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

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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.

Registry number for systematic reviews: The protocol was registered with PROSPERO (ID: CRD42022306066) on 8 February 2022.

Keywords: Food environment, UK, Food retail, Fast food, Food packaging, Food safety, Access to food, Sustainable diets

Introduction

Obesity has surpassed smoking as the leading contributor to death since 2014 in the UK (1). The prevalence of obesity across the UK is high, with 32% of adults in Scotland having obesity (2), and 22% and 26% of adults in Wales (3) and England (4), 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 (5). 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% (6). 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 (7).

While many continue to place the onus of change on individuals, it is increasingly recognized that food environments that encourage the consumption of unhealthy foods are critical drivers of food choice (8). 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, cafes/coffee shops, takeaways, mobile food vans, schools, universities, workplaces, and charities as well as deliveries from these places (9). 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 (10). Similar increases in availability of take-aways and grocers/convenience

stores were reported around secondary schools in East London from 2001 to 2005 (11). In 2022, there were an estimated 42,341 fast food outlets across the UK (12). 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) (13). 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 (14). 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 focused on the retail food environment (15-17) or specific population subgroups, such as school children (18-20), or specific health outcomes, such as obesity (21-23). 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 (24, 25).

The aim of this systematic review was to identify and narratively summarize 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

73 articles differed by geography (e.g., UK-wide versus England, Scotland, Wales or Northern
74 Ireland).

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

79

Methods

The protocol was registered with PROSPERO (ID: CRD42022306066) on 8 February 2022. As this was not deemed human subjects' research, it was exempt from institutional ethics committee review.

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 1**) (26). Whilst this framework proposes three types of food environments – built, cultivated, and natural – in the context of the UK, the built food environment is predominant (26).

Search strategy

The search strategy was developed by reviewing protocols on the food environment published in PROSPERO. Seven electronic databases were searched from inception 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 **Supplementary Table 1**. Searches were duplicated by a second reviewer to check for accuracy. Additional articles were identified after reviewing the references of articles meeting inclusion criteria.

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 (policy-makers prioritize 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 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 (κ=0.83), indicating substantial agreement between reviewers. Full texts of 3,418 articles were sought for retreival, 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.

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 (27) categorization 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) neighborhood food environment (all places to procure food within a physical region outside residential address), (5) macro food environment (national and regional food supply), (6) public facility food environment (including cafeterias, vending machines, and snack shops in recreation centers, health care facilities, and other public venues), and (7) restaurant food environment.

- Domains of food environment evaluated (**Table 1**). This included availability, affordability, promotion, product characteristics/quality, convenience, and sustainability (26). 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 (27) methodologies and instruments were adapted to define 12 types of methodologies, detailed in **Table 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 **Supplementary Table 2**. 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 **Supplementary Table 3**.

Results

Key characteristics of articles included in the systematic review are presented in **Table 3**. Most articles were from England [n=120, 38% (10, 11, 21, 24, 28-143)], followed by UK wide articles [n=87, 28%], Scotland [n=27, 9% (144-170)], Northern Ireland [n=9, 3% (171-179)], and Wales [n=10, 3% (180-189)]. There were 7 articles from Great Britain (190-196) and 21 (6%) multi-country studies (197-217). We further categorized 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**). 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 (42, 45, 50, 75, 90, 95, 106, 126, 131, 138, 155, 157, 162, 167, 168, 171, 175, 179, 191). After the search and analysis of articles had been conducted, one article retraction was published (218).

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, (24, 87, 90, 94, 111, 197, 213, 219-227)] 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. Most articles were cross-sectional (n=242, 78%), followed by longitudinal analysis [n=31, 10% (10, 11, 41, 45, 61, 72, 74, 77, 87, 90, 100, 138, 159, 186, 207, 219, 223, 224, 228-240)], intervention studies [n= 17, 5% (28, 43, 62, 63, 69, 86, 114, 115, 123, 160, 172, 208, 225, 241-244)], case studies [n= 10, 3% (31, 67, 153, 181-183, 185, 245, 246)] and 2% each (n=6) were randomized controlled trials (111, 112, 127, 128, 130, 220) and modelling studies (57, 133, 195, 247-249).

Since this review focused 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. On tabulation of articles based on type of food studied, 31% (n=97) of the articles focused on type of food outlets instead of focusing on any particular food or food group (10, 11, 31-33, 36, 38-42, 45-47, 49-52, 55, 57, 59, 60, 65-67, 72-79, 82, 87-92, 94, 95, 100-102, 106-108, 117-119, 122, 123, 126, 131, 141-143, 145, 148-151, 155, 157, 162, 169, 177, 182-184, 190, 191, 194, 199, 200, 210, 212, 213, 223, 228, 234, 246, 250-263). These were followed by articles on ready-to-eat foods [n=34, 11% (63, 83, 103, 109, 113, 114, 135, 139, 158, 159, 170, 172, 185-187, 189, 192, 201, 206, 211, 264-277)] and articles on meals served at schools, restaurants, or workplaces [n=32, 10% (28, 35, 43, 58, 62, 68-70, 84, 85, 97, 111-113, 127-129, 132, 140, 160, 181, 205, 220, 224, 278-285)]. 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 intergovermental bodies like World Health Organisation, and 5 articles (2%) received funding from private charities (74, 108, 114, 118, 286). One article noted joint funding from government and industry (184), while another stated joint funding from government and a private charity (217). A total of 63 articles (20%) did not mention their source of funding and 39 articles (12%) did not receive any funding.

Types of food environments

Articles on food store environments were the most common [n=208, 67% (30, 35, 50, 56, 61, 73, 79-81, 107, 114, 133, 135, 141, 143, 144, 159, 161, 178, 190, 195, 200, 202, 209, 215, 218, 225, 226, 230, 231, 237, 240, 242, 244, 249-251, 256, 261, 274, 278, 287-293)] [**Figure 3**]. These included articles on the nutrient content (29, 34, 53, 116, 124, 139, 140, 166, 192, 206,

