Int*. 2023;38(5).
384. Macdiarmid JI, Kyle J, Horgan GW, Loe J, Fyfe C, Johnstone A, McNeill G. Sustainable diets for the future: Can we contribute to reducing greenhouse gas emissions by eating a healthy diet? *Am J Clin Nutr*. 2012;96(3):632-9.
385. Revoredo-Giha C, Akaichi F, Chalmers N. Trading on Food Quality due to Changes in Prices: Are There Any Nutritional Effects? *Nutrients*. 2019;12(1).

386. Stewart C, Piernas C, Cook B, Jebb SA. Trends in UK meat consumption: analysis of data from years 1-11 (2008-09 to 2018-19) of the National Diet and Nutrition Survey rolling programme. *Lancet Planet Health*. 2021;5(10):e699-e708.
387. Briggs A, Kehlbacher A, Tiffin R, Garnett T, Rayner M, Scarborough P. Incorporating the societal cost of greenhouse gases into the price of foods could save lives from cardiovascular disease and cancer in England: a comparative risk assessment modelling study. *PLoS Medicine*. 2016.
388. Dogbe W, Revoredo-Giha C. Nutritional and Environmental Assessment of Increasing the Content of Fruit and Vegetables in the UK Diet. *Sustainability*. 2021;13(3):1076.
389. Coley D, Howard M, Winter M. Local food, food miles and carbon emissions: A comparison of farm shop and mass distribution approaches. *Food Policy*. 2009;34(2):150-5.
390. Aceves-Martins M, Bates RL, Craig LCA, Chalmers N, Horgan G, Boskamp B, de Roos B. Nutritional Quality, Environmental Impact and Cost of Ultra-Processed Foods: A UK Food-Based Analysis. *Int J Environ Res Public Health*. 2022;19(6).
391. Aceves-Martins M, Bates RL, Craig LCA, Chalmers N, Horgan G, Boskamp B, de Roos B. Food-Level Analysis to Identify Dietary Choices With the Highest Nutritional Quality and Lowest Greenhouse Gas Emissions and Price. *Front Nutr*. 2022;9:851826.
392. Gunning Y, Fong LKW, Watson AD, Philo M, Kemsley EK. Quantitative authenticity testing of buffalo mozzarella via α s1-Casein using multiple reaction monitoring mass spectrometry. *Food Control*. 2019;101:189-97.
393. Elson R, Burgess F, Little CL, Mitchell RT, Local Authorities Co-Ordinators of Regulatory S, the Health Protection A. Microbiological examination of ready-to-eat cold sliced meats and pate from catering and retail premises in the UK. *J Appl Microbiol*. 2004;96(3):499-509.
394. Rahilly J, Williams A, Chang M, Cummins S, Derbyshire D, Hassan S, et al. Changes in the number and outcome of takeaway food outlet planning applications in response to adoption of management zones around schools in England: A time series analysis. *Health Place*. 2024;87:103237.
395. Li J, Green C, Reynolds A, Shi H, Rotchell JM. Microplastics in mussels sampled from coastal waters and supermarkets in the United Kingdom. *Environ Pollut*. 2018;241:35-44.
396. McLauchlin J, Aird H, Elliott A, Forester E, Jorgensen F, Willis C. Microbiological quality of raw drinking milk and unpasteurised dairy products: results from England 2013-2019. *Epidemiol Infect*. 2020;148:e135.
397. Sagoo SK, Little CL, Greenwood M. Microbiological study of cooked crustaceans and molluscan shellfish from UK production and retail establishments. *Int J Environ Health Res*. 2007;17(3):219-30.
398. Garcia AL, Menon R, Parrett A. Extensive use of on-pack promotional claims on commercial baby foods in the UK. *Arch Dis Child*. 2022;107(6):606-11.
399. Jones M, Pitt H, Oxford L, Bray I, Kimberlee R, Orme J. Association between Food for Life, a Whole Setting Healthy and Sustainable Food Programme, and Primary School Children's Consumption of Fruit and Vegetables: A Cross-Sectional Study in England. *Int J Environ Res Public Health*. 2017;14(6).

400. Scarborough P, Matthews A, Eyles H, Kaur A, Hodgkins C, Raats MM, Rayner M. Reds are more important than greens: how UK supermarket shoppers use the different information on a traffic light nutrition label in a choice experiment. *Int J Behav Nutr Phys Act.* 2015;12:151.
401. Macintyre S, McKay L, Cummins S, Burns C. Out-of-home food outlets and area deprivation: case study in Glasgow, UK. *Int J Behav Nutr Phys Act.* 2005;2(16):16.
402. Notarnicola B, Tassielli G, Renzulli PA, Castellani V, Sala S. Environmental impacts of food consumption in Europe. *Journal of Cleaner Production.* 2017;140:753-65.
403. Crippa M, Solazzo E, Guizzardi D, Monforti-Ferrario F, Tubiello FN, Leip A. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nat Food.* 2021;2(3):198-209.
404. Monsivais P, Aggarwal A, Drewnowski A. Time spent on home food preparation and indicators of healthy eating. *Am J Prev Med.* 2014;47(6):796-802.
405. Traill WB, Chambers SA, Butler L. Attitudinal and demographic determinants of diet quality and implications for policy targeting. *J Hum Nutr Diet.* 2012;25(1):87-94.
406. Aceves-Martins M, Denton P, de Roos B. Ready meals, especially those that are animal-based and cooked in an oven, have lower nutritional quality and higher greenhouse gas emissions and are more expensive than equivalent home-cooked meals. *Public Health Nutr.* 2023;26(3):531-9.
407. (DEFRA) DoEFaRA. National statistics Family Food 2019-20 27 January 2022 [Available from: <https://www.gov.uk/government/statistics/family-food-201920/family-food-201920#table-11-uk-expenditure-on-food-and-drink-in-real-terms-201920supabcsup>].
408. Food Standards Scotland Situation Report: Changes to shopping and eating behaviours in Scotland during the COVID-19 pandemic in 2020. Scotland: Food Standards Scotland 2020.
409. Susannah Irvine AG, Brigid Francis-Devine. Food banks in the UK. House of Commons Library; 2022 14 July 2022.
410. Goudie S. Why food and diets should be central to the Government's levelling up agenda. White paper. The Food Foundation; 2022 31/01/2022.
411. Far-reaching ban on single-use plastics in England [press release]. 2023.
412. Directorate EaF. Food waste reduction: action plan. 24 April 2019.
413. A Green Growth Strategy for Northern Ireland - Balancing our climate, environment and economy. In: Department for Agriculture EaRAD, editor. 2022.
414. The Food (Promotion and Placement) England Regulations 2021 No. 1368 (2021).
415. Scottish Government Consultation on Restricting Promotions of Food and Drink High in Fat, Sugar or Salt. July 2022.
416. Welsh Government Healthy Food Environment -Exploring proposals to make the food environment in Wales healthier. Welsh Government 2022.
417. Monsivais P, Francis O, Lovelace R, Chang M, Strachan E, Burgoine T. Data visualisation to support obesity policy: case studies of data tools for planning and transport policy in the UK. *Int J Obes (Lond).* 2018;42(12):1977-86.

418. Bivoltsis A, Cervigni E, Trapp G, Knuiman M, Hooper P, Ambrosini GL. Food environments and dietary intakes among adults: does the type of spatial exposure measurement matter? A systematic review. *International journal of health geographics*. 2018;17(1):19.
419. Atanasova P, Kusuma D, Pineda E, Frost G, Sassi F, Miraldo M. The impact of the consumer and neighbourhood food environment on dietary intake and obesity-related outcomes: A systematic review of causal impact studies. *Soc Sci Med*. 2022;299:114879.
420. Kapoor D, Shields K, Reynolds C, Del Valle Menendez M, Jaacks LM. The UK Food Environment: A Systematic Review of Domains, Methodologies, and Outcomes. *Curr Dev Nutr*. 2025;9(11):107573.
421. d'Angelo C, Emily Ryen Gloinson, Alizon Draper, and Susan Guthrie Food consumption in the UK: Trends, attitudes and drivers.; 2020.
422. Olsen NV, Sijtsema SJ, Hall G. Predicting consumers' intention to consume ready-to-eat meals. The role of moral attitude. *Appetite*. 2010;55(3):534-9.
423. Scholliers P. Convenience foods. What, why, and when. *Appetite*. 2015;94(1 November 2015):2-6.
424. Jackson P, Viehoff V. Reframing convenience food. *Appetite*. 2016;98(1 March 2016):1-11.
425. Jabs J, Devine CM. Time scarcity and food choices: an overview. *Appetite*. 2006;47(2):196-204.
426. Venn D, Strazdins L. Your money or your time? How both types of scarcity matter to physical activity and healthy eating. *Soc Sci Med*. 2017;172:98-106.
427. Heesch KC, Masse LC. Lack of time for physical activity: perception or reality for African American and Hispanic women? *Women Health*. 2004;39(3):45-62.
428. Hasan A, Sharif AB, Jahan I. Perceived barriers to maintain physical activity and its association to mental health status of Bangladeshi adults: a quantile regression approach. *Sci Rep*. 2023;13(1):8993.
429. Welch N, McNaughton SA, Hunter W, Hume C, Crawford D. Is the perception of time pressure a barrier to healthy eating and physical activity among women? *Public Health Nutr*. 2009;12(7):888-95.
430. Ross AM, Melzer T. Beliefs as barriers to healthy eating and physical activity. *Australian Journal of Psychology*. 2016;68(4):251-60.
431. Appelhans BM, Segawa E, Janssen I, Nackers LM, Kazlauskaitė R, Baylin A, et al. Meal preparation and cleanup time and cardiometabolic risk over 14 years in the Study of Women's Health Across the Nation (SWAN). *Prev Med*. 2015;71:1-6.
432. Rogus S. Examining the influence of perceived and objective time constraints on the quality of household food purchases. *Appetite*. 2018;130:268-73.
433. Toure D, Herforth A, Pelto GH, Neufeld LM, Mbuya MNN. An Emergent Framework of the Market Food Environment in Low- and Middle-Income Countries. *Curr Dev Nutr*. 2021;5(4):nzab023.
434. Menezes MC, Diez Roux AV, Costa BVL, Lopes ACS. Individual and food environmental factors: association with diet. *Public Health Nutr*. 2018;21(15):2782-92.
435. Pelto GH, Armar-Klemesu M, Siekmann J, Schofield D. The focused ethnographic study 'assessing the behavioral and local market environment for

improving the diets of infants and young children 6 to 23 months old' and its use in three countries. *Matern Child Nutr.* 2013;9 Suppl 1(Suppl 1):35-46.

436. Bignante E. The use of photo-elicitation in field research. *EchoGéo.* 2010;11.
437. Spencer RA, McIsaac JD, Stewart M, Brushett S, Kirk SFL. Food in Focus: Youth Exploring Food in Schools Using Photovoice. *J Nutr Educ Behav.* 2019;51(8):1011-9.
438. Diez J, Conde P, Sandin M, Urtasun M, Lopez R, Carrero JL, et al. Understanding the local food environment: A participatory photovoice project in a low-income area in Madrid, Spain. *Health Place.* 2017;43(43:95-103):95-103.
439. Jessica R. Bogard SD, Elodie Casey, Penny Farrell, Adyya Gupta, Lais Miachon, Shaan Naughton, Wiktorija Staromiejska, Erica Reeve Convenience as a dimension of food environments: A systematic scoping review of its definition and measurement *Appetite.* 2024;194.
440. Clifford Astbury C, Penney TL, Foley L, Adams J. Foodwork in the United Kingdom from 1983 to 2014: A compositional data analysis of repeat cross-sectional time use surveys. *Appetite.* 2022;168:105694.
441. Karen S. Hamrick MA, Joanne Guthrie DH, Ket McClelland. <How Much Time Do Americans spend on food.pdf>. 2011.
442. Pickering J, Reynolds CJ. Meal mutability: Understanding how variations in meal concepts and recipe flexibility relate to food provisioning. *International Journal of Gastronomy and Food Science.* 2023;33(100797).
443. Elizabeth L, Machado P, Zinocker M, Baker P, Lawrence M. Ultra-Processed Foods and Health Outcomes: A Narrative Review. *Nutrients.* 2020;12(7).
444. Aschemann-Witzel J, Giménez A, Ares G. Convenience or price orientation? Consumer characteristics influencing food waste behaviour in the context of an emerging country and the impact on future sustainability of the global food sector. *Global Environ Chang.* 2018;49:85-94.
445. Liu C, Chen JX. Consuming takeaway food: Convenience, waste and Chinese young people's urban lifestyle. *Journal of Consumer Culture.* 2021;21(4):848-66.
446. Darmon N, Drewnowski A. Contribution of food prices and diet cost to socioeconomic disparities in diet quality and health: a systematic review and analysis. *Nutr Rev.* 2015;73(10):643-60.
447. Gould CF, Urpelainen J. LPG as a Clean Cooking Fuel: Adoption, Use, and Impact in Rural India. *Energy Policy.* 2018;122:395-408.
448. Iwona Bisaga ES, Jamie Stevenson, Fernando de Cuadra, Eduardo Sanchez Jacob, Matthew Leach, Alexandros Korkovelos. Integrating Clean Cooking into National Energy Access Planning: Tools and Considerations for Planning and Implementing eCooking. 2024.
449. Will Clements SB, Jerome Nsengiyaremye. Cooking Support On Mini Grids (Cosmo): Synthesis Report Briefing 2024.
450. Cowburn A. Iceland boss says foodbank users 'declining potatoes because they can't afford energy to boil them'. *Independent.* 2022 23 March 2022
451. Rasanga F, Harrison T, Calabrese R. Measuring the energy poverty premium in Great Britain and identifying its main drivers based on longitudinal household survey data. *Energy Economics.* 2024;136.

452. Boskovic A, Burgoine T, Hoenink JC. The socioeconomic patterning of Great-Britain's retail food environment: A repeated cross-sectional study of area-level deprivation and food outlet density from 2011-2024 (pre-print on MedRxiv <https://doi.org/10.1101/2025.03.07.25323573>). 2025.
453. Janatabadi F, Newing A, Ermagun A. Social and spatial inequalities of contemporary food deserts: A compound of store and online access to food in the United Kingdom. *Applied Geography*. 2024;163.
454. Mills S, Wright T. Access to food retail outlets in County Durham, UK: a pragmatic cross-sectional study. *Lancet*. 2015;385 Suppl 1:S70.
455. McEachern MG, Moraes C, Scullion L, Gibbons A. Urban poverty and the role of UK food aid organisations in enabling segregating and transitioning spaces of food access. *Urban Studies*. 2024;61(11):2231-49.
456. European Union Life expectancy at birth by sex 2024 [updated 06/09/2024 Life expectancy at birth is defined as the mean number of years that a new-born child can expect to live if subjected throughout his life to the current mortality conditions (age specific probabilities of dying)]. Available from: <https://ec.europa.eu/eurostat/databrowser/bookmark/cc29308f-98b8-4aa1-b791-9539745cb0c0?lang=en>.
457. Finch D WH, Bibby J. Leave no one behind- The state of health and health inequalities in Scotland.; 2023.
458. Scottish Government The Scottish Health Survey 2022 edition - Summary. In: Directorates TSGH, editor. 2022.
459. Elrick C FN, Wilson L. Monitoring out of home food and drink purchases in Scotland and Great Britain (2022 and 2023). *Food Standards Scotland* 2024 24 March 2024.
460. OpenAI JA, Steven Adler, Sandhini Agarwal, Lama Ahmad, Ilge Akkaya, Florencia Leoni Aleman, et al. . GPT-4 Technical Report.; 2-24 March 4, 2024.
461. R Core Team, R, a Language and environment for statistical computing [Internet], R Foundation for statistical computing, Vienna, Austria, 2022. [Available from: <https://www.R-project.org/>].
462. Scottish Government Scotland's Census 2022 - First results - Rounded population estimates 2022 [Available from: <https://www.scotlandscensus.gov.uk/2022-results/scotland-s-census-2022-rounded-population-estimates/>].
463. Scottish Government Scottish Index of Multiple Deprivation 2020 2020 [Collection of documents relating to the Scottish Index of Multiple Deprivation - a tool for identifying areas with relatively high levels of deprivation.]. Available from: <https://www.gov.scot/collections/scottish-index-of-multiple-deprivation-2020/>.
464. Scotland NRo. Scottish Statistics Postcode Lookup 2025 [updated Date published 24 April. Available from: <https://www.nrscotland.gov.uk/publications/scottish-statistics-postcode-lookup/>].
465. Disparities OfHI. Wider Determinants of Health: statistical commentary on the location of fast food outlets, February 2025 2025 [updated 10 February 2025. Available from: <https://www.gov.uk/government/statistics/wider-determinants-of-health->

[february-2025-update/wider-determinants-of-health-statistical-commentary-february-2025#fn:1](#).

466. Freathy P, Marshall D, Davies K, Calderwood E. The importance of the informal food economy to food access and security: An examination of the Western Isles of Scotland. *Journal of Rural Studies*. 2024;111(103392).

467. Calderwood E, Freathy P. Consumer mobility in the Scottish isles: The impact of internet adoption upon retail travel patterns. *Transportation Research Part A: Policy and Practice*. 2014;59:192-203.

468. Kirkman S, Hollingsworth B, Lake A, Hinke S, Sorrell S, Burgoine T, Brown H. Field validity and spatial accuracy of Food Standards Agency Food Hygiene Rating scheme data for England. *J Public Health (Oxf)*. 2021;43(4):e720-e7.

469. Public Health E. The Food (Promotion and Placement) (England) Regulations 2021. 2021.

470. Muir S, Dhuria P, Roe E, Lawrence W, Baird J, Vogel C. UK government's new placement legislation is a 'good first step': a rapid qualitative analysis of consumer, business, enforcement and health stakeholder perspectives. *BMC Med*. 2023;21(1):33.

471. Jaworowska A, Force S. Total Fat and Fatty Acid Content in Meals Served by Independent Takeaway Outlets Participating in the Healthier Catering Commitment Initiative in London, UK. *Int J Environ Res Public Health*. 2025;22(1).

472. Pearce J, Blakely T, Witten K, Bartie P. Neighborhood deprivation and access to fast-food retailing: a national study. *Am J Prev Med*. 2007;32(5):375-82.

473. McLoone P. Targeting deprived areas within small areas in Scotland: population study. *BMJ*. 2001;323(7309):374-5.

474. Shucksmith M, Cameron S, Merridew T, Pichler F. Urban-Rural Differences in Quality of Life across the European Union. *Regional Studies*. 2009;43(10):1275-89.

475. Jaworowska A, Blackham T, Davies IG, Stevenson L. Nutritional challenges and health implications of takeaway and fast food. *Nutr Rev*. 2013;71(5):310-8.

476. Rakhra V, Galappaththy SL, Bulchandani S, Cabandugama PK. Obesity and the Western Diet: How We Got Here. *Mo Med*. 2020;117(6):536-8.

477. Lim WM, Das M, Saha V. From consuming food away from home to on-the-go consumption: a multi-study exploration using focus groups and fsQCA. *Journal of Marketing Management*. 2025;41(1-2):1-45.

478. Ziauddeen N, Almiron-Roig E, Penney TL, Nicholson S, Kirk SFL, Page P. Eating at Food Outlets and "On the Go" Is Associated with Less Healthy Food Choices in Adults: Cross-Sectional Data from the UK National Diet and Nutrition Survey Rolling Programme (2008-2014). *Nutrients*. 2017;9(12).

479. Auchincloss AH, Li J, Moore KA, Franco M, Mujahid MS, Moore LV. Are neighbourhood restaurants related to frequency of restaurant meals and dietary quality? Prevalence and changes over time in the Multi-Ethnic Study of Atherosclerosis. *Public Health Nutr*. 2021;24(14):4630-41.

480. Zang J, Luo B, Wang Y, Zhu Z, Wang Z, He X, et al. Eating Out-of-Home in Adult Residents in Shanghai and the Nutritional Differences among Dining Places. *Nutrients*. 2018;10(7).

481. KANTAR. Simon Quirk HCCS. The Out of Home Environment in Scotland (2019). Commissioned by Food Standards Scotland; 2020 26th March 2020.

482. Nesta. Costs of Obesity in Scotland. 2023 29 JUNE 2023.
483. Government S. Scottish Health Survey Dashboard Scotland: Scottish Government; 2023 [Available from: <https://scotland.shinyapps.io/sg-scottish-health-survey/>].
484. Kapoor D, Kennedy J, Shields K, Reynolds C, Clemens T, Jaacks LM. Characterizing the food environment in Scotland and its association with deprivation: A national study. *Prev Med Rep.* 2025;59:103254.
485. Scottish Government Proposed National Good Food Nation Plan. Edinburgh: Scottish Government; 2025.
486. Federation SG. Analysis of responses to consultation on national Good Food Nation Plan 2024 [Available from: <https://www.sgfscot.co.uk/bulletins/analysis-of-responses-to-consultation-on-national-good-food-nation-plan>].
487. Scottish Parliament. Health SCaSC. Health, Social Care and Sport Committee – 21st Meeting, 2025 Scotland: Scottish Parliament; 2025 [Available from: <https://www.parliament.scot/chamber-and-committees/committees/current-and-previous-committees/session-6-health-social-care-and-sport-committee/meetings/2025/health-social-care-and-sport-committee-02-september-2025>].
488. BRAZIL MOHO. Dietary Guidelines for the Brazilian Population. 2015.
489. Canada H. Canada's Dietary Guidelines. 2019.
490. Nations FaAOotU. Food-based dietary guidelines - Japan 2010 [Available from: <https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/japan/en/>].
491. Wolfson JA, Leung CW, Richardson CR. More frequent cooking at home is associated with higher Healthy Eating Index-2015 score. *Public Health Nutr.* 2020;23(13):2384-94.
492. Lee J, Friend S, Horning ML, Linde JA, Flattum C, Lindberg R, Fulkerson JA. Are patterns of family evening meal practices associated with child and parent diet quality and weight-related outcomes? *Appetite.* 2022;171:105937.
493. Fertig AR, Loth KA, Trofholz AC, Tate AD, Miner M, Neumark-Sztainer D, Berge JM. Compared to Pre-prepared Meals, Fully and Partly Home-Cooked Meals in Diverse Families with Young Children Are More Likely to Include Nutritious Ingredients. *J Acad Nutr Diet.* 2019;119(5):818-30.
494. Clifford Astbury C, Penney TL, Adams J. Home-prepared food, dietary quality and socio-demographic factors: a cross-sectional analysis of the UK National Diet and nutrition survey 2008-16. *Int J Behav Nutr Phys Act.* 2019;16(1):82.
495. Mills S, Brown H, Wrieden W, White M, Adams J. Frequency of eating home cooked meals and potential benefits for diet and health: cross-sectional analysis of a population-based cohort study. *Int J Behav Nutr Phys Act.* 2017;14(1):109.
496. Stephen Hinchliffe VW, Jamie Macfarlane, Xanthippi Gounari and Caireen Roberts. The Scottish Health Survey, 2021- technical report Scotland: ScotCen Social Research, Edinburgh, The Scottish Government, Cambridge University; 2022 November 2022.
497. Scottish Government Revised Dietary Goals for Scotland - March 2016. 2016.

