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Barton KL, Wrieden WL, Sherriff A, Armstrong J, Anderson AS. Energy density of the Scottish diet estimated from food purchase data: relationship with socio-economic position and dietary targets. Br J Nutr. 2014 Jul 14;112(1):80-8.

What We Know, Think We Know, or Are Starting to Know

To say that socioeconomic status [SES] influences diet would be an understatement. Unfortunately, this basic fact has been politicised along 'left' or 'right' of centre fault lines, and the actual evidence supporting the role of numerous socioeconomic factors is often secondary to political ideology (1,2). An analysis of attitudes within the UK Conservative Party, in power from 2010 to date, revealed that food poverty was primarily seen as a failure of 'personal responsibility' identified with working classes, and based on the assumption that the SES of those experiencing food poverty reflected making "poor choices" (3).

SES is a composite of numerous factors, including income, education attainment, employment occupation, housing status and amenities, all of which may independently or interactively influence food choice and dietary intake (4). These factors influence food choice and diet through, for example, the food availability of the immediate built environment, cognitive-affective factors like stress and anxiety, and in-group social norms (5,6).

In the UK, just over half of daily energy intake is comprised of foods categorised as 'ultra-processed' by the NOVA categorisation*, i.e., foods comprised predominantly of refined starches and/or added sugars, added fats and oils, and added salt (7). These foods are characterised by their high energy-density, which is defined as the amount of energy per given weight of food - usually measured per 100g. Substantial evidence exists in support of a greater effect of energy-density on total energy intake (8). This should be considered in light of the decreasing consumer expenditure on food, with a lower share of household income spent on food purchases, and the concomitant increase in the cost of health-promoting diets (9).

Underscoring this shift to diets characterised by low economic cost and high energy-density is a complex interrelationship of socioeconomic, cultural, and environmental changes influencing diet at a societal and individual level (9). Determinants of dietary intake in the population have included, increased energy in the food supply, social disparity in health-promoting dietary behaviours, increased consumption of energy-dense foods within lower SES areas, increased consumption of energy outside the home, changes in the living environment, and bio-psycho-social determinants of energy intake (9-12).

The present study aimed to estimate the energy-density of the Scottish diet, and the relationship between SES, energy density, and diet quality.

*Geek Box: NOVA Classification

Most food classification systems have historically focused on broad food-group characteristics [e.g., "cereals and grains"], or definitions related to specific nutrients in a given food [e.g., "calcium-rich"]. However, these systems do not account for the processing techniques used in the manufacture of foods which define the food-scape of industrialised countries [and, increasingly, developing countries]. However, the term 'processing' is itself meaningless unless more refined definitions are used to characterise the type and extent of processing, and the nutritional composition of the food that is ultimately produced. At the very pedantic level, 'processing' may refer to any change of state, e.g., taking a raw salmon fillet and cooking it. Indeed, this argument is commonly deployed by the food industry to suggest an equivalence to foods defined by 'processing', as if the aforementioned transformation from raw to cooked salmon is equivocal to the manufacture of a BigMac. The NOVA classification system was developed to provide specific, clear, and workable definitions to food processing. NOVA in fact is not an acronym [oddly], just a name. NOVA groups foods according to the type, extent, and purpose of industrial processing that they have undergone. 'Food processing' in this context is defined as the physical, chemical, and biological processes used on a food after it has been separated from nature, and before consumption by consumers. There are four NOVA categories: 1) unprocessed/minimally processed foods; 2) processed culinary ingredients; 3) processed foods; 4) ultra-processed foods. Group 1 foods - minimally processed - are the edible parts of plants or animals once they are separated from nature, i.e., a chicken breast or pumpkin seeds. Group 2 includes ingredients like, for example, olive oil or butter, sugar or salt, which are derived from Group 1 foods by processes like churning, milling, pressing, refining, or drying. Group 2 foods are not usually consumed by themselves, but rather in the preparation of fresh meals or as condiments to meals or snacks. Group 3 - processed foods - includes bottled or canned foods, cheeses, or baked goods like breads. Group 3 foods are recognisable as modified versions of Group 1 foods, for example cheese is recognised as derived from milk and the processing techniques applied to produce bread or cheese involve the addition of Group 2 to Group 1 foods, e.g., flour, eggs, water, salt or milk, rennet, salt. Finally, Group 4 - ultra-processed foods - are not modified versions of Group 1 foods, but rather industrial formulations made with little, if any, intact recognisable Group 1 foods. Ultra-processed foods may be produced predominantly with Group 2 foods - fats, oils, sugars, salt - but contain additional ingredients which are not typically available household ingredients, including additives, preservatives, antioxidants, stabilising gums, and often use ingredients which themselves have been industrially processed, e.g., hydrogenation [of oils] or hydrolysation [of proteins]. Group 4 foods may include packaged foods and snacks, sugar-sweetened beverages, reconstituted meat products, pre-prepared frozen meals, etc. The NOVA classification system, like any food classification, has strengths and weaknesses. It may be too broad to make nuanced dietary recommendations, and often the high watermark of recommendations derived from NOVA is simply "avoid Group 4". There are often assumptions that degree of processing reflects nutrient status, however, this is not entirely correct as numerous habitual ultra-processed foods - for example breakfast cereals - are fortified with a range of nutrients. However, as a system that reflects the realities of the current food supply and habitually consumed foods at the population level, NOVA captures the characteristics of these foods better than, for example, the food pyramid or 'MyPlate'. For further reading on the merits and pros and cons of NOVA, see references [13,14].

