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**Citation:** Kapoor, D., Kennedy, J., Shields, K., Reynolds, C., Clemens, T. & Jaacks, L. M. (2025). Characterizing the food environment in Scotland and its association with deprivation: A national study. *Preventive Medicine Reports*, 59, 103254. doi: 10.1016/j.pmedr.2025.103254

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# Characterizing the food environment in Scotland and its association with deprivation: A national study

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## ARTICLE INFO

### Keywords:

Food environment  
Area deprivation  
UK  
Supermarket  
Takeaway  
Fast food  
Out of home  
Retail

## ABSTRACT

**Objectives:** To characterize food outlets across Scotland and analyze their distribution by neighborhood deprivation.

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

**Results:** Of all food outlets, 59 % ( $n = 18,409$ ) were OOH, 28 % ( $n = 8757$ ) retail, and 13 % ( $n = 3969$ ) other. The density of OOH (1.9 per km<sup>2</sup>) was more than double that of retail (0.8 per km<sup>2</sup>). Glasgow City had the highest OOH outlet density (18.5 per km<sup>2</sup>). Argyll and Bute, Western Isles, and Highlands had the lowest density of both OOH and retail ( $\leq 0.03$  per km<sup>2</sup>). Compared to the most deprived neighborhoods, the least deprived neighborhoods had more Restaurants/cafés/canteens (37 % versus 23 % of food outlets, respectively) and fewer Takeaways/sandwich shops (16 % versus 24 % of food outlets, respectively).

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

## 1. Introduction

Scotland has the lowest life expectancy at birth of any Western European country and it has continued to fall in recent years (European Union Life expectancy at birth by sex 2024, 2025; Scottish Government Life Expectancy in Scotland 2020–2022 Provisional Figures, 2023). The gap in time spent living in good health between individuals in the most and least deprived areas is widening, reaching 24 years in 2019 (David Finch and Bibby, 2023). Disparities in healthy weight likely contribute to healthy life expectancy disparities: 39 % of adults in Scotland's least deprived areas have a healthy weight compared to 28 % of adults in the most deprived areas (Scottish Government, 2022). A Scotland where everyone eats well and has a healthy weight is a key public health priority (Scottish Government, 2018), and several policies have been

adopted in recent years to support this vision. These policies have targeted improvements in food environments recognizing their role in influencing what people eat and drink (Katrine Lindberg Hansen SG, 2022). Policies such as taxing unhealthy foods, restricting their promotion, and implementing front-of-pack labeling have been prioritized by governments worldwide including the UK government (Vandevijvere et al., 2019). These policies are generally supported by the public (Adams et al., 2021), and have led to improvements in diet quality, such as reduction in sugar consumption as a result of the Soft Drinks Levy (Scarborough et al., 2020). Several studies in the UK have shown a positive association between proximity (Libuy et al., 2024) and density of fast-food outlets and obesity (Albalawi et al., 2020); though not all studies have shown a significant effect (Green et al., 2021).

In Scotland, the Good Food Nation (Scotland) Act, passed into Scots

**Abbreviations:** OOH, Out of Home; FSA, Food Standards Agency; SIMD, Scottish Index of Multiple Deprivation.

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

Received 25 June 2025; Received in revised form 16 September 2025; Accepted 17 September 2025

Available online 23 September 2025

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Law in 2022, aims to ensure that everyone in Scotland has “ready access to the healthy, nutritious food they need” and “People who serve and sell food – from schools to hospitals, retailers, cafes and restaurants – are committed to serving and selling good food”. Hence, all foods prepared outside home at establishments such as restaurants, pubs, cafés, and takeaways are considered out-of-home (OOH). Supporting this vision, Public Health Scotland and Food Standards Scotland (FSS) have developed an Eating Out, Eating Well Framework to help the OOH sector provide healthier foods, recognizing that OOH food and drink tends to be less healthy (Huang et al., 2021). According to FSS’s latest report on monitoring OOH food and drink purchases in Scotland, 98 % of the population visited OOH venues in 2023 (Clodagh Elrick NFAW, 2024).

Differences in food environments may contribute to health disparities and while government policies aim to improve food environments, no study has comprehensively evaluated the food environment across Scotland. To date, studies have only been conducted in Glasgow, Scotland’s largest city, and reported a positive association between the density of food outlets and neighborhood deprivation (Macdonald et al., 2018; Sauveplane-Stirling et al., 2014). We, therefore, aimed to (European Union Life expectancy at birth by sex 2024, 2025) characterize the food environment across Scotland and (Scottish Government Life Expectancy in Scotland 2020–2022 Provisional Figures, 2023) explore how the food environment varies by neighborhood deprivation.

## 2. Methods

### 2.1. Data source and food outlet classification

Scotland is divided into 32 designated council areas or local authorities. All food outlets must have a food hygiene inspection, undertaken by the local authority under the Food Hygiene Information Scheme rating. We obtained a list of all food outlets from the UK food hygiene rating data (Scotland) in 2024 ( $n = 55,249$ ), compiled by the Food Standards Agency (FSA): <https://ratings.food.gov.uk/open-data>, downloaded on 1st February 2024. Data available for each food outlet included business name, address, local authority, geocode, and classification. There were 14 classifications. Seven classifications were excluded from this analysis: care homes, distributors/ transporters,

farmers/growers, hotel/bed & breakfast/guest house, importers/exporters, manufacturers/packers, and school/college/universities. From the list of 55,249 food businesses, 13,445 (24 %) were classified in one of these seven categories and excluded, thus 41,804 (76 %) were included in this study (Fig. 1).

We categorized outlets using the existing FSA classifications: OOH (including restaurants, pubs, cafés, and takeaways), retail (including supermarkets and other establishments that primarily sell non-food products and a limited range of food products such as pharmacies), or other (mobile caterers, charity organizations, and home caterers) (Table 1).

Since businesses self-selected their classification from the FSA classifications (Table 1), a consistent definition was not always applied across businesses. If an outlet was categorized in more than one way, it appeared multiple times in the data as different records. For example, Costa Coffee at Edinburgh Airport, was categorized twice as “Restaurant/Cafe/Canteen” and “Takeaway/sandwich shop”. The name and address of such outlets were manually reviewed, resulting in removal of 6423 duplicates. The most recent data entry was retained.