207, 214, 216, 232, 236, 238, 264, 266, 267, 269-271, 275, 277, 285, 286, 294-304) and microbial content (93, 163, 168, 172-174, 176, 203, 204, 208, 305) of foods sold in UK food stores, availability of healthy foods (40, 59, 130, 146, 147, 156, 175, 182, 183, 229, 235, 242, 306) and access to food stores (37, 38, 49, 57, 66, 106, 110, 137, 138, 142, 150, 152, 153, 165, 171, 191, 194, 256, 307). The next most prevalent food environment was restaurant food environments [n=52, 16% (28, 43, 51, 89, 92, 102, 125, 151, 213, 233, 246, 253, 265, 308)] which included articles on nutrient content (70, 84, 111, 118, 205, 212, 220, 223, 257, 259, 260, 262, 263, 279, 281) or microbiological quality (103, 280, 309-312) of meals served at fast food or full service restaurants. Thirty-six articles evaluated different aspects of neighborhood (10, 31, 39, 48, 82, 94, 119, 120, 136, 252, 313, 314) such as 20-minute neighborhood (162) or out of home access in deprived neighborhoods (55, 78, 86, 95, 100, 101, 126, 131, 148, 157, 167, 182, 193, 247, 254, 315). Articles assessing nutritional content of school meals (68, 71, 132, 181, 243, 316) or vending machines (109) at schools were categorized under school food environments [n=28, 9% (11, 32, 67, 72, 75, 111, 117, 121, 122, 134, 145, 149, 177, 187, 210, 241, 283)]. Twelve articles assessed the online food environment: eight UK-wide articles (25, 219, 221, 222, 227, 245, 317), three from England (44, 87, 90) and one multi-country study (198). There were 15 articles on hospitals and other public venues categorised as public facility food environment (58, 60, 63, 65, 83, 104, 105, 113, 123, 129, 169, 185, 188, 282, 318); 8 articles on worksite food environment (62, 85, 97, 111, 127, 128, 160, 224) and 19 articles on macro food environment assessing impact of food policies (42, 52, 158, 164, 211, 217, 234, 248, 255, 276, 289, 319-326). There were 22 (7%) articles that evaluated two types of food environments (33, 45, 47, 73, 180, 189, 268), of which 13 were on food store and restaurant food environment (46, 77, 78, 88, 105,

186, 258, 327). For example, articles evaluating microbial quality of food samples collected from food stores and fast-food restaurants (103, 328).

There were no articles on natural food environments (both wild and cultivated). All of the above were classified as the built food environment.

Domains and methodologies

The most common domain studied was availability [n=100, 32% (10, 11, 24, 31-33, 38, 39, 41, 42, 45-52, 55, 57, 60, 65-67, 72, 73, 75-79, 81-83, 86-92, 94, 95, 100-102, 106, 108, 111-113, 117, 119, 121, 122, 126, 131, 133, 134, 136-138, 142, 143, 145, 147-151, 153, 155, 162, 167, 175, 177, 182-184, 191, 193, 194, 199, 210, 213, 228, 234, 242, 250, 252-256, 276, 306, 308, 315, 329, 330)], followed closely by product characteristics/quality [n=94, 30% (29, 34, 53, 56, 58, 70, 84, 85, 93, 97, 103-105, 107, 109, 120, 124, 129, 139, 144, 163, 168, 170, 172-174, 176, 178, 185-189, 192, 201, 203-208, 212, 216, 219, 223, 232, 236, 238, 257, 259, 260, 262-264, 266-271, 273-275, 277-283, 285, 286, 290, 294-301, 305, 310-312, 314, 317, 328, 331-334)] and promotion [n=33, 10% (25, 61, 64, 74, 81, 114, 125, 127, 128, 130, 141, 158, 159, 161, 169, 180, 190, 197, 200, 211, 215, 226, 227, 240-244, 249, 261, 272, 291, 335)] (**Figure 4**). There was a paucity of research on the domains of sustainability [n=19, 6% (43, 68, 69, 202, 224, 245-248, 251, 265, 284, 289, 319, 321, 322, 324, 336, 337)] and affordability [n=16, 5% (37, 80, 110, 164, 165, 179, 195, 209, 230, 231, 233, 235, 237, 287, 307, 323)]. There were no articles on the domain of convenience. Under the domain availability, most articles focused on assessing density or proximity of food outlets (41, 228). Others focused on the type of foods available in food stores (86, 112, 123). 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.] (139, 238, 273) or microbial pathogens in food store or restaurant food environments (311, 312). Articles on marketing and nutritional claims on food packaging were covered under the promotion domain (197, 272, 335), while those on food prices were most common under the affordability domain (195, 320). Lastly, articles on the environmental impact of food were covered under sustainability (336).

There were 50 articles (16%) that evaluated more than one domain, most common were articles evaluating availability and affordability [n=15, (37, 40, 44, 54, 59, 98, 99, 146, 156, 157, 160, 171, 182, 184, 258)], and articles assessing affordability and product characteristics/ quality [n=10, (30, 36, 37, 140, 220, 222, 229, 288, 320, 325)]. 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 (217). 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 **Supplementary Table 3**.

There was a clear preferred methodology to measure each domain (**Figure 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 (308). This was followed by market basket surveys [n=10, 9%] (155) policy analysis [n=5, 5%] (117) and physical measurements [n=2, 2%] (199). Assessing food purchase patterns using sales/cashier receipts [n=23, 58%] (36), market basket surveys [n=16, 40%] (37) and policy analysis [n=1, 2%] (217)were the most used methodologies to assess the affordability domain. To measure promotion, 7 (24%) articles used sales/ purchase analysis (64) and policy analysis

(138) each, 6 articles (21%) used nutrient information available on the package called nutrient fact panel analysis (335) and market basket surveys (74) each, and 3 articles (10%) used physical measurements (169). Nutrient fact panel analysis [n=44, 39%] (201), contaminant analysis [n=33, 29%] (331), articles on food samples tested in a laboratory, called nutrient analysis [n=21,18%] (85), menu analysis [n=12, 10%] (262), market basket surveys (198) and policy analysis [n=2, 2%] (283) 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%] (336) and sales/ purchase analysis [n=1, 5%] (224) were used. It is important to note that within ecological footprint analysis, multiple methodologies were used, such as life cycle analysis (284, 319), reduction in livestock product supply (248), and Water Footprint Impact Indicator estimated as scarcity weighted liters per portion and global hectares per annum (71). This highlights the multi-faceted nature of sustainability definitions and data sources.

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 (11, 28, 33, 34, 49, 58, 70, 84-86, 99, 107, 109, 112, 116, 118, 120, 125, 127, 128, 132, 136, 139, 140, 145, 170, 212, 223, 229, 230, 232, 235, 236, 238, 242, 260, 263, 264, 266, 267, 269-275, 277, 278, 282, 285, 294-296, 298, 299, 301, 303, 314, 317, 325, 333, 335), and 42 (13%) articles assessed associations with health (39, 45, 47, 48, 50-52, 55, 65, 66, 72, 73, 75-77, 80-82, 94, 97, 102, 126, 133, 134, 137, 138, 142, 194, 195, 199, 219, 228, 234, 247, 252, 254, 255, 276, 308, 315, 322) (**Table 4**). Of the articles assessing health associations, all focused on obesity and the impact of

food outlet proximity or density on body mass index, except four articles: one analyzed links with type 2 diabetes (276), two focused on cardiovascular disease and cancer (248, 254) and another with type 2 diabetes, cardiovascular disease and cancer (247). No country-wise differences were observed: descriptive articles were most common across all countries (**Table 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 (32, 37, 38, 40, 44, 55, 59, 60, 66, 67, 74-78, 82, 86, 87, 89, 90, 92, 95, 98, 100, 106, 114, 117, 131, 137, 138, 142, 147, 149-151, 154-158, 161, 162, 165-167, 171, 182-184, 190, 192, 193, 213, 231, 234, 242, 243, 250, 252, 253, 313, 315, 319, 329) and 15 (5%) articles conducted stratified analysis using two or more variables (33, 42, 73, 81, 89, 101, 122, 126, 133, 134, 225, 254, 255, 289, 321) (**Supplementary Table 4**). Area deprivation was the most common variable for stratification, for example, articles comparing food outlet density in the least and most deprived neighborhoods (37, 87).