498. Mills S, Adams J, Wrieden W, White M, Brown H. Sociodemographic characteristics and frequency of consuming home-cooked meals and meals from out-of-home sources: cross-sectional analysis of a population-based cohort study. *Public Health Nutr.* 2018;21(12):2255-66.
499. Adams J, Goffe L, Brown T, Lake AA, Summerbell C, White M, et al. Frequency and socio-demographic correlates of eating meals out and take-away meals at home: cross-sectional analysis of the UK national diet and nutrition survey, waves 1-4 (2008-12). *Int J Behav Nutr Phys Act.* 2015;12(51):51.
500. Cummins S, Kalbus AI, Cornelsen L, Adams J, Boyland E, Burgoine T, et al. Social inequalities in the use of online food delivery services and associations with weight status: cross-sectional analysis of survey and consumer data. *BMJ Public Health.* 2024;2(2):e000487.
501. Clifford Astbury C, Penney TL, Adams J. Comparison of individuals with low versus high consumption of home-prepared food in a group with universally high dietary quality: a cross-sectional analysis of the UK National Diet & Nutrition Survey (2008-2016). *Int J Behav Nutr Phys Act.* 2019;16(1):9.
502. Gesteiro E, Garcia-Carro A, Aparicio-Ugarriza R, Gonzalez-Gross M. Eating out of Home: Influence on Nutrition, Health, and Policies: A Scoping Review. *Nutrients.* 2022;14(6):1265.
503. Pulker CE, Farquhar HR, Pollard CM, Scott JA. The nutritional quality of supermarket own brand chilled convenience foods: an Australian cross-sectional study reveals limitations of the Health Star Rating. *Public Health Nutr.* 2020;23(12):2068-77.
504. Monteiro CA, Cannon, G., Lawrence, M., Costa Louzada, M.L. and Pereira Machado, P. . Ultra-processed foods, diet quality, and health using the NOVA classification system. Rome: FAO; 2019.
505. Chen X, Zhang Z, Yang H, Qiu P, Wang H, Wang F, et al. Consumption of ultra-processed foods and health outcomes: a systematic review of epidemiological studies. *Nutr J.* 2020;19(1):86.
506. Rauber F, da Costa Louzada ML, Steele EM, Millett C, Monteiro CA, Levy RB. Ultra-Processed Food Consumption and Chronic Non-Communicable Diseases-Related Dietary Nutrient Profile in the UK (2008(-)2014). *Nutrients.* 2018;10(5).
507. Robson SM, Crosby LE, Stark LJ. Eating dinner away from home: Perspectives of middle-to high-income parents. *Appetite.* 2016;96(96):147-53.
508. Food Standards Scotland Qualitative Consumer Research on eating outside the home. UK 2019 August 2019.
509. Gupta A, Backholer K, Huggins CE, Bennett R, Leung GKW, Peeters A. Understanding food choices and promoting healthier food options among online food delivery service users in Australia: a qualitative study. *BMC Public Health.* 2025;25(1):1721.
510. Care DoHS. Tackling obesity: empowering adults and children to live healthier lives. In: Care DoHS, editor. UK2020.
511. Pepper T, Hart KH, Hodgkins CE. Tackling (Childhood) Obesity through a Voluntary Food Reformulation Policy: A Repeated Cross-Sectional Study Investigating Nutritional Changes in the Out-of-Home Sector. *Nutrients.* 2023;15(14).

512. Alessandrini R, He FJ, Ma Y, Scrutinio V, Wald DS, MacGregor GA. Potential impact of gradual reduction of fat content in manufactured and out-of-home food on obesity in the United Kingdom: a modeling study. *Am J Clin Nutr.* 2021;113(5):1312-21.
513. Care DoHS. Government response to the House of Lords Food, Diet and Obesity Committee's report 'Recipe for health: a plan to fix our broken food system'. In: Care DoHS, editor. UK2025.
514. Frankowska A, Rivera XS, Bridle S, Kluczkowski A, Tereza da Silva J, Martins CA, et al. Impacts of home cooking methods and appliances on the GHG emissions of food. *Nat Food.* 2020;1(12):787-91.
515. Mills SDH, Wolfson JA, Wrieden WL, Brown H, White M, Adams J. Perceptions of 'Home Cooking': A Qualitative Analysis from the United Kingdom and United States. *Nutrients.* 2020;12(1).
516. Wolfson JA, Bleich SN, Smith KC, Frattaroli S. What does cooking mean to you?: Perceptions of cooking and factors related to cooking behavior. *Appetite.* 2016;97:146-54.
517. Smith LP, Ng SW, Popkin BM. Trends in US home food preparation and consumption: analysis of national nutrition surveys and time use studies from 1965-1966 to 2007-2008. *Nutr J.* 2013;12:45.
518. Lachat C, Nago E, Verstraeten R, Roberfroid D, Van Camp J, Kolsteren P. Eating out of home and its association with dietary intake: a systematic review of the evidence. *Obes Rev.* 2012;13(4):329-46.
519. Macdiarmid J, Blundell J. Assessing dietary intake: Who, what and why of under-reporting. *Nutr Res Rev.* 1998;11(2):231-53.
520. Lennox AB, Les; Page, Polly; Pell, David; Cole, Darren; Ziauddeen, Nida; Steer, Toni; Nicholson, Sonja; Goldberg, Gail; Prentice, Ann. NDNS Appendix X: Misreporting in the National Diet and Nutrition Survey Rolling Programme. London: Food Standards Agency; nd.
521. Statistics OfN. A Government Statistical Service perspective on official estimates of calorie consumption: Office for National Statistics; 2016 [Available from: <https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/methodologies/agovernmentstatisticalserviceperspectiveonofficial estimatesofcalorieconsumption>].
522. McLean R, Cameron C, Butcher E, Cook NR, Woodward M, Campbell NRC. Comparison of 24-hour urine and 24-hour diet recall for estimating dietary sodium intake in populations: A systematic review and meta-analysis. *J Clin Hypertens (Greenwich).* 2019;21(12):1753-62.
523. Tharrey M, Drogue S, Privet L, Perignon M, Dubois C, Darmon N. Industrially processed v. home-prepared dishes: what economic benefit for the consumer? *Public Health Nutr.* 2020;23(11):1982-90.
524. Mackay S, Vandevijvere S, Xie P, Lee A, Swinburn B. Paying for convenience: comparing the cost of takeaway meals with their healthier home-cooked counterparts in New Zealand. *Public Health Nutr.* 2017;20(13):2269-76.
525. G. Naruseviciute SW, J. I. Macdiarmid, G. McNeill, editor Is "home cooked" healthier and cheaper than ready meals? *Carbohydrates in health: friends or foes 2015* 15 April 2015: Cambridge University Press.

526. Djupegot IL, Nenseth CB, Bere E, Bjornara HBT, Helland SH, Overby NC, et al. The association between time scarcity, sociodemographic correlates and consumption of ultra-processed foods among parents in Norway: a cross-sectional study. *BMC Public Health*. 2017;17(1):447.
527. Schmidt Rivera XC, Azapagic A. Life cycle environmental impacts of ready-made meals considering different cuisines and recipes. *Sci Total Environ*. 2019;660:1168-81.
528. Rockström Jea. The EAT–Lancet Commission on healthy, sustainable, and just food systems. *The Lancet*. 2025;406(10512):1625 - 700.
529. Food Standards Scotland Estimating the cost of a healthy diet: testing an approach based on nutritionally analysed meal plans. 2023 June 2023.
530. Martin I AZ, McCall A, Ritchie P and Zhong C. Our Right to Food: Pakistani Households in Scotland. *Nourish Scotland*; 2025.
531. Coalition EFP. Discovering the role of food environments for sustainable food systems.; 2025.
532. Maguire M CS, Bain F. Planning for healthier communities: opportunities in the Scottish planning system. UK: Nesta in partnership with Public Health Scotland; 2025 17 November 2025.
533. Byatt LB. What is the government’s new healthy food standard, and how does it work? UK: Nesta; 2025 [Available from: <https://www.nesta.org.uk/project-updates/what-is-the-governments-new-healthy-food-standard-and-how-does-it-work/>].
534. Scottish Government A Healthier Future – Scotland’s Diet & Healthy Weight Delivery Plan. Edinburgh, Scotland: The Scottish Government; 2018.
535. Abimbola S. The uses of knowledge in global health. *BMJ Glob Health*. 2021;6(4).
536. Scottish Government Population Health Framework: Evidence paper. Directorate PH; 2025 17 June 2025.
537. Armstrong B BG, Oakden L, Reynolds C, Wang C et al. Using Citizen Science to measure consumer perceptions of Calorie Content, Carbon Footprint, Cooking Time, Cooking Method, Food Safety, and Animal Welfare of different foods. 2024 [Available from: https://osf.io/t7h4x/overview?view_only=83a37df45ab747609259575aa093ac01].
538. Food Standards Scotland An evaluation of a pilot on the use of MenuCal within small and medium Scottish food businesses. Scotland: Food Standards Scotland 2018 29 January 2018.
539. Argumedo G. Mexico Bans Junk Food in Schools: A Bold Step Towards Healthier Students 2025 12/10/2025. Available from: <https://communities.springernature.com/posts/mexico-bans-junk-food-in-schools-a-bold-step-towards-healthier-students>.
540. Jaacks LM GM, Runions R, Stewart C Dietary Intake in Scotland’s CHildren (DISH): An assessment of diets in children and young people aged 2 to 15 years living in Scotland, 2024. Food Standards Scotland and The University of Edinburgh; 2025.
541. Open Access Government Unhealthy food advertising decreased by 64% in Chile after policy change 2023 10/10/2025. Available from:

<https://www.openaccessgovernment.org/unhealthy-food-advertising-chile-policy-reinforcement/160870/>.

542. Obesity Actions Scotland Food and drink advertising. obesityactionsotland; 2023.

543. Daniels JP. Colombia introduces junk food tax. Lancet. 2023;402(10417):2062.

544. (UKRI) URal. Opinions on ultra-processed foods being sought 2025 [Available from: <https://www.ukri.org/news/opinions-on-ultra-processed-foods-being-sought>].

545. Ministry of Food AaFoD. Danish Action Plan for Plant-based Foods. Copenhagen: Ministry of Food, Agriculture and Fisheries of Denmark; 2023 October 2023.

546. Hawkes C, Gallagher-Squires C, Spires M, Hawkins N, Neve K, Brock J, et al. The full picture of people's realities must be considered to deliver better diets for all. Nat Food. 2024;5(11):894-900.

547. Nourish Scotland Public Diners- The Idea whose time has come. Scotland: Nourish Scotland; 2025.

548. Patel A. Could wartime-inspired restaurants tackle food inequality? BBC News. 2025 19 July 2025.

Supplementary materials

Supplementary materials

1. Chapter 2

Table S1. Search strategy used for each database

Database	Search strategy	Records Identified ¹
Pubmed	("sustainable diet*" OR "Food Access*" OR "nutrition label*" OR "Food Label*" OR "Menu Label*" OR "Food Desirability" OR "Food Market*" OR "Food Advertising" OR "food pric*" OR "food suppl*" OR "Food outlet*" OR "Convenience Store*" OR "supermarket*" OR "food retail*" OR "food store*" OR "grocery store*" OR "fast food*" OR "Food Kiosk*" OR "Vending Machine*" OR "Point of Purchase" OR "Restaurant*" OR "Canteen*" OR "Café*" OR "Food Swamp*" OR "Food Desert*" OR "Food Milieu*" OR "takeaway*" OR "take?away" OR " take away" OR "corner store" OR " grocery store" OR "food store" OR "food retail" OR supermarket OR "convenience store" OR "food outlet" OR "Food Sustainability" OR "Food Convenience" OR "food quality" OR "food promot*" OR "food afford*" OR "food cost*" OR "food avail*" OR Foodscape OR " obesogenic environment" OR "nutrition environment" OR "food environment") AND ("Scottish"[Tiab] OR "British"[Tiab] OR "English"[Tiab] OR "Welsh"[Tiab] OR "Great Britain"[Tiab] OR "GB"[Tiab] OR "Northern Ireland"[Tiab] OR "England"[Tiab] OR "Wales"[Tiab] OR "United Kingdom"[Tiab] OR "UK"[Tiab] OR "Scotland"[Tiab])	3,402

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Table S1. Search strategy used for each database (*cont.*)

Database	Search strategy	Records Identified
CAB Abstracts	(("sustainable diet*" OR "Food Access*" OR "nutrition label*" OR "Food Label*" OR "Menu Label*" OR "Food Desirability" OR "Food Market*" OR "Food Advertising" OR "food pric*" OR "food suppl*" OR "Food outlet*" OR "Convenience Store*" OR "supermarket*" OR "food retail*" OR "food store*" OR "grocery store*" OR "fast food*" OR "Food Kiosk*" OR "Vending Machine*" OR "Point of Purchase" OR "Restaurant*" OR "Canteen*" OR "Café*" OR "Food Swamp*" OR "Food Desert*" OR "Food Milieu*" OR "take away" OR "corner store" OR "grocery store" OR "food store" OR "food retail" OR supermarket OR "convenience store" OR "food outlet" OR "Food Sustainability" OR "Food Convenience" OR "food quality" OR "food promot*" OR "food afford*" OR "food cost*" OR "food avail*" OR Foodscape OR "obesogenic environment" OR "nutrition environment" OR "food environment") AND ("Scottish" OR "British" OR "English" OR "Welsh" OR "Great Britain" OR "GB" OR "Northern Ireland" OR "England" OR "Wales" OR "United Kingdom" OR "UK" OR "Scotland")) AND ((language:(("English")) geographic-location: "UK"))	3,902

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Table S1. Search strategy used for each database (cont.)

Database	Search strategy	Records Identified ¹
Global Health	(ab:(("Scottish" OR "British" OR "English" OR "Welsh" OR "Great Britain" OR "GB" OR "Northern Ireland" OR "England" OR "Wales" OR "United Kingdom" OR "UK" OR "Scotland")) AND ("sustainable diet*" OR "Food Access*" OR "nutrition label*" OR "Food Label*" OR "Menu Label*" OR "Food Desirability" OR "Food Market*" OR "Food Advertising" OR "food pric*" OR "food suppl*" OR "Food outlet*" OR "Convenience Store*" OR "supermarket*" OR "food retail*" OR "food store*" OR "grocery store*" OR "fast food*" OR "Food Kiosk*" OR "Vending Machine*" OR "Point of Purchase" OR "Restaurant*" OR "Canteen*" OR "Café*" OR "Food Swamp*" OR "Food Desert*" OR "Food Milieu*" OR "take away" OR "corner store" OR "grocery store" OR "food store" OR "food retail" OR supermarket OR "convenience store" OR "food outlet" OR "Food Sustainability" OR "Food Convenience" OR "food quality" OR "food promot*" OR "food afford*" OR "food cost*" OR "food avail*" OR Foodscape OR "obesogenic environment" OR "nutrition environment" OR "food environment")) AND (geographic-location:(("UK" OR "England")) (language:(("English"))))	4,122

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Table S1. Search strategy used for each database (cont.)

Database	Search strategy	Records Identified ¹
Web of Science	(AB=("Scottish" OR "British" OR "English" OR "Welsh" OR "Great Britain" OR "GB" OR "Northern Ireland" OR "England" OR "Wales" OR "United Kingdom" OR "UK" OR "Scotland")) AND ALL=("sustainable diet*" OR "Food Access*" OR "nutrition label*" OR "Food Label*" OR "Menu Label*" OR "Food Desirability" OR "Food Market*" OR "Food Advertising" OR "food pric*" OR "food suppl*" OR "Food outlet*" OR "Convenience Store*" OR "supermarket*" OR "food retail*" OR "food store*" OR "grocery store*" OR "fast food*" OR "Food Kiosk*" OR "Vending Machine*" OR "Point of Purchase" OR "Restaurant*" OR "Canteen*" OR "Café*" OR "Food Swamp*" OR "Food Desert*" OR "Food Milieu*" OR "take away" OR "corner store" OR "grocery store" OR "food store" OR "food retail" OR supermarket OR "convenience store" OR "food outlet" OR "Food Sustainability" OR "Food Convenience" OR "food quality" OR "food promot*" OR "food afford*" OR "food cost*" OR "food avail*" OR foodscapes OR "obesogenic environment" OR "nutrition environment" OR "food environment")	9,062

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Table S1. Search strategy used for each database (*cont.*)

Database	Search strategy	Records Identified¹
CINAHL	AB ("Scottish" OR "British" OR "English" OR "Welsh" OR "Great Britain" OR "GB" OR "Northern Ireland" OR "England" OR "Wales" OR "United Kingdom" OR "UK" OR "Scotland") AND TX ("sustainable diet*" OR "Food Access*" OR "nutrition label*" OR "Food Label*" OR "Menu Label*" OR "Food Desirability" OR "Food Market*" OR "Food Advertising" OR "food pric*" OR "food suppl*" OR "Food outlet*" OR "Convenience Store*" OR "supermarket*" OR "food retail*" OR "food store*" OR "grocery store*" OR "fast food*" OR "Food Kiosk*" OR "Vending Machine*" OR "Point of Purchase" OR "Restaurant*" OR "Canteen*" OR "Café*" OR "Food Swamp*" OR "Food Desert*" OR "Food Milieu*" OR "take away" OR "corner store" OR "grocery store" OR "food store" OR "food retail" OR supermarket OR "convenience store" OR "food outlet" OR "Food Sustainability" OR "Food Convenience" OR "food quality" OR "food promot*" OR "food afford*" OR "food cost*" OR "food avail*" OR Foodscape OR "obesogenic environment" OR "nutrition environment" OR "food environment")	966

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Table S1. Search strategy used for each database (*cont.*)

Database	Search strategy	Records Identified ¹
EMBASE	("sustainable diet*" or "Food Access*" or "nutrition label*" or "Food Label*" or "Menu Label*" or "Food Desirability" or "Food Market*" or "Food Advertising" or "food pric*" or "food suppl*" or "Food outlet*" or "Convenience Store*" or "supermarket*" or "food retail*" or "food store*" or "grocery store*" or "fast food*" or "Food Kiosk*" or "Vending Machine*" or "Point of Purchase" or "Restaurant*" or "Canteen*" or "Café*" or "Food Swamp*" or "Food Desert*" or "Food Milieu*" or "take away" or "corner store" or " grocery store" or "food store" or "food retail" or supermarket or "convenience store" or "food outlet" or "Food Sustainability" or "Food Convenience" or "food quality" or "food promot*" or "food afford*" or "food cost*" or "food avail*" or Foodscape or "obesogenic environment" or "nutrition environment" or "food environment").af. and ("Scottish" or "British" or "English" or "Welsh" or "Great Britain" or "GB" or "Northern Ireland" or "England" or "Wales" or "United Kingdom" or "UK" or "Scotland").ab.	4,952

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Table S1. Search strategy used for each database (*cont.*)

Database	Search strategy	Records Identified ¹
Scopus	(TITLE-ABS-KEY ("sustainable diet*" OR "Food Access*" OR "nutrition label*" OR "Food Label*" OR "Menu Label*" OR "Food Desirability" OR "Food Market*" OR "Food Advertising" OR "food pric*" OR "food suppl*" OR "Food outlet*" OR "Convenience Store*" OR "supermarket*" OR "food retail*" OR "food store*" OR "grocery store*" OR "fast food*" OR "Food Kiosk*" OR "Vending Machine*" OR "Point of Purchase" OR "Restaurant*" OR "Canteen*" OR "Café*" OR "Food Swamp*" OR "Food Desert*" OR "Food Milieu*" OR "take away" OR "corner store" OR "grocery store" OR "food store" OR "food retail" OR "convenience store" OR "food outlet" OR "Food Sustainability" OR "Food Convenience" OR "food quality" OR "food promot*" OR "food afford*" OR "food cost*" OR "food avail*" OR "Foodscape" OR "obesogenic environment" OR "nutrition environment" OR "food environment") AND TITLE-ABS-KEY ("Scottish" OR "British" OR "English" OR "Welsh" OR "Great Britain" OR "GB" OR "Northern Ireland" OR "England" OR "Wales" OR "United Kingdom" OR "UK" OR "Scotland")) AND (LIMIT-TO (AFFILCOUNTRY, "United Kingdom")) AND (LIMIT-TO (LANGUAGE, "English"))	5,033

Table S2. Variables extracted from included articles in the systematic review

S. No	Variable name	Details	Referred in Chapter 2
1	Author Name	Name of the first author	Not included in results, used for data management
2	Year	Year of Publication	Table 3
3	Country	England, Scotland, Wales, Northern Ireland or UK	Table 3 and Figure 2
4	Region	Name of area or region within the country if mentioned	Figure 2
5	International Territorial Levels (ITLs) classification	ITL is a geocode standard for referencing the administrative divisions of countries for statistical purposes.	
6	Location	Urban, rural, N/A	Table 3
7	Year(s) of Study	Year of data collection	Table 3
8	Population	Adults, School Children, Adolescents, Infants Elderly, N/A	Table 3
9	Study Design	E.g., Cross-sectional, Case study, Intervention etc.	Table 3
10	Sample size	Sample size reported	Reported in text (lines 187-189)
11	Type of Food Environment	Food Store Environment, Macro Food Environment, Public Facility Food Environment, Restaurant Food Environment, School Food Environment, Neighbourhood Food Environment and Worksite Food Environment	Figure 3
12	Domain of Food Environment	Availability, Affordability, Promotion, Quality, Convenience, Sustainability	Figure 4
13	Food(s) Evaluated	E.g., fruits and vegetables, breakfast cereals etc.	Table 3

Continues next page >>

Table S2. Variables extracted from included articles in the systematic review (*cont.*)

S. No	Variable name	Details	Referred in Chapter 2
14	Methodologies to Measure	Geographic analysis, Food supply analysis, Menu analysis, Market basket survey, Sales/ purchase analysis, Nutrient fact panel analysis, Nutrient analysis, Contaminant analysis, Physical measurements, Ecological footprint analysis, Policy analysis for intervention studies, details on type of intervention were extracted.	Figure 5
15	Outcome	None-Descriptive, Diet, Health	Table 4
16	Stratification (in analysis)	Area Deprivation, Education, Gender, Income, None	Supplementary table 5
17	Result	Short summary of result	Not included for this narrative summary
18	Funding Sources	Details on funding for the research	Table 3

Table S3. Country wise distribution of food environment domains

Domain type	Domain	UK	ENG	SCT	NIR	WAL
Single domains	Availability	51	37	12	2	2
	Affordability	10	3	2		
	Promotion	21	7	4		
	Product characteristics ('Quality')	73	13	5	4	5
	Sustainability	18	3	1	1	
Double domains	Affordability, Promotion			1		
	Affordability, Quality	9				
	Availability, Quality		2	1		
	Availability, Affordability	6	5	3		1
	Availability, Promotion	1	1			1
	Promotion, Quality	8				
	Promotion, Sustainability	1				
	Sustainability, Affordability	1		1		
	Sustainability, Quality	1	1			
Triple domains	Affordability, Promotion, Quality	1				
	Affordability, Quality, Sustainability	3				
Other	All domains except convenience		1			

Note: abbreviations correspond to England (ENG), Scotland (SCT), Northern Ireland (NIR) and Wales (WAL)

Table S4. Outcomes with stratification

Stratification		None- Descriptive	Diet	Health	Total
None	None	173	59	1	233
Single variable	Area Deprivation	45	4		49
	Gender	1			1
	Age	1			1
	Income	11			11
	Education	2			2
2 variables	Area Deprivation, Education		1		1
	Area Deprivation, Gender	1			1
	Area Deprivation, Income	5			5
	Area Deprivation, Ethnicity	2			2
	Gender, Education	1			1
	Gender, Age	1			1
Multiple variables	Area Deprivation, Gender, Ethnicity, Education			1	1
	Gender, Ethnicity, Income	1			1
	Area Deprivation, Gender, Income, Ethnicity, Education Level, Employment, Age,	1			1
	Area Deprivation, Income, Education	1			1
	Total	246	64	2	312