In addition, some businesses that are not traditionally considered part of OOH or retail, for example, banks and schools, were present in the dataset. The process of removing these non-food businesses was facilitated using Open-AI’s GPT-4 large language model (OpenAI JA et al., 2024), by developing an input prompt to identify them based on its domain knowledge and the business description (Supplementary Material S1). The model identified 8354 (24 %) potential businesses that should be excluded from the list of OOH and retail outlets. Of these, 34 (0.4 %) were not in the original list and were “hallucinated” by the model, although in many instances these businesses differed by only minor changes in spelling or punctuation from a business in the original list (Supplementary Material S1). In addition, this list of potential exclusions contained businesses that could not easily be classified using the name alone such as “A & A Bros” or “1841”. These were manually verified using a Google search. The business name and postcode were searched, typically yielding results such as the outlet’s website or its menu on online food delivery platforms. For non-food businesses, details about the company’s operations were often displayed. A total of 4124 outlets were manually removed following a Google search. A final

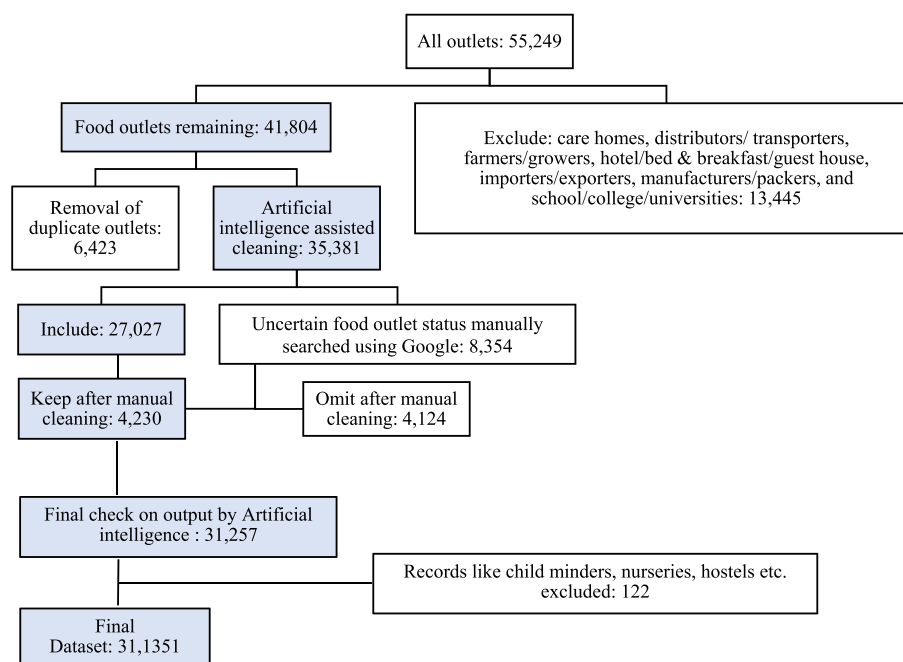


Fig. 1. Flowchart of data cleaning of food businesses in Scotland, 2024.

<sup>1</sup> Outlets with missing postcodes were excluded from Scottish Index of Multiple Deprivation analysis ( $n = 732$ ).

**Table 1**  
Definition of food outlets in Scotland, 2024.

| Food Standards Agency classification <sup>1</sup>   | Food Standards Agency description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Categorization for current analysis |
|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| Pub/ bar/ nightclub                                 | Commercial establishments that primarily serve alcohol in a public bar. If the establishment has a separate restaurant facility it is recorded under the pub category. Examples: Public Houses, Night clubs/ clubs with bars.                                                                                                                                                                                                                                                                                                                                                           | Out of home                         |
| Restaurant/ Café/ Canteen                           | Establishments whose primary business is to cook/ prepare food for customers. Examples: Restaurants, Cafés, Self-service caterer, “Fast food” establishments providing seating, e.g., McDonalds, Burger King, etc. The drive-thru variants of these chains are also included in this category.                                                                                                                                                                                                                                                                                          |                                     |
| Takeaway/ sandwich shop                             | Establishments that provide convenience food to customers, primarily for consumption off the premises. Establishments must be immobile and housed in a designated building. These establishments prepare and deliver convenience food directly to the customer. Examples: Fish & chip shops, Takeaway Sandwich shops.                                                                                                                                                                                                                                                                   |                                     |
| Retailers - supermarkets/ hypermarkets <sup>2</sup> | Supermarkets. Examples: Sainsbury, Tesco, Asda, Morrison, Co-op, Marks and Spencer, Waitrose, Aldi, Lidl, etc. that provide a range of food items from more than one grocery sector and from a range of brands. City center or local variants of larger supermarket groups, e.g., Sainsbury's local, Tesco Metro, Tesco Express, etc. Establishments like Londis and Spar are also included in this category.                                                                                                                                                                           | Retail                              |
| Retailers - other                                   | Retail establishments which do not fit into one of the other retailer categories, e.g., establishments that primarily sell non-food products and a very limited range of food products. Examples: Shops where the main business is not food for example a chemist/pharmacy. Smaller-scale food businesses such as Grocers, Confectioners, Butchers (retail only), Fishmongers, Greengrocer/fruiterer, Health food shops, Bakers shops (retail only), Newsagents and Garage minimarkets. Establishments like Costcutter, One-Stop, Nisa, and Premier are also included in this category. |                                     |
| Other catering premises                             | Restaurant/catering establishments that do not fit into one of the other restaurants and caterers' categories. Examples: Home caterers such as cake makers selling directly to consumers, village halls, community centers, etc. used by charitable/ community organizations.                                                                                                                                                                                                                                                                                                           | Other                               |
| Mobile caterer <sup>3</sup>                         | A food establishment that comprises a kitchen or catering facility operating from a mobile unit such as a vehicle, trailer, stall, marquee or other non-permanent structure. Examples: Mobile catering units, Burger vans and other fast-food vans/trailers/stalls.                                                                                                                                                                                                                                                                                                                     |                                     |

<sup>1</sup> The following business classifications were excluded from this analysis: care homes, distributors/ transporters, farmers/growers, hotel/bed & breakfast/ guest house, importers/exporters, manufacturers/packers, and school/college/ universities.