Discussion

A comprehensive understanding of the UK food environment requires interdisciplinary research involving public health experts, nutritionists, behavioral 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 (13), 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 behavior in the UK (13) as well as the impact of food systems on climate change (338), 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 (339). Similarly, evidence suggests that time spent on home food preparation is an indicator of healthy diets (340) and lack of time is a leading barrier to adopting dietary recommendations (341), 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

341 locally sourced food and expecting food businesses to play a role in climate change (12). There
342 is also a continued high demand for home food delivery post pandemic (12).

343 Only about one-fifth of articles identified in this review evaluated more than one domain
344 of the food environment. Valuable insights have come from the few articles identified in this
345 review that looked at multiple domains. For example, the Healthy Food Environment Policy
346 Index, which aimed to assess the extent of implementation of recommended food environment
347 policies by governments, provided a holistic view of the UK's food environment (217). It also
348 identified priority actions to meet implementation gaps (217). Another article evaluating multiple
349 domains identified in this review looked at what dietary changes are required to shift the UK
350 population to diets that meet dietary recommendations for health, have lower greenhouse gas
351 emissions, and are affordable for different income groups (313). To fully comprehend the impact
352 of the food environment on human and planetary health, research is needed that evaluates
353 multiple domains and how these domains interact with each other to influence food choice. For
354 example, ready-to-eat foods are convenient, but are often less affordable, less healthy, come in
355 plastic packaging, and require refrigeration, which impacts their sustainability (342).

356 With regards to the type of food environment studied, food store environments have been
357 the most researched food environment type by far. More than half of the articles (67%) in this
358 review were on the food store environment, followed by restaurants (16%), neighborhood food
359 environments (11%), and school food environments (9%). These findings differ slightly from
360 Lytle's systematic review of articles measuring the food environment published between 2007
361 and 2015, which found that 73% of articles measured the food store environment, 50% measured
362 restaurants, and 15% measured schools (percents do not add to 100 because some articles
363 measured both) (27). 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) (343). However, there is an increasing need to evaluate the online food environments given the rise in take-aways and deliveries (344), supermarket home delivery, and other forms of home delivery (e.g., vegetable boxes, Hello Fresh and Amazon Fresh) (13). 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 (1), 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 (345). 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

386 food as well as personal motivation to plan / prepare meals, availability of ingredients and
387 cooking equipment in the home, and access to transport to procure ingredients.

388 This study advances understanding of the knowledge gaps that must be filled in order to
389 design evidence-based policies to improve the healthfulness and sustainability of UK diets. At
390 the same time, there is enough evidence for governments to act in order to improve local food
391 environments to achieve healthy diet and weight goals (346). A recently published review of
392 systematic reviews on the effectiveness of food environment policies in improving population
393 diets found that food environment policies targeting the availability of foods in retail and food
394 establishments, food provision in school settings, product reformulation, and the size of
395 portions/packages are effective (347). There are many recent examples of the UK and devolved
396 government actions to improve the food environment. For example, the ban of single-use plastics
397 in England that was initiated from October 2023 (348) and initiatives to reduce food waste (349,
398 350) have the potential to improve the sustainability of food environments. Regulations on the
399 promotion of foods and beverages high in fat, sugar and salt in England (351) and under
400 consideration in Scotland (352) and Wales (353) have the potential to improve the healthfulness
401 of food environments across the UK. A data visualization tool has also been developed to help
402 local authorities explore their food environments (354). There is a need for a comprehensive
403 review of policies across the UK, including non-food policies and monitoring of the impact of
404 these policies on dietary intake, health and food environments. The better we understand the food
405 environment, the easier it will be to create interventions that bring about a positive change in
406 public health and planetary health.

407 To summarize, the current literature on the food environment in the UK focusses almost
408 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.

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Data sharing: Extracted data is publicly and freely available without restriction at https://figshare.com/articles/dataset/_b_The_UK_food_environment_a_systematic_review_of_domains_methodologies_and_outcomes_b_/29374151?file=55544885

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References

1. 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.
2. Erin Deakin VW, Sophie Birtwistle, Rory McClelland, Jordan Fox, Hannah Biggs, Sarah Minty. The Scottish Health Survey Main Report. In: Research SCfS, editor. 2023.
3. Victoria Hannah AW, Laura Rich, Bethan Jenkins, Amrita Jesurasa. The primary care needs of people living with overweight and obesity in Wales: Summary. In: Wales PH, editor. 2021.
4. Disparities OfHI. 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.
5. 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.
6. Digital N. Significant increase in obesity rates among primary-aged children, latest statistics show. 2021.
7. Disparities OfHI. National Diet and Nutrition Survey 2019 to 2023: report. UK2025.
8. Constantinides SV, Turner C, Frongillo EA, Bhandari S, Reyes LI, 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).
9. 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.
10. 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.
11. 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.
12. Intelligence L. The market and consumer trends shaping the future for UK quick service restaurants. 2022 March 2022.
13. Camilla A GR, Draper A, Guthrie S. Food consumption in the UK: Trends, attitudes and drivers.; 2020.
14. Agency FS. F&Y2 Wave 7: Executive summary. 2024.
15. 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.
16. 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.
17. 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.
18. 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.
19. 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.

20. 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.
21. 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.
22. Townshend T, Lake A. Obesogenic environments: current evidence of the built and food environments. Perspect Public Health. 2017;137(1):38-44.
23. 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.
24. 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).
25. Goodman MK, Jaworska S. Mapping digital foodscapes: Digital food influencers and the grammars of good food. Geoforum. 2020;117:183-93.
26. 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).
27. Lytle LA, Sokol RL. Measures of the food environment: A systematic review of the field, 2007-2015. Health Place. 2017;44:18-34.
28. 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.
29. 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).
30. 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.
31. 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.
32. 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.
33. 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.
34. Bath SC, Hill S, Infante HG, Elghul S, Nezianya 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.
35. 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.
36. 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.
37. 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.
38. 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.