The Study

The researchers used food purchase data from the Scottish sample of the UK Expenditure and Food Survey and UK Living Costs and Food Survey studies to estimate overall household food consumption. Individuals within each household completed a 14-day diet diary of all foods and beverages purchased for consumption for inside the home and out of the home. Mean food and nutrient intakes per person were calculated using this data.

Socio-economic status [SES] was assessed using the Scottish Index of Multiple Deprivation, an area-based classification of social deprivation. Energy-density was calculated for each household by dividing total household energy consumption by the total weight of food and milk consumed, expressed per 100g. Energy-density was examined by deprivation category, household composition, households meeting targets for fat [<35% energy] and fruit/vegetable intake [>400g/d], and households meeting national diet quality targets. Differences over time for the period 2001-2009 were examined.

Results: 5,020 households encompassing 11,374 individuals were included in the analysis. The average energy density of the Scottish diet overall was 171kcal/100g, and there was no significant difference over time between 2001-2009. The lowest quintile of energy density averaged 123kcal/100g, while the highest quintile averaged 230kcal/100g.

- ***Relationship with Social Deprivation:*** Households is the highest category of social deprivation had a dietary energy density of 176kcal/100g, compared to 166kcal/100g in the least deprived areas. Energy density increased linearly from the lowest to the highest quintile of social deprivation. Greater energy density in the highest category of social deprivation persisted after adjustment for household composition.
- ***Relationship with Household Composition:*** Single-parent households had the highest dietary energy density compared to other household compositions, with an average of 183kcal/100g. Single-parent households remained the household group with highest energy density after adjustment for social deprivation.
- ***Relationship with National Fat & Fruit/Vegetable Targets:*** 8.3% of all households met the dietary guidelines for <35% fat and >400g fruits/vegetables per day, and the average energy density for these households was 137kcal/100g. Conversely, the average energy density for households not meeting these targets was 174kcal/100g. Stratified by quintile of energy-density, 58% of households meeting the dietary guidelines were in the lowest quintile, compared to 2% in the highest quintile.
- ***Relationship with Diet Quality:*** Fruit and vegetable intake in the lowest quintile of energy-density was double that of the highest energy-density: 387g/d vs. 174g/d, respectively. In the lowest quintile of energy-density, consumption of wholemeal breads, high-fibre cereals, oily fish, white fish, and fresh potatoes were greater compared to the highest quintile. Conversely, consumption of confectionary, pastries, cakes and sweets, sugar-sweetened beverages, red and processed meat, and takeaway foods were all greater in the highest energy-density quintile.

The Critical Breakdown

Pros: The study sample was large and nationally representative across a range of socioeconomic status categories. There was a wide contrast in in dietary energy density across the population, which allowed for meaningful associations to be detected with regard to social deprivation, household composition, and diet quality measures. The national surveys upon which food purchase data was based is updated annually, and the addition of 14-days of diet diaries allowed for both within-home food and, crucially, food purchased outside the home to also be included in the overall assessment.

Cons: No demographic data for the participants was provided, thus while a range of socioeconomic categories and household compositions were included, further detail on participant demographics in terms of ethnicity, sex, age, etc., would have been useful [for example, do single-parent households differ as between a single mother or single father?]. While the method of computing energy-density is consistent with the WHO method, it may omit other sources of calories - in particular alcoholic beverages - which may also have correlations with social deprivation and/or household composition. The diet data was at the household level, which was important for the study design and the relevant exposure of interest, but important to note as it may not be entirely comparable to data based on individual dietary assessments.