<sup>2</sup> Cafés in supermarkets are included separately in out of home as Restaurant/ Café/Canteen.

<sup>3</sup> Mobile caterers were excluded from the out of home category because the address listed in the database reflects the business's registration location, which may differ from the actual site where food is sold.

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

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

This study used publicly available, non-human data and thus does not require ethics approval.

Cleaning was done using string matching in R version 4.2 (R Core Team, 2022).

## 2.2. Data analysis

The density per square kilometer and proportion of OOH, food retail, and other outlets was calculated overall, and by local authority and Scottish Index of Multiple Deprivation (SIMD) quintile. Population density for each local authority was added using 2022 census data (Scottish Government Scotland's Census, 2022). SIMD is a relative measure of deprivation across 6976 small areas (called data zones), taking into account information across seven domains: income, employment, education, health, access to services, crime, and housing (Scottish Government, 2020). Look-up tables which relate individual postcodes to data zones were used to link SIMD ranks to each food establishment (Scotland NRo, 2025). A total of 732 (2 %) food outlets were excluded from the analysis by SIMD as the postcode specified in the FSA database was not available in the lookup tables. Differences in the proportion of OOH, food retail versus other outlets between quintiles of neighborhood deprivation, overall and stratified by local authority, were evaluated using chi-square tests. Twenty-one of thirty-two local authorities had fewer than five outlets in a given SIMD quintile and were excluded from the analysis. To assess the association between deprivation and total outlet density, we employed a Poisson regression model, with SIMD quintile as the independent variable and outlet density as the dependent variable. All analyses were done in R version 4.2 (R Core Team, 2022).

## 3. Results

Overall, in Scotland, 59 % ( $n = 18,409$ ) of food outlets were OOH, 28 % ( $n = 8757$ ) retail, and 13 % ( $n = 3969$ ) other. “Restaurant/café/canteen” was the most common food outlet type ( $n = 9248$ , 30 %), followed by “Retailers – other” ( $n = 6881$ , 22 %), and “Takeaway/sandwich shops” ( $n = 5430$ , 17 %) (Supplementary Material S2). “Retailers - supermarkets/hypermarkets” accounted for only 6 % ( $n = 1876$ ) of food outlets.

### 3.1. Differences by local authority

The proportion of food outlet types varied by local authority, with densely populated areas having a higher number of outlets as well as outlet density. Glasgow City had the highest number of all types of food outlets ( $n = 4977$ ) including 65 % OOH and 23 % retail. The City of Edinburgh had the highest number of pubs/bars ( $n = 524$ , 15 % of total outlets) and Highlands had the highest number of home caterers/charities ( $n = 1016$ , 39 % of total outlets). Shetland Islands, Comhairle nan Eilean Siar (Western Isles), and Orkney Islands had fewer than 200 total food outlets (**Supplementary Material S3**).

Out of 32 local authorities, 30 had more than 50 % of their food outlets classified as OOH (**Supplementary Material S6**). Aberdeenshire and Highlands were the two exceptions where 41 % and 27 % of food outlets were OOH, respectively. The City of Edinburgh (78 %) had the highest proportion of OOH outlets, followed by Argyll and Bute (77 %). Shetland Islands (40 %) had the highest proportion of retail outlets, followed by Comhairle nan Eilean Siar (Western Isles) (39 %), West Dunbartonshire (37 %) and Inverclyde and North Ayrshire (both 36 %). Highlands was the only local authority with an equally low proportion of both OOH (27 %) and retail outlets (28 %); a majority of outlets were other (45 %).

On average, the OOH outlet density was nearly double that of retail in Scotland: 1.9 OOH outlets per km<sup>2</sup> versus 0.8 retail outlets per km<sup>2</sup>. Local authorities with a high population density such as Glasgow City, Dundee City, City of Edinburgh, and Aberdeen City had the highest OOH and retail densities (**Table 2**). Highlands, Argyll and Bute, Shetland

Islands, and Comhairle nan Eilean Siar (Western Isles) had the lowest OOH and retail density of less than one outlet per km<sup>2</sup>.

### 3.2. Differences by neighborhood deprivation

Overall, the most deprived areas had significantly higher total outlet density compared to all other less deprived quintiles (comparing 1st quintile (ref) and 5th SIMD quintile  $\beta = -0.31$ ,  $SD = 0.01$ ,  $p < 0.01$ ) [**Supplementary Material S4**]. The proportion of OOH outlets was higher in the least deprived neighborhoods compared to the most deprived (65 % versus 58 %,  $p < 0.01$ ) [**Fig. 2, Supplementary Material S5**]. This was driven by a higher proportion of “Restaurants/cafés/canteens” (37 % of total food outlets in the least deprived neighborhoods versus 23 % in the most deprived). In contrast, “Takeaways/sandwich shops” comprised a smaller proportion in the least deprived neighborhoods (16 % versus 24 % in the most deprived).

The proportion of food retail outlets was lower in the least deprived neighborhoods compared to the most deprived (24 % versus 32 %, respectively,  $p < 0.01$ ) [**Fig. 2, Supplementary Material S5**]. This was driven by a lower proportion of “Retailers - other” (outlets primarily selling non-food items with a limited food selection, 16 % in the least deprived neighborhoods versus 26 % in the most deprived neighborhoods). In contrast, the proportion of “Retailers - supermarkets/hypermarkets” was higher in the least deprived neighborhoods compared to the most deprived (7 % versus 6 %).

Five local authorities, namely, Aberdeen City, Fife, Glasgow City, City of Edinburgh and Stirling followed the same trend as in Scotland

**Table 2**

Population density (People per km<sup>2</sup>), percentage of data zones in the most deprived Scottish Index of Multiple Deprivation quintile, and density of total food outlets, out of home, retail, and other food outlets (outlets per km<sup>2</sup>), by local authority in Scotland, 2024 ( $n = 31,135$ ).