39. 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.
40. 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.
41. 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.
42. 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.
43. Buratto A, Lotti L. Encouraging sustainable food consumption through nudges: An experiment with menu labels. Ecological Economics. 2024;216.
44. 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.
45. Burgoine T, Alvanides S, Lake AA. Assessing the obesogenic environment of North East England. Health Place. 2011;17(3):738-47.
46. 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.
47. 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.
48. 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.
49. 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.
50. 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).
51. 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.
52. Burgoine T, Sarkar 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.
53. 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.
54. 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.
55. 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.
56. 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.
57. 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.
58. 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.

59. 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.
60. 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.
61. 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.
62. 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.
63. 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.
64. 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.
65. 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.
66. 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.
67. G. Gallo R, Barrett L, A. Lake A. The food environment within the primary school fringe. British Food Journal. 2014;116(8):1259-75.
68. 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.
69. 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.
70. 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.
71. 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).
72. 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.
73. 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.
74. 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.
75. 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.
76. 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.
77. 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.

78. 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.
79. 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.
80. Howard Wilsher S, Harrison F, Fearne A, Jones A. Food Sales and Adult Weight Status: Results of a Cross-Sectional Study in England. Nutrients. 2022;14(9).
81. Howard Wilsher S, Harrison F, Yamoah F, Fearne 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.
82. Ilyankou I, Newing A, Hood N. Supermarket Store Locations as a Proxy for Neighbourhood Health, Wellbeing, and Wealth. Sustainability. 2023;15(15).
83. 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.
84. 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.
85. Jaworowska A, Rotaru G, Christides T. Nutritional Quality of Lunches Served in South East England Hospital Staff Canteens. Nutrients. 2018;10(12).
86. 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.
87. 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.
88. 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.
89. 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.
90. 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.
91. 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).
92. 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.
93. 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.
94. 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).

95. 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.
96. 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.
97. 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.
98. 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.
99. 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.
100. 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.
101. 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.
102. 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.
103. 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.
104. 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.
105. 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.
106. 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.
107. Mulrooney HM, Bell J. Does the food retail environment reflect UK public health recommendations for healthy eating? Public Health. 2016;134:114-6.
108. 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.
109. 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.
110. 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).
111. 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.
112. 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.

113. 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.
114. 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.
115. 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.
116. 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).
117. 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.
118. 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.
119. 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.
120. 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.
121. 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.
122. Shoari N, Beevers S, Brauer M, Blangiardo M. Towards healthy school neighbourhoods: A baseline analysis in Greater London. Environ Int. 2022;165:107286.
123. 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.
124. 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.
125. 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.
126. 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.
127. 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.
128. 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.
129. Vitale M, Crossland S, Shinwell J, Stretesky PB, Defeyter 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).
130. 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.

131. 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.
132. 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.
133. 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.
134. 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.
135. 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.
136. 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.
137. 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.
138. 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.
139. Yip YL, Ensaff H. Breakfast on the go: Evaluating the nutritional content of supermarket products. Nutrition. 2021;84:111098.
140. Remnant J, Adams J. The nutritional content and cost of supermarket ready-meals. Cross-sectional analysis. Appetite. 2015;92:36-42.
141. 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.
142. 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.
143. 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.
144. 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.
145. 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.
146. 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.
147. 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.
148. 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.
149. 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.
150. 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.

151. 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.
152. 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.
153. 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.
154. 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.
155. 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.
156. 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.
157. 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.
158. Dogbe W, Revoredo-Giha C. Industry levy versus banning promotion on soft drinks in Scotland: A distributional analysis. Food Policy. 2022;106.
159. 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.
160. 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.
161. 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.
162. 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.
163. 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.
164. Revoredo-Giha C, Lamprinopoulou-Kranis, Chrysa Toma, Luiza, Kupiec-Teahan, Beata Leat, Philip M.K., Cacciolatti, Luca. Bread consumption models; Scotland; Food prices. The 83rd Annual Conference of the Agricultural Economics Society Dublin 2009.
165. 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.
166. 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.
167. 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.
168. 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.

169. 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.
170. 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).
171. 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.
172. 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.
173. 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.
174. 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.
175. 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.
176. Soultos 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.
177. Williams JL. Spaces between home and school: The effect of eating location on adolescent nutrition. Ecol Food Nutr. 2016;55(1):65-86.
178. Wilson IG. Salmonella and campylobacter contamination of raw retail chickens from different producers: a six year survey. Epidemiol Infect. 2002;129(3):635-45.
179. 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.
180. 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.
181. 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.
182. Guy C. Neighbourhood retailing and food poverty: a case study in Cardiff. International Journal of Retail & Distribution Management. 2004;32(12):577-81.
183. Guy Cliff ; Clarke Graham ; Eyre H. 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.
184. 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.
185. Kibblewhite S, Bowker S, Jenkins HR. Vending machines in hospitals – are they healthy? Nutrition & Food Science. 2010;40(1):26-8.
186. 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.
187. 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.
188. 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.
189. 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.

190. 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.
191. 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.
192. 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.
193. 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.
194. Dolton PJ, Tafesse W. Childhood obesity, is fast food exposure a factor? Econ Hum Biol. 2022;46:101153.
195. 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.
196. 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.
197. 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).
198. 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.
199. Cameron A, Waterlander WE, Svastisalee CM. The correlation between supermarket size and national obesity prevalence. BMC Obesity. 2014;1(1):1-4.
200. 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.
201. 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.
202. 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.
203. 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.
204. 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.
205. 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.
206. 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.

