**Supplementary Appendices**

For the paper: *Investigating foods and beverages sold and advertised in deprived urban neighbourhoods in Ghana and Kenya: A cross-sectional study.*

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**Appendix A – Location of study sites**

Low income neighbourhoods were randomly selected in each city. In Accra, the selection of a neighbourhood was informed by the Accra Poverty Mapping Exercise (CHF International, 2010; https://www.globalcommunities.org/publications/2010-accra-poverty-map.pdf). Four areas were identified as being poverty endemic. Amongst these, Ga Mashie which is made up of James Town and Ussher Town, was purposively selected. A simple random sampling exercise was then applied and James Town was selected as the neighbourhood of interest. In the city of Ho, the United Nations Human Settlements Programme (UN-HABITAT) urban profiling report informed the selection of the study site. The report highlighted that 36% of the population lived in four poor areas within the city: Bankoe, Hliha, Ahoe and Dome (UNHABITAT 2009; https://uni.unhabitat.org/wp-content/uploads/2014/07/Ghana-Ho-City-Profile.pdf). Amongst these four areas, Dome was then randomly selected. In Nairobi, we used data from the Kenya National Bureau of Statistics (KNBS) to identify the deprivation level of locations (wards), and randomly selected Makadara Constituency. Jericho, Bahati, Maringo, Hamza, Makongeni and Mbotela communities in Makadara were purposively selected as these were areas we could feasibly work in.

Figures A1-A3 visualise the data collected within our study sites. Maps were created using R and the 'ggmap' library (1). Base maps were taken from 'stamen' maps. Map tiles by Stamen Design, under CC BY 3.0. Data by OpenStreetMap, under ODbL.


**Figure A1: Location of data collection points (red points) within Accra, Ghana.**

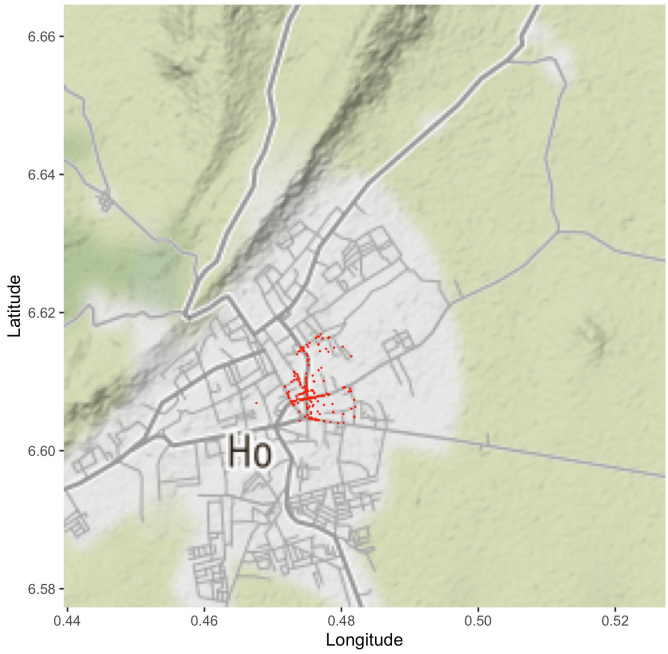


**Figure A2: Location of data collection points (red points) within Ho, Ghana.**


**Figure A3: Location of data collection points (red points) within Nairobi, Kenya.**

**Appendix B – Description of outlet, advert, food and beverage types**

Outlet type descriptions

Outlet and advertisement types were defined following a project meeting involving all of the international project partners, researchers and local field workers representing both Ghana and Kenya. The aim was to find consensus over our definitions based on individual expertise and evidence from the wider literature (summarised during discussions), as well as local subject knowledge. Definitions were then validated and refined during the pilot phase of our tool. We opted against using other existing classifications since they were often derived for other settings or countries that were not always relevant to the contexts we were collecting data in. Through designing our own classification, we developed a new system that was relevant to both urban Ghana and Kenya, as well as simple and efficient for data collection.