2. Chapter 3

Table S5. Search results from Pubmed

S. No.	Article details	Comments
1	Neighbourhood Food Environment and Children's BMI: A New Framework with Structural Equation Modelling. Abdumijit T, Zhao D, Zhang R. Nutrients. 2022 Nov 3;14(21):4631. doi: 10.3390/nu14214631. PMID: 36364893 Free PMC article.	Not Relevant
2	Comprehensive review of water management and wastewater treatment in food processing industries in the framework of water-food-environment nexus. Asgharnejad H, Khorshidi Nazloo E, Madani Larijani M, Hajinajaf N, Rashidi H. Compr Rev Food Sci Food Saf. 2021 Sep;20(5):4779-4815. doi: 10.1111/1541-4337.12782. Epub 2021 Jun 30. PMID: 34190421 Review.	Not Relevant
3	Assessing food and nutrition literacy in children and adolescents: a systematic review of existing tools. Carroll N, Perreault M, Ma DW, Haines J; Guelph Family Health Study. Public Health Nutr. 2021 Nov 3;25(4):1-16. doi: 10.1017/S1368980021004389. Online ahead of print. PMID: 34728004 Free PMC article. Review.	Not Relevant
4	An Emergent Framework of the Market Food Environment in Low- and Middle-Income Countries. Toure D, Herforth A, Pelto GH, Neufeld LM, Mbuya MNN. Curr Dev Nutr. 2021 Mar 13;5(4):nzab023. doi: 10.1093/cdn/nzab023. eCollection 2021 Apr. PMID: 33948531 Free PMC article.	Included

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
5	<p>The African urban food environment framework for creating healthy nutrition policy and interventions in urban Africa.</p> <hr/> <p>Osei-Kwasi HA, Laar A, Zotor F, Pradeilles R, Aryeetey R, Green M, Griffiths P, Akparibo R, Wanjohi MN, Rousham E, Barnes A, Booth A, Mensah K, Asiki G, Kimani-Murage E, Bricas N, Holdsworth M.</p> <hr/> <p>PLoS One. 2021 Apr 22;16(4):e0249621. doi: 10.1371/journal.pone.0249621. eCollection 2021.</p> <hr/> <p>PMID: 33886599 Free PMC article.</p>	Included
6	<p>Understanding stigma and food inequity: a conceptual framework to inform research, intervention, and policy.</p> <hr/> <p>Earnshaw VA, Karpyn A.</p> <hr/> <p>Transl Behav Med. 2020 Dec 31;10(6):1350-1357. doi: 10.1093/tbm/ibaa087.</p> <hr/> <p>PMID: 33421077 Free PMC article. Review.</p>	Not Relevant
7	<p>Barriers and facilitators to healthy eating among low-income Latino adolescents.</p> <hr/> <p>Beck AL, Iturralde E, Haya-Fisher J, Kim S, Keeton V, Fernandez A.</p> <hr/> <p>Appetite. 2019 Jul 1;138:215-222. doi: 10.1016/j.appet.2019.04.004. Epub 2019 Apr 4.</p> <hr/> <p>PMID: 30954634 Free PMC article.</p>	Not Relevant
8	<p>Food environment solutions for childhood obesity in Latin America and among Latinos living in the United States.</p> <hr/> <p>Duran AC, Mialon M, Crosbie E, Jensen ML, Harris JL, Batis C, Corvalán C, Taillie LS.</p> <hr/> <p>Obes Rev. 2021 Jun;22 Suppl 3(Suppl 3):e13237. doi: 10.1111/obr.13237.</p> <hr/> <p>PMID: 34152071 Free PMC article. Review.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
9	<p>Food environment interactions after migration: a scoping review on low- and middle-income country immigrants in high-income countries.</p> <hr/> <p>Berggreen-Clausen A, Hseing Pha S, Mølsted Alvesson H, Andersson A, Daivadanam M.</p> <hr/> <p>Public Health Nutr. 2022 Jan;25(1):136-158. doi: 10.1017/S1368980021003943. Epub 2021 Sep 13.</p> <hr/> <p>PMID: 34509180 Free PMC article. Review.</p>	Not Relevant
10	<p>An Indicator Measuring the Influence of the Online Public Food Environment: An Analytical Framework and Case Study.</p> <hr/> <p>Cong N, Zhao A, Kwan MP, Yang J, Gong P.</p> <hr/> <p>Front Nutr. 2022 Jun 30;9:818374. doi: 10.3389/fnut.2022.818374. eCollection 2022.</p> <hr/> <p>PMID: 35845771 Free PMC article.</p>	Included
11	<p>Children's and parents' opinions on the sport-related food environment: a systematic review.</p> <hr/> <p>Smith M, Signal L, Edwards R, Hoek J.</p> <hr/> <p>Obes Rev. 2017 Sep;18(9):1018-1039. doi: 10.1111/obr.12558. Epub 2017 May 31.</p> <hr/> <p>PMID: 28560820 Review.</p>	Not Relevant
12	<p>The potential of food environment policies to reduce socioeconomic inequalities in diets and to improve healthy diets among lower socioeconomic groups: an umbrella review.</p> <hr/> <p>Løvhaug AL, Granheim SI, Djojoseparto SK, Harrington JM, Kamphuis CBM, Poelman MP, Roos G, Sawyer A, Stronks K, Torheim LE, Twohig C, Vandevijvere S, van Lenthe FJ, Terragni L.</p> <hr/> <p>BMC Public Health. 2022 Mar 4;22(1):433. doi: 10.1186/s12889-022-12827-4.</p> <hr/> <p>PMID: 35246074 Free PMC article. Review.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
13	<p>Toward a Healthy and Environmentally Sustainable Campus Food Environment: A Scoping Review of Postsecondary Food Interventions.</p> <p>Lee KM, Dias GM, Boluk K, Scott S, Chang YS, Williams TE, Kirkpatrick SI.</p> <p>Adv Nutr. 2021 Oct 1;12(5):1996-2022. doi: 10.1093/advances/nmab026.</p> <p>PMID: 33836531 Free PMC article. Review.</p>	Not Relevant
14	<p>Food Environment Typology: Advancing an Expanded Definition, Framework, and Methodological Approach for Improved Characterization of Wild, Cultivated, and Built Food Environments toward Sustainable Diets.</p> <p>Downs SM, Ahmed S, Fanzo J, Herforth A.</p> <p>Foods. 2020 Apr 22;9(4):532. doi: 10.3390/foods9040532.</p> <p>PMID: 32331424 Free PMC article.</p>	Included
15	<p>Mapping the digital food environment: A systematic scoping review.</p> <p>Granheim SI, Løvhaug AL, Terragni L, Torheim LE, Thurston M.</p> <p>Obes Rev. 2022 Jan;23(1):e13356. doi: 10.1111/obr.13356. Epub 2021 Sep 14.</p> <p>PMID: 34519396 Review.</p>	Not Relevant
16	<p>Traditional Food Environment and Factors Affecting Indigenous Food Consumption in Munda Tribal Community of Jharkhand, India.</p> <p>Ghosh-Jerath S, Kapoor R, Barman S, Singh G, Singh A, Downs S, Fanzo J.</p> <p>Front Nutr. 2021 Feb 1;7:600470. doi: 10.3389/fnut.2020.600470. eCollection 2020.</p> <p>PMID: 33598474 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
17	Examining the New Zealand school food environment: what needs to change? Pillay D, Ali A, Wham CA. Nutr Res Rev. 2022 Aug 15;1-14. doi: 10.1017/S0954422422000154. Online ahead of print. PMID: 35968693 Review.	Not Relevant
18	International Trade and Investment Agreements as Barriers to Food Environment Regulation for Public Health Nutrition: A Realist Review. Garton K, Thow AM, Swinburn B. Int J Health Policy Manag. 2021 Dec 1;10(12):745-765. doi: 10.34172/ijhpm.2020.189. PMID: 33105969 Free PMC article. Review.	Not Relevant
19	Food Environment in the Lower Mississippi Delta: Food Deserts, Food Swamps and Hot Spots. Goodman M, Thomson J, Landry A. Int J Environ Res Public Health. 2020 May 12;17(10):3354. doi: 10.3390/ijerph17103354. PMID: 32408579 Free PMC article.	Not Relevant
20	Food access, dietary acculturation, and food insecurity among international tertiary education students: A scoping review. Shi Y, Lukomskyj N, Allman-Farinelli M. Nutrition. 2021 May;85:111100. doi: 10.1016/j.nut.2020.111100. Epub 2020 Dec 5. PMID: 33545541 Review.	Not Relevant
21	Fish Acquisition and Consumption in the African Great Lakes Region through a Food Environment Lens: A Scoping Review. de Bruyn J, Wesana J, Bunting SW, Thilsted SH, Cohen PJ. Nutrients. 2021 Jul 14;13(7):2408. doi: 10.3390/nu13072408. PMID: 34371918 Free PMC article. Review.	Not Relevant

Continues next page >>

Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
22	Exploring food environment interventions for diet-related outcomes using a food sovereignty framework: a systematic review. Lofton S, Simonovich SD, Buscemi J, Grant A, O'Donnell A, Nwafor G, Reid M. Health Promot Int. 2023 Apr 1;38(2):daac164. doi: 10.1093/heapro/daac164. PMID: 36866404	Not Relevant
23	Food and Beverage Marketing to Latinos: A Systematic Literature Review. Adeigbe RT, Baldwin S, Gallion K, Grier S, Ramirez AG. Health Educ Behav. 2015 Oct;42(5):569-82. doi: 10.1177/1090198114557122. Epub 2014 Dec 10. PMID: 25504570 Review.	Not Relevant
24	An Analytical Framework for Integrating the Spatiotemporal Dynamics of Environmental Context and Individual Mobility in Exposure Assessment: A Study on the Relationship between Food Environment Exposures and Body Weight. Wang J, Kwan MP. Int J Environ Res Public Health. 2018 Sep 15;15(9):2022. doi: 10.3390/ijerph15092022. PMID: 30223592 Free PMC article.	Not Relevant
25	Addressing Food Insecurity through a Health Equity Lens: a Case Study of Large Urban School Districts during the COVID-19 Pandemic. McLoughlin GM, McCarthy JA, McGuirt JT, Singleton CR, Dunn CG, Gadhoke P. J Urban Health. 2020 Dec;97(6):759-775. doi: 10.1007/s11524-020-00476-0. PMID: 32959216 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
26	Exploring the fast food and planning appeals system in England and Wales: decisions made by the Planning Inspectorate (PINS). O'Malley CL, Lake AA, Townshend TG, Moore HJ. Perspect Public Health. 2021 Sep;141(5):269-278. doi: 10.1177/1757913920924424. Epub 2020 Jun 25. PMID: 32580644 Free PMC article. Review.	Not Relevant
27	Concerns and priorities of Aboriginal and Torres Strait Islander peoples regarding food and nutrition: a systematic review of qualitative evidence. Christidis R, Lock M, Walker T, Egan M, Browne J. Int J Equity Health. 2021 Oct 7;20(1):220. doi: 10.1186/s12939-021-01551-x. PMID: 34620180 Free PMC article. Review.	Not Relevant
28	Transitioning food environments and diets of African migrants: implications for non-communicable diseases. Osei-Kwasi H, Boateng D, Asamane EA, Akparibo R, Holdsworth M. Proc Nutr Soc. 2023 Feb;82(1):69-79. doi: 10.1017/S0029665122002828. Epub 2022 Dec 1. PMID: 36453152 Review.	Not Relevant
29	School Food Environment in Urban Zambia: A Qualitative Analysis of Drivers of Adolescent Food Choices and Their Policy Implications. Mukanu MM, Thow AM, Delobelle P, Mchiza ZJ. Int J Environ Res Public Health. 2022 Jun 17;19(12):7460. doi: 10.3390/ijerph19127460. PMID: 35742706 Free PMC article.	Not Relevant
30	What Works to Improve Nutrition and Food Sustainability across the First 2000 Days of Life: A Rapid Review. Laws R, Adam M, Esdaile E, Love P, Campbell KJ. Nutrients. 2022 Feb 9;14(4):731. doi: 10.3390/nu14040731. PMID: 35215381 Free PMC article. Review.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
31	Obesity and the food environment: dietary energy density and diet costs. Drewnowski A. Am J Prev Med. 2004 Oct;27(3 Suppl):154-62. doi: 10.1016/j.amepre.2004.06.011. PMID: 15450626	Not Relevant
32	The role of reinforcement learning and value-based decision-making frameworks in understanding food choice and eating behaviors. Pearce AL, Fuchs BA, Keller KL. Front Nutr. 2022 Nov 22;9:1021868. doi: 10.3389/fnut.2022.1021868. eCollection 2022. PMID: 36483928 Free PMC article. Review.	Not Relevant
33	Food environment index and preterm birth rate in the counties of the United States. Das A, Trivedi MM, Bellingham-Young DA. J Neonatal Perinatal Med. 2023 Sep 14. doi: 10.3233/NPM-221180. Online ahead of print. PMID: 37718862	Not Relevant
34	Monitoring and benchmarking government policies and actions to improve the healthiness of food environments: a proposed Government Healthy Food Environment Policy Index. Swinburn B, Vandevijvere S, Kraak V, Sacks G, Snowdon W, Hawkes C, Barquera S, Friel S, Kelly B, Kumanyika S, L'Abbé M, Lee A, Lobstein T, Ma J, Macmullan J, Mohan S, Monteiro C, Neal B, Rayner M, Sanders D, Walker C; INFORMAS. Obes Rev. 2013 Oct;14 Suppl 1:24-37. doi: 10.1111/obr.12073. PMID: 24074208 Review.	Included

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
35	Adult food choices in association with the local retail food environment and food access in resource-poor communities: a scoping review protocol. Madlala SS, Hill J, Kunneke E, Faber M. BMJ Open. 2021 Aug 17;11(8):e044904. doi: 10.1136/bmjopen-2020-044904. PMID: 34404696 Free PMC article.	Not Relevant
36	Development and validation of a food and nutrition literacy questionnaire for Chinese school-age children. Liu T, Su X, Li N, Sun J, Ma G, Zhu W. PLoS One. 2021 Jan 6;16(1):e0244197. doi: 10.1371/journal.pone.0244197. eCollection 2021. PMID: 33406105 Free PMC article.	Not Relevant
37	Dynamics of the complex food environment underlying dietary intake in low-income groups: a systems map of associations extracted from a systematic umbrella literature review. Sawyer ADM, van Lenthe F, Kamphuis CBM, Terragni L, Roos G, Poelman MP, Nicolaou M, Waterlander W, Djojoseparto SK, Scheidmeir M, Neumann-Podczaska A, Stronks K; PEN Consortium. Int J Behav Nutr Phys Act. 2021 Jul 13;18(1):96. doi: 10.1186/s12966-021-01164-1. PMID: 34256794 Free PMC article. Review.	Not Relevant
38	A Cross-Sectional Evaluation of the Food Environment at an Australian University Campus. Coyle DH, Sanavio L, Barrett E, Huang L, Law KK, Nanayakkara P, Hodgson JM, O'Connell M, Meggitt B, Tsai C, Pettigrew S, Wu JHY. Nutrients. 2023 Mar 27;15(7):1623. doi: 10.3390/nu15071623. PMID: 37049463 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
39	<p>Creating healthy food environments in recreation and sport settings using choice architecture: a scoping review. Prowse R, Lawlor N, Powell R, Neumann EM. Health Promot Int. 2023 Oct 1;38(5):daad098. doi: 10.1093/heapro/daad098. PMID: 37705493 Free PMC article. Review.</p>	Not Relevant
40	<p>Riverine food environments and food security: a case study of the Mekong River, Cambodia. Manohar S, Downs S, Shaikh S, Mak S, Sok S, Graham E, Miachon L, Fanzo J. Bull World Health Organ. 2023 Feb 1;101(2):140-148. doi: 10.2471/BLT.22.288830. Epub 2022 Dec 8. PMID: 36733629 Free PMC article.</p>	Not Relevant
41	<p>A systematic review employing the GeoFERN framework to examine methods, reporting quality and associations between the retail food environment and obesity. Wilkins E, Radley D, Morris M, Hobbs M, Christensen A, Marwa WL, Morrin A, Griffiths C. Health Place. 2019 May;57:186-199. doi: 10.1016/j.healthplace.2019.02.007. Epub 2019 May 3. PMID: 31060018</p>	Not Relevant
42	<p>Farmers' markets and the local food environment: identifying perceived accessibility barriers for SNAP consumers receiving temporary assistance for needy families (TANF) in an urban Oklahoma community. Wetherill MS, Gray KA. J Nutr Educ Behav. 2015 Mar-Apr;47(2):127-33.e1. doi: 10.1016/j.jneb.2014.12.008. PMID: 25754298 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
43	Monitoring the availability of healthy and unhealthy foods and non-alcoholic beverages in community and consumer retail food environments globally. Ni Mhurchu C, Vandevijvere S, Waterlander W, Thornton LE, Kelly B, Cameron AJ, Snowdon W, Swinburn B; INFORMAS. Obes Rev. 2013 Oct;14 Suppl 1:108-19. doi: 10.1111/obr.12080. PMID: 24074215 Review.	Not Relevant
44	Rapid tool based on a food environment typology framework for evaluating effects of the COVID-19 pandemic on food system resilience. Ahmed S, Downs SM, Yang C, Chunlin L, Ten Broek N, Ghosh-Jerath S. Food Secur. 2020;12(4):773-778. doi: 10.1007/s12571-020-01086-z. Epub 2020 Jul 16. PMID: 32837654 Free PMC article.	Not Relevant
45	A description of Chilean food and nutrition health policies. Rodríguez-Osiac L, Fernandes ACP, Mujica-Coopman MF, Caro-Moya P, Navarro-Rosenblatt D. Rev Med Chil. 2021 Oct;149(10):1485-1494. doi: 10.4067/s0034-98872021001001485. PMID: 35319638	Not Relevant
46	Efficiency of In-Store Interventions to Impact Customers to Purchase Healthier Food and Beverage Products in Real-Life Grocery Stores: A Systematic Review and Meta-Analysis. Slapø H, Schjøll A, Strømgren B, Sandaker I, Lekhal S. Foods. 2021 Apr 22;10(5):922. doi: 10.3390/foods10050922. PMID: 33922185 Free PMC article. Review.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
47	Mapping the digital food environment: a scoping review protocol. Granheim SI, Opheim E, Terragni L, Torheim LE, Thurston M. BMJ Open. 2020 Apr 22;10(4):e036241. doi: 10.1136/bmjopen-2019-036241. PMID: 32327482 Free PMC article.	Not Relevant
48	Integrating nutrition into the education sector in low- and middle-income countries: A framework for a win-win collaboration. Xu YY, Sawadogo-Lewis T, King SE, Mitchell A, Roberton T. Matern Child Nutr. 2021 Jul;17(3):e13156. doi: 10.1111/mcn.13156. Epub 2021 Feb 16. PMID: 33590645 Free PMC article. Review.	Not Relevant
49	Integrating coordination of food purchasing into activity space-based food environment research: Toward a household perspective. Liu B, Widener MJ, Smith LG, Gesink D. Health Place. 2023 Jul;82:103046. doi: 10.1016/j.healthplace.2023.103046. Epub 2023 May 29. PMID: 37257251	Not Relevant
50	How to bridge the intention-behavior gap in food parenting: Automatic constructs and underlying techniques. Larsen JK, Hermans RCJ, Sleddens EFC, Vink JM, Kremers SPJ, Ruiters ELM, Fisher JO. Appetite. 2018 Apr 1;123:191-200. doi: 10.1016/j.appet.2017.12.016. Epub 2017 Dec 24. PMID: 29277519 Review.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
51	Creating the Scratch Cooked School Food Framework: Qualitative Data Analysis of a Scratch Cooking Pilot. Ahmed DI, Trent R, Koch P. Health Promot Pract. 2022 Nov;23(6):963-972. doi: 10.1177/15248399211038942. Epub 2021 Sep 22. PMID: 34549651	Not Relevant
52	Murradambirra Dhangaang (make food secure): Aboriginal community and stakeholder perspectives on food insecurity in urban and regional Australia. Sherriff S, Kalucy D, Tong A, Naqvi N, Nixon J, Eades S, Ingram T, Slater K, Dickson M, Lee A, Muthayya S. BMC Public Health. 2022 May 28;22(1):1066. doi: 10.1186/s12889-022-13202-z. PMID: 35643511 Free PMC article.	Not Relevant
53	Capturing diversity and cultural drivers of food choice in eastern India. Samaddar A, Cuevas RP, Custodio MC, Ynion J, Ray Chakravarti A, Mohanty SK, Demont M. Int J Gastron Food Sci. 2020 Dec;22:100249. doi: 10.1016/j.ijgfs.2020.100249. PMID: 33343768 Free PMC article.	Not Relevant
54	The Food Supply Prior to the Implementation of the Chilean Law of Food Labeling and Advertising. Kanter R, Reyes M, Swinburn B, Vandevijvere S, Corvalán C. Nutrients. 2018 Dec 28;11(1):52. doi: 10.3390/nu11010052. PMID: 30597842 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
55	<p>Implementation of a food retail intervention to reduce purchase of unhealthy food and beverages in remote Australia: mixed-method evaluation using the consolidated framework for implementation research.</p> <hr/> <p>Brimblecombe J, Miles B, Chappell E, De Silva K, Ferguson M, Mah C, Miles E, Gunther A, Wycherley T, Peeters A, Minaker L, McMahon E.</p> <hr/> <p>Int J Behav Nutr Phys Act. 2023 Feb 17;20(1):20. doi: 10.1186/s12966-022-01377-y.</p> <hr/> <p>PMID: 36803988 Free PMC article. Clinical Trial.</p>	Not Relevant
56	<p>An integrative approach to dietary balance across the life course.</p> <hr/> <p>Raubenheimer D, Senior AM, Mirth C, Cui Z, Hou R, Le Couteur DG, Solon-Biet SM, Léopold P, Simpson SJ.</p> <hr/> <p>iScience. 2022 Apr 28;25(5):104315. doi: 10.1016/j.isci.2022.104315. eCollection 2022 May 20.</p> <hr/> <p>PMID: 35602946 Free PMC article. Review.</p>	Not Relevant
57	<p>Is an Iranian Health Promoting School status associated with improving school food environment and snacking behaviors in adolescents?</p> <hr/> <p>Yazdi-Feyzabadi V, Omidvar N, Keshavarz Mohammadi N, Nedjat S, Karimi-Shahanjarini A, Rashidian A.</p> <hr/> <p>Health Promot Int. 2018 Dec 1;33(6):1010-1021. doi: 10.1093/heapro/dax045.</p> <hr/> <p>PMID: 28973644</p>	Not Relevant
58	<p>Exploring the Experience and Determinants of the Food Choices and Eating Practices of Elderly Thai People: A Qualitative Study.</p> <hr/> <p>Chalerm Sri C, Herzig van Wees S, Ziaei S, Ekström EC, Muangpaisan W, Rahman SM.</p> <hr/> <p>Nutrients. 2020 Nov 13;12(11):3497. doi: 10.3390/nu12113497.</p> <hr/> <p>PMID: 33203013 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
59	Support for healthy eating at schools according to the comprehensive school health framework: evaluation during the early years of the Ontario School Food and Beverage Policy implementation. Orava T, Manske S, Hanning R. Health Promot Chronic Dis Prev Can. 2017 Sep;37(9):303-312. doi: 10.24095/hpcdp.37.9.05. PMID: 28902479 Free PMC article.	Not Relevant
60	Contextual Uncertainties, Human Mobility, and Perceived Food Environment: The Uncertain Geographic Context Problem in Food Access Research. Chen X, Kwan MP. Am J Public Health. 2015 Sep;105(9):1734-7. doi: 10.2105/AJPH.2015.302792. Epub 2015 Jul 16. PMID: 26180982 Free PMC article.	Not Relevant
61	Exploring drivers of food choice among PLHIV and their families in a peri-urban Dar es Salaam, Tanzania. Boncyk M, Shemdoe A, Ambikapathi R, Mosha D, Froese SL, Verissimo CK, Mwanyika-Sando M, Killewo J, Leyna GH, Gunaratna NS, Patil CL. BMC Public Health. 2022 May 30;22(1):1068. doi: 10.1186/s12889-022-13430-3. PMID: 35637504 Free PMC article.	Not Relevant
62	Indicators of a health-promoting local food environment: a conceptual framework to inform urban planning policy and practice. Murphy M, Badland H, Koohsari MJ, Astell-Burt T, Trapp G, Villanueva K, Mavoa S, Davern M, Giles-Corti B. Health Promot J Austr. 2017 Mar;28(1):82-84. doi: 10.1071/HE15098. PMID: 27376397 No abstract available.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
63	<p>A moveable feast: Exploring barriers and enablers to food citizenship.</p> <hr/> <p>O'Kane G.</p> <hr/> <p>Appetite. 2016 Oct 1;105:674-87. doi: 10.1016/j.appet.2016.07.002. Epub 2016 Jul 6.</p> <hr/> <p>PMID: 27395411</p>	Not Relevant
64	<p>Street Food Environment in Maputo (STOOD Map): a Cross-Sectional Study in Mozambique.</p> <hr/> <p>Gelormini M, Damasceno A, Lopes SA, Maló S, Chongole C, Muholove P, Casal S, Pinho O, Moreira P, Padrão P, Lunet N.</p> <hr/> <p>JMIR Res Protoc. 2015 Aug 5;4(3):e98. doi: 10.2196/resprot.4096.</p> <hr/> <p>PMID: 26245231 Free PMC article.</p>	Not Relevant
65	<p>Benchmarking policy goals and actions for healthy food environments in Ethiopia to prevent malnutrition in all its forms using document analysis.</p> <hr/> <p>Trübswasser U, Candel J, Genye T, Bossuyt A, Holdsworth M, Baye K, Talsma E.</p> <hr/> <p>BMJ Open. 2022 Aug 19;12(8):e058480. doi: 10.1136/bmjopen-2021-058480.</p> <hr/> <p>PMID: 35985782 Free PMC article.</p>	Not Relevant
66	<p>Exploring experiences of the food environment among immigrants living in the Region of Waterloo, Ontario.</p> <hr/> <p>Rodriguez PI, Dean J, Kirkpatrick S, Berbary L, Scott S.</p> <hr/> <p>Can J Public Health. 2016 Jun 9;107(Suppl 1):5310. doi: 10.17269/cjph.107.5310.</p> <hr/> <p>PMID: 27281516 Free PMC article.</p>	Not Relevant
67	<p>A rapid review of stocking and marketing practices used to sell sugar-sweetened beverages in U.S. food stores.</p> <hr/> <p>Houghtaling B, Holston D, Szocs C, Penn J, Qi D, Hedrick V.</p> <hr/> <p>Obes Rev. 2021 Apr;22(4):e13179. doi: 10.1111/obr.13179. Epub 2020 Dec 16.</p> <hr/> <p>PMID: 33331094 Free PMC article. Review.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
68	<p>Nutrition policies in Germany: a systematic assessment with the Food Environment Policy Index.</p> <hr/> <p>von Philipsborn P, Geffert K, Klinger C, Hebestreit A, Stratil J, Rehfuess EA; PEN Consortium.</p> <hr/> <p>Public Health Nutr. 2022 Jun;25(6):1691-1700. doi: 10.1017/S1368980021004742. Epub 2021 Dec 9.</p> <hr/> <p>PMID: 34881689 Free PMC article.</p>	Not Relevant
69	<p>Evaluating the food environment: application of the Healthy Eating Index-2005.</p> <hr/> <p>Reedy J, Krebs-Smith SM, Bosire C.</p> <hr/> <p>Am J Prev Med. 2010 May;38(5):465-71. doi: 10.1016/j.amepre.2010.01.015. Epub 2010 Feb 20.</p> <hr/> <p>PMID: 20171823</p>	Not Relevant
70	<p>Using Geographic Information Systems to measure retail food environments: Discussion of methodological considerations and a proposed reporting checklist (Geo-FERN).</p> <hr/> <p>Wilkins EL, Morris MA, Radley D, Griffiths C.</p> <hr/> <p>Health Place. 2017 Mar;44:110-117. doi: 10.1016/j.healthplace.2017.01.008. Epub 2017 Feb 23.</p> <hr/> <p>PMID: 28236788 Review.</p>	Not Relevant
71	<p>Spicing up food interactions: Development of a healthy food education activity targeting fathers and their young children.</p> <hr/> <p>Moura AF, Grønhøj A, Aschemann-Witzel J.</p> <hr/> <p>J Hum Nutr Diet. 2023 Oct;36(5):1795-1810. doi: 10.1111/jhn.13179. Epub 2023 May 9.</p> <hr/> <p>PMID: 37158136</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
72	Research on food-related chronic diseases in Latin America and the Caribbean: Are we building the evidence for gender-equitable approaches? Ludwick T, Neri D. Rev Panam Salud Publica. 2019 Jun 7;43:e43. doi: 10.26633/RPSP.2019.43. eCollection 2019. PMID: 31171920 Free PMC article.	Not Relevant
73	Implementation lessons for school food policies and marketing restrictions in the Philippines: a qualitative policy analysis. Reeve E, Thow AM, Bell C, Engelhardt K, Gamolo-Naliponguit EC, Go JJ, Sacks G. Global Health. 2018 Jan 23;14(1):8. doi: 10.1186/s12992-017-0320-y. PMID: 29361951 Free PMC article.	Not Relevant
74	Nutrition interventions addressing structural racism: a scoping review. Greene M, Houghtaling B, Sadeghzadeh C, De Marco M, Bryant D, Morgan R, Holston D. Nutr Res Rev. 2023 Jun;36(1):155-174. doi: 10.1017/S0954422422000014. Epub 2022 Jan 13. PMID: 35022096 Review.	Not Relevant
75	A systematic review of factors that influence food store owner and manager decision making and ability or willingness to use choice architecture and marketing mix strategies to encourage healthy consumer purchases in the United States, 2005-2017. Houghtaling B, Serrano EL, Kraak VI, Harden SM, Davis GC, Misyak SA. Int J Behav Nutr Phys Act. 2019 Jan 14;16(1):5. doi: 10.1186/s12966-019-0767-8. PMID: 30642352 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
76	<p>Evolutionary considerations on social status, eating behavior, and obesity.</p> <hr/> <p>Caldwell AE, Sayer RD.</p> <hr/> <p>Appetite. 2019 Jan 1;132:238-248. doi: 10.1016/j.appet.2018.07.028. Epub 2018 Aug 3.</p> <hr/> <p>PMID: 30078673 Free PMC article. Review.</p>	Not Relevant
77	<p>How to increase community participation capacity in food environment policymaking: Results of a scoping review.</p> <hr/> <p>Zerafati-Shoae N, Jamshidi E, Salehi L, Asgari Tae F.</p> <hr/> <p>Med J Islam Repub Iran. 2020 Mar 9;34:18. doi: 10.34171/mjiri.34.18. eCollection 2020.</p> <hr/> <p>PMID: 32551307 Free PMC article.</p>	Not Relevant
78	<p>The role of a food policy coalition in influencing a local food environment: an Australian case study.</p> <hr/> <p>McCartan J, Palermo C.</p> <hr/> <p>Public Health Nutr. 2017 Apr;20(5):917-926. doi: 10.1017/S1368980016003001. Epub 2016 Nov 24.</p> <hr/> <p>PMID: 27881210 Free PMC article.</p>	Not Relevant
79	<p>Systemic Barriers and Equitable Interventions to Improve Vegetable and Fruit Intake in Children: Interviews with National Food System Actors.</p> <hr/> <p>Gerritsen S, Harré S, Swinburn B, Rees D, Renker-Darby A, Bartos AE, Waterlander WE.</p> <hr/> <p>Int J Environ Res Public Health. 2019 Apr 17;16(8):1387. doi: 10.3390/ijerph16081387.</p> <hr/> <p>PMID: 30999659 Free PMC article.</p>	Not Relevant
80	<p>The evolution of insect biodiversity.</p> <hr/> <p>Tihelka E, Cai C, Giacomelli M, Lozano-Fernandez J, Rota-Stabelli O, Huang D, Engel MS, Donoghue PCJ, Pisani D.</p> <hr/> <p>Curr Biol. 2021 Oct 11;31(19):R1299-R1311. doi: 10.1016/j.cub.2021.08.057.</p> <hr/> <p>PMID: 34637741 Review.</p>	Not Relevant

Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
81	<p>Rapid review of factors influencing dietary behaviors in Fiji.</p> <hr/> <p>Boxer B, Trübswasser U, Lesi V, Naika A, Dahal P, Sagan S, Joshi K, Irache A, Singh P, Nand D, Kama A, Deo A, Goudet S.</p> <hr/> <p>Front Nutr. 2023 Aug 9;10:1164855. doi: 10.3389/fnut.2023.1164855. eCollection 2023.</p> <hr/> <p>PMID: 37621737 Free PMC article. Review.</p>	Not Relevant
82	<p>A Nutrition Report Card on food environments for children and youth: 5 years of experience from Canada.</p> <hr/> <p>Ferdinands AR, Olstad DL, Milford KM, Maximova K, Nykiforuk CI, Raine KD.</p> <hr/> <p>Public Health Nutr. 2020 Aug;23(12):2088-2099. doi: 10.1017/S1368980020000130. Epub 2020 May 21.</p> <hr/> <p>PMID: 32434601 Free PMC article.</p>	Not Relevant
83	<p>Organizational Food Environments: Advancing Their Conceptual Model.</p> <hr/> <p>de Castro IRR, Canella DS.</p> <hr/> <p>Foods. 2022 Mar 29;11(7):993. doi: 10.3390/foods11070993.</p> <hr/> <p>PMID: 35407080 Free PMC article.</p>	Not Relevant
84	<p>A Scoping Review of Obesity among Indigenous Peoples in Canada.</p> <hr/> <p>Batal M, Decelles S.</p> <hr/> <p>J Obes. 2019 Jun 3;2019:9741090. doi: 10.1155/2019/9741090. eCollection 2019.</p> <hr/> <p>PMID: 31281674 Free PMC article. Review.</p>	Not Relevant
85	<p>Association between activity space exposure to food establishments and individual risk of overweight.</p> <hr/> <p>Kestens Y, Lebel A, Chaix B, Clary C, Daniel M, Pampalon R, Theriault M, P Subramanian SV.</p> <hr/> <p>PLoS One. 2012;7(8):e41418. doi: 10.1371/journal.pone.0041418. Epub 2012 Aug 22.</p> <hr/> <p>PMID: 22936974 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
86	<p>Effect of COVID-19 Pandemic on Food Systems and Determinants of Resilience in Indigenous Communities of Jharkhand State, India: A Serial Cross-Sectional Study.</p> <hr/> <p>Ghosh-Jerath S, Kapoor R, Dhasmana A, Singh A, Downs S, Ahmed S.</p> <hr/> <p>Front Sustain Food Syst. 2022 Mar 24;6:724321. doi: 10.3389/fsufs.2022.724321.</p> <hr/> <p>PMID: 35586613 Free PMC article.</p>	Not Relevant
87	<p>School nutritional capacity, resources and practices are associated with availability of food/beverage items in schools.</p> <hr/> <p>Mâsse LC, de Niet JE.</p> <hr/> <p>Int J Behav Nutr Phys Act. 2013 Feb 19;10:26. doi: 10.1186/1479-5868-10-26.</p> <hr/> <p>PMID: 23421918 Free PMC article.</p>	Not Relevant
88	<p>Socioeconomic position and the impact of increasing availability of lower energy meals vs. menu energy labelling on food choice: two randomized controlled trials in a virtual fast-food restaurant.</p> <hr/> <p>Marty L, Jones A, Robinson E.</p> <hr/> <p>Int J Behav Nutr Phys Act. 2020 Jan 31;17(1):10. doi: 10.1186/s12966-020-0922-2.</p> <hr/> <p>PMID: 32005255 Free PMC article. Clinical Trial.</p>	Not Relevant
89	<p>Food-related environmental, behavioral, and personal factors associated with body mass index among urban, low-income African-American, American Indian, and Caucasian women.</p> <hr/> <p>Dammann KW, Smith C.</p> <hr/> <p>Am J Health Promot. 2011 Jul-Aug;25(6):e1-e10. doi: 10.4278/ajhp.091222-QUAN-397.</p> <hr/> <p>PMID: 21721954</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
90	<p>Access to nutritious food, socioeconomic individualism and public health ethics in the USA: a common good approach.</p> <hr/> <p>Azétsop J, Joy TR.</p> <hr/> <p>Philos Ethics Humanit Med. 2013 Oct 29;8:16. doi: 10.1186/1747-5341-8-16.</p> <hr/> <p>PMID: 24165577 Free PMC article.</p>	Not Relevant
91	<p>Precision nutrition: Maintaining scientific integrity while realizing market potential.</p> <hr/> <p>Berciano S, Figueiredo J, Brisbois TD, Alford S, Koecher K, Eckhouse S, Ciati R, Kussmann M, Ordovas JM, Stebbins K, Blumberg JB.</p> <hr/> <p>Front Nutr. 2022 Sep 2;9:979665. doi: 10.3389/fnut.2022.979665. eCollection 2022.</p> <hr/> <p>PMID: 36118748 Free PMC article. Review.</p>	Not Relevant
92	<p>An integrated deep-learning and multi-level framework for understanding the behavior of terrorist groups.</p> <hr/> <p>Jiang D, Wu J, Ding F, Ide T, Scheffran J, Helman D, Zhang S, Qian Y, Fu J, Chen S, Xie X, Ma T, Hao M, Ge Q.</p> <hr/> <p>Heliyon. 2023 Aug 6;9(8):e18895. doi: 10.1016/j.heliyon.2023.e18895. eCollection 2023 Aug.</p> <hr/> <p>PMID: 37636372 Free PMC article.</p>	Not Relevant
93	<p>Childhood obesity prevention: focusing on the community food environment.</p> <hr/> <p>Mayer K.</p> <hr/> <p>Fam Community Health. 2009 Jul-Sep;32(3):257-70. doi: 10.1097/FCH.0b013e3181ab3c2e.</p> <hr/> <p>PMID: 19525707 Review.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
94	Mobile produce market influences access to fruits and vegetables in an urban environment. Hsiao BS, Sibeko L, Wicks K, Troy LM. Public Health Nutr. 2018 May;21(7):1332-1344. doi: 10.1017/S1368980017003755. Epub 2018 Jan 10. PMID: 29317002 Free PMC article.	Not Relevant
95	"Because we missed the way that we eat at the middle of the day." Dietary acculturation and food routines among Dominican women. Weisberg-Shapiro P, Devine CM. Appetite. 2015 Dec;95:293-302. doi: 10.1016/j.appet.2015.07.024. Epub 2015 Jul 26. PMID: 26212269	Not Relevant
96	Policy options to support healthy eating in schools. McKenna ML. Can J Public Health. 2010 Jul-Aug;101 Suppl 2(Suppl 2):S14-7. doi: 10.1007/BF03405619. PMID: 21133196 Free PMC article. Review.	Not Relevant
97	Free Food at Work: A Concept Analysis. Horton Dias C, Dawson RM, Abshire DA, Harris D, Wirth MD. Workplace Health Saf. 2021 Jun;69(6):277-289. doi: 10.1177/2165079921997328. Epub 2021 Apr 13. PMID: 33845694	Not Relevant
98	Recent applications of organic molecule-based framework porous materials in solid-phase microextraction for pharmaceutical analysis. Gao Y, Sheng K, Bao T, Wang S. J Pharm Biomed Anal. 2022 Nov 30;221:115040. doi: 10.1016/j.jpba.2022.115040. Epub 2022 Sep 9. PMID: 36126613 Review.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
99	<p>The role of Australian local governments in creating a healthy food environment: an analysis of policy documents from six Sydney local governments.</p> <hr/> <p>Reeve B, Thow AM, Baker P, Hresc J, May S.</p> <hr/> <p>Aust N Z J Public Health. 2020 Apr;44(2):137-144. doi: 10.1111/1753-6405.12968. Epub 2020 Feb 26.</p> <hr/> <p>PMID: 32101352</p>	Not Relevant
100	<p>Bringing Healthy Retail to Urban "Food Swamps": a Case Study of CBPR-Informed Policy and Neighborhood Change in San Francisco.</p> <hr/> <p>Minkler M, Estrada J, Thayer R, Juachon L, Wakimoto P, Falbe J.</p> <hr/> <p>J Urban Health. 2018 Dec;95(6):850-858. doi: 10.1007/s11524-018-0234-x.</p> <hr/> <p>PMID: 29633226 Free PMC article.</p>	Not Relevant
101	<p>The Determinants of Food Insecurity Among Hispanic/Latinx Households With Young Children: A Narrative Review.</p> <hr/> <p>Varela EG, McVay MA, Shelnuttt KP, Mobley AR.</p> <hr/> <p>Adv Nutr. 2023 Jan;14(1):190-210. doi: 10.1016/j.advnut.2022.12.001. Epub 2022 Dec 24.</p> <hr/> <p>PMID: 36811589 Free PMC article. Review.</p>	Not Relevant
102	<p>A Review on the Rising Prevalence of International Standards: Threats or Opportunities for the Agri-Food Produce Sector in Developing Countries, with a Focus on Examples from the MENA Region.</p> <hr/> <p>Faour-Klingbeil D, Todd ECD.</p> <hr/> <p>Foods. 2018 Mar 3;7(3):33. doi: 10.3390/foods7030033.</p> <hr/> <p>PMID: 29510498 Free PMC article. Review.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
103	<p>Development of an item bank for food parenting practices based on published instruments and reports from Canadian and US parents.</p> <hr/> <p>O'Connor TM, Pham T, Watts AW, Tu AW, Hughes SO, Beauchamp MR, Baranowski T, Mâsse LC.</p> <hr/> <p><i>Appetite</i>. 2016 Aug 1;103:386-395. doi: 10.1016/j.appet.2016.04.033. Epub 2016 Apr 27.</p> <hr/> <p>PMID: 27131416</p>	Not Relevant
104	<p>Perspective: A Conceptual Framework for Adaptive Personalized Nutrition Advice Systems (APNASs).</p> <hr/> <p>Renner B, Buyken AE, Gedrich K, Lorkowski S, Watzl B, Linseisen J, Daniel H; working group "Personalized Nutrition" of the German Nutrition Society.</p> <hr/> <p><i>Adv Nutr</i>. 2023 Sep;14(5):983-994. doi: 10.1016/j.advnut.2023.06.009. Epub 2023 Jul 5.</p> <hr/> <p>PMID: 37419418 Free PMC article.</p>	Not Relevant
105	<p>Beyond the Individual -A Scoping Review and Bibliometric Mapping of Ecological Determinants of Eating Behavior in Older Adults.</p> <hr/> <p>Montez De Sousa ÍR, Bergheim I, Brombach C.</p> <hr/> <p><i>Public Health Rev</i>. 2022 Aug 3;43:1604967. doi: 10.3389/phrs.2022.1604967. eCollection 2022.</p> <hr/> <p>PMID: 35992753 Free PMC article. Review.</p>	Not Relevant
106	<p>Evaluation of a pilot healthy eating intervention in restaurants and food stores of a rural community: a randomized community trial.</p> <hr/> <p>Martínez-Donate AP, Riggall AJ, Meinen AM, Malecki K, Escaron AL, Hall B, Menzies A, Garske G, Nieto FJ, Nitzke S.</p> <hr/> <p><i>BMC Public Health</i>. 2015 Feb 12;15:136. doi: 10.1186/s12889-015-1469-z.</p> <hr/> <p>PMID: 25885704 Free PMC article. Clinical Trial.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
107	Enhancing healthy eating patterns among Hong Kong young adults. Kwok ST, Capra S, Leveritt M. Health Promot Int. 2020 Apr 1;35(2):386-396. doi: 10.1093/heapro/daz018. PMID: 30927410	Not Relevant
108	Building the field of food systems research: commentary on a research funder's role. Pelletier H, Bleecker L, Sauveplane-Stirling V, Di Ruggiero E, Sellen D. Health Res Policy Syst. 2021 Jul 16;19(1):101. doi: 10.1186/s12961-021-00745-7. PMID: 34271926 Free PMC article.	Not Relevant
109	An analysis of public health policy and legal issues relevant to mobile food vending. Tester JM, Stevens SA, Yen IH, Laraia BL. Am J Public Health. 2010 Nov;100(11):2038-46. doi: 10.2105/AJPH.2009.185892. Epub 2010 Sep 23. PMID: 20864711 Free PMC article.	Not Relevant
110	Research for leveraging food policy in universal eating disorder prevention. F Rodgers R, Sonnevile K. Int J Eat Disord. 2018 Jun;51(6):503-506. doi: 10.1002/eat.22877. Epub 2018 May 7. PMID: 29734466	Not Relevant
111	Protocol to monitor trade agreement food-related aspects: the Fiji case study. Ravuvu A, Friel S, Thow AM, Snowdon W, Wate J. Health Promot Int. 2018 Oct 1;33(5):887-900. doi: 10.1093/heapro/dax020. PMID: 28453626	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
112	School-Based Nutrition Interventions in Children Aged 6 to 18 Years: An Umbrella Review of Systematic Reviews. O'Brien KM, Barnes C, Yoong S, Campbell E, Wyse R, Delaney T, Brown A, Stacey F, Davies L, Lorien S, Hodder RK. Nutrients. 2021 Nov 17;13(11):4113. doi: 10.3390/nu13114113. PMID: 34836368 Free PMC article. Review.	Not Relevant
113	Factors influencing food choice in an Australian Aboriginal community. Brimblecombe J, Maypilama E, Colles S, Scarlett M, Dhurrkay JG, Ritchie J, O'Dea K. Qual Health Res. 2014 Mar;24(3):387-400. doi: 10.1177/1049732314521901. Epub 2014 Feb 18. PMID: 24549409	Not Relevant
114	The Socio-Ecological Context of the Nutrition Transition in Indonesia: A Qualitative Investigation of Perspectives from Multi-Disciplinary Stakeholders. Anyanwu OA, Naumova EN, Chomitz VR, Zhang FF, Chui K, Kartasurya MI, Foltz SC. Nutrients. 2022 Dec 21;15(1):25. doi: 10.3390/nu15010025. PMID: 36615684 Free PMC article.	Not Relevant
115	Hospital and Shift Work Influences on Nurses' Dietary Behaviors: A Qualitative Study. Horton Dias C, Dawson RM. Workplace Health Saf. 2020 Aug;68(8):374-383. doi: 10.1177/2165079919890351. Epub 2020 Jan 10. PMID: 31920166 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
116	Evidence Gaps in Assessments of the Healthiness of Online Supermarkets Highlight the Need for New Monitoring Tools: a Systematic Review. Maganja D, Miller M, Trieu K, Scapin T, Cameron A, Wu JHY. Curr Atheroscler Rep. 2022 Apr;24(4):215-233. doi: 10.1007/s11883-022-01004-y. Epub 2022 Feb 9. PMID: 35138570 Free PMC article. Review.	Not Relevant
117	An Appetite for Modernizing the Regulatory Framework for Protein Content Claims in Canada. Marinangeli CPF, Foisy S, Shoveller AK, Porter C, Musa-Veloso K, Sievenpiper JL, Jenkins DJA. Nutrients. 2017 Aug 23;9(9):921. doi: 10.3390/nu9090921. PMID: 28832556 Free PMC article.	Not Relevant
118	Comparison of Responsive Feeding Practices in Child Care and Home Environments in Nova Scotia. Mcisaac JD, Richard B, Turner J, Rossiter MD. Can J Diet Pract Res. 2022 Dec 1;83(4):168-174. doi: 10.3148/cjdpr-2022-017. Epub 2022 Aug 25. PMID: 36004728	Not Relevant
119	Nutrition Interventions in Low-Income Rural and Urban Retail Environments: A Systematic Review. Fergus L, Seals K, Holston D. J Acad Nutr Diet. 2021 Jun;121(6):1087-1114. doi: 10.1016/j.jand.2020.12.018. Epub 2021 Feb 13. PMID: 33589382	Not Relevant
120	A statistical modelling approach for source attribution meta-analysis of sporadic infection with foodborne pathogens. Mughini-Gras L, Benincà E, McDonald SA, de Jong A, Chardon J, Evers E, Bonačić Marinović AA. Zoonoses Public Health. 2022 Aug;69(5):475-486. doi: 10.1111/zph.12937. Epub 2022 Mar 10. PMID: 35267243 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
121	How Do African-American Caregivers Navigate a Food Desert to Feed Their Children? A Photovoice Narrative. Colón-Ramos U, Monge-Rojas R, Stevenson TR, Burns H, Thurman S, Gittelsohn J, Gurman TA. J Acad Nutr Diet. 2018 Nov;118(11):2045-2056. doi: 10.1016/j.jand.2018.04.016. Epub 2018 Jun 19. PMID: 29934282	Not Relevant
122	How Latina mothers navigate a 'food swamp' to feed their children: a photovoice approach. Colón-Ramos U, Monge-Rojas R, Cremm E, Rivera IM, Andrade EL, Edberg MC. Public Health Nutr. 2017 Aug;20(11):1941-1952. doi: 10.1017/S1368980017000738. Epub 2017 May 18. PMID: 28514988 Free PMC article.	Not Relevant
123	Development and implementation of nutrition labelling in Iran: A retrospective policy analysis. Edalati S, Omidvar N, Haghhighian Roudsari A, Ghodsi D, Zargaraan A. Int J Health Plann Manage. 2020 Jan;35(1):e28-e44. doi: 10.1002/hpm.2924. Epub 2019 Nov 10. PMID: 31709620	Not Relevant
124	Spatial access to restaurants and grocery stores in relation to frequency of home cooking. Pinho MGM, Mackenbach JD, Charreire H, Oppert JM, Bárdos H, Rutter H, Compernelle S, Beulens JWJ, Brug J, Lakerveld J. Int J Behav Nutr Phys Act. 2018 Jan 16;15(1):6. doi: 10.1186/s12966-017-0640-6. PMID: 29338756 Free PMC article.	Not Relevant
125	Parasites and wildlife in a changing world: The vector-host- pathogen interaction as a learning case. Rizzoli A, Tagliapietra V, Cagnacci F, Marini G, Arnoldi D, Rosso F, Rosà R. Int J Parasitol Parasites Wildl. 2019 Jun 12;9:394-401. doi: 10.1016/j.ijppaw.2019.05.011. eCollection 2019 Aug. PMID: 31341772 Free PMC article. Review.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
126	Enablers and barriers to improving worksite canteen nutrition in Pudong, China: a mixed-methods formative research study. Li R, Wu Y, Jing L, Jaacks LM. BMJ Open. 2018 Apr 12;8(4):e020529. doi: 10.1136/bmjopen-2017-020529. PMID: 29654034 Free PMC article.	Not Relevant
127	Achieving Food System Transformation: Insights From A Retrospective Review of Nutrition Policy (In)Action in High-Income Countries. Lee AJ, Cullerton K, Herron LM. Int J Health Policy Manag. 2021 Dec 1;10(12):766-783. doi: 10.34172/ijhpm.2020.188. PMID: 33105968 Free PMC article.	Not Relevant
128	Analysing the impact of trade agreements on national food environments: the case of Vanuatu. Ravuvu A, Lui JP, Bani A, Tavoia AW, Vuti R, Win Tin ST. Global Health. 2021 Sep 16;17(1):107. doi: 10.1186/s12992-021-00748-7. PMID: 34530860 Free PMC article.	Not Relevant
129	A European-wide dataset to uncover adaptive traits of <i>Listeria monocytogenes</i> to diverse ecological niches. Félix B, Sevellec Y, Palma F, Douarre PE, Felten A, Radomski N, Mallet L, Blanchard Y, Leroux A, Soumet C, Bridier A, Piveteau P, Ascensio E, Hébraud M, Karpíšková R, Gelbíčová T, Torresi M, Pomilio F, Cammà C, Di Pasquale A, Skjerdal T, Pietzka A, Ruppitsch W, Canelhas MR, Papić B, Hurtado A, Wullings B, Bulawova H, Castro H, Lindström M, Korkeala H, Šteingolde Ž, Kramarenko T, Cabanova L, Szymczak B, Gareis M, Oswaldi V, Marti E, Seyfarth AM, Leblanc JC, Guillier L, Roussel S. Sci Data. 2022 Apr 28;9(1):190. doi: 10.1038/s41597-022-01278-6. PMID: 35484273 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
130	Scrutinize of healthy school canteen policy in Iran's primary schools: a mixed method study. Babashahi M, Omidvar N, Joulaei H, Zargaraan A, Zayeri F, Veisi E, Doustmohammadian A, Kelishadi R. BMC Public Health. 2021 Aug 18;21(1):1566. doi: 10.1186/s12889-021-11587-x. PMID: 34407797 Free PMC article.	Not Relevant
131	Digital behaviour change interventions to increase vegetable intake in adults: a systematic review. Livingstone KM, Rawstorn JC, Partridge SR, Godrich SL, McNaughton SA, Hendrie GA, Blekkenhorst LC, Maddison R, Zhang Y, Barnett S, Mathers JC, Packard M, Alston L. Int J Behav Nutr Phys Act. 2023 Mar 27;20(1):36. doi: 10.1186/s12966-023-01439-9. PMID: 36973716 Free PMC article.	Not Relevant
132	Implementation of a regulatory food policy to reduce availability of energy-dense foods in Costa Rican high schools. Jensen ML, Gonzalez W, Bolaños-Palmieri C, Monge-Rojas R, Frongillo EA. Public Health Nutr. 2021 Dec;24(18):6499-6511. doi: 10.1017/S1368980021003013. Epub 2021 Aug 19. PMID: 34407907	Not Relevant
133	Identification of chemical mixtures to which women are exposed through the diet: Results from the French E3N cohort. Mancini FR, Frenoy P, Fiolet T, Fagherazzi G, Crépet A. Environ Int. 2021 Jul;152:106467. doi: 10.1016/j.envint.2021.106467. Epub 2021 Mar 9. PMID: 33711762	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
134	<p>The role of local food availability in explaining obesity risk among young school-aged children.</p> <hr/> <p>Lee H.</p> <hr/> <p>Soc Sci Med. 2012 Apr;74(8):1193-203. doi: 10.1016/j.socscimed.2011.12.036. Epub 2012 Feb 10.</p> <hr/> <p>PMID: 22381683</p>	Not Relevant
135	<p>Who influences nutrition policy space using international trade and investment agreements? A global stakeholder analysis.</p> <hr/> <p>Garton K, Swinburn B, Thow AM.</p> <hr/> <p>Global Health. 2021 Oct 2;17(1):118. doi: 10.1186/s12992-021-00764-7.</p> <hr/> <p>PMID: 34600556 Free PMC article.</p>	Not Relevant
136	<p>Regulating environments to reduce obesity.</p> <hr/> <p>Hayne CL, Moran PA, Ford MM.</p> <hr/> <p>J Public Health Policy. 2004;25(3-4):391-407. doi: 10.1057/palgrave.jphp.3190038.</p> <hr/> <p>PMID: 15683074</p>	Not Relevant
137	<p>Appetite for change? Facilitators and barriers to nutrition guideline implementation in Canadian recreational facilities.</p> <hr/> <p>Kirk SFL, Olstad DL, McIsaac JD, Prowse RJL, Caswell S, Hanning R, Raine KD, Mâsse LC, Naylor PJ.</p> <hr/> <p>Health Promot Int. 2021 Dec 23;36(6):1672-1682. doi: 10.1093/heapro/daab017.</p> <hr/> <p>PMID: 33615376</p>	Not Relevant
138	<p>Understanding the need for a whole-of-society approach in school nutrition policy implementation: a qualitative analysis.</p> <hr/> <p>Sobers NP, Bishop L, Ng SW, Soares-Wynter S, Greaves NS, Murphy MM.</p> <hr/> <p>Implement Sci Commun. 2021 Jul 17;2(1):79. doi: 10.1186/s43058-021-00184-z.</p> <hr/> <p>PMID: 34274014 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
139	Participatory prioritisation of interventions to improve primary school food environments in Gauteng, South Africa. Erzse A, Karim SA, Rwafa-Ponela T, Kruger P, Hofman K, Foley L, Oni T, Goldstein S. BMC Public Health. 2023 Jun 29;23(1):1263. doi: 10.1186/s12889-023-16101-z. PMID: 37386466 Free PMC article.	Not Relevant
140	A Systematic Review of Mobile Produce Markets: Facilitators and Barriers to Use, and Associations with Reported Fruit and Vegetable Intake. Hsiao BS, Sibeko L, Troy LM. J Acad Nutr Diet. 2019 Jan;19(1):76-97.e1. doi: 10.1016/j.jand.2018.02.022. PMID: 29764767	Not Relevant
141	A call for joined-up action to promote nutrition across the first 2000 days of life using a food systems approach. Love P, Laws R, Adam M, Esdaile E, Campbell KJ. Public Health Res Pract. 2022 Oct 12;32(3):3232226. doi: 10.17061/phrp3232226. PMID: 36220562	Not Relevant
142	Contextual and Cultural Influences on Parental Feeding Practices and Involvement in Child Care Centers among Hispanic Parents. Mena NZ, Gorman K, Dickin K, Greene G, Tovar A. Child Obes. 2015 Aug;11(4):347-54. doi: 10.1089/chi.2014.0118. Epub 2015 May 7. PMID: 25951503	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
143	<p>Development of family and dietary habits questionnaires: the assessment of family processes, dietary habits and adolescents' impulsiveness in Norwegian adolescents and their parents.</p> <hr/> <p>Bjelland M, Hausken SE, Sleddens EF, Andersen LF, Lie HC, Finset A, Maes L, Melbye EL, Glavin K, Hanssen-Bauer MW, Lien N.</p> <hr/> <p>Int J Behav Nutr Phys Act. 2014 Oct 15;11:130. doi: 10.1186/s12966-014-0130-z.</p> <hr/> <p>PMID: 25316270 Free PMC article.</p>	Not Relevant