994 207. Ellis KA, Innocent G, Grove-White D, Cripps P, McLean WG, Howard CV, Mihm M. Comparing
995 the fatty acid composition of organic and conventional milk. J Dairy Sci. 2006;89(6):1938-50.
996 208. Agency FS. UK-wide Survey of Salmonella and Campylobacter Contamination of Fresh and
997 Frozen Chicken on Retail Sale. 2003.
998 209. Grashuis J, Hakelius K. Pricing strategies of corporations and consumer co-operatives in the
999 food retail sector: Evidence from England, Sweden, and the Netherlands. Journal of Co-Operative
1000 Organization and Management. 2023;11(1).
1001 210. Heroux M, Iannotti RJ, Currie D, Pickett W, Janssen I. The food retail environment in school
1002 neighborhoods and its relation to lunchtime eating behaviors in youth from three countries. Health
1003 Place. 2012;18(6):1240-7.
1004 211. Hieke S, Kuljanic N, Pravst I, Miklavec K, Kaur A, Brown KA, et al. Prevalence of Nutrition and
1005 Health-Related Claims on Pre-Packaged Foods: A Five-Country Study in Europe. Nutrients.
1006 2016;8(3):137.
1007 212. Hobin E, White C, Li Y, Chiu M, O'Brien MF, Hammond D. Nutritional quality of food items on
1008 fast-food 'kids' menus': comparisons across countries and companies. Public Health Nutr.
1009 2014;17(10):2263-9.
1010 213. Hoenink JC, Huang Y, Keeble M, Mackenbach JD, Pinho MG, Burgoine T, Adams J.
1011 Socioeconomic distribution of food outlet availability through online food delivery services in seven
1012 European countries: A cross-sectional study. Health Place. 2023;84:103135.
1013 214. Kaur A, Scarborough P, Hieke S, Kusar A, Pravst I, Raats M, Rayner M. The nutritional quality
1014 of foods carrying health-related claims in Germany, The Netherlands, Spain, Slovenia and the United
1015 Kingdom. Eur J Clin Nutr. 2016;70(12):1388-95.
1016 215. Thornton LE, Cameron AJ, McNaughton SA, Waterlander WE, Sodergren M, Svastisalee C, et
1017 al. Does the availability of snack foods in supermarkets vary internationally? Int J Behav Nutr Phys
1018 Act. 2013;10:56.
1019 216. Trichterborn J, Harzer G, Kunz C. Nutrient profiling and food label claims: evaluation of dairy
1020 products in three major European countries. Eur J Clin Nutr. 2011;65(9):1032-8.
1021 217. Vandevijvere S, Barquera S, Caceres G, Corvalan C, Karupaiah T, Kroker-Lobos MF, et al. An
1022 11-country study to benchmark the implementation of recommended nutrition policies by national
1023 governments using the Healthy Food Environment Policy Index, 2015-2018. Obes Rev. 2019;20 Suppl
1024 2:57-66.
1025 218. Potter C, Pechey R, Clark M, Frie K, Bateman PA, Cook B, et al. Effects of environmental
1026 impact labels on the sustainability of food purchases: Two randomised controlled trials in an
1027 experimental online supermarket. PLoS One. 2022;17(11):e0272800.
1028 219. Bandy LK, Hollowell S, Jebb SA, Scarborough P. Changes in the salt content of packaged
1029 foods sold in supermarkets between 2015-2020 in the United Kingdom: A repeated cross-sectional
1030 study. PLoS Med. 2022;19(10):e1004114.
1031 220. Bianchi F, Luick M, Bandy L, Bone J, Kelly S, Farrington J, et al. The impact of altering
1032 restaurant and menu option position on food selected from an experimental food delivery platform:
1033 a randomised controlled trial. Int J Behav Nutr Phys Act. 2023;20(1):60.
1034 221. De-loyde K, Pilling MA, Munafò MR, Attwood A, Maynard OM. How are milk substitutes
1035 labelled in the UK? Should the term ‘milk’ be added to milk substitute labelling? Behavioural Public
1036 Policy. 2023:1-17.
1037 222. Glover A, Hayes HE, Ni H, Raikos V. A comparison of the nutritional content and price
1038 between dairy and non-dairy milks and cheeses in UK supermarkets: A cross sectional analysis. Nutr
1039 Health. 2024;30(1):157-65.
1040 223. Huang YR, Theis DRZ, Burgoine T, Adams J. Trends in energy and nutrient content of menu
1041 items served by large UK chain restaurants from 2018 to 2020: an observational study. Bmj Open.
1042 2021;11(12):e054804.
1043 224. Mcphedran R, Zhuo S, Zamperetti L, Gold N. The effects of Veganuary on meal choices in
1044 workplace cafeterias: an interrupted time series analysis. Behavioural Public Policy. 2023.

225. Thomas M, Moore JB, Onuselogu 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.
226. 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.
227. 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.
228. 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).
229. 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.
230. 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.
231. Beatty TKM. Do the Poor Pay More for Food? Evidence from the United Kingdom. American Journal of Agricultural Economics. 2010;92(3):608-21.
232. 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).
233. Cornelsen L, Mytton OT, Adams J, Gasparrini 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.
234. 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).
235. 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.
236. 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.
237. Revoredo-Giha C, Renwick A. Retailers Price Behavior in the UK Fresh Fruit and Vegetable Market. Agribusiness. 2012;28(4):451-68.
238. 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.
239. 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.
240. 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.
241. Nikolaou CK, Lean ME, Hankey CR. Calorie-labelling in catering outlets: acceptability and impacts on food sales. Prev Med. 2014;67:160-5.
242. 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.

243. 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).
244. 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.
245. 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.
246. Filimonau V, Nghiem VN, Wang LE. Food waste management in ethnic food restaurants. International Journal of Hospitality Management. 2021;92.
247. 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.
248. 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.
249. 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.
250. 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.
251. 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.
252. 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.
253. Macdonald L, Cummins S, Macintyre S. Neighbourhood fast food environment and area deprivation-substitution or concentration? Appetite. 2007;49(1):251-4.
254. 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.
255. 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.
256. 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.
257. Megan Jones ECF, Kathleen Hennessy-Priest, Ricardo J. S. Costa. . 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.
258. 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).
259. 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.
260. 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.
261. 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.
262. 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).

263. 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.
264. 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.
265. 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.
266. 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.
267. 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.
268. 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.
269. 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.
270. 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.
271. 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.
272. 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.
273. 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.
274. 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.
275. Moore JB, Sutton EH, Hancock N. Sugar Reduction in Yogurt Products Sold in the UK between 2016 and 2019. Nutrients. 2020;12(1).
276. 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.
277. 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.
278. 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.
279. 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.
280. 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.
281. 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.

282. 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.
283. Parnham JC, Millett C, Vamos EP. School meals in the UK: ultra-processed, unequal and inadequate. Public Health Nutr. 2023;26(1):297-301.
284. Takacs B, Stegemann JA, Kalea AZ, 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.
285. 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.
286. Coyne KJ, Baldridge 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.
287. 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.
288. 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.
289. 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.
290. 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.
291. 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.
292. Jones P, Comfort D, Hillier DJ, editors. Interpretations of the Concept of Sustainability Amongst the UK's Leading Food and Drink Wholesalers2016.
293. 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.
294. 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.
295. 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.
296. 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).
297. 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.
298. 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.
299. 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.
300. Ghodsian B, Madden AM. Evaluating the </=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.
301. 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.

302. 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.
303. Khehra R, Fairchild RM, Morgan MZ. UK children's breakfast cereals - an oral health perspective. Br Dent J. 2018;225(2):164-9.
304. 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.
305. 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.
306. 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.
307. 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.
308. 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.
309. 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.
310. 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.
311. 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.
312. 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.
313. 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.
314. 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.
315. Shaw H. Food access, diet and health in the UK: an empirical study of Birmingham. British Food Journal. 2012;114(4-5):598-616.
316. 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.
317. 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.
318. 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).
319. 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.
320. 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).