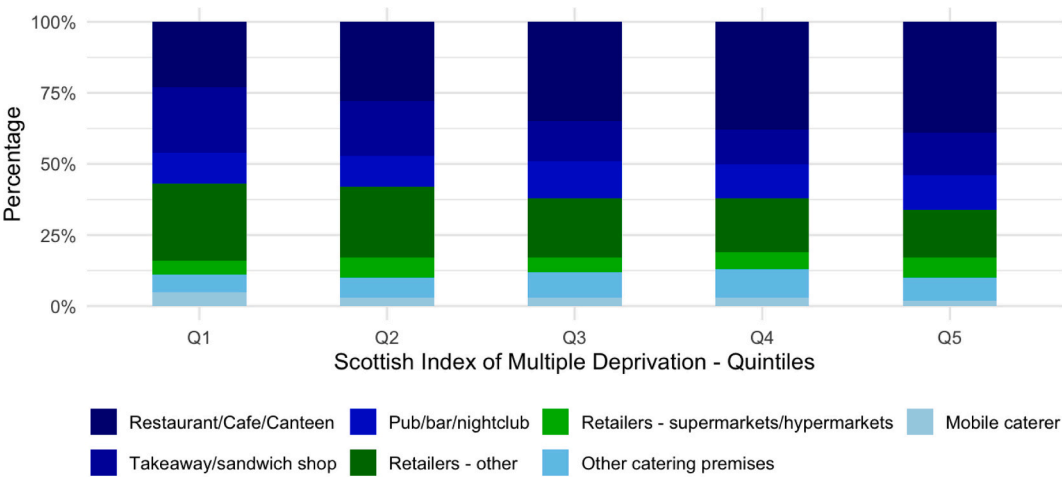
| Local Authority                              | Population Density <sup>1</sup><br>(People per km <sup>2</sup> ) | Most deprived data<br>zones <sup>2</sup> (%) | Outlet Density (Total<br>Outlets per km <sup>2</sup> ) | Out of home Density<br>(Outlets per km <sup>2</sup> ) | Retail Density<br>(Outlets per km <sup>2</sup> ) | Other <sup>3</sup> Density<br>(Outlets per km <sup>2</sup> ) |
|----------------------------------------------|------------------------------------------------------------------|----------------------------------------------|--------------------------------------------------------|-------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------|
| Glasgow City                                 | 3555                                                             | 45                                           | 28.5                                                   | 18.5                                                  | 6.4                                              | 3.6                                                          |
| Dundee City                                  | 2477                                                             | 37                                           | 16.5                                                   | 10.2                                                  | 4.4                                              | 1.8                                                          |
| Edinburgh (City of)                          | 1947                                                             | 12                                           | 13.1                                                   | 10.3                                                  | 2.2                                              | 0.6                                                          |
| Aberdeen City                                | 1207                                                             | 10                                           | 7.5                                                    | 4.6                                                   | 2.2                                              | 0.7                                                          |
| North Lanarkshire                            | 726                                                              | 34                                           | 3.2                                                    | 1.8                                                   | 1.1                                              | 0.3                                                          |
| Renfrewshire                                 | 703                                                              | 25                                           | 3.6                                                    | 2.2                                                   | 1.1                                              | 0.3                                                          |
| East Dunbartonshire                          | 625                                                              | 4                                            | 2.2                                                    | 1.3                                                   | 0.7                                              | 0.2                                                          |
| West Dunbartonshire                          | 557                                                              | 40                                           | 2.7                                                    | 1.6                                                   | 1                                                | 0.1                                                          |
| East Renfrewshire                            | 556                                                              | 6                                            | 1.1                                                    | 0.6                                                   | 0.4                                              | 0.1                                                          |
| Falkirk                                      | 533                                                              | 16                                           | 2.4                                                    | 1.5                                                   | 0.8                                              | 0.1                                                          |
| Inverclyde                                   | 489                                                              | 45                                           | 2.2                                                    | 1.3                                                   | 0.8                                              | 0.1                                                          |
| West Lothian                                 | 424                                                              | 15                                           | 0.9                                                    | 0.6                                                   | 0.3                                              | < 0.1                                                        |
| Clackmannanshire                             | 325                                                              | 25                                           | 1.9                                                    | 1                                                     | 0.6                                              | 0.2                                                          |
| Fife                                         | 280                                                              | 20                                           | 1.8                                                    | 1                                                     | 0.6                                              | 0.2                                                          |
| Midlothian                                   | 273                                                              | 9                                            | 1.0                                                    | 0.7                                                   | 0.3                                              | < 0.1                                                        |
| South Lanarkshire                            | 185                                                              | 20                                           | 0.9                                                    | 0.6                                                   | 0.3                                              | 0.1                                                          |
| East Lothian                                 | 165                                                              | 6                                            | 0.7                                                    | 0.4                                                   | 0.2                                              | 0.1                                                          |
| North Ayrshire                               | 151                                                              | 40                                           | 0.8                                                    | 0.5                                                   | 0.3                                              | 0.1                                                          |
| East Ayrshire                                | 95                                                               | 31                                           | 0.5                                                    | 0.3                                                   | 0.2                                              | < 0.1                                                        |
| South Ayrshire                               | 91                                                               | 18                                           | 0.6                                                    | 0.4                                                   | 0.2                                              | < 0.1                                                        |
| Angus                                        | 52                                                               | 8                                            | 0.3                                                    | 0.2                                                   | 0.1                                              | < 0.1                                                        |
| Aberdeenshire                                | 42                                                               | 3                                            | 0.2                                                    | 0.1                                                   | 0.1                                              | < 0.1                                                        |
| Moray                                        | 42                                                               | 3                                            | 0.2                                                    | 0.1                                                   | 0.1                                              | < 0.1                                                        |
| Stirling                                     | 42                                                               | 12                                           | 0.2                                                    | 0.1                                                   | 0.1                                              | < 0.1                                                        |
| Perth and Kinross                            | 29                                                               | 6                                            | 0.1                                                    | 0.1                                                   | < 0.1                                            | < 0.1                                                        |
| Scottish Borders                             | 25                                                               | 6                                            | 0.1                                                    | 0.1                                                   | < 0.1                                            | < 0.1                                                        |
| Dumfries and Galloway                        | 23                                                               | 9                                            | 0.1                                                    | 0.1                                                   | < 0.1                                            | < 0.1                                                        |
| Orkney Islands                               | 22                                                               | 0                                            | 0.2                                                    | 0.1                                                   | 0.1                                              | < 0.1                                                        |
| Shetland Islands                             | 16                                                               | 0                                            | 0.1                                                    | < 0.1                                                 | < 0.1                                            | < 0.1                                                        |
| Argyll and Bute                              | 13                                                               | 10                                           | < 0.1                                                  | < 0.1                                                 | < 0.1                                            | < 0.1                                                        |
| Highlands                                    | 9                                                                | 10                                           | 0.1                                                    | < 0.1                                                 | < 0.1                                            | < 0.1                                                        |
| Comhairle nan Eilean Siar<br>(Western Isles) | 9                                                                | 0                                            | 0.1                                                    | < 0.1                                                 | < 0.1                                            | < 0.1                                                        |
| <b>Average</b>                               | <b>689</b>                                                       | <b>20</b>                                    | <b>0.4</b>                                             | <b>1.9</b>                                            | <b>0.8</b>                                       | <b>0.3</b>                                                   |