144	<p>The barriers and enablers to implementing the New South Wales Healthy School Canteen Strategy in secondary schools in the Illawarra and Shoalhaven regions - A qualitative study.</p> <hr/> <p>Johnston R, Norman J, Furber S, Parkinson J.</p> <hr/> <p>Health Promot J Austr. 2022 Jul;33(3):686-695. doi: 10.1002/hpja.528. Epub 2021 Aug 25.</p> <hr/> <p>PMID: 34382275</p>	Not Relevant
145	<p>Point of choice kilocalorie labelling in the UK eating out of home sector: a descriptive study of major chains.</p> <hr/> <p>Robinson E, Burton S, Gough T, Jones A, Haynes A.</p> <hr/> <p>BMC Public Health. 2019 May 28;19(1):649. doi: 10.1186/s12889-019-7017-5.</p> <hr/> <p>PMID: 31138179 Free PMC article.</p>	Not Relevant
146	<p>Drawing on Strategic Management Approaches to Inform Nutrition Policy Design: An Applied Policy Analysis for Salt Reduction in Packaged Foods.</p> <hr/> <p>Trevena H, Neal B, Downs SM, Davis T, Sacks G, Crino M, Thow AM.</p> <hr/> <p>Int J Health Policy Manag. 2021 Dec 1;10(12):896-908. doi: 10.34172/ijhpm.2020.204.</p> <hr/> <p>PMID: 33160294 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
147	<p>Consolidating evidence on the effectiveness of interventions promoting fruit and vegetable consumption: an umbrella review.</p> <hr/> <p>Wolfenden L, Barnes C, Lane C, McCrabb S, Brown HM, Gerritsen S, Barquera S, Véjar LS, Munguía A, Yoong SL.</p> <hr/> <p>Int J Behav Nutr Phys Act. 2021 Jan 11;18(1):11. doi: 10.1186/s12966-020-01046-y.</p> <hr/> <p>PMID: 33430879 Free PMC article.</p>	Not Relevant
148	<p>Innovative matrix for applying a food systems approach for developing interventions to address nutrient deficiencies in indigenous communities in India: a study protocol.</p> <hr/> <p>Ghosh-Jerath S, Downs S, Singh A, Paramanik S, Goldberg G, Fanzo J.</p> <hr/> <p>BMC Public Health. 2019 Jul 15;19(1):944. doi: 10.1186/s12889-019-6963-2.</p> <hr/> <p>PMID: 31307415 Free PMC article.</p>	Not Relevant
149	<p>Chronological Incongruences between Mitochondrial and Nuclear Phylogenies of Aedes Mosquitoes.</p> <hr/> <p>Zadra N, Rizzoli A, Rota-Stabelli O.</p> <hr/> <p>Life (Basel). 2021 Feb 25;11(3):181. doi: 10.3390/life11030181.</p> <hr/> <p>PMID: 33669100 Free PMC article.</p>	Not Relevant
150	<p>Grain legume cultivation and children's dietary diversity in smallholder farming households in rural Ghana and Kenya.</p> <hr/> <p>de Jager I, Abizari AR, Douma JC, Giller KE, Brouwer ID.</p> <hr/> <p>Food Secur. 2017;9:1053-1071. doi: 10.1007/s12571-017-0720-0. Epub 2017 Oct 11.</p> <hr/> <p>PMID: 32952744 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
151	Factors affecting fruit and vegetable consumption and purchase behavior of adults in sub-Saharan Africa: A rapid review. Stadlmayr B, Trübswasser U, McMullin S, Karanja A, Wurzinger M, Hundscheid L, Riefler P, Lemke S, Brouwer ID, Sommer I. Front Nutr. 2023 Apr 11;10:1113013. doi: 10.3389/fnut.2023.1113013. eCollection 2023. PMID: 37113298 Free PMC article.	Not Relevant
152	Trade liberalisation and the nutrition transition: mapping the pathways for public health nutritionists. Thow AM. Public Health Nutr. 2009 Nov;12(11):2150-8. doi: 10.1017/S1368980009005680. Epub 2009 May 12. PMID: 19433005	Not Relevant
153	Exploring the dynamics of a free fruit at work intervention. Lake AA, Smith SA, Bryant CE, Alinia S, Brandt K, Seal CJ, Tetens I. BMC Public Health. 2016 Aug 19;16(1):839. doi: 10.1186/s12889-016-3500-4. PMID: 27542384 Free PMC article. Clinical Trial.	Not Relevant
154	Themes in Train-the-Trainer Nutrition Education Interventions Targeting Middle School Students: A Systematic Review. St Pierre C, Guan W, Barry L, Dease G, Gottlieb S, Morris A, Merrill J, Sacheck JM. Nutrients. 2021 Aug 10;13(8):2749. doi: 10.3390/nu13082749. PMID: 34444910 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
155	<p>The translational implications of applying multiple measures to evaluate the nutrient quality of the food supply: a case study of two food pantries in Montana.</p> <p>Byker Shanks C, Webber E, Larison L, Wytcherley B.</p> <p>Transl Behav Med. 2020 Dec 31;10(6):1367-1381. doi: 10.1093/tbm/ibaa108.</p> <p>PMID: 33421084 Free PMC article.</p>	Not Relevant
156	<p>Journey to Promoting Structural Change for Chronic Disease Prevention: Examining the Processes for Developing Policy, Systems, and Environmental Supports in Native American Nations.</p> <p>Jock BWI, Maudrie T, Fleischhacker S, Porter KP, Gittelsohn J.</p> <p>Curr Dev Nutr. 2022 Mar 16;6(3):nzab031. doi: 10.1093/cdn/nzab031. eCollection 2022 Mar.</p> <p>PMID: 35310617 Free PMC article.</p>	Not Relevant
157	<p>The Impact of COVID-19 Restrictions and Changes to Takeaway Regulations in England on Consumers' Intake and Methods of Accessing Out-of-Home Foods: A Longitudinal, Mixed-Methods Study.</p> <p>Fong M, Scott S, Albani V, Brown H.</p> <p>Nutrients. 2023 Aug 18;15(16):3636. doi: 10.3390/nu15163636.</p> <p>PMID: 37630827 Free PMC article.</p>	Not Relevant
158	<p>Translation and implementation of added sugars consumption recommendations: a conference report from the American Heart Association Added Sugars Conference 2010.</p> <p>Van Horn L, Johnson RK, Flickinger BD, Vafiadis DK, Yin-Piazza S; Added Sugars Conference Planning Group.</p> <p>Circulation. 2010 Dec 7;122(23):2470-90. doi: 10.1161/CIR.0b013e3181ffdc0. Epub 2010 Nov 8.</p> <p>PMID: 21060079</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
159	<p>Bringing down barriers to children's healthy eating: a critical review of opportunities, within a complex food system.</p> <hr/> <p>Varela P, De Rosso S, Moura AF, Galler M, Philippe K, Pickard A, Rageliene T, Sick J, van Nee R, Almli VL, Ares G, Grønhøj A, Spinelli S, van Kleef E.</p> <hr/> <p>Nutr Res Rev. 2023 Sep 25;1-58. doi: 10.1017/S0954422423000203. Online ahead of print.</p> <hr/> <p>PMID: 37746804 Review.</p>	Not Relevant
160	<p>Comparing Different Residential Neighborhood Definitions and the Association Between Density of Restaurants and Home Cooking Among Dutch Adults.</p> <hr/> <p>Pinho MGM, Mackenbach JD, Charreire H, Oppert JM, Rutter H, Beulens JWJ, Brug J, Lakerveld J.</p> <hr/> <p>Nutrients. 2019 Aug 3;11(8):1796. doi: 10.3390/nu11081796.</p> <hr/> <p>PMID: 31382624 Free PMC article.</p>	Not Relevant
161	<p>Engaging South Australian local governments in the development of healthy eating policies.</p> <hr/> <p>Matwiejczyk L, Mehta K, Scott J.</p> <hr/> <p>Health Promot J Austr. 2017 Aug;28(2):148-150. doi: 10.1071/HE15109.</p> <hr/> <p>PMID: 27397761</p>	Not Relevant
162	<p>Individual, social and environmental factors influencing dietary behaviour in shift workers with type 2 diabetes working in UK healthcare: A cross-sectional survey.</p> <hr/> <p>Rubner S, D'Annibale M, Oliver N, McGowan B, Guess N, Lorencatto F, Gibson R.</p> <hr/> <p>J Hum Nutr Diet. 2023 Oct;36(5):1992-2009. doi: 10.1111/jhn.13198. Epub 2023 Jul 15.</p> <hr/> <p>PMID: 37452756</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
163	<p>Voluntary industry initiatives to promote healthy diets: a case study on a major European food retailer.</p> <hr/> <p>von Philipsborn P, Stratil JM, Heise TL, Landgraf R, Hauner H, Rehfuess EA.</p> <hr/> <p>Public Health Nutr. 2018 Dec;21(18):3469-3476. doi: 10.1017/S1368980018002744. Epub 2018 Oct 18.</p> <hr/> <p>PMID: 30334511 Free PMC article.</p>	Not Relevant
164	<p>Regional trade and the nutrition transition: opportunities to strengthen NCD prevention policy in the Southern African Development Community.</p> <hr/> <p>Thow AM, Sanders D, Drury E, Puoane T, Chowdhury SN, Tsolekile L, Negin J.</p> <hr/> <p>Glob Health Action. 2015 Jul 22;8:28338. doi: 10.3402/gha.v8.28338. eCollection 2015.</p> <hr/> <p>PMID: 26205364 Free PMC article.</p>	Not Relevant
165	<p>"He's not fat, he just has asthma": a qualitative study exploring weight management in families living with pediatric asthma.</p> <hr/> <p>Clarke R, Heath G, Nagakumar P, Pattison H, Farrow C.</p> <hr/> <p>J Asthma. 2022 Sep;59(9):1750-1757. doi: 10.1080/02770903.2021.1975739. Epub 2021 Sep 13.</p> <hr/> <p>PMID: 34470559</p>	Not Relevant
166	<p>Promotion and Prevention Focused Feeding Strategies: Exploring the Effects on Healthy and Unhealthy Child Eating.</p> <hr/> <p>Melbye EL, Hansen H.</p> <hr/> <p>Biomed Res Int. 2015;2015:306306. doi: 10.1155/2015/306306. Epub 2015 Aug 25.</p> <hr/> <p>PMID: 26380269 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
167	Neighborhood attributes and cardiovascular disease risk in breast cancer survivors: The Pathways Study. Conroy SM, Von Behren J, Kwan ML, Kushi LH, Kim MO, Iribarren C, Roh JM, Laurent CA, Thomsen C, Chu JN, Greenlee H, Gomez SL, Shariff-Marco S. Cancer. 2023 Aug 1;129(15):2395-2408. doi: 10.1002/cncr.34794. Epub 2023 Apr 25. PMID: 37096827 Free PMC article.	Not Relevant
168	Nickel metal-organic framework 2D nanosheets with enhanced peroxidase nanozyme activity for colorimetric detection of H ₂ O ₂ . Chen J, Shu Y, Li H, Xu Q, Hu X. Talanta. 2018 Nov 1;189:254-261. doi: 10.1016/j.talanta.2018.06.075. Epub 2018 Jun 25. PMID: 30086915	Not Relevant
169	Using Individual GPS Trajectories to Explore Foodscape Exposure: A Case Study in Beijing Metropolitan Area. Wei Q, She J, Zhang S, Ma J. Int J Environ Res Public Health. 2018 Feb 27;15(3):405. doi: 10.3390/ijerph15030405. PMID: 29495449 Free PMC article.	Not Relevant
170	RE-AIM evaluation of a one-year trial of a combined educational and environmental workplace intervention to lower salt intake in Switzerland. Beer-Borst S, Hayoz S, Eisenblätter J, Jent S, Siegenthaler S, Strazzullo P, Luta X. Prev Med Rep. 2019 Aug 28;16:100982. doi: 10.1016/j.pmedr.2019.100982. eCollection 2019 Dec. PMID: 31516815 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
171	<p>Pathways to Diverse Diets-a Retrospective Analysis of a Participatory Nutrition-Sensitive Project in Kenya.</p> <hr/> <p>Boedecker J, Lachat C, Hawwash D, Van Damme P, Nowicki M, Termote C.</p> <hr/> <p>Curr Dev Nutr. 2021 Nov 26;5(12):nzab140. doi: 10.1093/cdn/nzab140. eCollection 2021 Dec.</p> <hr/> <p>PMID: 35024542 Free PMC article.</p>	Not Relevant
172	<p>Loss of protozoan and metazoan intestinal symbiont biodiversity in wild primates living in unprotected forests.</p> <hr/> <p>Barelli C, Pafčo B, Manica M, Rovero F, Rosà R, Modrý D, Hauffe HC.</p> <hr/> <p>Sci Rep. 2020 Jul 2;10(1):10917. doi: 10.1038/s41598-020-67959-7.</p> <hr/> <p>PMID: 32616818 Free PMC article.</p>	Not Relevant
173	<p>Examining capabilities, opportunities, and motivations for healthy eating behaviors in Latin American restaurants: a quantitative application of the COM-B model to inform future interventions.</p> <hr/> <p>Fuster M, Santos MP, Dimond E, Huang TTK, Handley MA.</p> <hr/> <p>BMC Nutr. 2023 Mar 27;9(1):57. doi: 10.1186/s40795-023-00712-1.</p> <hr/> <p>PMID: 36973765 Free PMC article.</p>	Not Relevant
174	<p>Hydrochar and hydrochar co-compost from OFMSW digestate for soil application: 1. production and chemical characterization.</p> <hr/> <p>Scrinzi D, Bona D, Denaro A, Silvestri S, Andreottola G, Fiori L.</p> <hr/> <p>J Environ Manage. 2022 May 1;309:114688. doi: 10.1016/j.jenvman.2022.114688. Epub 2022 Feb 15.</p> <hr/> <p>PMID: 35180435</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
175	Milk Authentication: Stable Isotope Composition of Hydrogen and Oxygen in Milks and Their Constituents. Hamzić Gregorčič S, Potočnik D, Camin F, Ogrinc N. Molecules. 2020 Sep 2;25(17):4000. doi: 10.3390/molecules25174000. PMID: 32887306 Free PMC article.	Not Relevant
176	A practical, theory-based approach to establishing school nutrition advisory councils. Kubik MY, Lytle LA, Story M. J Am Diet Assoc. 2001 Feb;101(2):223-8. doi: 10.1016/S0002-8223(01)00058-X. PMID: 11271696 Clinical Trial.	Not Relevant
177	Modelling armed conflict risk under climate change with machine learning and time-series data. Ge Q, Hao M, Ding F, Jiang D, Scheffran J, Helman D, Ide T. Nat Commun. 2022 May 20;13(1):2839. doi: 10.1038/s41467-022-30356-x. PMID: 35595793 Free PMC article.	Not Relevant
178	Volatilomics of raspberry fruit germplasm by combining chromatographic and direct-injection mass spectrometric techniques. Farneti B, Khomenko I, Ajelli M, Wells KE, Betta E, Aprea E, Giongo L, Biasioli F. Front Mol Biosci. 2023 Apr 13;10:1155564. doi: 10.3389/fmolb.2023.1155564. eCollection 2023. PMID: 37122562 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
179	<p>ONS: an ontology for a standardized description of interventions and observational studies in nutrition.</p> <hr/> <p>Vitali F, Lombardo R, Rivero D, Mattivi F, Franceschi P, Bordoni A, Trimigno A, Capozzi F, Felici G, Taglino F, Miglietta F, De Cock N, Lachat C, De Baets B, De Tré G, Pinart M, Nimptsch K, Pischon T, Bouwman J, Cavalieri D; ENPADASI consortium.</p> <hr/> <p>Genes Nutr. 2018 Apr 30;13:12. doi: 10.1186/s12263-018-0601-y. eCollection 2018.</p> <hr/> <p>PMID: 29736190 Free PMC article.</p>	Not Relevant
180	<p>A decision support tool to enhance agricultural growth in the Mékrou river basin (West Africa).</p> <hr/> <p>Udias A, Pastori M, Dondeynaz C, Carmona Moreno C, Ali A, Cattaneo L, Cano J.</p> <hr/> <p>Comput Electron Agric. 2018 Nov;154:467-481. doi: 10.1016/j.compag.2018.09.037.</p> <hr/> <p>PMID: 30739969 Free PMC article.</p>	Not Relevant
181	<p>[Human rights, an opportunity for public policies in health].</p> <hr/> <p>Franco-Giraldo A, Alvarez-Dardet C.</p> <hr/> <p>Gac Sanit. 2008 May-Jun;22(3):280-6. doi: 10.1157/13123975.</p> <hr/> <p>PMID: 18579055 Spanish.</p>	Not Relevant
182	<p>Improving children's nutrition environments: a survey of adoption and implementation of nutrition guidelines in recreational facilities.</p> <hr/> <p>Olstad DL, Downs SM, Raine KD, Berry TR, McCargar LJ.</p> <hr/> <p>BMC Public Health. 2011 Jun 1;11:423. doi: 10.1186/1471-2458-11-423.</p> <hr/> <p>PMID: 21631946 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
183	<p>Monitoring of carbon-water fluxes at Eurasian meteorological stations using random forest and remote sensing.</p> <hr/> <p>Xie M, Ma X, Wang Y, Li C, Shi H, Yuan X, Hellwich O, Chen C, Zhang W, Zhang C, Ling Q, Gao R, Zhang Y, Ochege FU, Frankl A, De Maeyer P, Buchmann N, Feigenwinter I, Olesen JE, Juszczak R, Jacotot A, Korrensalo A, Pitacco A, Varlagin A, Shekhar A, Lohila A, Carrara A, Brut A, Kruijt B, Loubet B, Heinesch B, Chojnicki B, Helfter C, Vincke C, Shao C, Bernhofer C, Brümmer C, Wille C, Tuittila ES, Nemitz E, Meggio F, Dong G, Lanigan G, Niedrist G, Wohlfahrt G, Zhou G, Goded I, Gruenwald T, Olejnik J, Jansen J, Neiryneck J, Tuovinen JP, Zhang J, Klumpp K, Pilegaard K, Šigut L, Klemedtsson L, Tezza L, Hörtnagl L, Urbaniak M, Roland M, Schmidt M, Sutton MA, Hehn M, Saunders M, Mauder M, Aurela M, Korkiakoski M, Du M, Vendrame N, Kowalska N, Leahy PG, Alekseychik P, Shi P, Weslien P, Chen S, Fares S, Friborg T, Tallec T, Kato T, Sachs T, Maximov T, di Cella UM, Moderow U, Li Y, He Y, Kosugi Y, Luo G.</p> <hr/> <p>Sci Data. 2023 Sep 7;10(1):587. doi: 10.1038/s41597-023-02473-9.</p> <hr/> <p>PMID: 37679357 Free PMC article.</p>	Not Relevant
184	<p>The Impact of Fast Radiation on the Phylogeny of Bactrocera Fruit Flies as Revealed by Multiple Evolutionary Models and Mutation Rate-Calibrated Clock.</p> <hr/> <p>Valerio F, Zadra N, Rota-Stabelli O, Ometto L.</p> <hr/> <p>Insects. 2022 Jun 30;13(7):603. doi: 10.3390/insects13070603.</p> <hr/> <p>PMID: 35886779 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
185	Relaxation of Natural Selection in the Evolution of the Giant Lungfish Genomes. Fuselli S, Greco S, Biello R, Palmitessa S, Lago M, Meneghetti C, McDougall C, Trucchi E, Rota Stabelli O, Biscotti AM, Schmidt DJ, Roberts DT, Espinoza T, Hughes JM, Ometto L, Gerdol M, Bertorelle G. Mol Biol Evol. 2023 Sep 1;40(9):msad193. doi: 10.1093/molbev/msad193. PMID: 37671664 Free PMC article.	Not Relevant
186	An upstream approach to addressing the childhood obesity epidemic in New Zealand-a call to action. Men V. N Z Med J. 2024 Jun 7;137(1596):86-93. doi: 10.26635/6965.6384. PMID: 38843552	Not Relevant
187	Experts' perceptions on motivators and barriers of healthy and sustainable dietary behaviors among adolescents: The SWITCH project. Raghoobar S, Mesch A, Gulikers J, Winkens LHH, Wesselink R, Haveman-Nies A. Appetite. 2024 Mar 1;194:107196. doi: 10.1016/j.appet.2023.107196. Epub 2023 Dec 26. PMID: 38154577	Not Relevant
188	'Healthier options tend to get lost in the noise of online' - Australian shoppers' experiences with online grocery platforms. Bennett R, Driessen C, Zorbas C, Sacks G, Gupta A, Cameron A, Gomez-Donoso C, Peeters A, Backholer K. Public Health Nutr. 2024 May 14;27(1):e134. doi: 10.1017/S1368980024001046. PMID: 38742445 Free PMC article.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
189	<p>Effects of increasing the availability of vegetarian options on main meal choices, meal offer satisfaction and liking: a pre-post analysis in a French university cafeteria.</p> <hr/> <p>Arrazat L, Cambriels C, Noan CL, Nicklaus S, Marty L.</p> <hr/> <p>Int J Behav Nutr Phys Act. 2024 Jul 16;21(1):75. doi: 10.1186/s12966-024-01624-4.</p> <hr/> <p>PMID: 39010118 Free PMC article.</p>	Not Relevant
190	<p>Looking to the past: Investigating 10-year place histories as a determinant of home food environments in the Healthy Communities Study.</p> <hr/> <p>Lang IM, Kim Y, Ritchie LD, Au LE, Colabianchi N.</p> <hr/> <p>Soc Sci Med. 2024 Dec;363:117478. doi: 10.1016/j.socscimed.2024.117478. Epub 2024 Nov 5.</p> <hr/> <p>PMID: 39536654</p>	Not Relevant
191	<p>Sociodemographic and behavioural determinants of vegetarian main dish selection in a French university cafeteria: A three-month observational study with repeated measures.</p> <hr/> <p>Arrazat L, Teil F, Nicklaus S, Marty L.</p> <hr/> <p>Appetite. 2025 Mar 1;207:107856. doi: 10.1016/j.appet.2025.107856. Epub 2025 Jan 9.</p> <hr/> <p>PMID: 39798931</p>	Not Relevant
192	<p>Translation and implementation of added sugars consumption recommendations: a conference report from the American Heart Association Added Sugars Conference 2010.</p> <hr/> <p>How big is too big? A qualitative study of discretionary food portion size norms among Australian consumers.</p> <hr/> <p>Liu Q, Wang L, Allman-Farinelli M, Rangan A.</p> <hr/> <p>Public Health Nutr. 2024 Oct 24;27(1):e242. doi: 10.1017/S1368980024001964.</p> <hr/> <p>PMID: 39444353 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
193	"It does help but there's a limit ...": Young people's perspectives on policies to manage hot food takeaways opening near schools. Savory B, Thompson C, Hassan S, Adams J, Amies-Cull B, Chang M, Derbyshire D, Keeble M, Liu B, Medina-Lara A, Mytton OT, Rahilly J, Rogers N, Smith R, White M, Burgoine T, Cummins S. Soc Sci Med. 2025 Mar;368:117810. doi: 10.1016/j.socscimed.2025.117810. Epub 2025 Feb 5. PMID: 39929025	Not Relevant
194	Strengths and weaknesses of food eco-labeling: a review. Tiboni-Oschilewski O, Abarca M, Santa Rosa Pierre F, Rosi A, Biasini B, Menozzi D, Scazzina F. Front Nutr. 2024 Mar 27;11:1381135. doi: 10.3389/fnut.2024.1381135. eCollection 2024. PMID: 38600991 Free PMC article. Review.	Not Relevant
195	Expanding the food environment framework to include family dynamics: A systematic synthesis of qualitative evidence using HIV as a case study. Ambikapathi R, Boncyk M, Gunaratna NS, Fawzi W, Leyna G, Kadiyala S, Patil CL. Glob Food Sec. 2024 Sep;42:100788. doi: 10.1016/j.gfs.2024.100788. PMID: 39309213 Free PMC article. Review.	Not Relevant
196	Food environment research in Canada: a rapid review of methodologies and measures deployed between 2010 and 2021. Vaillancourt C, Ahmed M, Kirk S, Labonté MÈ, Laar A, Mah CL, Minaker L, Olstad DL, Potvin Kent M, Provencher V, Prowse R, Raine KD, Schram A, Zavala-Mora D, Rancourt-Bouchard M, Vanderlee L. Int J Behav Nutr Phys Act. 2024 Feb 19;21(1):18. doi: 10.1186/s12966-024-01558-x. PMID: 38373957 Free PMC article. Review.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
197	Associations between household food environment and daily intake of regular and diet soft drinks per BMI status of European children: Feel4Diabetes Study. Reppas K, Papamichael MM, Usheva N, Iotova V, Chakarova N, Cardon G, Rurik I, Antal E, Valve P, Liatis S, Makrilakis K, Moreno L, Manios Y, Moschonis G. Nutr Bull. 2024 Mar;49(1):82-95. doi: 10.1111/nbu.12659. Epub 2024 Jan 30. PMID: 38288678	Not Relevant
198	Evidence for Policies and Practices to Address Global Food Insecurity. Iannotti L, Kleban E, Fracassi P, Oenema S, Lutter C. Annu Rev Public Health. 2024 May;45(1):375-400. doi: 10.1146/annurev-publhealth-060922-041451. Epub 2024 Apr 3. PMID: 38166503 Review.	Not Relevant
199	Food environments in the Pacific region and efforts to improve them: a scoping review. Fusi SKF, Gómez-Donoso C, Backholer K, Browne J, Ferguson M, Cameron AJ. Public Health Nutr. 2024 Nov 26;28(1):e5. doi: 10.1017/S1368980024002350. PMID: 39587426 Free PMC article.	Not Relevant
200	Inequalities in Research on Food Environment Policies: An Evidence Map of Global Evidence from 2010-2020. Blanchard L, Ray S, Law C, Vega-Salas MJ, Rutter H, Egan M, Petticrew M, Potvin Kent M, Bennett C, Lucas PJ, Knai C. Adv Nutr. 2024 Nov;15(11):100306. doi: 10.1016/j.advnut.2024.100306. Epub 2024 Sep 23. PMID: 39322035 Free PMC article. Review.	Not Relevant