**Table B1: Descriptions of each outlet type.**

| Outlet type | Description |
|---|---|
| Bar/pub | A formal vendor primarily selling alcohol |
| Kiosk | A hut or cubicle selling items |
| Local vendor | Informal street seller operating on the floor (off a mat) or makeshift counter |
| Restaurant | A formal organisation where individuals sit and consume foods and beverages on site |
| Shop | A small and formal building that sells many items |
| Supermarket | A large organisation selling a diverse set of goods |
| Vegetable/fruit/food stand/table top | Informal street seller operating from a single table or stand |

We did not record mobile local vendors since they did not have a fixed location, though accept that their non-trivial prevalence means our audit has undercounted the number of outlets. We initially included categories for bakeries (n = 1), chop bars and cold stores (Ghana only, n = 11 and 2 respectively), markets (we record each outlet within the market, not the overall market it itself, n = 1) and an 'other' category (n = 36). We did not include these categories in the analyses due to their low prevalence and excluded the data from all analyses.

**Table B2: Advertisement descriptions**

| Outlet type | Description |
|---|---|
| Onsite | Signs and fittings demonstrating items sold by the outlet |
| Poster | A small printed paper sign |
| Painting | The exterior of a building that includes artwork depicting a brand |
| Billboard | A large outdoor sign |

Food and beverage type descriptions

Individual items were classified into broader groups to help improve their interpretation and minimise small number issues. We also grouped items (based on expert opinions and evidence across the literature) into whether we would expect them to increase or decrease in

consumption following the nutrition transition to situate our data within broader nutritional trends in African countries.

**Table B3: Food and beverage category descriptions.**

| Nutrition transition | Category | Examples | Healthy** |
|---|---|---|---|
| Expect to increase | Fats/oils | Cooking oils or fats | No |
| | Sugar sweetened spreads | Jam, hazelnut spread | No |
| | Fresh meat/poultry | Raw/uncooked beef, pork, chicken | Yes |
| | Fresh fish/shellfish | Raw/uncooked | Yes |
| | Milk | Milk | Yes |
| | Eggs | Eggs | Yes |
| | Sugar sweetened beverages | Cola, soda | No |
| | Alcohol | Beer, vodka, wine | No |
| | Processed/fried foods | Fried plantain, processed meats, pies | No |
| | Cakes/sweets | Cake, ice cream, chocolate | No |
| | Modern mixed dishes | Pizza, lasagne, | No |
| | Condiments* | Ketchup, shito | No |
| Expect to decrease | Staples | Grains, cereals, roots, tubers | Yes |
| | Legumes/pulses | Beans, peas, lentils | Yes |
| | Nuts/seeds | Cashews, sesame seeds | Yes |
| | Traditional dishes | Jollof rice, banku, waakye | Yes |
| | Fruits | Mango, watermelon, oranges | Yes |
| | Vegetables | Peppers, onions | Yes |

* Condiments could include products that are commercially processed from multinational companies, as well as those prepared at home or with local small-scale production.
** The classification of foods and beverages into “healthy” and “unhealthy” was informed by our related work on dietary intake (as part of the broader project), which used a nutrient profiling classification based on recognised methods (2) of foods and beverages consumed in the same cities. We did not classify items during data collection, however applied the classification after to aid the interpretation of our results.

**Appendix C – Descriptive statistics on items sold by outlet type**

Table C1 presents summary statistics on the number of items sold by outlet type. Outlet types that sold a low number of items were bars/pubs, local vendors and vegetable/fruit/food stand/table top. Restaurants, shops, and kiosks sold a greater number of items. The high proportion of vegetable/fruit/food stand/table top in James Town may help to explain the lower number of items sold on average (and lower variety as well) compared to the other locations. Formal outlets also sold a greater diversity of items than compared to informal outlets.