Local authorities are sorted from highest to lowest population density.

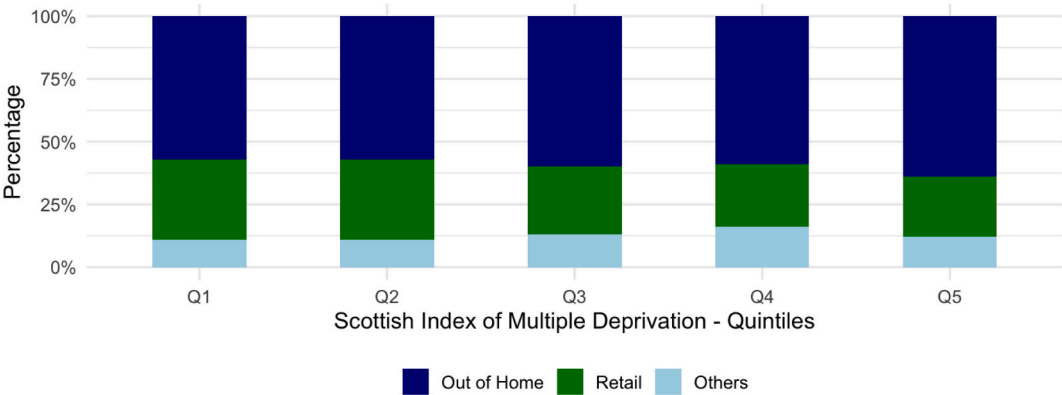
<sup>1</sup> <https://www.scotlandscensus.gov.uk/2022-results/scotland-s-census-2022-rounded-population-estimates/>

<sup>2</sup> <https://www.gov.scot/publications/social-capital-community-wellbeing-scotland/pages/13/>

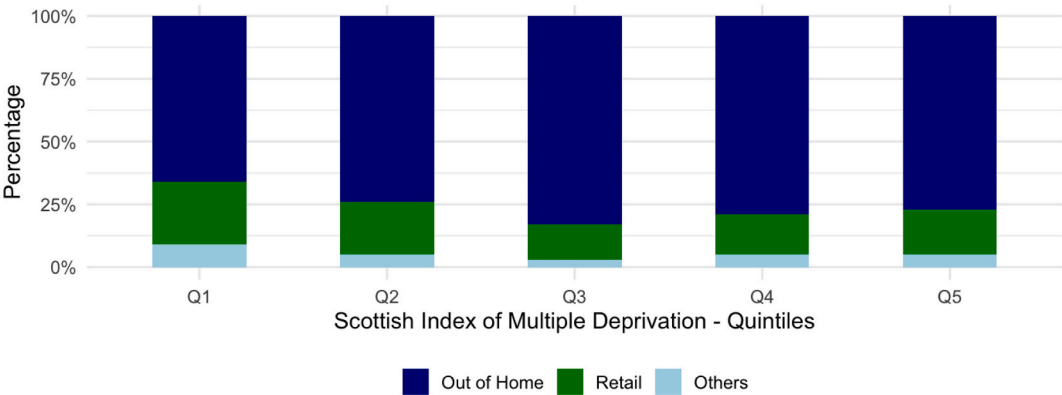
<sup>3</sup> “Other” includes home caterers, charitable/community organizations, and mobile caterers.



(a) Overall Scotland- all outlets



(b) Overall Scotland- subcategorized

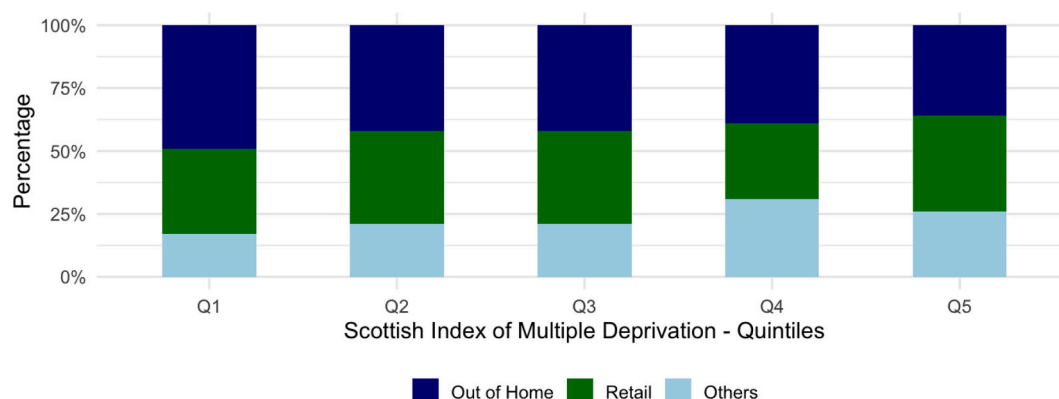


(c) City of Edinburgh example of a local authority with higher proportion of Out of home in the least deprived neighborhoods compared to the most deprived and lower proportion of retail outlets in the least deprived neighborhoods compared to the most deprived

