The effect of snacking and eating frequency on dietary quality in British adolescents

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ABSTRACT

Purpose: To describe the effects of number of eating occasions and snacks on dietary quality (DQ), defined as adherence to dietary recommendations.

Methods: A sample of 884 adolescents (11-18y) in the UK National Diet and Nutrition Survey (NDNS) were included. The Diet Quality Index for Adolescents (DQI-A) was implemented. The total number of eating occasions and snacks was frequency of food or beverages consumed over 24h and frequency of foods or beverages consumed outside of the three mealtimes respectively. Results were generated with and without low energy food under 210KJ (50kcal). Regression models were generated with DQ score as the outcome variable and number of eating occasions and snacks as predictors.

Results: The mean(95%CI) DQ score was 31.1%(30.2, 32.0). The mean number of eating occasions and snacks was 7.5(7.3, 7.7) and 2.6(2.6, 2.7) times/day respectively. When low energy events were excluded, mean number of eating occasions and snacks reduced to 6.2(6.1, 6.4) and 2.0(2.0, 2.1) times/day respectively. DQ score increased by 0.74 points (0.42, 1.05; $p<0.01$) and 0.55 points (-0.08, 0.69; $p=0.17$) for total eating occasions and snacks respectively. When low energy events were excluded, DQ score increased by 0.30 points (-0.84, 0.69; $p=0.13$) for each eating occasion and decreased by 1.20 points (-2.1,-0.3; $p<0.01$) for each snack.

Conclusion Eating more frequently improves dietary quality especially if some eating occasions, are low in energy. A focus on replacing high-energy snacks with low-energy alternatives rather than reducing the number of eating occasions may result in improved dietary quality in adolescents.

Keywords: adolescents · dietary quality · snacking · eating occasions · cross-sectional data

INTRODUCTION

Childhood obesity increases the risk of health problems such as cardiovascular disease, hypertension, some cancers and asthma [1]. In the UK the most recent data show that since 2004, prevalence of overweight in childhood has been decline, however the levels of obesity remain relatively high [2]. In 2013, prevalence of excess weight among 3-17y was higher than 20% in the UK [3]. In consequence, efforts to identify causal factors for obesity risk, including diet, are necessary [3]. In 2011, data published from the National Diet and Nutrition Survey (NDNS) 3y rolling programme (2008-2011) indicated that many children and adolescents follow a poor diet [4]. Dietary quality (DQ) is an innovative concept which combines quality and variety of the whole diet [5] and can be assessed by a number of different tools to evaluate how closely food patterns adhere to dietary recommendations of different populations [6,7]. Evaluation of dietary quality provides a single value to represent the complexity of human diets, having taken into account the interactions between nutrients, food preparation methods and eating patterns [8].

Some dietary quality indices are associated with health and disease outcomes [8,9] and provide an alternative to studying individual nutrients or foods [8, 10]. Low dietary quality scores have been reported to be associated with higher rates of all-mortality in adult population [5] however, it is necessary to conduct more research on dietary quality indices in paediatric and adolescent populations and their relation to health outcomes [6]. In 1990, the Healthy Diet Indicator (HDI) has been developed by Huijbregts et al [11] to quantify the diet adherence to World Health Organization (WHO) guidelines for the prevention of chronic disease. The WHO-DI tool characterises dietary quality, according to dietary intake and some food groups and was designed for adults, but can also be applied to children [6]. Recently, in 2013, the HELENA study validated a tool to assess dietary quality in European adolescents [8] called the Diet Quality Index for Adolescents (DQI-A). It was described in 1997, and it is an adapted version of the previously validated Diet Quality Index (DQI) [11] for pre-school children according to Flemish food–based dietary guidelines (FBDG).

Many dietary habits may have an impact on dietary quality [12] such as snacking and consumption of sugar-sweetened beverages which are very popular among adolescents [13]. Definition of the term “snack” is ambiguous and different classification systems exist with no universally agreed definition [5]. Snacks generally refer to the foods consumed between mealtimes, which often comprise energy dense foods [5]. Snacking patterns have changed over the last two decades in UK adolescents; in 1997 snacking involving non-diet carbonated drinks was lower than in 2005, and these snacks provided a higher energy intake due to larger portion sizes of energy dense foods [13]. During this period of time, intakes of high-energy carbonated and soft drinks, tea and coffee consumption have increased and vegetable consumption has decreased [13]. Snacks are reported to contribute proportionally more sugar but less protein and fat than mealtimes [14]. Snacking has also been found to contribute to increased intakes of specific micronutrients such as vitamin C, vitamin E, dietary folate, dietary fibre, iron, calcium, magnesium, and sodium; and higher consumption of specific foods such as fruit and oils [12, 15].

