Social deprivation is associated with poorer to healthy eating dietary goals: analysis of household food purchases.

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ABSTRACT

Background

The Scottish Dietary Goals (SDGs) were published to promote healthier diets. The higher cost of healthier diets may be a barrier to their adoption by households in deprived areas. The aim was to estimate dietary intakes relevant to the SGDs, derived from purchase data of food and drinks brought into the home by area of deprivation.

Methods A cross-sectional study of estimated intakes of food and nutrients, and on fruit and vegetables (F&V) specifically, from Kantar Worldpanel household food purchase data in Scotland from 2012 (n = 2586). Households were grouped by area based index of multiple deprivation.

Results Diets of households were further from achieving the SDGs as deprivation increased. Linear regression showed that estimated intakes of oil rich fish decreased, and red and processed meat increased with increasing deprivation (both $p<0.001$), while estimated intakes of F&V decreased ($p<0.001$) mainly because of lower amounts of fresh F&V ($p<0.001$). Negative linear associations were observed between deprivation and the amount spent per person on F&V ($P<0.001$), and the amount spent per 100g of F&V ($p<0.001$).

Conclusions This study provides further insights into the relationship between social deprivation and diet quality in Scotland, notably in amounts of fresh F&V purchased.

Keywords: Diet quality, deprivation, energy density, fruit and vegetables

Introduction

Poor diet quality is associated with a greater risk of obesity [1] and a range of chronic diseases [2]. On average, people in Scotland consume a diet in which total fat, saturated fat and sugar contribute more to energy intake than is recommended in the Scottish Dietary Goals (SDG) [3]. Salt intakes are also higher, and fruits, vegetables and oil rich fish are lower than recommended amounts.

The SDGs were published in 2013 to monitor improvement of dietary intakes and the health of the population and to assist policy development in reducing the burden of obesity and diet-related disease in Scotland [4]. They were developed from, and share many of the objectives of, the earlier (1996) Scottish Dietary Targets. One of the SDGs recommends increasing fruit and vegetable (F&V) intake to more than 400g/day, with average intakes estimated from the Living Costs and Food Survey, which collects purchase data from a representative sample of households in Scotland, being 269g/day in 2012 [5]. Increasing F&V intakes will contribute directly to other SDGs of lowering energy density and increasing fibre intakes, because of the relatively low energy density and high fibre content of these foods. The F&V SDG includes frozen and canned products and, depending on the product, these are not always less nutrient dense than fresh F&V [6, 7]. Healthier diets tend to be more expensive than less healthy diets [8, 9], partly because fruit and vegetables are expensive compared to energy dense, highly processed foods [10] and are a large component of a healthy diet. This is partly because energy dense foods tend to be dried products, or manufactured products that are mixtures of refined complex carbohydrates, fats and sugars with long shelf lives. Frozen and canned F&V may be seen as a more attractive alternative to fresh produce, especially for lower income households, because of their longer shelf lives.

This study aimed to explore estimated intakes of food and drink, derived from purchase data of food and drinks brought into the home (excluding those consumed outside the home) collected by Kantar Worldpanel (KWP), that are relevant to the Scottish Dietary Goals, with a focus on the fruit and vegetable goals, and investigate whether there are differences by area of deprivation.

Methods

KWP use UK census data and the Broadcasters' Audience Research Panel Establishment Survey to define and predict demographic targets and to monitor the national representativeness of their panel of 3,000 households in Scotland. Compliance with scanning is encouraged by frequent postal, email or telephone reminders. Households report food and drink purchases for periods ranging from months to many years and participation is rewarded with points redeemable for consumer goods [11]. All food and drink purchases brought into the home are recorded by scanning till receipts and product bar codes, with non-bar-coded items that are sold loose also being recorded. Items consumed outside the home (for example in a restaurant or take-away outlet) and home-grown food are not available in the dataset used for this study. The information recorded includes; the name of the item, weight/volume, price, and date of purchase. Analyses were conducted on Scottish households (n = 2586 households) collected by KWP during 2012.