**Table C1: Summary statistics of items sold by outlet type.**

| Outlet type | Mean items sold | Standard Deviation | Per cent selling 1 item | Per cent selling 2 or fewer items | Per cent selling less than 5 items |
|---|---|---|---|---|---|
| Bar/pub | 2.63 | 1.87 | 17.81 | 75.34 | 86.30 |
| Kiosk | 4.27 | 2.84 | 18.95 | 34.68 | 61.69 |
| Local vendor | 2.98 | 2.04 | 26.85 | 57.41 | 77.78 |
| Restaurant | 6.60 | 3.39 | 0.00 | 10.00 | 25.00 |
| Shop | 6.78 | 3.55 | 10.00 | 19.50 | 28.00 |
| Supermarket | 10.67 | 3.84 | 0.00 | 0.00 | 11.11 |
| Vegetable/fruit/food stand/table top | 3.05 | 1.94 | 22.25 | 47.52 | 81.59 |
| Informal | 3.46 | 2.38 | 15.36 | 31.41 | 57.34 |
| Formal | 5.88 | 3.76 | 3.23 | 9.39 | 14.29 |

There were some noticeable differences in the number of advertisements by outlet type (Table C2). You most likely to encounter an advertisement within a supermarket (with the mean count also being three times higher than any other outlet). Bars/pubs also had high proportion of adverts within them, as did restaurants and shops. There was low prevalence in table tops and local vendors. Formal outlets were more likely to contain adverts.

**Table C2: Summary statistics of items advertised by outlet type.**

| Outlet type | Mean items advertised | Standard Deviation | Per cent containing an advert |
|---|---|---|---|
| Bar/pub | 1.01 | 0.84 | 69.86 |
| Kiosk | 0.41 | 1.06 | 24.60 |
| Local vendor | 0.44 | 1.30 | 16.67 |
| Restaurant | 1.40 | 2.19 | 55.00 |
| Shop | 0.95 | 1.53 | 48.50 |
| Supermarket | 3.44 | 3.13 | 88.89 |
| Vegetable/fruit/food stand/table top | 0.15 | 0.77 | 7.14 |
| Informal | 0.28 | 0.98 | 10.27 |
| Formal | 1.07 | 1.57 | 16.34 |

**Table C3: Percentage of foods and beverages sold between formal and informal outlets.**

| | Formal | Informal |
|---|---|---|
| Fats/oils | 46.9 | 16.0 |
| Sugar sweetened spreads | 45.2 | 12.6 |
| Fresh meat/poultry | 16.7 | 16.4 |
| Fresh fish/shellfish | 9.8 | 12.3 |
| Milk | 52.5 | 20.1 |
| Eggs | 49.2 | 30.2 |
| Sugar sweetened beverages | 75.7 | 22.8 |
| Alcohol | 40.0 | 3.5 |
| Processed/fried foods | 43.9 | 40.5 |
| Cakes/sweets | 53.8 | 22.0 |
| Modern mixed dishes | 2.3 | 5.4 |
| Condiments | 39.0 | 16.3 |
| Staples | 52.8 | 47.2 |
| Legumes/pulses | 24.3 | 14.2 |
| Nuts/seeds | 27.9 | 12.2 |
| Traditional dishes | 13.1 | 27.5 |
| Fruits | 3.0 | 16.7 |
| Vegetables | 19.0 | 31.0 |