Specific snacking patterns have been related to overall dietary quality in US adults [17] ,children and adolescents[18], with each additional snack consumed decreasing the overall dietary quality. However, the energy content of a snack is also likely to be important. In the UK population, the effect of snacks on dietary quality is less clear with a paucity of published data available. Eating occasions are considered as the main meals occurring at morning (breakfast), mid-day (lunch) or evening (dinner) [16] as well as snacks consumed between meals. However, some studies define an eating event when a minimum of 210kJ (50Kcal) have been consumed in order to exclude eating events where only water or tea has been consumed [16].

The hypothesis of this research is that snacks and eating occasions particularly with higher-energy options may reduce overall dietary quality in UK adolescents. Thus, the aim of the present study is to describe the dietary quality of a representative population of UK adolescents, and to examine the effect of frequency of eating occasions and snacks on dietary quality as a measure of adherence to dietary recommendations of UK adolescents.

METHODS

Study Design and Participants

The NDNS is a cross-sectional survey administered and analysed by a consortium of three organisations: the National Centre for Social Research (NatCen), MRC Human Nutrition Research, and the department of Epidemiology and Public Health at the University College London Medical School. The NDNS survey was conducted according to the guidelines laid down in the Helsinki's Declaration and all procedures involving human subjects were approved by the Oxfordshire Research Ethics Committee.

The NDNS consists of dietary and nutritional data as well as anthropometric information assessing nutritional status of a representative population of the UK (England, Wales, Scotland and Northern Ireland) aged 1.5 and older living in private households. The current available data of the 4y rolling programme involves data collected each year among 2008 to 2012. A list of all addresses of the UK was randomly assigned from each Primary Sampling Unit. The selected addresses received information about the survey and then a face-to-face visit recruit participants.

The survey design and data-collection methods are described in detail elsewhere [19]. The inclusion criteria in this analysis were adolescents aged 11-18y recruited among 2008 to 2012. The exclusion of the analysis was a lack of inclusion criteria. Finally, the sample used in this study included 884 participants.

Dietary measures

Dietary data were collected on consecutive days using a 3-d or 4-d semi weighted dietary record [19]. Briefly, each subject received a food diary and was asked to keep a record of everything they ate and drank over the four days, inside and outside the home. Participants of 16y and older described portion sizes and could use photographs of ten frequently consumed foods using an adult food diary meanwhile younger adolescents used a food photograph atlas using a child diary. Although the food diaries are different, they collected the same dietary information. The food-diary was explained to the participant at 1st visit by the interviewer. At second or third day of recording, interviewers visit or telephone the participants to improve recording for the remaining days. In the 2nd visit, the interviewer reviewed the completion of the food-diary and fill in the gaps with the participant no later than 3 days after the final day of recording where interviewers check that at least 3-d were recorded [20].

Eating occasions and snacks

The NDNS database provides information on the exact time of the day that a food was consumed, and this information is necessary in order to classify each eating occasion as a meal, or a snack. Meal categories were defined as food consumed within three specific time frames according to Northern Ireland classification [13]. These time frames are 06.00 to 08.59 hours (breakfast), 12.00 to 13.59 hours (lunch) and 17.00 to 19.59 hours (evening meal) while eating occasions outside of these time frames were categorised as snacks.

Frequency of eating occasions is defined as the total number of times foods or beverages are consumed each day, both at mealtimes and at snacks [12]. Frequency of snacks is defined as the total number of foods or beverages consumed between mealtimes each day. If two foods were consumed with a difference of more than 15 minutes it was counted as a separate eating occasion or snack. The number of eating occasions and snacks were calculated using two different methods; firstly, for each time that a participant consumed one or more foods or beverages, and secondly, for each time that a participant consumed one or more foods or beverages, excluding those containing fewer than 210kJ (50Kcal) [16, 20]. Data from weekend days were excluded in this analysis due to the fact that eating patterns and timing of meals at weekends are different to week days [21].