321. 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.
322. 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.
323. 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.
324. 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.
325. 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).
326. 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.
327. Gunning Y, Fong LKW, Watson AD, Philo M, Kemsley EK. Quantitative authenticity testing of buffalo mozzarella via αs1-Casein using multiple reaction monitoring mass spectrometry. Food Control. 2019;101:189-97.
328. 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.
329. 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.
330. 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.
331. 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.
332. McLauchlin J AH, Elliott A, Forester E, Jørgensen F, Willis C. . Microbiological quality of raw drinking milk and unpasteurised dairy products: results from England 2013–2019. . Epidemiology and Infection 2020. 2020;148.
333. 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.
334. 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.
335. 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.
336. 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).
337. 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.
338. 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.
339. 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.

340. 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.
341. 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.
342. 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.
343. (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.
344. Scotland FS. Situation Report: Changes to shopping and eating behaviours in Scotland during the COVID-19 pandemic in 2020. Scotland; 2020.
345. Susannah Irvine AG, Brigid Francis-Devine. Food banks in the UK. House of Commons Library; 14 July 2022.
346. 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.
347. 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.
348. Far-reaching ban on single-use plastics in England [press release]. 2023.
349. Directorate EaF. Food waste reduction: action plan. 24 April 2019.
350. A Green Growth Strategy for Northern Ireland - Balancing our climate, environment and economy. In: Department for Agriculture EaRAD, editor. 2022.
351. The Food (Promotion and Placement) England Regulations 2021 No. 1368 (2021).
352. Scottish Goverment Consultation on Restricting Promotions of Food and Drink High in Fat, Sugar or Salt. July 2022.
353. Government W. Healthy Food Environment -Exploring proposals to make the food environment in Wales healthier. 2022.
354. 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.

Figure Legends

Figure 1. PRISMA flow diagram for systematic review of food environments in the UK.

Figure 2. Geographic distribution of number of articles by country in a systematic review of the UK food environment (n=312).

Figure 3. Number of articles by type of food environment and country in a systematic review of the UK food environment. Categories are non-exclusive, i.e., articles that evaluated more than one type of food environment are counted more than once.

Figure 4. Number of articles by domain of food environment in a systematic review of the UK food environment (n=312). The colored boxes represent the domains while the number on the bar represents the number of articles in the domains. The presence of multiple, colored boxes signifies more than one domain.

Figure 5. Type of methodology under each domain of food environment in a systematic review of the UK food environment. Categories are non-exclusive, i.e., articles that used more than one methodology are counted more than once.

Tables

Table 1. Six domains of food environments as proposed by Downs et al. 2020 (26).	
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

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Table 2. Definitions of methodologies to measure the food environment		
Name	**Definition**	**Example**
Geographic analysis	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	Number of fast-food restaurants and convenience stores around home and school neighborhoods for 3,089 adolescents (121)
Menu analysis	Collects standardized information from menus	Energy and nutritional content of menu items from 100 restaurants in the UK (262)
Market basket survey	Collects standardized 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	Using a healthy food basket to determine availability and pricing of key items from shops in two localities (98)
Sales/ purchase analysis	Use data from sales, cashier receipts, and annotated receipts to assess food purchasing patterns	An experimental study to examine the effect on vegetarian sales by increasing the proportion of vegetarian options available in university cafeterias (69)
Nutrient fact panel analysis	The nutrient content of foods available in a food environment is analyzed using existing information provided on the product itself (e.g., nutrient fact panel or claims on labeling) or using a nutrient database	Comparion of the Nutrition Information Panel content, serving size and package size of children's ready-to-eat breakfast cereals in 5 countries (201).
Nutrient analysis	Food samples are collected from a food outlet and analyzed in a laboratory for specific nutrients	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 (333)
Contaminant analysis	Food samples are collected from a food outlet and analyzed in a laboratory for contaminants such as pesticides or pathogens	Assessment of the microbiological safety of salad vegetables and sauces from kebab take-away restaurants in the UK (312)
Physical measurements	Data collected via physical measurements of stores such as aisle length, shelf length, and placement	Association of supermarket size (measured as total aisle length) and national obesity prevalence in England (199)
Ecological footprint analysis	Life cycle assessments determine the environmental impact of foods available in food environments	Environmental Impact Score of sandwiches and beverages available in 18 university-owned food outlets (71)
Policy analysis	Articles analyzing policies or recommendations that impact on the domains of food environments such as taxes or food labelling requirements	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 (165)
Food supply analysis	Uses national level data such as food prices, food availability, or food consumption	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 (313)

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Table 3. Key characteristics of articles included in the systematic review of the UK food environment (n=312)	
Characteristic	**n (%) or range**
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)
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)
Randomized 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
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)
Intergovermental 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)