Key Characteristic

The use of energy density as the exposure of interest, given the evidence that energy-density has a greater effect on total energy intake than macronutrient variations [(8)]. Yet, the primary focus of much of the field has been on diets varying in macronutrient composition, and the effects of these manipulations on energy intake. This may be short-sighted, given that as a percentage of energy the macronutrient content of habitual diets in the UK or US has not changed substantially in the past twenty years [(15,16)]. This strongly implicates increased food supply energy availability and energy-density as a primary driver of adiposity and related health risks, supported by data on consumption of foods high in fat, starch, and/or sugar in the UK diet [(7,8,10)].

In a recent study we covered here (Deepdive 'Energy Intake - Plant-Based vs. Keto'), a low-fat plant-based diet resulted in an ad libitum energy-density of 90kcal/100g compared 190kcal/100g on a low-carb ketogenic diet, however the total mass of food consumed was 2,140g vs. 1,473g on the low-fat diet vs. low-carb diets, respectively. If we look closely at the data in the present study, we can see a similar relationship: the lowest quintile of energy-density in this study also had higher gram amounts of intake of foods, in particular fruits and vegetables, white fish, high-fibre cereals, and fresh potatoes. While the previous Deepdive was comparing two extreme variations in diet style, the present study supports a relationship between low energy-density foods and overall diet quality in the general population.

Interesting Finding

The relationship between both household composition and social deprivation and energy density is indicative of the complexity of factors which may influence diet quality and energy intake. In this analysis, higher energy-density was more likely in areas of greatest social deprivation after adjusting for household composition. This association between energy-density and SES is evident across populations, and a characteristic of many Western industrialised countries is that low-income population groups would have to spend a disproportionate amount of disposal income to meet fruit and vegetable guidelines [9,10]. In terms of real purchasing cost, energy-dense foods and non-perishables cost less as a proportion of available food budget compared to fresh foods.

What might explain the relationship with household composition, which was independent of SES? There has been an overall decline in household income spent on food supplies, and this may mean that single-parent households simply have less purchasing power and, factoring in the real cost implications, economically more reliant on energy-dense foods [9]. In addition, there are strong correlations between working hours and obesity rates [9], and while adiposity was not an outcome in this study, these factors suggest two factors which may impact single-parent households: lack of time, less resources.