Demographic characteristics

KWP collected household information including the age and sex of each household member. Socio-economic disadvantage was measured through the Scottish Index of Multiple Deprivation (SIMD), which is based on ranking from one to five (with one as the most deprived) of geographic areas by a single value calculated from seven domains; current income, employment, health, education skills and training, geographic access to services, housing and crime [12]. Each household's SIMD in 2012 was obtained by KWP through data linkage to the Scottish Neighbourhood Statistics database [13] using home postcodes. Annual household income was coded by KWP into 8 bands, from £0–£9999 (Band 1) to £70 000 + (Band 8).

Equalizing households

Household composition within KWP varies by the number of people and their ages, therefore household energy requirements (and the amount of food needed to be bought each week) will also vary. To account for this equalized household values were used to give per person values comparable to the SDGs [19]. A reference energy requirement for all adults was estimated as the average for 19-59 year old males and females (9.3MJ per day) [14]. The contribution of children under 2 years old was not included, but for all other children and adolescents (2 – 18 years old), a *pro rata* adult equivalent estimated energy requirement was calculated. The total estimated energy requirement for each household was calculated by summing the values for adults and adult equivalent requirements for children. Household values were then divided by the total number of adult equivalents to provide a per person estimation.

Purchase and consumption data

KWP collect data on the weight and volume of foods and drinks “as purchased” whereas the SDG are based on the amounts foods “as consumed”. Therefore adjustments were made to account for any food preparation weight changes and food waste between purchase and consumption. Food waste was defined as “unavoidable waste” (e.g. vegetable peelings) and “avoidable waste” (food that could have been eaten with better management, but was uneaten because it had spoiled or become out-of-date) [15]. Unavoidable waste was estimated for each food or drink item using information from food composition tables [16]. A waste factor of 10% was used where some waste was assumed but where information was not available (e.g. canned unspecified vegetables). An avoidable waste factor was estimated for each of the 2091 food groups that were defined by KWP for retail purposes by mapping food products on to the categories for which Waste and Resource Action Programme

(WRAP) have published household level waste information [17]. A final adjustment for the difference in avoidable waste by household size was estimated based on the overall amount of avoidable waste, and the amounts of avoidable waste created by households of different sizes [15, 17-19]. Amounts of food and drink purchased were, therefore, adjusted for estimated avoidable and unavoidable waste to amounts that were available for consumption; these amounts are referred to in this paper as "estimated intakes".

Nutrition information

Nutritional information (energy, protein, total fat, saturated fat, carbohydrate, total sugars, fibre and sodium) was collected by KWP from product labels where available. Approximately 80% of products included in the current analyses use nutritional information taken directly from product labels, or from food composition tables, with the remainder imputed from product group averages. Many food products within the KWP dataset are composite dishes (e.g. ready-meals such as lasagne). Disaggregation of composite dishes and foods was conducted as detailed below.

Estimation of food and nutrient intakes relevant to the Scottish Dietary Goals

The equalized per person estimated intakes of fruit and vegetables, red and processed meat, oil-rich fish, salt, fibre, and percentage energy from fat, saturated fat and non-milk extrinsic sugars (NMES), which is a definition similar to "added sugars", along with energy density were calculated, and compared to SDGs.

Energy density: Energy density (kcal/100g) of the food purchased was calculated from the contribution of all food and milks, but excluded all drinks (tea, coffee, water,

fruit juices, squashes, sugar-containing drinks, and artificially-sweetened drinks) [4, 20, 21].

Red and processed meat: The proportion of meat in each food item was calculated based on the KWP grouping and representative ready-meal ingredients, recipes from food composition tables [16], from similar foods and dishes, or from internet sources. Similarly, the red meat and processed meat proportions were calculated.

Oil-rich fish: The proportion of oil-rich fish in each food item was estimated as above. Oil-rich fish were categorized according to the Scientific Advisory Committee on Nutrition definition [22]. For fresh, frozen and canned oil-rich fish a factor of 1 was assigned. Canned tuna was not categorized as oil-rich fish [22]. The proportion of fish in fish-based ready meals was taken to be 0.5, of which 0.3 was taken to be oil-rich fish where the type of fish was not specified [23]. A value of 0.3 was also assumed for unspecified fish and fish products.