Continues next page >>

Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
201	School food and nutrition environments in the Pacific Islands: opportunities to support healthier diets. Burkhart S, Singh P, Hunter D, Raneri JE. Proc Nutr Soc. 2025 Feb 14;1-7. doi: 10.1017/S0029665125000102. Online ahead of print. PMID: 39949236 Review.	Not Relevant
202	Environmental Sustainability of Food Environments: Development and Application of a Framework in 4 cities in South Asia. Bellows AL, Ganpule A, Raza A, Kapoor D, Musicus A, Spiker ML, Jaacks LM. Curr Dev Nutr. 2024 Jun 11;8(7):103791. doi: 10.1016/j.cdnut.2024.103791. eCollection 2024 Jul. PMID: 39045144 Free PMC article.	Not Relevant
203	Who has a high level of food literacy, and who does not?: a qualitative study of college students in South Korea. Yoo H, Jo E, Lee H, Ko E, Jang E, Sim J, Park S. Nutr Res Pract. 2023 Dec;17(6):1155-1169. doi: 10.4162/nrp.2023.17.6.1155. Epub 2023 Aug 3. PMID: 38053819 Free PMC article.	Not Relevant
204	Designing and Evaluating a Hierarchical Framework for Matching Food Outlets across Multi-sourced Geospatial Datasets: a Case Study of San Diego County. Cao Y, Yang JA, Nara A, Jankowska MM. J Urban Health. 2024 Feb;101(1):155-169. doi: 10.1007/s11524-023-00817-9. Epub 2024 Jan 2. PMID: 38167974 Free PMC article.	Not Relevant
205	The current research status of immobilized lipase performance and its potential for application in food are developing toward green and healthy direction: A review. Wang N, Wang W, Su Y, Zhang J, Sun B, Ai N. J Food Sci. 2025 Feb;90(2):e70038. doi: 10.1111/1750-3841.70038. PMID: 39961802 Review.	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
206	<p>Convenience as a dimension of food environments: A systematic scoping review of its definition and measurement.</p> <hr/> <p>Bogard JR, Downs S, Casey E, Farrell P, Gupta A, Miachon L, Naughton S, Staromiejska W, Reeve E.</p> <hr/> <p><i>Appetite</i>. 2024 Mar 1;194:107198. doi: 10.1016/j.appet.2023.107198. Epub 2024 Jan 2.</p> <hr/> <p>PMID: 38176442</p>	Included
207	<p>HOW CLOSE AND HOW MUCH? LINKING HEALTH OUTCOMES TO BUILT ENVIRONMENT SPATIAL DISTRIBUTIONS.</p> <hr/> <p>Peterson AT, Berrocal VJ, Sanchez-Vaznaugh EV, SÁnchez BN.</p> <hr/> <p><i>Ann Appl Stat</i>. 2023 Jun;17(2):1641-1662. doi: 10.1214/22-AOAS1687. Epub 2023 May 1.</p> <hr/> <p>PMID: 39605799 Free PMC article.</p>	Not Relevant
208	<p>Which factors influence the transition towards a healthy and sustainable food environment in Dutch hospitals? A qualitative view from stakeholders.</p> <hr/> <p>Wierda JJ, van Nassau F, Djojoseparto SK, Poelman MP.</p> <hr/> <p><i>BMC Med</i>. 2025 Jan 27;23(1):45. doi: 10.1186/s12916-025-03872-y.</p> <hr/> <p>PMID: 39871337 Free PMC article.</p>	Not Relevant
209	<p>Instruments and indicators for assessing organisational food environments: a scoping review protocol.</p> <hr/> <p>Azevedo ABC, Curioni CC, Bandoni DH, Canella DS.</p> <hr/> <p><i>BMJ Open</i>. 2024 Feb 7;14(2):e077307. doi: 10.1136/bmjopen-2023-077307.</p> <hr/> <p>PMID: 38326268 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
210	<p>Madrid immigrants' perceptions of urban food environments and their dietary behaviours.</p> <hr/> <p>Chuquitarco-Morales A, Rivera-Navarro J, La Parra-Casado D, Fuster M, Franco M.</p> <hr/> <p><i>Appetite</i>. 2024 Aug 1;199:107390. doi: 10.1016/j.appet.2024.107390. Epub 2024 May 3.</p> <hr/> <p>PMID: 38703792</p>	Not Relevant
211	<p>Process evaluation of Project Daire: a food environment intervention that impacted food knowledge, wellbeing and dietary habits of primary school children.</p> <hr/> <p>Anderson N, Brennan SF, Lavelle F, Moore SE, Olgacher D, Junkin A, Dean M, McKinley MC, McCole P, Hunter RF, Dunne L, O'Connell NE, Elliott CT, McCarthy D, Woodside JV.</p> <hr/> <p><i>BMC Public Health</i>. 2025 Feb 6;25(1):486. doi: 10.1186/s12889-025-21628-4.</p> <hr/> <p>PMID: 39910503 Free PMC article. Clinical Trial.</p>	Not Relevant
212	<p>Developing meaningful water-energy-food-environment (WEFE) nexus indicators with stakeholders: An Upper White Nile case study.</p> <hr/> <p>Schlemm A, Mulligan M, Tang T, Agramont A, Namugize J, Malambala E, van Griensven A.</p> <hr/> <p><i>Sci Total Environ</i>. 2024 Jun 25;931:172839. doi: 10.1016/j.scitotenv.2024.172839. Epub 2024 Apr 28.</p> <hr/> <p>PMID: 38685436</p>	Not Relevant
213	<p>Exploring the multiple dimensions of perceived food access in the local food environment in Flanders: Perceptions of adults in socioeconomically disadvantaged situations.</p> <hr/> <p>D'Hooghe S, Inaç Y, Vandevijvere S, Deforche B, de Ridder K, Van Dyck D, Van de Weghe N, Dury S.</p> <hr/> <p><i>Appetite</i>. 2024 Dec 1;203:107609. doi: 10.1016/j.appet.2024.107609. Epub 2024 Jul 31.</p> <hr/> <p>PMID: 39094845</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
214	<p>How are intra-household dynamics, gender roles and time availability related to food access and children's diet quality during the Covid-19 lockdown?</p> <hr/> <p>Pemjean I, Hernández P, Mediano F, Corvalán C.</p> <hr/> <p>Soc Sci Med. 2024 Mar;345:116661. doi: 10.1016/j.socscimed.2024.116661. Epub 2024 Feb 13.</p> <hr/> <p>PMID: 38377834</p>	Not Relevant
215	<p>COVID-19's impact on food environment in the Indian states of Telangana, Maharashtra, West Bengal, Tamil Nadu and Punjab: a descriptive qualitative study to build further research in India's food environment resilience building.</p> <hr/> <p>Johnsen JT, Rafaela Lima do Vale M, Bhangaonkar R, Nyaga W, Ayyad S, Ray S.</p> <hr/> <p>BMJ Nutr Prev Health. 2024 Aug 17;7(2):e000844. doi: 10.1136/bmjnp-2023-000844. eCollection 2024.</p> <hr/> <p>PMID: 39882298 Free PMC article.</p>	Not Relevant
216	<p>Systems map of interventions to improve dietary intake of pre-school aged children: A scoping review.</p> <hr/> <p>Chan J, Conroy P, Phongsavan P, Raubenheimer D, Allman-Farinelli M.</p> <hr/> <p>Prev Med. 2023 Dec;177:107727. doi: 10.1016/j.ypmed.2023.107727. Epub 2023 Oct 15.</p> <hr/> <p>PMID: 37848165</p>	Not Relevant
217	<p>Changing the food environment in secondary school canteens to promote healthy dietary choices: a qualitative study with school caterers.</p> <hr/> <p>Murphy M, Coffey A, Pallan M, Oyebode O.</p> <hr/> <p>BMC Public Health. 2024 Jul 23;24(1):1970. doi: 10.1186/s12889-024-19513-7.</p> <hr/> <p>PMID: 39044155 Free PMC article.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
218	Healthy Kai (Food) Checker Web-Based Tool to Support Healthy Food Policy Implementation: Development and Usability Study. Rosin M, Ni Mhurchu C, Umali E, Mackay S. JMIR Form Res. 2025 Jan 13;9:e60447. doi: 10.2196/60447. PMID: 39805585 Free PMC article.	Not Relevant
219	Participatory Systems Thinking to Elucidate Drivers of Food Access and Diet Disparities among Minoritized Urban Populations. Langellier BA, Argibay S, Henson RM, Kravitz C, Eastus A, Stankov I, Headen I. J Urban Health. 2024 Dec;101(6):1235-1247. doi: 10.1007/s11524-024-00895-3. Epub 2024 Jul 24. PMID: 39046675 Free PMC article.	Not Relevant
220	How Children's Experiences and Perceptions of Their School Food Environment Influence Their Food-Related Decisions In-School in Urban Ghana. Tandoh A, Holdsworth M, Aryeetey R, Agyemang C, Laar A. Matern Child Nutr. 2025 Mar 6:e70011. doi: 10.1111/mcn.70011. Online ahead of print. PMID: 40051183	Not Relevant
221	'Doing school food!': a practical toolkit for adopting a whole school food approach. Rose K, O'Malley C, Lake AA, Lalli GS. Perspect Public Health. 2023 Oct 17:17579139231185302. doi: 10.1177/17579139231185302. Online ahead of print. PMID: 37846731	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
222	<p>Understanding family food purchasing behaviour of low-income urban UK families: An analysis of parent capability, opportunity and motivation.</p> <hr/> <p>Screti C, Edwards K, Blissett J.</p> <hr/> <p><i>Appetite</i>. 2024 Apr 1;195:107183. doi: 10.1016/j.appet.2023.107183. Epub 2024 Jan 4.</p> <hr/> <p>PMID: 38182053</p>	Not Relevant
223	<p>"The Dollar Store Got It Going On": Understanding Food Shopping Patterns and Policy Preferences among Dollar Store Shoppers with Low Incomes.</p> <hr/> <p>Reimold AE, Hall MG, Ng SW, Taillie LS, Ribisl KM, Charles EL, Golden SD.</p> <hr/> <p><i>Curr Dev Nutr</i>. 2024 Sep 13;8(10):104457. doi: 10.1016/j.cdnut.2024.104457. eCollection 2024 Oct.</p> <hr/> <p>PMID: 39886353 Free PMC article.</p>	Not Relevant
224	<p>National nutrition surveillance programmes in 18 countries in South-East Asia and Western Pacific Regions: a systematic scoping review.</p> <hr/> <p>Peters R, Li B, Swinburn B, Allender S, He Z, Lim SY, Chea M, Ding G, Zhou W, Keonakhone P, Vongxay M, Khamphanthong S, Selamat R, Dayanghirang A, Abella E, Da Costa F, Chotivichien S, Ungkanavin N, Truong MT, Nguyen SD, Poh BK.</p> <hr/> <p><i>Bull World Health Organ</i>. 2023 Nov 1;101(11):690-706F. doi: 10.2471/BLT.23.289973. Epub 2023 Oct 4.</p> <hr/> <p>PMID: 37961057 Free PMC article.</p>	Not Relevant
225	<p>Characteristics of built food environments associated with alternative protein food choices: a systematic review.</p> <hr/> <p>Zaleskiewicz H, Kulis E, Siwa M, Szczuka Z, Banik A, Grossi F, Chrysochou P, Nystrand BT, Perrea T, Samoggia A, Xhelili A, Krystallis A, Luszczynska A.</p> <hr/> <p><i>Int J Behav Nutr Phys Act</i>. 2024 May 16;21(1):58. doi: 10.1186/s12966-024-01606-6.</p> <hr/> <p>PMID: 38755618 Free PMC article. Review.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
226	Recent progress of chiral metal-organic frameworks in enantioselective separation and detection. Chen H, Xia L, Li G. Mikrochim Acta. 2024 Oct 2;191(11):640. doi: 10.1007/s00604-024-06729-y. PMID: 39356328 Review.	Not Relevant
227	Regulatory responses to ultra-processed foods are skewed towards behaviour change and not food system transformation. Northcott T, Lawrence M, Parker C, Reeve B, Baker P. Nat Food. 2025 Jan 10. doi: 10.1038/s43016-024-01101-y. Online ahead of print. PMID: 39794395	Not Relevant
228	Transitioning towards more plant-based diets: sharing expert knowledge through a system lens. Blokhuis C, Hofstede GJ, Ocké M, de Vet E. Appetite. 2024 Apr 1;195:107193. doi: 10.1016/j.appet.2023.107193. Epub 2023 Dec 26. PMID: 38154575	Not Relevant
229	Building a Culture of Health Through Leader-Inspired Nutrition. Currie TL, Crawford CC, Scott JM, Troncoso MR, McCarthy MS, Lindsey AT, Deuster PA. Mil Med. 2025 Jan 25:usaf021. doi: 10.1093/milmed/usaf021. Online ahead of print. PMID: 39865645	Not Relevant
230	Prevalence of processed foods in major US grocery stores. Ravandi B, Ispirova G, Sebek M, Mehler P, Barabási AL, Menichetti G. Nat Food. 2025 Jan 13. doi: 10.1038/s43016-024-01095-7. Online ahead of print. PMID: 39806219	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
231	<p>Individuals with minoritized and intersecting identities in the prevention of body image and eating disorder pathology: Grounding theoretical frameworks of resilience and risk.</p> <hr/> <p>Rodgers RR, Beccia AL, Schaefer LM, Hazzard VM, Burke NL.</p> <hr/> <p>Clin Psychol Rev. 2025 Feb 14;117:102554. doi: 10.1016/j.cpr.2025.102554. Online ahead of print.</p> <hr/> <p>PMID: 39987765 Review.</p>	Not Relevant
232	<p>High Non-affordability of Diets and Malnutrition in Africa's Drylands: Systems Analysis to Guide Action.</p> <hr/> <p>Hobbs N, Hug J, de Pee S.</p> <hr/> <p>Food Nutr Bull. 2023 Dec;44(2_suppl):S45-S57. doi: 10.1177/03795721231178065.</p> <hr/> <p>PMID: 37850927</p>	Not Relevant
233	<p>The use of private regulatory measures to create healthy food retail environments: a scoping review.</p> <hr/> <p>Dancey J, Reeve B, Jones A, Ferguson M, van Burgel E, Brimblecombe J.</p> <hr/> <p>Public Health Nutr. 2024 Mar 11;27(1):e88. doi: 10.1017/S136898002400065X.</p> <hr/> <p>PMID: 38465376 Free PMC article.</p>	Not Relevant
234	<p>Bringing down barriers to children's healthy eating: a critical review of opportunities, within a complex food system.</p> <hr/> <p>Varela P, De Rosso S, Ferreira Moura A, Galler M, Philippe K, Pickard A, Rageliene T, Sick J, van Nee R, Almlí VL, Ares G, Grønhøj A, Spinelli S, van Kleef E.</p> <hr/> <p>Nutr Res Rev. 2024 Dec;37(2):331-351. doi: 10.1017/S0954422423000203. Epub 2023 Sep 25.</p> <hr/> <p>PMID: 37746804 Review.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
235	<p>What does it take for healthy food retail programmes to be successful? Lessons learned in New York City. Setiono FJ, Heller SP, Leak TM. Public Health Nutr. 2024 Oct 3;27(1):e188. doi: 10.1017/S1368980024001368. PMID: 39360456 Free PMC article.</p>	Not Relevant
236	<p>Fiscal policies and regulations for healthy diets in Sri Lanka: an analysis of the political economy of taxation and traffic light labelling for sugar-sweetened beverages. Madurawala S, Kiringoda K, Thow AM, Arunatilake N. Glob Health Action. 2023 Dec 31;16(1):2280339. doi: 10.1080/16549716.2023.2280339. Epub 2023 Nov 29. PMID: 38018465 Free PMC article.</p>	Not Relevant
219	<p>Participatory Systems Thinking to Elucidate Drivers of Food Access and Diet Disparities among Minoritized Urban Populations. Langellier BA, Argibay S, Henson RM, Kravitz C, Eastus A, Stankov I, Headen I. J Urban Health. 2024 Dec;101(6):1235-1247. doi: 10.1007/s11524-024-00895-3. Epub 2024 Jul 24. PMID: 39046675 Free PMC article.</p>	Not Relevant
220	<p>How Children's Experiences and Perceptions of Their School Food Environment Influence Their Food-Related Decisions In-School in Urban Ghana. Tandoh A, Holdsworth M, Aryeetey R, Agyemang C, Laar A. Matern Child Nutr. 2025 Mar 6:e70011. doi: 10.1111/mcn.70011. Online ahead of print. PMID: 40051183</p>	Not Relevant
221	<p>'Doing school food!': a practical toolkit for adopting a whole school food approach. Rose K, O'Malley C, Lake AA, Lalli GS. Perspect Public Health. 2023 Oct 17:17579139231185302. doi: 10.1177/17579139231185302. Online ahead of print. PMID: 37846731</p>	Not Relevant