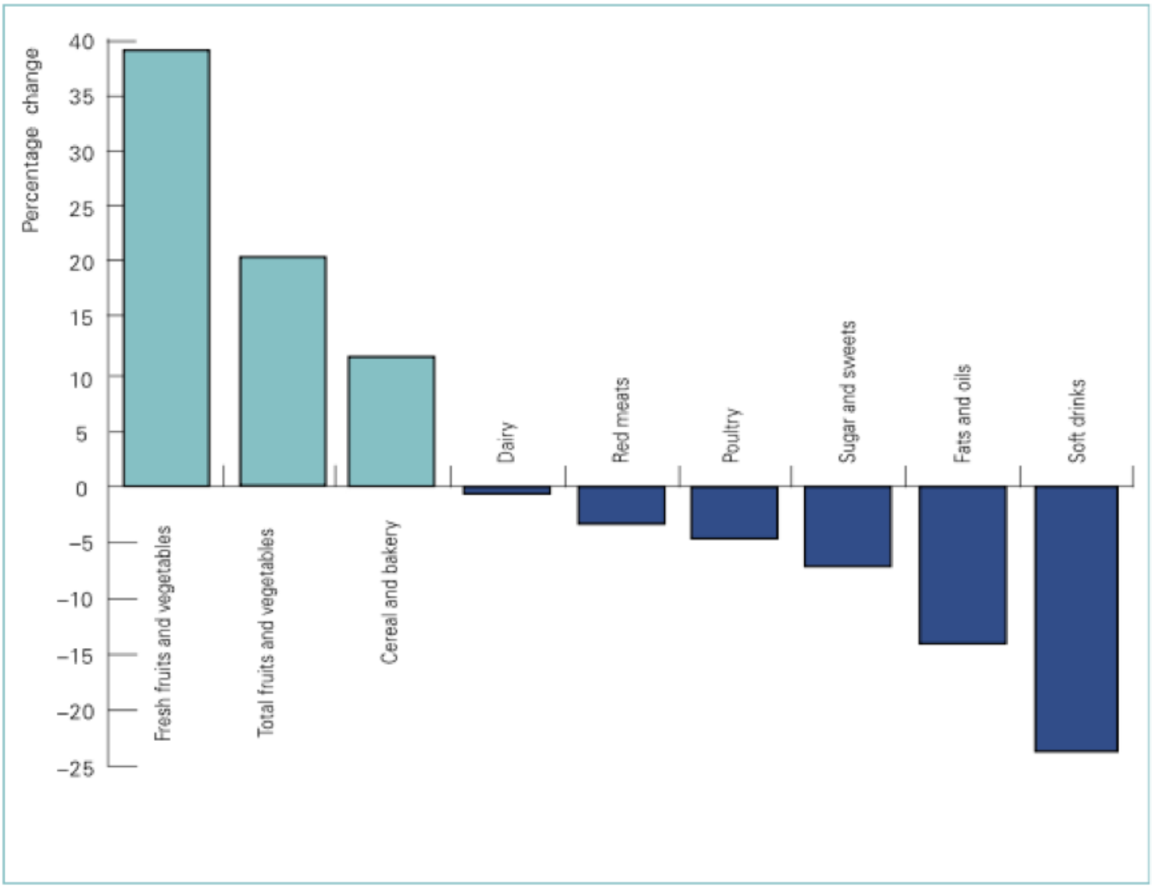

Figure *from [9] demonstrating the change in real purchasing costs of different foods based on US data from 1985 to 2000. The real cost of fruits and vegetables as a proportion of food budgets increased by nearly 40%, while the real cost of sugar-sweetened drinks as a proportion of food budgets declined by nearly 25%.*

Relevance

The term 'health inequalities' means differences between social groups. The recent Foresight Report called for a redefining of population health as a "societal and economic issue" [9]. Many of the explanations for the rise of chronic diet-related diseases over the past decades may be compelling in their simplicity, but fail to illuminate the complex and multifactorial changes in social, cultural, environmental, economic, political, and biological determinants of health, and the interrelations between them, which have driven the phenomenon.

This study illuminates some of those factors, but from a nutritional perspective they are important: dietary energy-density, and the relationship with diet quality, SES, and household composition. The relationship between energy-density and SES demonstrates the need for a population-based approach that focuses "upstream" on policy and environmental change [16]. An upstream focus, in turn, is more capable of reducing disparity for socially disadvantaged population sub-groups, who currently lack options for healthy eating and have limited resources, in particular financial and time resources [16]. A population approach retains the ability to direct universal prevention strategies in a targeted manner to more at-risk populations, and can therefore focus initiatives in the right direction, namely lower socio-economic areas [16,17].

From the perspective of energy-density, the evidence indicates that people consume the same volume and weight of food per day, rather than similar energy intake [8,18]. Experimental studies demonstrating this have provided diets of varying energy-density but in the same total volume and weight of food, showing that participants consumed greater total energy intake at the same weight of intake [18]. Thus, greater energy-density even at lower weights of foods may correlate with greater total energy intake, an association which was evident in the present study.

These data also suggest a relationship between adherence to dietary guidelines and energy density. Indeed, while dietary guidelines are much maligned by certain 'diet camps' [ahem, low-carb], the CRESSIDA study in the UK tested the effects of adherence to UK guidelines against a typical British diet as control [19]. Over 12-weeks, the dietary guideline intervention group reduced body weight, blood pressure, and the total to HDL cholesterol ratio, reflecting an increase in fibre, reduction in added sugars and sodium, increase in omega-3 PUFA, reduction in SFA. The reductions in blood pressure and cholesterol observed with adherence to the dietary guidelines would be predicted to reduce risk of fatal CVD by 15% and nonfatal CVD by 30%. Thus, major dietary overhaul is not necessarily required to make meaningful changes in disease risk from minor adjustments in food choice and intake.

There are no easy solutions to this complex interaction of risk factors. However, upstream policy-based interventions at the level of industry combined with targeted community initiatives would be expected to improve the disparities in health related to disparities in opportunity for diet quality.

Application to Practice

How can practitioners better factor in socioeconomic determinants into the clinical setting? A pragmatic number of considerations has been offered by the CLEAR Collaboration from McGill University [20]:

What can be done at the patient level?

- The barriers will differ from individual to individual, and will not always be obvious to the practitioner.
- Ask about social and economic challenges in a caring and sensitive manner.
- Refer when appropriate and help with accessing benefits or support services.

What can be done at the practitioner level?

- Improve access for hard-to-reach patient groups.
- Integrate social support workers into a multidisciplinary team.
- Know about local resources for different social challenges.

Facilitating access to healthier diets is always relative: meet people where they are at.

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