Fig. 2. Association of Scottish Index of Multiple Deprivation with classification of food outlets in Scotland, 2024.

overall. However, the opposite was true in Aberdeenshire, Renfrewshire and South Lanarkshire, where the proportion of OOH was higher in the most deprived neighborhoods and the proportion of retail outlets was

lower in the most deprived neighborhoods. City of Edinburgh and Aberdeenshire shown as examples in Fig. 2, the rest shown in **Supplementary Material S6**). In Perth and Kinross, the most deprived



(d) **Aberdeenshire** example of a local authority with higher proportion of Out of home in the most deprived neighborhoods and lower proportion of retail outlets in the least deprived neighborhoods compared to the most deprived neighborhoods compared to the least deprived

Fig. 2. (continued).

neighborhoods had a significantly greater proportion of both OOH and retail outlets than the least deprived neighborhoods. North Lanarkshire had the same proportion of OOH outlets in the most and least deprived neighborhoods but a higher proportion of retail outlets in the most deprived neighborhoods.

#### 4. Discussion

This first comprehensive analysis of Scotland's food environment, covering 31,135 registered food businesses, found that 60 % were OOH, with restaurants/café/canteens accounting for half of these outlets. Across all deprivation levels, OOH outlets outnumbered supermarkets and other food retailers, but their makeup varied: takeaways were more common in deprived areas, while restaurants and cafés were more common in affluent ones. Several local authorities had fewer than one food retail outlet per km<sup>2</sup>, and some of these had a high proportion of "Other" outlets, such as, home caterers and charitable/community organizations, highlighting potentially unique aspects of food environments in these areas of Scotland where limited food retail access appears to be supplemented by informal or community-based sources.

It is understandable that retail outlets are less numerous than OOH outlets, as the area occupied by a single large supermarket could accommodate several OOH outlets. Nevertheless, these results highlight a significant opportunity to improve public health through the OOH sector, as proposed in the Scottish Government's *Eating Out, Eating Well* framework. The OOH sector varied by local authority and deprivation. For example, consistent with one previous study (Sauveplane-Stirling et al., 2014), we found an especially high density of OOH in Glasgow City. Takeaways/sandwich shops were more prevalent in the most deprived areas compared to the least deprived. This is consistent with a recent analysis in England of the same FSA database which found fast food outlets per 100,000 population in the most deprived decile of lower tier local authorities were double the level in the least deprived decile (Disparities, 2025).

Beyond OOH, other aspects of the food environment varied by local authority. In particular, the Highlands was the only local authority where the informal food economy, including home caterers, village halls, and community centers, comprised the largest share (46 %) of food outlets. This contrasts with other local authorities such as Dundee City and Glasgow City where 99 % of people reside in large urban areas and have a higher number and proportion of both OOH and retail food outlets. These results align with other studies conducted in remote rural areas in Scotland which found that populations access food through various channels, such as crofts, community co-operatives, social

enterprises, community gardens, and food banks (Freathy et al., 2024). Grocery provision is limited outside the main towns in these areas (Calderwood and Freathy, 2014). Our analysis highlighted that while the Comhairle nan Eilean Siar (Western Isles), Orkney Islands, and Shetland Islands did not have a high proportion of "Other" outlets compared to the Highlands, they had very few outlets overall, which may result in poor food accessibility.

While this is the first study of all registered food businesses in Scotland using the latest FSA data, it has limitations. While we were able to capture some level of specificity within the food sector in terms of business classification, a more granular classification of food outlets (e. g., bakeries, fish and chips) would provide a more complete picture of the food environment. Self-selecting business categories and manual cleaning for others may have introduced some measurement error. Further, OOH may be underestimated by not including mobile caterers. This research does not take into account the digital food environment, including online delivery options from both OOH and food retail outlets, or "dark kitchens" which rent kitchens to many delivery-only restaurants. Future studies could include information on whether businesses offer delivery services, as this may impact food access. Data were downloaded on 1st February 2024, but it is possible that some of the food businesses permanently closed or new food businesses have registered since that date. While collecting primary data on food outlets is ideal, such "ground truthing" is resource and time intensive. Thus, secondary data plays a crucial role in quantifying food environments. Some studies have addressed the accuracy and reliability of secondary food outlet data sources in relation to their utility for use in food environment research in the UK and found it useful for surveillance of the food environment (Lake et al., 2012). An evaluation of the validity and spatial accuracy of the FSA database in England demonstrated high reliability, with a positive predictive value of 95 % and a sensitivity of 89 % (Kirkman et al., 2021), suggesting the results presented herein are likely to be reasonably accurate.

This study highlights improvements to both the OOH and retail food environment are necessary. The Scottish Government proposals to restrict promotion of high fat, sugar, and salt (HFSS) foods in retail and OOH settings aim to tackle this issue, following similar measures introduced in England in 2022 (Public, 2021; Scottish Government, 2022). However, early qualitative analysis shows uneven implementation, highlighting the need for complementary policies to improve the accessibility, affordability, and promotion of healthier options (Muir et al., 2023). Despite this, the legislation could reduce impulse HFSS purchases creating healthier retail environments for consumers (Muir et al., 2023). A recent longitudinal analysis found that fast food outlet

density has grown faster than supermarkets in Great Britain, especially in deprived areas (Boskovic et al., 2025). Changes to neighborhood planning and licensing of food premises are needed to put food environments on a new trajectory, future proofing further growth in food outlets primarily selling unhealthy food. Takeaway management zones offer one. An evaluation of local authorities in England who adopted takeaway management zones found 0.83 fewer new outlets opened per local authority than expected without such policies (Rahilly et al., 2024a) and improve health by reducing obesity and related diseases (Rogers et al., 2024). However, studies also state limitations like such policies may regulate *future* growth but do not address the existing high density of takeaway outlets, particularly in deprived areas (Brown et al., 2021) or 'grab and go' type of foods which are the main form of OOH food in Scotland (Clodagh Elrick NFaLW, 2024). Evidence also suggests that they are most effective when implemented as full management zones, compared with time management zones, which only restrict opening hours for new outlets (Rahilly et al., 2024b). However, restricting access to unhealthy options must be accompanied by parallel efforts to promote and improve access to affordable healthier alternatives. Our study offers insights to inform stakeholder discussions on improving both the OOH and retail sectors across Scotland.