Fruit and vegetables: Foods that were entirely F&V were identified from the KWP food grouping and allocated a factor of 1. For composite foods (e.g. pizza) food group proportions were estimated as for red and processed meat, above. Foods in the various “ready meal” categories, where there was no indication of the meal’s composition, were assumed to contain 40% vegetables [24, 25]. Pulses, baked beans, lentils, and vegetable and fruit juices were allocated a value of 1. A contribution cap in the recommendations of one portion per day for pulses and one portion per day for fruit and vegetable juices was not applied because it was not possible to estimate over how many days food and drink purchases were consumed. This estimate of F&V intake corresponded closely to that of the SDG and are referred to here as Total F&V.

Purchases of discrete F&V items were coded as fresh, frozen, canned or other (e.g. dried or pickled), and vegetable and fruit juices were identified separately. Estimated intakes of these are referred to here as “distinct F&V”.

***Fat*:** The contribution of total fat and saturated fat to food energy was calculated from food labels.

Fibre: Fibre reported in food labels is based on the Association of Analytical Communities (AOAC) method [26] rather than the Non-Starch Polysaccharide value given in the SDGs [4]. Therefore, fibre values calculated using the AOAC method are not directly comparable to the SDG, and are likely to be over-estimated.

Sugars: Food labels give a total sugar value only whereas the SDG for sugar relates to NMES, which is similar to “added sugars”. The proportion of the total sugar content that was NMES of the 2091 food groups was estimated using methods described by Kelly *et al.* [27]. Briefly, this proportion was 1 for table sugar, honey and fruit juice, and 0.5 for dried and canned fruit, and preserves. For manufactured products the proportions of naturally occurring sugars, added sugars and milk sugar were estimated based on the approximate proportions of sugar containing ingredients. NMES proportions were calculated as the sum of added sugars, and naturally occurring sugars using the proportions of 1 or 0.5 as above.

Salt: Salt in food items was calculated as 2.5 times the sodium content of foods. Table salt was not included as it was clear from purchasing patterns across the year that not all table salt was for consumption.

Statistical analysis

Analyses were conducted using SPSS Version 22 (SPSS/IBM Corp, Armonk, New York, NY). One sample t-tests were used to compare average estimated intakes against the SDGs. ANOVA, with a least significant difference adjustment for *post hoc*

multiple comparisons was used to test for differences in expenditure, energy density, and estimated nutrient and food intakes by groups of deprivation. Associations between level of deprivation and expenditure, energy density, and estimated nutrient and food intakes were assessed by linear regression.

Results

Household demographic information is given in table 1. Household composition did not differ by SIMD ($p = 0.288$), but the numbers of households in, and median household income of, each group by SIMD were significantly different (both $p < 0.001$). Mean (SD) household KWP recording period was 37.5 (14.5) weeks.

Dietary energy density, and estimated intakes of foods and nutrients failed to meet all of the SDGs ($p < 0.001$), with the exception of estimated intakes of red and processed meat, and salt (table 2). Although mean estimated intakes of red and processed meat were within the SDG upper limit of 70g per person per day (52.0g per person per day, $p < 0.001$), these did not include foods consumed outside the home, and total intakes of red and processed meat are likely to have been higher. Similarly, estimated intakes of fruit and vegetables, and fibre, failed to meet the SDG minimum recommended limit but did not include foods consumed outside the home. Estimated average salt intake was below the SDG upper intake, but did not include table salt, or, again, salt added to and in foods eaten outside the home. Distinct F&V contributed 75% of total F&V intakes, with fresh F&V being the greater part by far (57%). The remainder of the total F&V came from vegetable and fruit juices, and F&V within composite dishes.

Estimated dietary intakes by deprivation

Weekly expenditure on food and drinks, when expressed per household and per equivalized person, increased linearly from households in areas of greatest deprivation (SIMD 1) to lowest deprivation (table 2).

Statistically significant linear associations were observed between level of deprivation and all SDGs, with the exception of percentage energy from total fat and saturated fat (table 2). Diets of households were further from achieving the SDGs as

level of deprivation increased. Dietary energy density and estimated intakes of oil-rich fish, fruit and vegetables, and fibre were furthest from the SDG for all households at all levels of deprivation.

Estimated intakes of distinct F&V increased with decreasing level of deprivation with fresh F&V being the main contributor to this effect as there were no statistically significant differences across SIMD groups for estimated intakes of frozen, canned or “other” F&V. Linear associations were observed between level of deprivation and the amount spent per person on distinct F&V and fruit juice, and the amount spent per 100g of distinct F&V purchased.