**Table C4: Percentage of foods and beverages advertised between formal and informal outlets.**

| | Formal | Informal |
|---|---|---|
| Fats/oils | 3.6 | 5.5 |
| Sugar sweetened spreads | 4.1 | 2.7 |
| Fresh meat/poultry | 6.5 | 13.6 |
| Fresh fish/shellfish | 3.0 | 8.2 |
| Milk | 27.2 | 20.9 |
| Eggs | 3.0 | 6.4 |
| Sugar sweetened beverages | 50.3 | 42.7 |
| Alcohol | 42.6 | 5.5 |
| Processed/fried foods | 7.1 | 12.7 |
| Cakes/sweets | 10.1 | 6.4 |
| Modern mixed dishes | 3.6 | 4.5 |
| Condiments | 5.9 | 18.2 |
| Staples | 14.2 | 15.5 |
| Legumes/pulses | 1.8 | 1.8 |
| Nuts/seeds | 1.8 | 1.8 |
| Traditional dishes | 3.0 | 12.7 |
| Fruits | 1.8 | 0.9 |
| Vegetables | 1.8 | 7.3 |

We compared the foods and beverages being sold (Table C3) and advertised (Table C4) in formal and informal outlets. The items sold between formal and informal outlets were somewhat different. Most products were more common in formal outlets, reflecting that they sold a greater number of items (see Table C1). Noticeably, unhealthy foods were more common in formal outlets (e.g. fats/oils 46.9% vs 16.0%; sugar sweetened spreads 45.2% vs 12.6%), with similar patterns for drinks as well (i.e. sugar sweetened beverages 75.7% vs 22.8%; alcohol 40.0% vs 3.5%). Not all items were more common in formal outlets; vegetables and fruits were more common in informal outlets. Fresh meat, poultry and fish were similar between outlet type. There was little difference in the foods and beverages being advertised. Only alcohol displayed a large difference, with it being uncommon in informal outlets than compared to formal outlets where it was more prevalent.

We repeated these summary statistics by specific outlet type as well (see Tables C5 to C7). In summary, they present similar patterns to those described above. Foods and beverages sold by local vendors and stands/table tops tended to be dominated by healthier foods and raw ingredients (Table C5). Supermarkets and shops had a greater diversity of items sold. Pubs and bars mostly sold alcohol and sugar sweetened beverages, with a few selling snacks or fresh meat/poultry. The foods and beverages sold by outlets differed to those advertised (Table C6). There was less diversity with lower values reported (bar supermarkets). Many of the foods and beverages advertised represented the most common items sold (i.e. the higher values in Table C5). For advert types, drinks were most commonly advertised. These were particularly common in posters, with onsite and painting having a greater diversity of foods and beverages advertised (reflecting outlet fronts advertising what they sold).

**Table C5: Percentage of foods and beverages sold by outlet type.**

| | Supermarket | Shop | Kiosk | Stand/table top | Local vendor | Restaurant | Bar/pub |
|---|---|---|---|---|---|---|---|
| Fats/oils | 88.9 | 64.0 | 30.3 | 10.2 | 3.5 | 25.0 | 0.0 |
| Sugar sweetened spreads | 77.8 | 62.6 | 24.3 | 7.5 | 3.5 | 15.0 | 1.4 |
| Fresh meat/poultry | 44.4 | 6.9 | 16.7 | 14.2 | 22.8 | 80.0 | 23.3 |
| Fresh fish/shellfish | 22.2 | 5.9 | 9.2 | 12.6 | 18.4 | 65.0 | 4.1 |
| Milk | 88.9 | 72.4 | 34.3 | 15.8 | 2.6 | 25.0 | 0.0 |
| Eggs | 88.9 | 63.5 | 39.0 | 25.7 | 25.4 | 50.0 | 4.1 |
| Sugar sweetened beverages | 88.9 | 77.8 | 39.8 | 15.5 | 8.8 | 50.0 | 75.3 |
| Alcohol | 11.1 | 21.7 | 4.8 | 2.4 | 4.4 | 25.0 | 98.6 |
| Processed/fried foods | 88.9 | 51.7 | 36.7 | 39.1 | 53.5 | 75.0 | 8.2 |
| Cakes/sweets | 0.0 | 74.9 | 34.3 | 19.3 | 3.5 | 10.0 | 1.4 |
| Modern mixed dishes | 22.2 | 1.5 | 3.2 | 6.2 | 7.9 | 5.0 | 1.4 |
| Condiments | 88.9 | 53.7 | 26.7 | 10.5 | 12.3 | 10.0 | 0.0 |
| Staples | 77.8 | 62.1 | 51.4 | 42.1 | 54.4 | 95.0 | 12.3 |
| Legumes/pulses | 66.7 | 29.1 | 21.5 | 9.7 | 13.2 | 40.0 | 1.4 |
| Nuts/seeds | 77.8 | 36.9 | 15.1 | 12.3 | 5.3 | 5.0 | 2.7 |
| Traditional dishes | 22.2 | 4.4 | 19.5 | 31.6 | 31.6 | 75.0 | 19.2 |
| Fruits | 22.2 | 2.5 | 16.3 | 17.7 | 14.0 | 10.0 | 0.0 |
| Vegetables | 33.3 | 15.3 | 33.1 | 30.0 | 29.8 | 55.0 | 17.8 |