## 5. Conclusions

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

## CRediT authorship contribution statement

**Deksha Kapoor:** Conceptualization, Methodology, Formal analysis, Writing – original draft. **Joe Kennedy:** Software (AI), Methodology, Data curation, Writing – review and editing. **Kirsteen Shields:** Conceptualization, Writing – review and editing. **Christian Reynolds:** Conceptualization, Writing – review and editing. **Tom Clemens:** Data curation, Conceptualization, Methodology, Writing – review and editing. **Lindsay M. Jaacks:** Conceptualization, Methodology, Validation, Supervision, Writing – review and editing.

## Informed consent statement

Not applicable. This study is based on publicly available food outlet data and is exempt from human subjects' ethics committee review.

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for profit sector.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: CR has advisory positions on boards at the Nutrition Society (Food systems theme lead) and the Institute of Food Science & Technology (Sustainability working group). He is part of the Sustainable Diet Working Group, Faculty of Public Health, and the British Standards Institution/ International Organization for Standardization committee ISO/TC 34/SC 20 (Food loss and waste). CR has received payment via City, University of London for consulting for: WRAP (a UK NGO); Zero Waste Scotland; DEFRA and the FSA (UK government). CR has discussed his research in expert interviews or as part of an expert advisory group (for no fee/ Pro Bono) with the following organizations: Collider Lab, YUM Brands (2020); Fwd. (2020); Greener Beans (2020); QUT Digital

Media Research Centre (2020); Haier Israel Innovation Center, Ltd. (2021); Almond Board of California, via Porter Novelli (2022). CR has carried out Pro-bono grant reviews for the Fruit Juice Science Centre (2023). CR has been paid a Speaker's Stipend by the following events: The Folger Institute (2020). CR has chaired panels and has presented at the following organizations (for no fee/Pro Bono): British Nutrition Foundation (2023); Nutrilicious (2022/2023/2024); MyNutriWeb (2022/2023/2024); Nutrition Society (2022/2023/2024); Aprifel (2018/2023). CR is a member of the EGEA Scientific Committee and co-chair of a session of the EGEA conference (2023). This has meant his registration and flight/accommodation have been paid for by Aprifel. CR has won competitive research funding (€49,858) from the following independent foundation: The Alpro Foundation (2020). DK, JK, KS, TC, and LMJ have no conflicts of interest to declare.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2025.103254>.

## Data availability

The dataset and R scripts used in this study are available from <https://github.com/Deksha1/Scotland-Food-Environment>

## References

- Adams, J., Pell, D., Penney, T.L., Hammond, D., Vanderlee, L., White, M., 2021. Public acceptability of the UK soft drinks industry levy: repeat cross-sectional analysis of the international food policy study (2017-2019). *BMJ Open* 11 (9), e051677.
- Albalawi, A., Hambly, C., Speakman, J., 2020. Associations of food outlet densities with obesity measures identify fish and Chip shops as a uniquely important problem. *Nutrients* 12 (4), 1–68.
- Boskovic, A., Burgoine, T., Hoenink, J.C., 2025. The socioeconomic patterning of Great Britain's retail food environment: A repeated cross-sectional study of area-level deprivation and food outlet density from 2011–2024 (pre-print on MedRxiv <https://doi.org/10.1101/2025.03.07.25323573>).
- Brown, H., Kirkman, S., Albani, V., Goffe, L., Akhter, N., Hollingsworth, B., et al., 2021. 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* 70, 102600.
- Calderwood, E., Freathy, P., 2014. Consumer mobility in the Scottish isles: the impact of internet adoption upon retail travel patterns. *Transp. Res. A Policy Pract.* 59, 192–203.
- Clodagh Elrick NFaLW, 2024. Public Health Nutrition Division, Food Standards Scotland. Monitoring out of home food and drink purchases in Scotland and Great Britain (2022 and 2023). 2024 24 March.
- David Finch, H.W., Bibby, Jo, 2023. Leave no one behind- The state of health and health inequalities in Scotland.
- Disparities, OfHI, February 2025. Wider Determinants of Health: Statistical Commentary on the Location of Fast Food Outlets, February 2025 2025 Updated 10. Available from: <https://www.gov.uk/government/statistics/wider-determinants-of-health-february-2025-update/wider-determinants-of-health-statistical-commentary-february-2025#fn:1>.
- European Union Life expectancy at birth by sex 2024, 2025. updated 06/09/2024 Life expectancy at birth is defined as the mean number of years that a new-born child can expect to live if subjected throughout his life to the current mortality conditions (age specific probabilities of dying). Available from: <https://ec.europa.eu/eurostat/databrowser/bookmark/cc29308f-98b8-4aa1-b791-9539745cb0c0?lang=en>.
- Freathy, P., Marshall, D., Davies, K., Calderwood, E., 2024. The importance of the informal food economy to food access and security: an examination of the Western isles of Scotland. *J. Rural. Stud.* 111 (103392).
- Green, M.A., Hobbs, M., Ding, D., Widener, M., Murray, J., Reece, L., Singleton, A., 2021. 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* 18 (24).
- Huang, Y.R., Theis, D.R.Z., Burgoine, T., Adams, J., 2021. Trends in energy and nutrient content of menu items served by large UK chain restaurants from 2018 to 2020: an observational study. *BMJ Open* 11 (12).
- Katrine Lindberg Hansen SG, 2022. Christian Ulrich Eriksen, Torben Jørgensen, Ulla Toft effectiveness of food environment policies in improving population diets: a review of systematic reviews. *Eur. J. Clin. Nutr.* 76, 637–646.
- Kirkman, S., Hollingsworth, B., Lake, A., Hinke, S., Sorrell, S., Burgoine, T., Brown, H., 2021. Field validity and spatial accuracy of Food Standards Agency food hygiene rating scheme data for England. *J. Public Health (Oxf.)* 43 (4) e720–e7.
- Lake, A.A., Burgoine, T., Stamp, E., Grieve, R., 2012. 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.* 9, 37.