Discussion

Main findings of the study

Households, on average, failed to meet the Scottish Dietary Goals, with the exception of red and processed meat, and salt, although these are likely to be underestimates as the contribution of food eaten outside the home was not included. Significant linear associations were observed between level of deprivation and, dietary energy density and estimated intakes of most of the SDG foods and nutrients. Households in the least deprived areas had estimated intakes nearer to achieving the SDGs.

What is already known on this topic

Barton & Wrieden [25] previously showed a linear association between SIMD and total F&V intakes in the Living Costs and Food Survey. A bigger difference between the two extremes of level of deprivation (200g/d and 348g/d per person for the most and least deprived quintiles of SIMD respectively) was reported, although these values are not directly comparable to those of the current study as the former are *per capita* and weighted to the Scottish population. They also included food eaten outside the home. This notwithstanding it is apparent that people living in households in more deprived areas consumed fewer F&V than did those in less deprived areas.

The Living Costs and Food Survey also showed a significant positive linear association between SIMD and dietary energy density [25]. Increasing the amounts of fruits and vegetables in the diet has been suggested as a way of lowering overall energy density in order to limit, or even lower, energy intakes by displacing more energy dense and less satiating foods [28]. All SIMD groups were far from meeting the

SDG for energy density, even households in the least deprived areas who purchased more fruits and vegetables.

Although expenditure on food and drink decreased in households from the least to the most deprived areas this is likely to represent a larger proportion of the household budget being spent on food and drink for households in the more deprived areas [29]. A recognized barrier to having a healthy diet in deprived areas is access to healthy food at affordable prices; price is an important factor driving food choice [8]. Cummins et al. [30] reported no clear pattern of fruit and vegetables prices by area of deprivation across Scotland, but generally that prices decreased with increasing store size. Availability of a small selection of fresh, frozen and canned F&V was poorest in small stores located in the most deprived areas of Scotland, but availability was good across all quintiles of level of deprivation in medium and large stores [30]. Store size and type, and level of deprivation of the area were related to the quality of fresh F&V that were available, with the lowest quality being in more deprived areas [31], although differences in subjectively rated quality were not great. Therefore, price is important in influencing the purchasing of F&V, but the presence of large stores in an area has a greater influence on the availability and, to a lesser extent, price of F&V than does the level of deprivation of the area. The effect of level of deprivation on access to fresh F&V is mediated by location, with better physical access in deprived urban than less-deprived urban locations. Outside urban areas the association tended to be reversed [32].

What this study adds

This is the first study to investigate the relationship between level of deprivation and estimated food and nutrient intakes of households in Scotland using longitudinal collected household purchase data. Estimated intakes were considered against the Scottish Dietary Goals. The amount of money spent per person on food and drink, and F&V, increased from most to least deprived area. Uniquely, findings of this study are that the amount spent per 100g of F&V also increased from most to least deprived area, because of the increasing proportion of fresh F&V bought rather than a difference in the prices paid. Households in the least deprived areas had higher estimated intakes of F&V, whether measured as total F&V or distinct F&V. The higher distinct F&V amounts being mainly because of higher amounts of fresh F&V.

Notably, there were no differences in the amount of frozen or canned F&V across quintile of deprivation. Although households in less deprived areas bought more fresh F&V, this did not appear to displace frozen or canned F&V. Thus, it would appear that households with more money available to spend on food purchased more F&V overall and that this was achieved mainly by purchasing more fresh F&V.

Limitations of this study

A limitation of the data used in the current analyses is that food and drink consumed outside the home was not recorded. Evidence from similar studies suggests that the types of foods eaten inside and outside the home differs, with the latter, in 2012, contributing only 1% and 2% of total fruit and vegetable intakes respectively, excluding fruit and vegetables incorporated into composite dishes [33]. For red and processed meat, and fish and fish-based dishes, the proportions were higher, around

7% and 9% respectively [33]. Fruits and vegetables grown at home in gardens or allotments were also not included, and these contributed 2.7% of total fruit and vegetables in 2012 [33]. Therefore, the effects of omitting eaten out food, and home-grown food, will have been relatively small for fruit and vegetables intakes and larger, but still less than 10%, for meat and fish intakes.