**Table C6: Percentage of foods and beverages advertised by outlet type.**

| | Supermarket | Shop | Kiosk | Stand/table top | Local vendor | Restaurant | Bar/pub |
|---|---|---|---|---|---|---|---|
| Fats/oils | 0.0 | 6.1 | 6.6 | 3.3 | 5.3 | 0.0 | 0.0 |
| Sugar sweetened spreads | 25.0 | 5.1 | 4.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fresh meat/poultry | 0.0 | 5.1 | 6.6 | 13.3 | 36.8 | 45.5 | 2.0 |
| Fresh fish/shellfish | 0.0 | 3.0 | 3.3 | 6.7 | 26.3 | 18.2 | 0.0 |
| Milk | 50.0 | 42.4 | 32.8 | 6.7 | 5.3 | 0.0 | 0.0 |
| Eggs | 12.5 | 3.0 | 6.6 | 10.0 | 0.0 | 9.1 | 0.0 |
| Sugar sweetened beverages | 62.5 | 55.6 | 52.5 | 36.7 | 21.1 | 45.5 | 39.2 |
| Alcohol | 12.5 | 15.2 | 3.3 | 6.7 | 10.5 | 54.5 | 98.0 |
| Processed/fried foods | 37.5 | 6.1 | 4.9 | 20.0 | 26.3 | 27.3 | 0.0 |
| Cakes/sweets | 37.5 | 14.1 | 9.8 | 3.3 | 0.0 | 0.0 | 0.0 |
| Modern mixed dishes | 12.5 | 4.0 | 3.3 | 6.7 | 5.3 | 9.1 | 0.0 |
| Condiments | 12.5 | 9.1 | 6.6 | 30.0 | 36.8 | 0.0 | 0.0 |
| Staples | 50.0 | 18.2 | 9.8 | 16.7 | 31.6 | 18.2 | 0.0 |
| Legumes/pulses | 12.5 | 1.0 | 1.6 | 3.3 | 0.0 | 9.1 | 0.0 |
| Nuts/seeds | 25.0 | 1.0 | 3.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| Traditional dishes | 0.0 | 1.0 | 6.6 | 10.0 | 36.8 | 18.2 | 3.9 |
| Fruits | 25.0 | 1.0 | 0.0 | 3.3 | 0.0 | 0.0 | 0.0 |
| Vegetables | 12.5 | 1.0 | 4.9 | 13.3 | 5.3 | 0.0 | 2.0 |