- Libuy, N., Church, D., Ploubidis, G., Fitzsimons, E., 2024. Fast food proximity and weight gain in childhood and adolescence: evidence from Great Britain. *Health Econ.* 33 (3), 449–465.
- Macdonald, L., Olsen, J.R., Shortt, N.K., Ellaway, A., 2018. 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* 51, 224–231.
- Muir, S., Dhuria, P., Roe, E., Lawrence, W., Baird, J., Vogel, C., 2023. UK government's new placement legislation is a 'good first step': a rapid qualitative analysis of consumer, business, enforcement and health stakeholder perspectives. *BMC Med.* 21 (1), 33.
- OpenAI JA, Adler, Steven, Agarwal, Sandhini, Ahmad, Lama, Akkaya, Ilge, Aleman, Florencia Leoni, Almeida, Diogo, Altmanschmidt, Janko, Altman, Sam, Anadkat, Shyamal, Avila, Red, Babuschkin, Igor, Balaji, Suchir, Balcom, Valerie, Baltescu, Paul, Bao, Haiming, Bavarian, Mohammad, Belgum, Jeff, Bello, Irwan, Berdine, Jake, Bernadett-Shapiro, Gabriel, Berner, Christopher, Bogdonoff, Lenny, Boiko, Oleg, Boyd, Madelaine, Brakman, Anna-Luisa, Brockman, Greg, Brooks, Tim, Brundage, Miles, Button, Kevin, Cai, Trevor, Campbell, Rosie, Cann, Andrew, Carey, Brittany, Carlson, Chelsea, Carmichael, Rory, Chan, Brooke, Chang, Che, Chantzis, Fotis, Chen, Derek, Chen, Sully, Chen, Ruby, Chen, Jason, Chen, Mark, Chess, Ben, Cho, Chester, Chu, Casey, Chung, Hyung Won, Cummings, Dave, Currier, Jeremiah, Dai, Yunxing, Decareaux, Cory, Degry, Thomas, Deutsch, Noah, Deville, Damien, Dhar, Arka, Dohan, David, Dowling, Steve, Dunning, Sheila, Ecoffet, Adrien, Eleti, Atty, Eloundou, Tyna, Farhi, David, Fedus, Liam, Felix, Niko, Fishman, Simón Posada, Forte, Juston, Fulford, Isabella, Gao, Leo, Georges, Elie, Gibson, Christian, Goel, Vik, Gogineni, Tarun, Goh, Gabriel, Gontijo-Lopes, Rapha, Gordon, Jonathan, Grafstein, Morgan, Gray, Scott, Greene, Ryan, Gross, Joshua, Gu, Shixiang Shane, Guo, Yufei, Hallacy, Chris, Han, Jesse, Harris, Jeff, He, Yuchen, Heaton, Mike, Heidecke, Johannes, Hesse, Chris, Hickey, Alan, Hickey, Wade, Hoeschele, Peter, Houghton, Brandon, Hsu, Kenny, Hu, Shengli, Hu, Xin, Huizinga, Joost, Jain, Shantanu, Jain, Shawn, 181 additional authors not shown, et al., 2024. GPT-4 Technical Report.; 2–24 March 4.
- Public, Health E., 2021. The food (promotion and placement). (England) Regulations 2021.
- R Core Team, 2022. R, a Language and Environment for Statistical Computing [Internet], R Foundation for Statistical Computing, Vienna, Austria.. Available from: <https://www.R-project.org/>.
- Rahilly, J., Amies-Cull, B., Chang, M., Cummins, S., Derbyshire, D., Hassan, S., et al., 2024a. 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.* 26, 101646.
- Rahilly, J., Williams, A., Chang, M., Cummins, S., Derbyshire, D., Hassan, S., et al., 2024b. 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* 87, 103237.
- Rogers, N.T., Amies-Cull, B., Adams, J., Chang, M., Cummins, S., Derbyshire, D., et al., 2024. Health impacts of takeaway management zones around schools in six different local authorities across England: a public health modelling study using PRIMETIME. *BMC Med.* 22 (1), 545.
- Sauveplane-Stirling, V., Crichton, D., Tessier, S., Parrett, A., Garcia, A.L., 2014. The food retail environment and its use in a deprived, urban area of Scotland. *Public Health* 128 (4), 360–366.
- Scarborough, P., Adhikari, V., Harrington, R.A., Elhussein, A., Briggs, A., Rayner, M., et al., 2020. 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.* 17 (2), e1003025.
- Scotland NRo, 2025. Scottish Statistics Postcode Lookup. updated Date published 24 April. Available from: <https://www.nrscotland.gov.uk/publications/scottish-statistics-postcode-lookup/>.
- Scottish Government, 2022. Consultation on restricting promotions of food and drink high in fat, Sugar or Salt. July.
- Scottish Government, A., 2018. healthier future: Scotland's diet and healthy weight delivery plan.
- Scottish Government, 2022. The Scottish Health Survey 2022 edition - Summary. In: Directorates TSGH, editor.
- Scottish Government Life Expectancy in Scotland 2020–2022 Provisional Figures, 2023. NRo, Scotland editor. Scotland.
- Scottish Government Scotland's Census, 2022. 2022 - First results - Rounded population estimates. Available from. <https://www.scotlandscensus.gov.uk/2022-results/scotland-s-census-2022-rounded-population-estimates/>.
- Scottish Government Scottish Index of Multiple Deprivation 2020, 2020. Collection of documents relating to the Scottish Index of Multiple Deprivation - a tool for identifying areas with relatively high levels of deprivation. Available from. <https://www.gov.scot/collections/scottish-index-of-multiple-deprivation-2020/>.
- Vandevijvere, S., Barquera, S., Caceres, G., Corvalan, C., Karupaiah, T., Kroker-Lobos, M. F., et al., 2019. An 11-country study to benchmark the implementation of recommended nutrition policies by national governments using the healthy food environment policy index, 2015–2018. *Obes. Rev.* 20 (Suppl. 2), 57–66.