Overall Dietary Quality

Dietary quality was measured using the DQI-A score, [8] a validated version of the DQI used in the HELENA study in adolescents from Ten European Cities [12]. DQI-A is based on the mean of three components: the DQ component (DQc), the dietary diversity component (DDc) and the dietary equilibrium component (DEc), comprised of two subcomponents: the Diet Adequacy sub-component and the Diet Excess sub-component. In addition, the relationship of each component with dietary quality was analysed separately, to understand more about dietary quality.

The DQI-A score is calculated as a percentage for each day with the mean percentage of at least 3-d dietary records calculated for each participant and then reported as an overall percentage for the whole sample. A higher percentage indicates a better dietary quality score and the possible range is from -33% to 100%, with higher scores reflecting a higher dietary quality [8]. More detailed information on the technical aspects has been provided elsewhere [12].

Dietary Quality component (DQc)

DQc is based on optimal food quality choices within a food group which reflect dietary recommendations. The daily amount consumed of each food group was multiplied by different factors: “1” if it belonged to a preference food or healthy food group, “0” if it belonged to an intermediate food group and “-1” if it belonged to a low-nutrient energy-dense food group. The Supplementary Table presents the classification by “preference”, “intermediate” and “low-nutrient or energy-dense” food groups based on the criteria established by Vyncke [8].

These values are summed together, divided by the total amount of food (in grams) eaten per day and multiplied by 100. The methods were followed according to previous published research [8] apart for a small number of exceptions which took into account regional eating patterns. These exceptions were the following: beverages dry weight was not included in the analysis because powdered beverages are not sold in the UK, green beans were classified as vegetables rather than legumes, alternative milk products and ice cream that were not milk based were deleted from the milk products group and excluded from the analysis. The low fat rice puddings and custards were classified in the intermediate milk group, and whole milk rice puddings and custards were included in the energy-dense group in line with their nutritional profile. Also, fromage-frais was included as an intermediate milk product. These changes were agreed by members of the research team.

Dietary Diversity component (DDc)

DDc expresses the variation in the diet and was calculated by assigning one point for each serving consumed for each of the 9 recommended food groups which included: 1) water, 2) bread and cereal, 3) potatoes and grains, 4) vegetables, 5) fruits, 6) milk products, 7) cheese, 8) meat, fish and substitutes, and 9) fat and oils[8].

All the points were summed together and divided by 9 (food groups) and then, multiplied by 100%. DDc score ranged from 0 to 100%. The servings of each food group used were the portion sizes recommended by the British Dietetic association [22]: 1) water (250ml), 2) bread and cereal (35 g), 3) potatoes and grains (180g), 4) vegetables (80g), 5) fruit (80g), 6) milk products (170 g), 7) cheese (30 g), 8) meat, fish and substitutes (100g) and, 9) fat and oils (4.5g).

Dietary Equilibrium component (DEc)

Lastly, the DEc expressed how well minimum and maximum recommended intakes of each food group were met based on the DQI-A information [8]. The intake of foods groups were divided into two categories a) 9 recommended foods groups and b) 2 non-recommended food groups which were: 10) snacks and candy, and 11) sugared drinks and fruit juice as proposed by Flemish food–based dietary guidelines [23].

It was calculated by taking the difference of the diet adequacy subcomponent (percentage of minimum recommended intake in 9 recommended food groups) and the diet excess subcomponent (percentage of intake exceeding the upper level recommendation in 9 recommended food groups and 2 non-recommended food groups), and each of them were multiplied by 100%.

Statistical Analysis

The statistical analysis was performed using STATA statistical software version 12 (Stata Corporation). Statistical significance was assigned to P value < 0.05 for all tests. Descriptive data were presented using means and 95% Confidence Intervals (CI) or percentages and 95% CI. Unpaired T-test analyses were carried out to analyse differences between population characteristics by gender.

Multiple regression analyses were carried out with dietary quality score as the outcome variable and eating occasions and snacking events as predictors in different models. The distribution of dietary quality was checked to ensure it was broadly normally distributed. The analyses were carried out twice for each model, once with total number of eating occasions and total number of snacks and secondly with low energy eating occasions and snacks excluded. A low energy eating event was defined as a meal or snack with fewer than 210Kj (50Kcal) such as water or small pieces of fruit. The results were reported as the change in dietary quality score with each single unit increase in the number of eating occasions or snacking events. Results included 95% confidence intervals and p values. All reported models were adjusted for age and sex. Regression models were also carried out to determine the effect of increasing eating occasions and snacks on energy intake.