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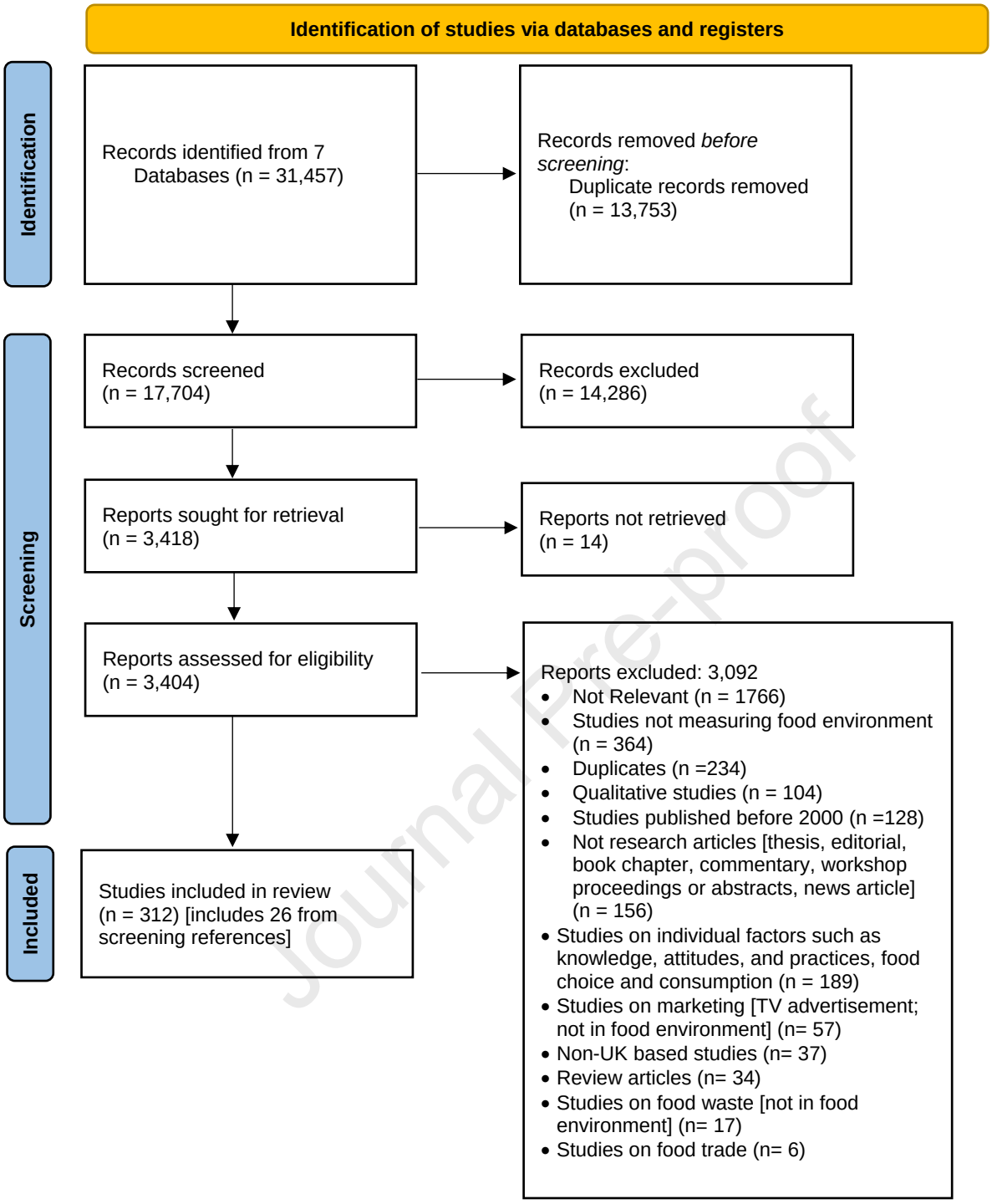
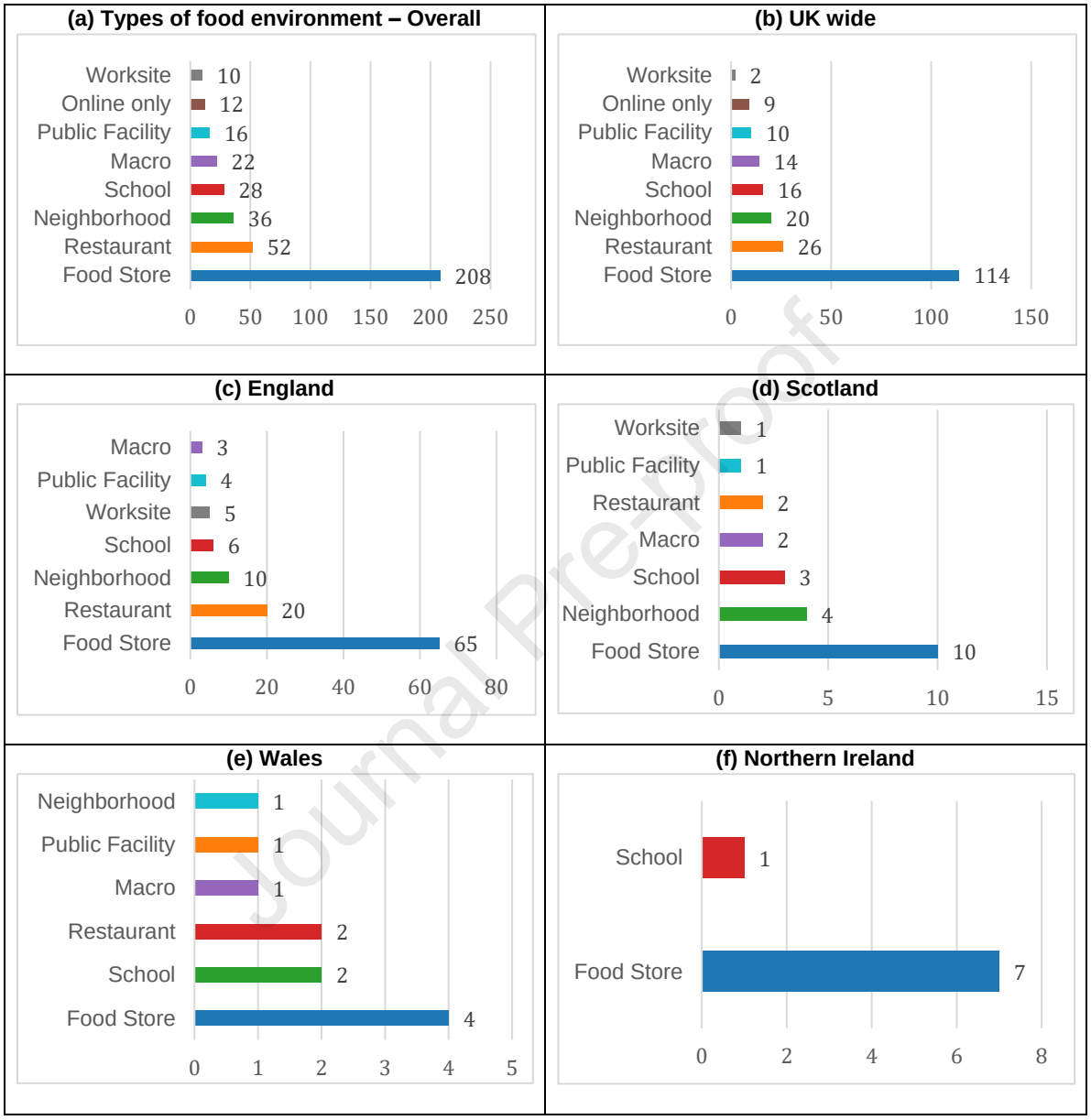
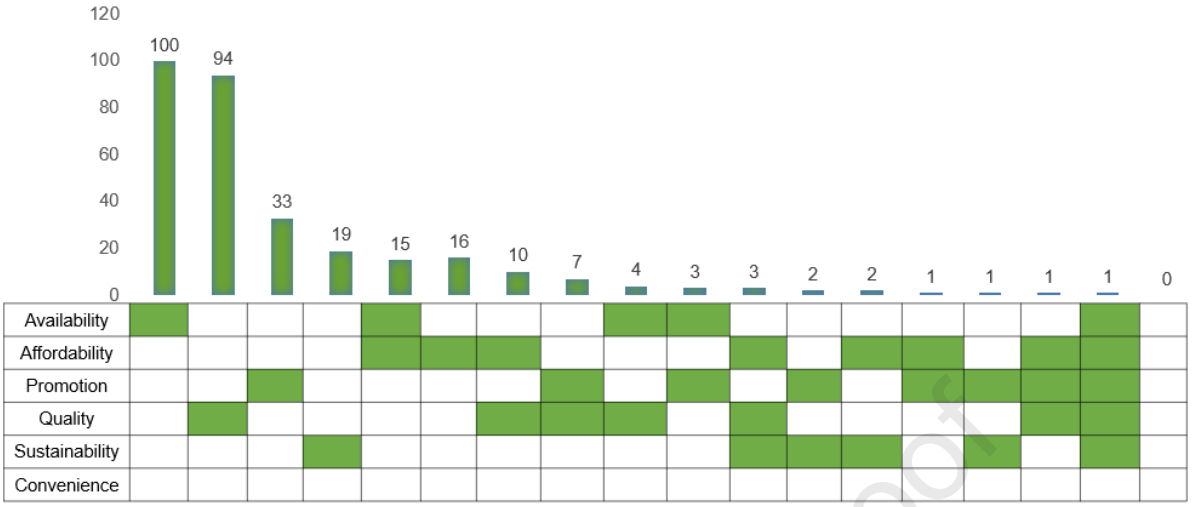
Table 4. Outcomes stated in articles included in the systematic review of the UK food environment (n=312)