**Table C7: Percentage of foods and beverages advertised by advert type.**

| | Billboard | Poster | Onsite | Painting |
|---|---|---|---|---|
| Fats/oils | 22.2 | 3.1 | 3.6 | 5.8 |
| Sugar sweetened spreads | 11.1 | 3.6 | 3.6 | 1.9 |
| Fresh meat/poultry | 11.1 | 5.7 | 15.5 | 13.5 |
| Fresh fish/shellfish | 0.0 | 2.6 | 10.0 | 7.7 |
| Milk | 22.2 | 23.8 | 28.2 | 21.2 |
| Eggs | 11.1 | 4.7 | 2.7 | 1.9 |
| Sugar sweetened beverages | 44.4 | 57.5 | 49.1 | 28.8 |
| Alcohol | 44.4 | 34.2 | 23.6 | 42.3 |
| Processed/fried foods | 0.0 | 6.2 | 10.9 | 13.5 |
| Cakes/sweets | 22.2 | 9.8 | 10.0 | 9.6 |
| Modern mixed dishes | 11.1 | 5.7 | 2.7 | 3.8 |
| Condiments | 11.1 | 6.2 | 10.9 | 17.3 |
| Staples | 11.1 | 15.0 | 19.1 | 13.5 |
| Legumes/pulses | 0.0 | 2.6 | 3.6 | 0.0 |
| Nuts/seeds | 11.1 | 2.6 | 0.9 | 0.0 |
| Traditional dishes | 0.0 | 5.7 | 10.0 | 9.6 |
| Fruits | 11.1 | 1.0 | 0.9 | 3.8 |
| Vegetables | 11.1 | 3.1 | 2.7 | 9.6 |

**Appendix D – Evaluation of the number of latent classes for each model**

Latent Class Analysis is an exploratory approach used when no theoretical background can determine what the expected latent classes are. Since no previous studies have undertaken a classification of the food environment in Africa, there was no understanding of what latent classes to expect particularly how many classes best describe the data. To select the number of latent classes in our data, we ran multiple models and compared their model fit. We searched for the parsimonious solution. Each additional latent class in our model would likely result in improved model fit, however additional classes introduce added complexity to the model making it harder to interpret.

We ran latent class analyses on our data varying the number of classes between 1 and 10. We did not consider greater than 10 classes since such models would not form much of a data reduction and be difficult to interpret (making any typology less useful). We then compared three model fit statistics (AIC, BIC and $G^2$) to assess how well they could explain the data. We searched for distinct 'knee points' in graphs of model fit whereby additional classes did not result in significant model improvement (i.e. added complexity in additional classes resulted in minimal gains in model fit). We also compared the model results where it was not clear to aid our interpretation of which model to select.