Apportioning food and drink purchases based on estimated energy requirements may introduce some error when estimating per person food and nutrient intakes because some foods are more likely to be consumed by adults and others more likely to be consumed by children. The method also assumes that all members of the sample have average level energy requirements; physically active individuals will tend to raise estimated per person energy and food intakes whereas less active individuals will tend to lower it.

Food and drink purchases were adjusted for estimated food waste, and differences in waste by households size was also taken into account when estimating the amount of food available for consumption. Several household factors appear to be correlated with the amount of avoidable food and drink waste including the age of the main shopper, household composition, job status and life-stage [34]. It was not possible to account for all of these, but the strongest correlate with avoidable food and drink waste in the WRAP survey, household size, was used. It is possible that our method of adjustment for avoidable waste introduced some bias in the estimation of food and nutrient intakes.

The KWP consumer panel may differ from other surveys as they report lower household incomes, are more likely to be middle aged and have a greater proportion of multiple-adult households compared to households participating in the Living Costs and Food Survey [11]. Also, there is evidence that not all food purchases that

are brought into the home are recorded by panel members, with fruit and fish appearing to be the food groups particularly different, when compared to reporting in the Living Costs and Food Survey [35]. Therefore, the amounts of produce reported are likely to be under estimated.

These analyses compared purchase data collected in 2012 against dietary goals set in 2013. However, many of the 2012 SDGs are the same or similar to the 1996 Scottish Dietary Targets they replace and other dietary recommendations.

Conclusion

On average households failed to meet the Scottish Dietary Goals, with the exception of red and processed meat, and salt.

Households in the most deprived areas had estimated intakes that were further from achieving the Goals and they spent less money per person on food and drink, and fruit and vegetables, than did households in less deprived areas. They purchased less fruit and vegetables overall and this was mainly through purchasing less fresh than frozen or canned produce.

This study adds to the evidence on deprivation and diet inequality.

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Table 1. Demographic characteristics of the Kantar Worldpanel households by Scottish Index of Multiple Deprivation

	All	1 Most deprived	2	3	4	5 Least deprived
Number of households	2586	439 (17.0%)	571 (22.1%)	565 (21.8%)	543 (21.0%)	468 (18.1%)
Number of adult males	2389	391	506	513	531	448
Number of adult females	2648	452	585	575	562	474
Number of children (<18 years old)	1631	287	331	322	398	293
Median income band [1]	Band 3 (£20,000 to £29,999)	Band 2 (£10,000 to £19,999)	Band 3 (£20,000 to £29,999)	Band 3 (£20,000 to £29,999)	Band 4 (£30,000 to £39,999)	Band 4 (£30,000 to £39,999)

[1] Median annual household income band.

Table 2. Estimated intakes by area based level of deprivation (Scottish Index of Multiple Deprivation). Mean and 95% C.I.s

	SDG	All	1 Most deprived	2	3	4	5 Least deprived	P ANOVA	P for linear association
Energy intake (MJ)		6.98 (6.87, 7.09)	6.83 (6.53,7.13)	7.02 (6.78,7.26)	7.15 (6.92,7.38)	7.05 (6.81,7.29)	6.80 (6.57,7.03)	0.248	0.916
Energy density (kcal/100g)	=< 125	165 (164,166)	168 (165,171)	167 (165,170)	166 (164,168)	164 (162,166)	158 (155,160)	<0.001	<0.001
Fruit and vegetables intake (g/day)	>400	257 (251, ,262)	228 (214,242)	244 (232,256)	256 (243,268)	267 (254,279)	288 (274,301)	<0.001	<0.001
Oil-rich fish (g/day)	20	3.3 (3.1,3.5)	2.7 (2.3,3.2)	2.9 (2.5,3.4)	3.5 (3.1,3.9)	3.4 (3,3.8)	4.0 (3.5,4.4)	0.001	<0.001
Red and processed meat (g/day)	=<70	52.0 (50.6, 53.3)	54.7 (51,58.5)	54.6 (51.7,57.5)	53.7 (50.7,56.7)	49.9 (47.2,52.6)	46.4 (43.8,48.9)	<0.001	<0.001
Red meat (g/day)	N/A	24.1 (23.4, 24.9)	25.8 (23.9,27.6)	25.0 (23.5,26.5)	25.6 (23.8,27.5)	22.7 (21.2,24.2)	21.5 (20.1,22.9)	0.001	<0.001
Processed meat (g/day)	N/A	27.8 (27.0, 28.6)	29.0 (26.6,31.3)	29.6 (27.8,31.4)	28.1 (26.5,29.7)	27.2 (25.6,28.7)	24.9 (23.3,26.4)	0.003	<0.001
Total fat (% food energy)	=<35	37.3 (37.1, 37.5)	37.3 (36.8,37.8)	37.5 (37,37.9)	37.5 (37,38)	37.2 (36.7,37.7)	37.0 (36.4,37.5)	0.522	0.186
Saturated fat (% food energy)	=<11	14.2 (14.1, 14.2)	14.0 (13.8,14.3)	14.1 (13.9,14.3)	14.3 (14.1,14.5)	14.1 (13.9,14.3)	14.2 (14,14.4)	0.429	0.352
NMES (% food energy)	<11	12.4 (12.3, 12.6)	12.7 (12.2,13.2)	12.8 (12.4,13.1)	12.4 (12,12.8)	12.4 (12,12.8)	11.8 (11.5,12.2)	0.018	0.002
Salt (g/day)	6	4.5 (4.4, 4.6)	4.5 (4.3,4.7)	4.6 (4.5,4.8)	4.6 (4.5,4.8)	4.5 (4.3,4.7)	4.2 (4.1,4.4)	0.002	0.007