Country	Outcomes n (%)		
	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

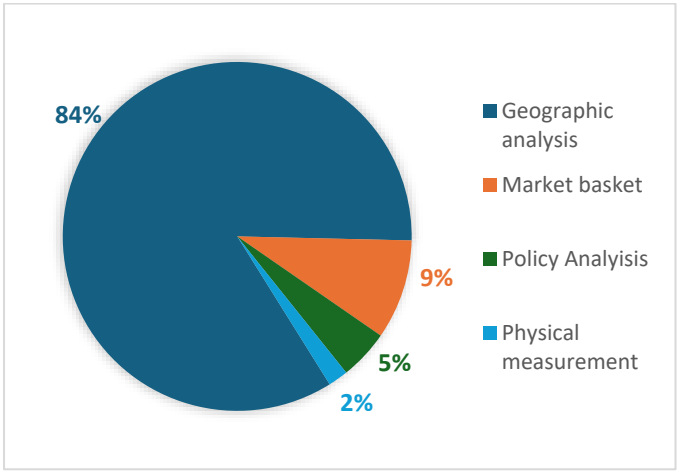
1410



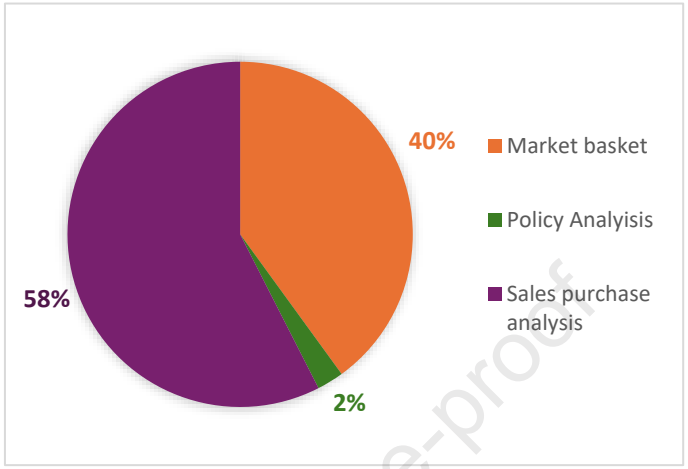




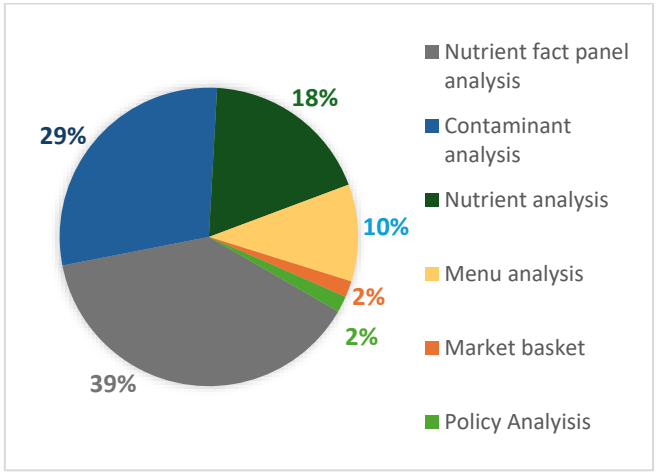
(a) Availability



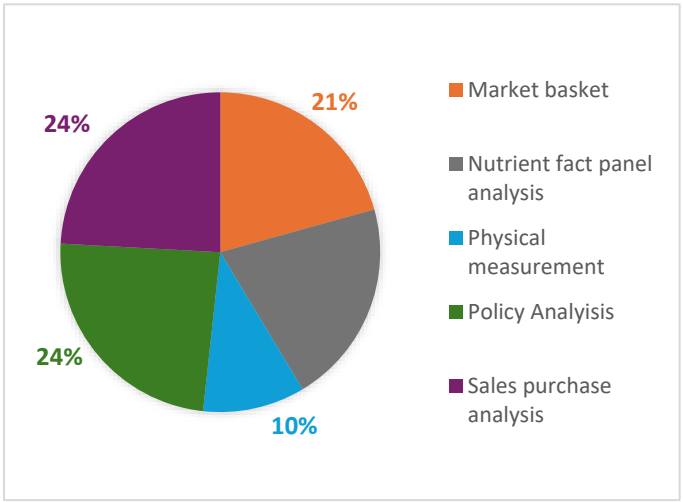
(b)Affordability



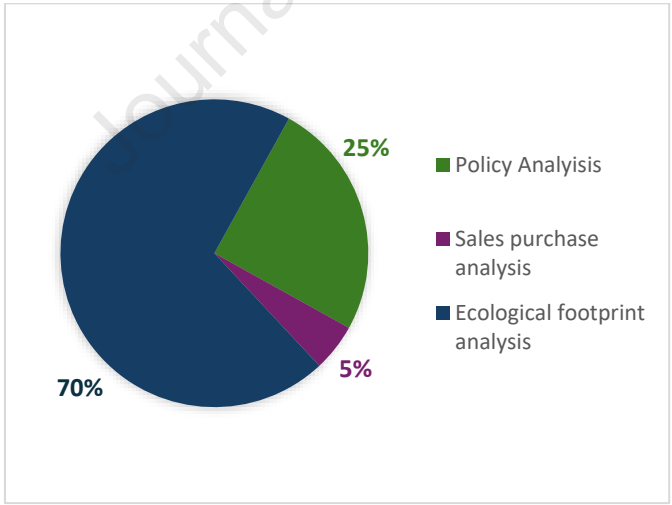
(c) Quality



(d) Promotion



(e) Sustainability



Declaration of interests

☐ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☒ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Dr Christian Reynolds reports a relationship with Centre for Food Policy, City St Georges, University of London that includes: consulting or advisory. Dr Christian Reynolds reports a relationship with The Alpro Foundation that includes: funding grants. Dr Christian Reynolds reports a relationship with The Folger Institute that includes: speaking and lecture fees. Dr Christian Reynolds reports a relationship with The Nutrition Society that includes: travel reimbursement. Dr Christian Reynolds reports a relationship with The Institute of Food Science & Technology , The Nutrition Society that includes: consulting or advisory. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.