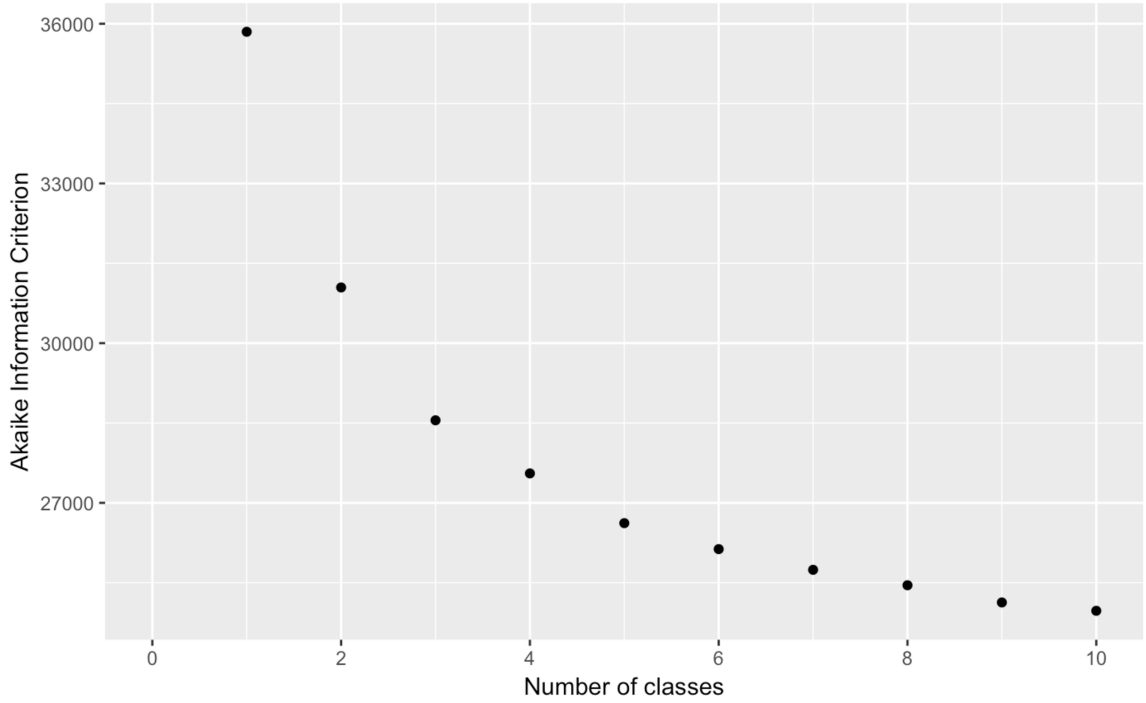


**Figure D1: Comparison of Akaike Information Criterion (AIC) for latent class analyses with varying number of classes (1 to 10).**

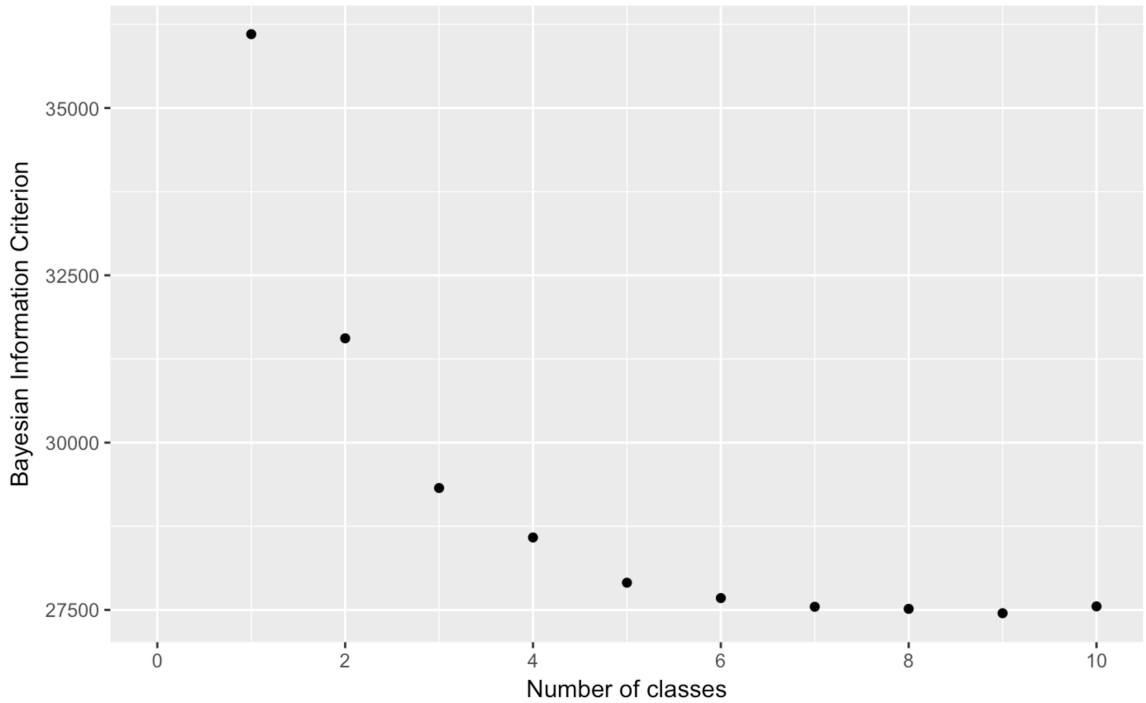


**Figure D2: Comparison of Bayesian Information Criterion (BIC) for latent class analyses with varying number of classes (1 to 10).**