Fibre (g/day)	approx. 24g AOAC	13.5 (13.3, 13.8)	12.7 (12.2,13.3)	13.3 (12.8,13.8)	13.7 (13.3,14.2)	13.8 (13.3,14.2)	14.1 (13.6,14.6)	0.005	<0.001
Distinct F&V Fresh (g)		146 (141, 150)	124 (114,135)	136 (127,145)	145 (136,154)	149 (140,157)	174 (164,185)	<0.001	<0.001
Distinct F&V Frozen (g)		9.5 (8.8, 10.1)	9.0 (7.8,10.1)	9.8 (8.1,11.5)	9.4 (8.2,10.5)	9.6 (8.1,11.2)	9.5 (8.2,10.9)	0.953	0.726
Distinct F&V Canned (g)		29.1 (28.1, 30.1)	28.7 (26.1,31.3)	29.4 (27.2,31.7)	29.8 (27.7,31.8)	28.7 (26.5,30.8)	28.7 (26.6,30.9)	0.936	0.801
Distinct F&V Other (g)		8.4 (7.9, 8.8)	8.6 (7.1,10)	7.7 (6.9,8.5)	8.5 (7.4,9.6)	8.1 (7.2,9)	9.1 (8.1,10.2)	0.436	0.364
Distinct F&V Total (g)		192 (188, 197)	171 (159,183)	183 (172,193)	193 (182, 203)	195 (185, 205)	222 (210,234)	<0.001	<0.001
Distinct F&V Juice (g)		22.0 (20.6, 23.5)	17.3 (13.2,21.3)	18.3 (15.6,20.9)	22.7 (19.6,25.8)	26.9 (23.7,30.2)	24.7 (21.3,28)	<0.001	<0.001
Spend (p per person per day) Distinct F&V		42.7 (41.5, 43.9)	34.6 (31.9,37.3)	40.1 (37.4,42.7)	42.3 (39.8,44.9)	44.3 (41.6,47)	52.1 (49,55.2)	<0.001	<0.001
Cost of Distinct F&V (p per 100g) as bought		18.5 (18.3, 18.8)	17.3 (16.7,17.8)	18.4 (17.9,18.8)	18.2 (17.8,18.6)	19.1 (18.6,19.5)	19.7 (19.1,20.2)	<0.001	<0.001
Total spend on food and drink (£ per household per week)		50.0 (49.0, 50.9)	43.5 (41.5, 45.4)	47.8 (45.9, 49.7)	50.0 (48.0, 52.0)	54.5 (52.3, 56.6)	53.4 (51.0, 55.8)	<0.001	<0.001
Total spend on food and drink (£ per equivalized person per week)		23.8 (23.3, 24.2)	21.6 (20.5,22.6)	23.7 (22.7,24.7)	23.9 (22.9,24.8)	24.4 (23.4,25.3)	25.1 (24.0,26.2)	<0.001	<0.001

SDG, Scottish Dietary Goal. F&V, fruit and vegetables. AOAC, Association Of Analytical Communities