Continues next page >>

Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
222	<p>Understanding family food purchasing behaviour of low-income urban UK families: An analysis of parent capability, opportunity and motivation.</p> <hr/> <p>Screti C, Edwards K, Blissett J.</p> <hr/> <p><i>Appetite</i>. 2024 Apr 1;195:107183. doi: 10.1016/j.appet.2023.107183. Epub 2024 Jan 4.</p> <hr/> <p>PMID: 38182053</p>	Not Relevant
223	<p>"The Dollar Store Got It Going On": Understanding Food Shopping Patterns and Policy Preferences among Dollar Store Shoppers with Low Incomes.</p> <hr/> <p>Reimold AE, Hall MG, Ng SW, Taillie LS, Ribisl KM, Charles EL, Golden SD.</p> <hr/> <p><i>Curr Dev Nutr</i>. 2024 Sep 13;8(10):104457. doi: 10.1016/j.cdnut.2024.104457. eCollection 2024 Oct.</p> <hr/> <p>PMID: 39886353 Free PMC article.</p>	Not Relevant
224	<p>National nutrition surveillance programmes in 18 countries in South-East Asia and Western Pacific Regions: a systematic scoping review.</p> <hr/> <p>Peters R, Li B, Swinburn B, Allender S, He Z, Lim SY, Chea M, Ding G, Zhou W, Keonakhone P, Vongxay M, Khamphanthong S, Selamat R, Dayanghirang A, Abella E, Da Costa F, Chotivichien S, Ungkanavin N, Truong MT, Nguyen SD, Poh BK.</p> <hr/> <p><i>Bull World Health Organ</i>. 2023 Nov 1;101(11):690-706F. doi: 10.2471/BLT.23.289973. Epub 2023 Oct 4.</p> <hr/> <p>PMID: 37961057 Free PMC article.</p>	Not Relevant
225	<p>Characteristics of built food environments associated with alternative protein food choices: a systematic review.</p> <hr/> <p>Zaleskiewicz H, Kulis E, Siwa M, Szczuka Z, Banik A, Grossi F, Chrysochou P, Nystrand BT, Perrea T, Samoggia A, Xhelili A, Krystallis A, Luszczynska A.</p> <hr/> <p><i>Int J Behav Nutr Phys Act</i>. 2024 May 16;21(1):58. doi: 10.1186/s12966-024-01606-6.</p> <hr/> <p>PMID: 38755618 Free PMC article. Review.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
226	Recent progress of chiral metal-organic frameworks in enantioselective separation and detection. Chen H, Xia L, Li G. Mikrochim Acta. 2024 Oct 2;191(11):640. doi: 10.1007/s00604-024-06729-y. PMID: 39356328 Review.	Not Relevant
227	Regulatory responses to ultra-processed foods are skewed towards behaviour change and not food system transformation. Northcott T, Lawrence M, Parker C, Reeve B, Baker P. Nat Food. 2025 Jan 10. doi: 10.1038/s43016-024-01101-y. Online ahead of print. PMID: 39794395	Not Relevant
228	Transitioning towards more plant-based diets: sharing expert knowledge through a system lens. Blokhuis C, Hofstede GJ, Ocké M, de Vet E. Appetite. 2024 Apr 1;195:107193. doi: 10.1016/j.appet.2023.107193. Epub 2023 Dec 26. PMID: 38154575	Not Relevant
229	Building a Culture of Health Through Leader-Inspired Nutrition. Currie TL, Crawford CC, Scott JM, Troncoso MR, McCarthy MS, Lindsey AT, Deuster PA. Mil Med. 2025 Jan 25:usaf021. doi: 10.1093/milmed/usaf021. Online ahead of print. PMID: 39865645	Not Relevant
230	Prevalence of processed foods in major US grocery stores. Ravandi B, Ispirova G, Sebek M, Mehler P, Barabási AL, Menichetti G. Nat Food. 2025 Jan 13. doi: 10.1038/s43016-024-01095-7. Online ahead of print. PMID: 39806219	Not Relevant

Continues next page >>

Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
231	<p>Individuals with minoritized and intersecting identities in the prevention of body image and eating disorder pathology: Grounding theoretical frameworks of resilience and risk.</p> <hr/> <p>Rodgers RR, Beccia AL, Schaefer LM, Hazzard VM, Burke NL.</p> <hr/> <p>Clin Psychol Rev. 2025 Feb 14;117:102554. doi: 10.1016/j.cpr.2025.102554. Online ahead of print.</p> <hr/> <p>PMID: 39987765 Review.</p>	Not Relevant
232	<p>High Non-affordability of Diets and Malnutrition in Africa's Drylands: Systems Analysis to Guide Action.</p> <hr/> <p>Hobbs N, Hug J, de Pee S.</p> <hr/> <p>Food Nutr Bull. 2023 Dec;44(2_suppl):S45-S57. doi: 10.1177/03795721231178065.</p> <hr/> <p>PMID: 37850927</p>	Not Relevant
233	<p>The use of private regulatory measures to create healthy food retail environments: a scoping review.</p> <hr/> <p>Dancey J, Reeve B, Jones A, Ferguson M, van Burgel E, Brimblecombe J.</p> <hr/> <p>Public Health Nutr. 2024 Mar 11;27(1):e88. doi: 10.1017/S136898002400065X.</p> <hr/> <p>PMID: 38465376 Free PMC article.</p>	Not Relevant
234	<p>Bringing down barriers to children's healthy eating: a critical review of opportunities, within a complex food system.</p> <hr/> <p>Varela P, De Rosso S, Ferreira Moura A, Galler M, Philippe K, Pickard A, Rageliene T, Sick J, van Nee R, Almlí VL, Ares G, Grønhøj A, Spinelli S, van Kleef E.</p> <hr/> <p>Nutr Res Rev. 2024 Dec;37(2):331-351. doi: 10.1017/S0954422423000203. Epub 2023 Sep 25.</p> <hr/> <p>PMID: 37746804 Review.</p>	Not Relevant

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Table S5. Search results from Pubmed (*cont.*)

S. No.	Article details	Comments
235	What does it take for healthy food retail programmes to be successful? Lessons learned in New York City. Setiono FJ, Heller SP, Leak TM. Public Health Nutr. 2024 Oct 3;27(1):e188. doi: 10.1017/S1368980024001368. PMID: 39360456 Free PMC article.	Not Relevant
236	Fiscal policies and regulations for healthy diets in Sri Lanka: an analysis of the political economy of taxation and traffic light labelling for sugar-sweetened beverages. Madurawala S, Kiringoda K, Thow AM, Arunatilake N. Glob Health Action. 2023 Dec 31;16(1):2280339. doi: 10.1080/16549716.2023.2280339. Epub 2023 Nov 29. PMID: 38018465 Free PMC article.	Not Relevant

Note: results refer to search on 10th February 2025

3. Chapter 4

Table S6. Use of Open-AI's GPT-4 large language model for categorizing food outlets in Scotland, 2024

Prompt used for identifying businesses to exclude from the list of food businesses

“Use your extensive domain knowledge of businesses in Scotland to go through the list {LIST OF OUTLETS} and assess whether it engages in the direct sale of food and/or drink to consumers such as butchers, newsagents, grocery stores, coffee shops, supermarkets, restaurants, cafés, bakeries, butchers, fishmongers and similar outlets. If the business DOES NOT meet these criteria, such as a village hall or a catering company, include it in a new list of companies that do not primarily sell food and drink. Only output the new list. Do not include any other text in the output.”

List of businesses hallucinated by the model, i.e., those businesses that were not included in the original list of businesses and were generated by GPT-4 (n = 34)

'A And M Catering - Street Trader'	'Piazza News',
'Delta Facility',	'Pollok House',
'ELIOR @ BABCOCK (Terminal 2)',	'Reliance @ ABDN SHERIFF COURT (CELL AREA',
'Glasgowean Health Shop',	'SCAMPS (AFTER SCHOOL CLUB)',
'GLOW With Gayle',	'SODEXO @ SCOTTISH GOVERNMENT (MARINE LAB)',
'Govan Community Fire Station',	'SODEXO @ SHELL (WOODBANK)',
'GRANITE CITY (Landside)',	'ST MARYS (SHARED) CHURCH',
'HALFORDS (RETAIL SHOP ONLY)',	'SUPERDRUG (UNIT 15)',
'HAZLEHEAD GOLF CLUB (Bar only)',	'THE 1224 CLUB (MASONIC LODGE)',
'Hill Of Banchory School',	'The Balloon And Chocolate Company',
'Hobbycraft',	'The KEY',
'J and JG Dickson And Son Ltd',	'The Tunnels',
'Linkes (SCIO)',	'W H SMITH (AIRSIDE)',
'MacKays Ltd. Retail Shop',	'W H SMITH (LANDSIDE)',
'Maitland Bowling Club',	'W H SMITH (LANDSIDE) (ARRIVALS)',
'Motor Fuel Group Ltd (Grantown))',	'Woodend Bowling Club']
'NATURES WAY (CHINESE HERBAL MEDICINE)',	
'Option One Events',	

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Table S6. Use of Open-AI's GPT-4 large language model for categorising food outlets in Scotland, 2024 (cont.)

Type of hallucinations by the model (examples)
1. Generated 'A And M Catering - Street Trader' from the original A and M Catering - Street Trader by changing case
2. Generated "ELIOR @ BABCOCK [Terminal 2]" from the original ELIOR @ BABCOCK (Terminal 2) by changing brackets
3. Generated 'Glasgowean Health Shop' from the original "Glaswegian Health Shop" by misspelling.

Table S7. Classification of food outlets in Scotland, 2024

Food outlet type	n (%)
Restaurant/Cafe/Canteen	9,248 (30)
Takeaway/sandwich shop	5,430 (17)
Pub/bar/nightclub	3,731 (12)
Subtotal out-of-home	18,409 (59)
Retailers - supermarkets/hypermarkets	1,876 (6)
Retailers - other	6,881 (22)
Subtotal food retail	8,757 (28)
Other catering premises	2,803 (9)
Mobile caterer	1,166 (4)
Subtotal other	3,969 (13)
Total (all types)	31,135

b) Proportion of food outlets

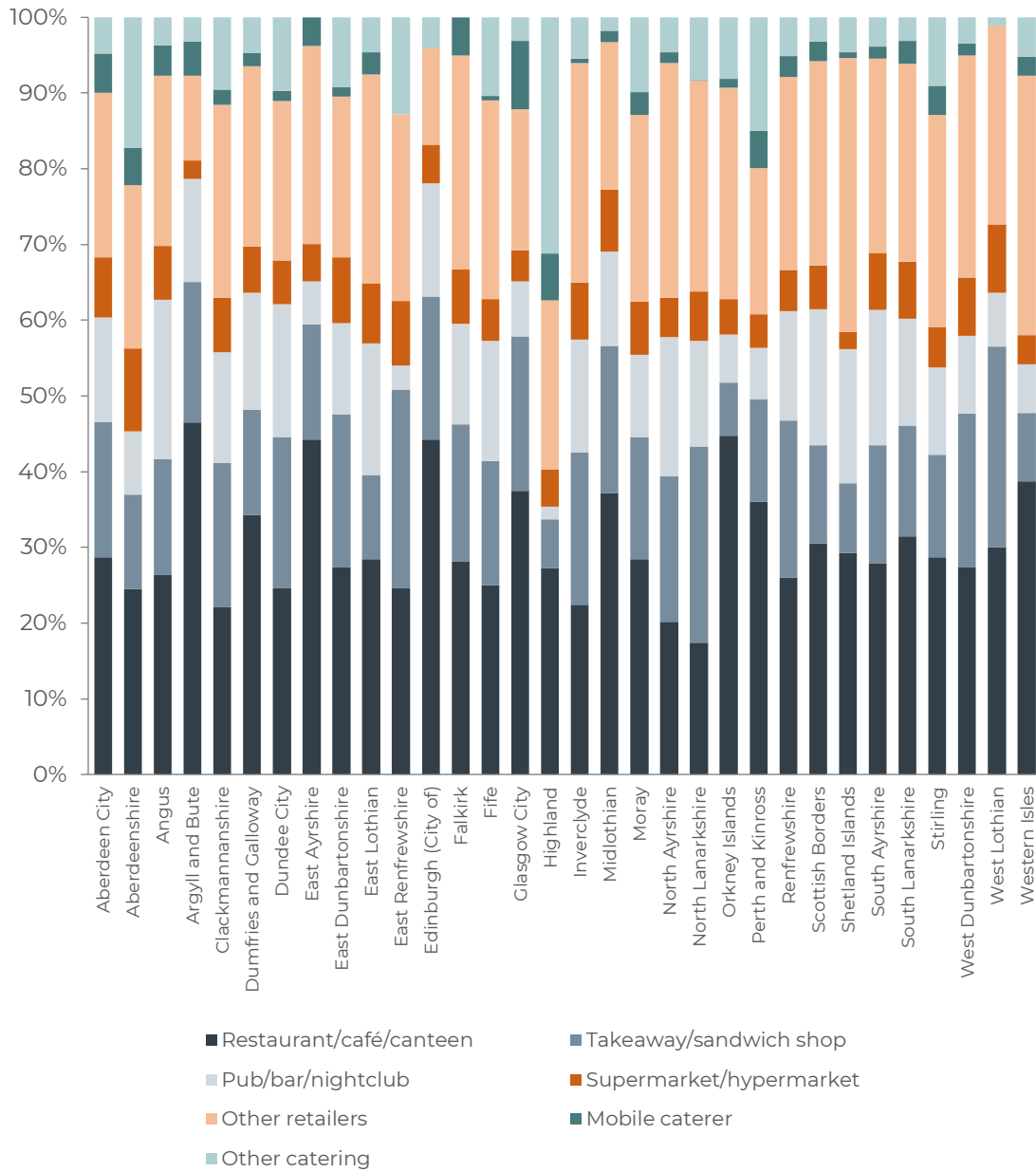


Table S8. Association of density of total food outlets (area per km²) and by Scottish Index of Multiple Deprivation quintile in Scotland, 2024

SIMD Quintile	β	SE	p-value
Quintile 1 (ref)	1.00		–
Quintile 2	-0.13	0.01	<0.01
Quintile 3	-0.30	0.01	<0.01
Quintile 4	-0.52	0.01	<0.01
Quintile 5	-0.31	0.01	<0.01

Table S9. Food outlet classification, overall and by Scottish Index of Multiple Deprivation quintile in Scotland, 2024

Characteristic	Overall ^{1,a}	1 ^{2,a}	2 ^{3,a}	3 ^{4,a}	4 ^{5,a}	5 ^{6,a}	p-value ^b
Business type							
Mobile caterer	1,027 (3%)	337 (5%)	229 (3%)	209 (3%)	170 (3%)	82 (2%)	
Other catering premises	2,728 (9%)	451 (6%)	616 (8%)	669 (10%)	697 (12%)	295 (9%)	
Pub/bar/nightclub	3,658 (12%)	821 (11%)	885 (12%)	868 (13%)	698 (12%)	386 (12%)	
Restaurant/Café/Canteen	9,062 (30%)	1,641 (23%)	2,020 (27%)	2,158 (33%)	2,005 (35%)	1,238 (37%)	<0.01
Retailers - other	6,747 (22%)	1,884 (26%)	1,853 (24%)	1,384 (21%)	1,081 (19%)	545 (16%)	
Retailers – supermarkets / hypermarkets	1,838 (6%)	402 (6%)	506 (7%)	354 (5%)	339 (6%)	237 (7%)	
Takeaway/sandwich shop	5,343 (18%)	1,715 (24%)	1,461 (19%)	979 (15%)	662 (12%)	526 (16%)	
Food outlet classification							
Out-of-home	18,063 (59%)	4,177 (58%)	4,366 (58%)	4,005 (60%)	3,365 (60%)	2,150 (65%)	
Other	3,755 (12%)	788 (11%)	845 (11%)	878 (13%)	867 (15%)	377 (11%)	<0.01
Retail	8,585 (28%)	2,286 (32%)	2,359 (31%)	1,738 (26%)	1,420 (25%)	782 (24%)	

¹Overall: N = 30,403

⁵4: N = 5,652

²1: N = 7,251

⁶5: N = 3,309

³2: N = 7,570

^a n(%)

⁴3: N = 6,621

^b Pearson's Chi-squared test

Table S10. Food outlet classification by local authority and Scottish Index of Multiple Deprivation in Scotland, 2024

Local authorities and SIMD quintile	OOH <i>n</i> (%)	Other <i>n</i> (%)	Retail <i>n</i> (%)	Grand total	p-value*
Aberdeen City	845 (61%)	139 (10%)	412 (30%)	1,396	0.03
1	58(55)	10(9)	38(36)	106	
2	226(60)	29(8)	123(33)	378	
3	283(64)	54(12)	104(24)	441	
4	86(59)	10(7)	51(35)	147	
5	178(60)	30(10)	90(30)	298	
Aberdeenshire	433 (41%)	282 (27%)	346 (33%)	1,061	0.03
1	59(49)	20(17)	41(34)	120	
2	39(42)	19(21)	34(37)	92	
3	104(42)	51(21)	92(37)	247	
4	113(39)	89(31)	86(30)	288	
5	70(36)	51(26)	74(38)	195	
Angus	356 (63%)	48 (8%)	165 (29%)	569	sample size too small
1	46(69)	4(6)	17(25)	67	
2	117(60)	11(6)	68(35)	196	
3	98(59)	13(8)	54(33)	165	
4	70(63)	16(14)	26(23)	112	
5	17(71)	2(8)	5(21)	24	
Argyll and Bute	221 (77%)	25 (9%)	40 (14%)	286	sample size too small
1	67(89)	2(3)	6(8)	75	
2	54(86)	3(5)	6(10)	63	
3	43(61)	14(20)	14(20)	71	
4	45(76)	6(10)	8(14)	59	
5	5(56)	0(0)	4(44)	9	

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Table S10. Food outlet classification by local authority and Scottish Index of Multiple Deprivation in Scotland, 2024 (cont.)

Local authorities and SIMD quintile	OOH <i>n(%)</i>	Other <i>n(%)</i>	Retail <i>n(%)</i>	Grand total	p-value*
Clackmannanshire	162 (55%)	36 (12%)	96 (33%)	294	
1	72(52)	19(14)	48(35)	139	
2	43(55)	5(6)	30(38)	78	sample size too small
3	17(55)	5(16)	9(29)	31	
4	12(63)	4(21)	3(16)	19	
5	17(65)	2(8)	7(27)	26	
Comhairle nan Eilean Siar (Western Isles)	81 (52%)	14 (9%)	60 (39%)	155	
2	32(60)	6(11)	15(28)	2	sample size too small
3	46(46)	8(8)	45(45)	3	
Dumfries and Galloway	583 (64%)	61 (7%)	272 (30%)	916	
1	145(73)	3(2)	51(26)	1	
2	149(59)	18(7)	84(33)	2	sample size too small
3	205(63)	27(8)	93(29)	3	
4	59(58)	9(9)	34(33)	4	
5	22(56)	4(10)	13(33)	5	
Dundee City	612 (62%)	110 (11%)	265 (27%)	987	
1	217(62)	9(3)	123(35)	349	
2	135(48)	87(31)	57(20)	279	sample size too small
3	89(74)	3(3)	28(23)	120	
4	138(70)	11(6)	47(24)	196	
5	33(77)	0(0)	10(23)	43	

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Table S10. Food outlet classification by local authority and Scottish Index of Multiple Deprivation in Scotland, 2024 (cont.)