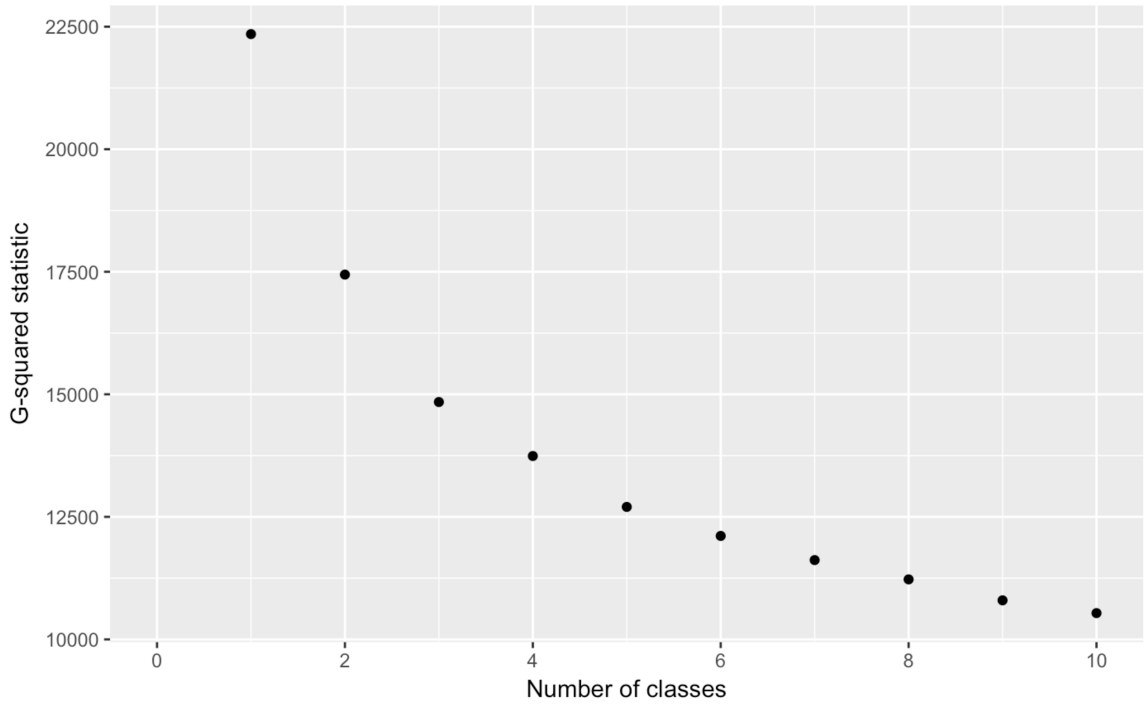


**Figure D3: Comparison of $G^2$ statistic for latent class analyses with varying number of classes (1 to 10).**

The AIC and $G^2$ models produced similar patterns (Figures D1 and D3). For the BIC the pattern was clearer (Figure D2). An increasing number of groups produces better fitting models, but a decreasing rate of improvement. There is no clear knee point though. Following a 5 class solution there is little improvement with subsequent additional class added. Since we are looking for the parsmonious solution, a 5 class solution might work best given that additional classes are not associated with large improvements in model fit. The results for BIC are clearer (Figure D2). We broadly see an improving solution upto 5 classes, whereby model performance is flat onwards. Based on these metrics, a 5 class solution was selected as the final model. Exploring model interpretation of additonal class solutions does not reveal any distinct classes, merely splitting up established classes into less similar classes that differ on small characteristic.

## References

1. Kahle D, Wickham H. 2013. ggmap: Spatial Visualization with ggplot2. *The R Journal* 5: 144-161.
2. Drewnowski, A. 2005. Concept of a nutritious food: toward a nutrient density score. *American Journal of Clinical Nutrition* 82: 721–732.