Local authorities and SIMD quintile	OOH <i>n(%)</i>	Other <i>n(%)</i>	Retail <i>n(%)</i>	Grand total	p-value*
East Ayrshire	412 (65%)	25 (4%)	194 (31%)	631	
1	139(60)	12(5)	82(35)	233	
2	112(62)	3(2)	66(36)	181	sample size too small
3	96(75)	5(4)	27(21)	128	
4	40(69)	1(2)	17(29)	58	
5	21(75)	4(14)	3(11)	28	
East Dunbartonshire	232 (59%)	42 (11%)	117 (30%)	391	
1	16(57)	3(11)	9(32)	28	
2	93(62)	13(9)	45(30)	151	sample size too small
3	5(42)	3(25)	4(33)	12	
4	40(63)	9(14)	15(23)	64	
5	77(57)	13(10)	44(33)	134	
East Lothian	274 (57%)	38 (8%)	166 (35%)	478	
1	24(73)	0(0)	9(27)	33	
2	94(52)	11(6)	75(42)	180	sample size too small
3	92(56)	15(9)	56(34)	163	
4	45(58)	10(13)	23(29)	78	
5	12(55)	2(9)	8(36)	22	

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Table S10. Food outlet classification by local authority and Scottish Index of Multiple Deprivation in Scotland, 2024 (cont.)

Local authorities and SIMD quintile	OOH <i>n(%)</i>	Other <i>n(%)</i>	Retail <i>n(%)</i>	Grand total	p-value*
East Renfrewshire	100 (53%)	25 (13%)	62 (33%)	187	
1	13(54)	4(17)	7(29)	24	
2	17(41)	5(12)	19(46)	41	sample size too small
3	27(59)	3(7)	16(35)	46	
4	14(54)	4(15)	8(31)	26	
5	29(58)	9(18)	12(24)	50	
Edinburgh (City of)	2,703 (78%)	156 (5%)	587 (17%)	3,446	
1	173(66)	23(9)	66(25)	262	
2	336(74)	21(5)	95(21)	452	<0.01
3	776(83)	26(3)	137(15)	939	
4	525(79)	30(5)	107(16)	662	
5	783(77)	50(5)	188(18)	1,021	
Falkirk	435 (60%)	40 (6%)	247 (34%)	722	
1	89(52)	26(15)	56(33)	171	
2	111(56)	2(1)	86(43)	199	sample size too small
3	145(66)	5(2)	71(32)	221	
4	51(60)	3(4)	31(36)	85	
5	26(70)	0(0)	11(30)	37	

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Table S10. Food outlet classification by local authority and Scottish Index of Multiple Deprivation in Scotland, 2024 (cont.)

Local authorities and SIMD quintile	OOH <i>n</i> (%)	Other <i>n</i> (%)	Retail <i>n</i> (%)	Grand total	p-value*
Fife	1,359 (56%)	302 (12%)	758 (31%)	2,419	
1	233(51)	61(13)	159(35)	453	
2	455(54)	90(11)	293(35)	838	
3	197(57)	39(11)	107(31)	343	0.01
4	264(57)	66(14)	132(29)	462	
5	180(62)	47(16)	64(22)	291	
Glasgow City	3,234 (65%)	622 (12%)	1,121 (23%)	4,977	
1	1,097(57)	297(15)	534(28)	1,928	
2	550(63)	105(12)	212(24)	867	
3	554(72)	63(8)	155(20)	772	<0.01
4	672(79)	36(4)	143(17)	851	
5	260(75)	38(11)	49(14)	347	
Highland	712 (27%)	1,193 (45%)	732 (28%)	2,637	
1	100(29)	145(42)	102(29)	347	
2	160(27)	249(42)	186(31)	595	
3	239(27)	393(45)	242(28)	874	<0.01
4	170(24)	375(52)	174(24)	719	
5	5(9)	33(62)	15(28)	53	

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Table S10. Food outlet classification by local authority and Scottish Index of Multiple Deprivation in Scotland, 2024 (cont.)

Local authorities and SIMD quintile	OOH <i>n(%)</i>	Other <i>n(%)</i>	Retail <i>n(%)</i>	Grand total	p-value*
Inverclyde	201 (58%)	21 (6%)	126 (36%)	348	
1	138(57)	12(5)	91(38)	241	
2	17(57)	2(7)	11(37)	30	sample size too small
3	20(65)	2(6)	9(29)	31	
4	14(61)	2(9)	7(30)	23	
5	11(52)	1(5)	9(43)	21	
Midlothian	234 (69%)	12 (4%)	93 (27%)	339	
1	31(56)	2(4)	22(40)	55	
2	85(64)	3(2)	44(33)	132	sample size too small
3	50(71)	3(4)	17(24)	70	
4	45(85)	3(6)	5(9)	53	
5	21(72)	2(7)	6(21)	29	
Moray	283 (54%)	73 (14%)	171 (32%)	527	
1	19(66)	3(10)	7(24)	29	
2	59(58)	8(8)	34(34)	101	sample size too small
3	58(49)	23(19)	37(31)	118	
4	88(50)	27(15)	60(34)	175	
5	30(57)	8(15)	15(28)	53	
North Ayrshire	411 (58%)	45 (6%)	257 (36%)	713	
1	232(58)	18(5)	148(37)	398	
2	58(55)	10(10)	37(35)	105	sample size too small
3	62(55)	10(9)	40(36)	112	
4	44(57)	5(6)	28(36)	77	
5	12(57)	2(10)	7(33)	21	

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Table S10. Food outlet classification by local authority and Scottish Index of Multiple Deprivation in Scotland, 2024 (cont.)

Local authorities and SIMD quintile	OOH <i>n</i> (%)	Other <i>n</i> (%)	Retail <i>n</i> (%)	Grand total	p-value*
North Lanarkshire	853 (58%)	125 (8%)	503 (34%)	1,481	
1	340(58)	31(5)	219(37)	590	
2	236(55)	45(10)	149(35)	430	0.01
3	97(58)	21(13)	48(29)	166	
4	110(56)	21(11)	65(33)	196	
5	46(58)	10(13)	23(29)	79	
Orkney Islands	100 (58%)	16 (9%)	56 (33%)	172	
2	46(62)	2(3)	26(35)	74	sample size too small
3	12(60)	1(5)	7(35)	20	
4	40(53)	13(17)	23(30)	76	
5	2(100)	0(0)	0(0)	2	
Perth and Kinross	422 (55%)	162 (21%)	179 (23%)	763	
1	61(70)	8(9)	18(21)	87	
2	102(63)	20(12)	40(25)	162	<0.01
3	66(48)	35(26)	36(26)	137	
4	121(50)	60(25)	59(25)	240	
5	69(52)	37(28)	26(20)	132	
Renfrewshire	575 (61%)	80 (8%)	288 (31%)	943	
1	202(61)	18(5)	111(34)	331	
2	172(63)	16(6)	86(31)	274	0.01
3	77(56)	21(15)	40(29)	138	
4	86(60)	16(11)	41(29)	143	
5	28(56)	8(16)	14(28)	50	

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Table S10. Food outlet classification by local authority and Scottish Index of Multiple Deprivation in Scotland, 2024 (cont.)

Local authorities and SIMD quintile	OOH <i>n</i> (%)	Other <i>n</i> (%)	Retail <i>n</i> (%)	Grand total	p-value*
Scottish Borders	330 (61%)	34 (6%)	176 (33%)	540	
1	25(58)	2(5)	16(37)	43	
2	132(64)	9(4)	66(32)	207	sample size too small
3	83(58)	8(6)	51(36)	142	
4	47(63)	6(8)	22(29)	75	
5	29(56)	6(12)	17(33)	52	
Shetland Islands	71 (55%)	7 (5%)	52 (40%)	130	
2	4(44)	0(0)	5(56)	9	sample size too small
3	44(56)	5(6)	29(37)	78	
4	23(55)	2(5)	17(40)	42	
South Ayrshire	429 (62%)	40 (6%)	228 (33%)	697	
1	102(62)	9(5)	54(33)	165	
2	145(61)	17(7)	77(32)	239	sample size too small
3	75(56)	6(4)	53(40)	134	
4	66(67)	4(4)	29(29)	99	
5	30(60)	3(6)	17(34)	50	
South Lanarkshire	994 (61%)	102 (6%)	528 (33%)	1,624	
1	242(59)	30(7)	141(34)	413	
2	316(60)	26(5)	181(35)	523	0.05
3	180(65)	11(4)	84(31)	275	
4	169(60)	26(9)	88(31)	283	
5	56(51)	7(6)	47(43)	110	

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Table S10. Food outlet classification by local authority and Scottish Index of Multiple Deprivation in Scotland, 2024 (cont.)

Local authorities and SIMD quintile	OOH <i>n(%)</i>	Other <i>n(%)</i>	Retail <i>n(%)</i>	Grand total	p-value*
Stirling	229 (52%)	65 (15%)	149 (34%)	443	0.05
1	38(43)	17(19)	33(38)	88	
2	16(33)	10(21)	22(46)	48	
3	31(47)	11(17)	24(36)	66	
4	105(58)	18(10)	57(32)	180	
5	31(55)	10(18)	15(27)	56	
West Dunbartonshire	288 (58%)	25 (5%)	184 (37%)	497	sample size too small
1	115(52)	11(5)	94(43)	220	
2	74(53)	9(6)	56(40)	139	
3	69(73)	4(4)	22(23)	95	
4	14(67)	0(0)	7(33)	21	
5	11(73)	1(7)	3(20)	15	
West Lothian	235 (64%)	4 (1%)	127 (35%)	366	sample size too small
1	33(58)	0(0)	24(42)	57	
2	132(65)	3(1)	68(33)	203	
3	27(64)	1(2)	14(33)	42	
4	22(54)	0(0)	19(46)	41	
5	16(73)	0(0)	6(27)	22	

* Pearson's Chi-squared test

4. Chapter 5

Table S11. Calculation of adherence to the Scottish Dietary Goals

Component	Dietary Goal	Calculation	Source
Energy density	Average energy density of the diet to be lowered to 125kcal/100g by reducing intake of high fat and/or sugary products and by replacing with starchy carbohydrates (e.g. bread, pasta, rice and potatoes), fruits and vegetables.	We will calculate the energy density of each recall by summing the energy consumed from food and milk (kcal/day) and dividing this by the total weight of food and milk (g/day) consumed. We will then create a binary variable to indicate whether a participant met the recommendation (≤ 125 kcal/100g) or not (> 125 kcal/100g).	SHeS dataset

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Table S11. Calculation of adherence to the Scottish Dietary Goals (*cont.*)

Component	Dietary Goal	Calculation	Source
Fruit & vegetables	Average intake of Fruit and Vegetables to reach at least 5 portions per person per day (>400g/day).	<p>A new variable will be derived to capture the total quantity (g) of fruit and vegetables consumed. This will sum up the following variables already defined in the INTAKE24 output:</p> <ul style="list-style-type: none"> • fruit • dried fruit (maximum allowed towards the Goal: 30g/day) • fruit from fruit juice • fruit from smoothies • tomatoes • tomato puree • brassicas • yellow, red and green vegetables • other vegetables • beans (maximum allowed towards the Goal: 80g/day) <p>We will then create a binary variable to indicate if a participant met the recommendation ($\geq 400\text{g/day}$) or not ($< 400\text{g/day}$).</p>	SHeS dataset
Red meat	<p>Average intake of red and processed meat to be pegged at around 70g per person per day</p> <p>Limit the individual intake of red and processed meat to no more than 90g/day.</p> <p>No increase in average intakes of red and processed meat.</p>	We will calculate the total quantity (g) of red and red processed meat consumed and create a binary variable to indicate whether a participant met the recommendation ($\leq 70\text{g/day}$) or not ($> 70\text{g/day}$).	SHeS dataset

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Table S11. Calculation of adherence to the Scottish Dietary Goals (*cont.*)

Component	Dietary Goal	Calculation	Source
Fats	The average intake of total fat to reduce to no more than 35% food energy.	We will derive the total quantity of energy consumed (kcal/day) from food (not including energy from alcohol). To calculate intake of total fat, saturated fatty acids, and trans fatty acids as a percentage of food energy, we will multiply the quantities of fat consumed (g) by 9, divide this by the food energy consumed (kcal), and multiply this by 100 to establish daily total fat, saturated fatty acids, and trans fatty acids intake as % of total energy. We will then create three binary variables to indicate if a participant met each of the fat recommendations (total fat $\leq 35\%$ food energy, saturated fatty acids $\leq 11\%$ food energy, and trans fatty acids $< 1\%$ food energy) or not (total fat $> 35\%$ food energy, saturated fatty acids $> 11\%$ food energy, and trans fatty acids $\geq 1\%$ food energy).	SHeS dataset
	The average intake in saturated fat to reduce to no more than 11% food energy.		SHeS dataset
	No increase of trans fatty acids above 1% food energy.		Derived

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Table S11. Calculation of adherence to the Scottish Dietary Goals (*cont.*)

Component	Dietary Goal	Calculation	Source
Sugar	Average intake of free sugars not to exceed 5% of total energy in adults and children over 2 years.	We will multiply free sugar intake by 3.75, divide this by their total energy intake (including energy from alcohol), and multiply this by 100 to establish daily free sugar intake as % of total energy. We will then create a binary variable to indicate if a participant met the recommendation ($\leq 11\%$ total energy) or not ($> 11\%$ total energy).	SHeS dataset
Salt	The average intake of salt to reduce to 6g/day	We will calculate the total quantity (mg) of sodium consumed and multiply by 2.498 to establish daily salt intake (g). We will then create a binary variable to indicate whether a participant met the recommendation ($\leq 6\text{g/day}$) or not ($> 6\text{g/day}$).	Derived
Total carbohydrate	Total carbohydrate to be maintained at an average population intake of approximately 50% of total dietary energy with no more than 5% total energy from free sugars.	We will multiply total carbohydrates by 3.75, divide this by their total energy intake (excluding energy from alcohol), and multiply this by 100 to establish daily carbohydrate intake as % of total energy. We will then create a binary variable to indicate if a participant met the recommendation (total carbohydrate 45-55% total energy) or not (total carbohydrate $< 45\%$ or $> 55\%$ total energy).	Derived

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Table S11. Calculation of adherence to the Scottish Dietary Goals (*cont.*)

Component	Dietary Goal	Calculation	Source
Fibre	An increase in average consumption of fibre (non-starch polysaccharide) to increase to 18g/day by increasing consumption of wholegrains, pulses and vegetables.	We will calculate their daily average consumption of AOAC fibre. We will then create a binary variable to indicate whether a participant met the recommendation ($\geq 18\text{g/day}$) or not ($< 18\text{g/day}$).	SHeS dataset

Table S12. Proportion of people consumption by food type among adults 16+ years living in Scotland, 2021

Characteristic	n = 3,447
Number of days consumed any home-prepared food	
0	0.9% (16)
1	5.0% (108)
2	94.1% (2,918)
Number of days consumed any ready-to-eat food	
0	0.5% (13)
1	5.6% (155)
2	93.9% (2,874)
Number of days consumed any out-of-home food	
0	67.0% (2,072)
1	26.2% (764)
2	6.8% (206)

Note: numbers refer to a grand total of n = 3,447 (unweighted)

Table S13. Quintiles of proportion of energy by food type, unweighted

Characteristic	Q1	Q2	Q3	Q4	Q5
Proportion of Energy - Home-prepared quintile					
n	690	690	689	689	689
Mean	19.8	37.9	49.0	59.9	76.7
(Min-Max)	(0.0-31.4)	(31.4-43.9)	(43.9-54.3)	(54.3-66.0)	(66.0-100.0)
Proportion of Energy - RTE quintile					
n	690	690	689	689	689
Mean	17.3	32.6	42.7	53.1	71.5
(Min-Max)	(0.0-26.9)	(26.9-37.9)	(38.0-47.3)	(47.3-59.6)	(59.6-100.0)
Proportion of Energy - OOH quintile					
n	2,397	263	263	262	262
Mean	0.0	8.3	18.6	27.8	49.7
(Min-Max)	(0.0-0.0)	(0.0-14.4)	(14.4-22.4)	(22.4-33.8)	(33.8-100.0)

Table S14. Association of proportion of energy by food type with age, sex and SIMD among adults aged 16+ years living in Scotland, 2021

Characteristics	Proportion of energy from...		
	Home-prepared foods	Ready-to-eat foods	Out-of-home foods
	<i>β (95% CI)</i>		
Age			
16-34 years (ref)			
35-54 years	6.61 (4.56 - 8.67)	-3.36 (-5.36 - -1.37)	-3.25 (-4.81 - -1.69)
55+ years	9.59 (7.43 - 11.75)	-5.03 (-7.13 - -2.94)	-4.56 (-6.20 - -2.91)
Sex			
Female (ref)			
Male	-3.10 (-4.46 - -1.73)	3.38 (2.05 - 4.70)	-0.28 (-1.32 - 0.76)
SIMD			
Most deprived - 1 st quintile (ref)			
2 nd quintile	4.03 (1.51 - 6.56)	-3.86 (-6.31 - -1.41)	-0.17 (-2.09 - 1.74)
3 rd quintile	4.06 (1.58 - 6.55)	-2.58 (-4.99 - -0.17)	-1.48 (-3.37 - 0.40)
4 th quintile	4.63 (2.19 - 7.07)	-3.02 (-5.39 - -0.66)	-1.61 (-3.46 - 0.25)
Least deprived - 5 th quintile	4.90 (2.37 - 7.43)	-2.63 (-5.08 - -0.18)	-2.27 (-4.19 - -0.35)

Note: Additionally adjusted for education, employment, physical activity, income, ethnicity, family history of cardiovascular disease and chronic disease status; †Poisson regression

Table S15. Association of proportion of total energy by food type with adherence to Scottish dietary goals

Scottish Dietary Goals	Proportion of energy from...		
	Home-prepared foods	Ready-to-eat foods	Out-of-home foods
	<i>RR (95% CI)</i>		
Energy (<125 kcal/100g)	1.03 (1.02-1.03)	0.98 (0.97-0.98)	0.98 (0.97-0.99)
CHO (≤50% total energy)	0.99 (0.99-1.00)	1.01 (1.01-1.01)	1.00 (1.00-1.00)
Fat (≤35% food energy)	1.00 (1.00-1.01)	1.00 (1.00-1.00)	0.99 (0.99-1.00)
Saturated FA (≤11% food energy)	1.01 (1.00-1.01)	1.00 (0.99-1.00)	1.00 (0.99-1.00)
Trans FA (<1% food energy)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Fibre (≥18g/day)	1.01 (1.01-1.02)	1.00 (0.99-1.00)	0.98 (0.96-0.99)
Fruit & vegetables (>400g/day)	1.02 (1.02-1.02)	0.99 (0.98-0.99)	0.98 (0.97-0.99)
Red processed meat (<70g/day)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Salt (≤6g/day)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Sugar (≤11% total energy)	1.02 (1.02-1.03)	0.98 (0.97-0.98)	0.99 (0.99-1.00)

Note: Additionally adjusted for education, employment, physical activity, income, ethnicity, family history of cardiovascular disease and chronic disease status; † Poisson regression

Table S16. Association of proportion of total energy by food type with dietary adherence score with age, sex and SIMD among Scottish adults aged 16+ years, 2021

Term	Proportion of energy from...		
	Home-prepared foods	Ready-to-eat foods	Out-of-home foods
	<i>IRR (95% CI)</i>		
Age			
Age 35-54 x Quintile 2	0.91 (0.78-1.07)	1.08 (0.9-1.29)	0.96 (0.79-1.17)
Age 55+ x Quintile 2	0.90 (0.78-1.05)	1.08 (0.91-1.28)	0.98 (0.83-1.17)
Age 35-54 x Quintile 3	1.00 (0.85-1.17)	0.98 (0.83-1.16)	1.04 (0.86-1.27)
Age 55+ x Quintile 3	0.99 (0.85-1.15)	0.94 (0.80-1.10)	1.07 (0.90-1.29)
Age 35-54 x Quintile 4	0.95 (0.81-1.12)	0.96 (0.8-1.14)	1.01 (0.85-1.21)
Age 55+ x Quintile 4	0.95 (0.81-1.11)	0.92 (0.78-1.08)	1.03 (0.87-1.22)
Age 35-54 x Quintile 5	0.99 (0.82-1.19)	1.03 (0.87-1.22)	1.00 (0.82-1.21)
Age 55+ x Quintile 5	0.96 (0.81-1.15)	0.94 (0.8-1.11)	1.03 (0.85-1.25)
Sex			
Male x Quintile 2	1.04 (0.93-1.17)	1.06 (0.95-1.18)	1.03 (0.90-1.18)
Male x Quintile 3	1.04 (0.93-1.16)	1.02 (0.91-1.14)	1.00 (0.88-1.14)
Male x Quintile 4	1.07 (0.95-1.20)	1.07 (0.96-1.20)	1.02 (0.89-1.17)
Male x Quintile 5	1.06 (0.94-1.19)	0.96 (0.85-1.08)	0.98 (0.85-1.14)
SIMD			
SIMD 2 x Quintile 2	1.00 (0.82-1.23)	0.85 (0.68-1.05)	1.20 (0.89-1.64)
SIMD3 x Quintile 2	1.05 (0.86-1.28)	0.95 (0.77-1.17)	1.34 (1.00-1.80)
SIMD4 x Quintile 2	1.08 (0.89-1.30)	0.89 (0.73-1.09)	1.15 (0.88-1.54)
SIMD5 x Quintile 2	1.06 (0.87-1.29)	0.93 (0.76-1.14)	1.19 (0.90-1.59)
SIMD 2 x Quintile 3	0.96 (0.79-1.17)	0.89 (0.71-1.10)	0.88 (0.70-1.11)
SIMD 3 x Quintile 3	0.91 (0.75-1.11)	0.91 (0.73-1.12)	0.89 (0.72-1.10)

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Table S16. Association of proportion of total energy by food type with dietary adherence score with age, sex and SIMD among Scottish adults aged 16+ years, 2021 (*cont.*)

Term	Proportion of energy from...		
	Home-prepared foods	Ready-to-eat foods	Home-prepared foods
	<i>IRR (95% CI)</i>		
SIMD			
SIMD 4 x Quintile 3	1.01 (0.84-1.22)	0.87 (0.71-1.07)	0.96 (0.79-1.18)
SIMD 5 x Quintile 3	0.99 (0.82-1.20)	0.88 (0.71-1.08)	0.93 (0.76-1.14)
SIMD 2 x Quintile 4	1.02 (0.83-1.27)	0.90 (0.73-1.11)	0.95 (0.75-1.21)
SIMD 3 x Quintile 4	0.97 (0.79-1.19)	0.88 (0.72-1.08)	0.98 (0.78-1.25)
SIMD 4 x Quintile 4	1.02 (0.84-1.25)	0.85 (0.70-1.03)	0.98 (0.78-1.23)
SIMD 5 x Quintile 4	1.09 (0.89-1.33)	0.88 (0.72-1.07)	0.96 (0.76-1.21)
SIMD 2 x Quintile 5	1.12 (0.91-1.37)	0.99 (0.81-1.22)	0.79 (0.60-1.03)
SIMD 3 x Quintile 5	1.09 (0.88-1.34)	1.03 (0.84-1.27)	0.89 (0.69-1.16)
SIMD 4 x Quintile 5	1.13 (0.93-1.38)	0.95 (0.78-1.15)	0.87 (0.68-1.12)
SIMD 5 x Quintile 5	1.15 (0.94-1.41)	0.94 (0.77-1.15)	0.80 (0.61-1.04)

Note: Additionally adjusted for education, employment, physical activity, income, ethnicity, family history of cardiovascular disease and chronic disease status; † Poisson regression

Figure S2. Directed acyclic graph for identification of confounders