Regression models were also carried out with total number of eating occasions and snacks, and eating occasions and snacks as categorical variables. Frequency of eating occasions was grouped into five approximately equal categories based on quintiles according to the two different definitions of total eating occasions: a) Considering all foods and beverages: 1 to 5 eating occasions/day, ≥5 to <6 eating occasions/day, ≥6 to <7.5 eating occasions/day, ≥7.5 to <9.5 eating occasions/day and ≥9.5 eating occasions/day; b) Excluding eating occasions less than 50kcal: 1 to 4.5 eating occasions/day, ≥4.5 to <5.5 eating occasions/day, ≥5.5 to <6.5 eating occasions/day, ≥6.5 to <8 eating occasions/day and ≥8 eating occasions/day. Frequency of snacking occasions was grouped into the same four groups for both definitions: <1.5 snacks/day, ≥1.5 to <2.5 snacks/day, ≥2.5 to <3.5 snacks/day, and ≥3.5 snacks/day. Results were reported as the difference in dietary quality score for each category compared with the reference category which was the lowest number of eating or snacking occasions together with 95% confidence intervals and p values. All reported models were adjusted for age and sex.

RESULTS

Sample characteristics

Participants of the NDNS, surveyed from 2008 - 2012, included a total of 884 adolescents aged between 11-18y, all with at least, 3 d-dietary records completed. The adolescents had a mean (95% CI) age of 14.5y (14.4, 14.7) and 50.3% were male. The mean total daily energy intake was 1786 kcal/day (95% CI 1751, 1820), boys had higher energy intake than girls 1984 kcal/day (95% CI 1934, 2034) and 1584 kcal/day (95% CI 1545, 1623) respectively, (P<0.01).

Dietary quality

The dietary quality evaluated by DQI-A is described in Table 1, with the different components of this score; DQc, DDc and DEc comprised of the Diet Adequacy sub-component and the Diet Excess sub-component. The mean score of the DQI-A was 31.1% (95% CI 30.2, 32.0), 31.4% in girls, and 30.8% in boys with no significant gender differences.

Eating occasions and Snacks

The mean number of eating occasions, considering all food and beverages, was 7.5 times/day, with a minimum of 1 eating occasion/day and a maximum of 18.5 eating occasions/day. The mean number of eating occasions when low-energy eating events containing fewer than 210Kj (50Kcal) were excluded was 6.2 times/day, with a minimum of 1 eating occasion/day and a maximum of 18 eating occasions/day. There were no differences between genders for either result.

The mean number of snacks, considering all food and beverages, was 2.6 times/day, with a minimum of zero snacks/day and a maximum of 9.3 snacks/day. The mean number of snacks, when low-energy snacks containing fewer than 210kJ (50Kcal) were excluded, was 2 times/day, with a minimum of zero snacks/day and a maximum of 9 snacks/day. There were no significant differences between genders for either result.

There was a positive association between daily energy intake and eating occasions: a) for each 1 extra eating occasion/day (considering all food and beverages) the daily energy intake increased by 21 kcal (95% CI 9, 33; p<0.01) and; b) for each 1 extra eating occasion/day (considering all food and beverages excluding meals containing fewer than 210kJ (50Kcal)) the daily energy intake increased by 52 kcal (95% CI 39, 66; p<0.01).

There was also a positive association between daily energy intake and snacks: a) for each 1 extra snack/day (considering all food and beverages), the daily energy intake increased by 141 kcal (95%CI 114, 169; p<0.01).; b) for each 1 extra snack/day (considering all food and beverages excluding snacks containing fewer than 210kJ (50Kcal), the daily energy intake increased by 216 kcal (95%CI 189, 244; p<0.01).

Relationship between eating occasions and dietary quality

The analysis of the effect of number of eating occasions on dietary quality, defining eating occasions by the first method which considered all food and beverages showed a positive relationship between dietary quality and eating occasions/day. An increase of one eating occasion/day was associated with an increase in the dietary quality score of 0.74 points (95% CI 0.42, 1.05; p<0.01). If low energy eating occasions less than 210KJ (50kcal) were excluded the positive association was attenuated. In this case, each increase of one eating occasion increased the dietary quality score by 0.30 points (95% CI-0.08, 0.69; p=0.13). The regression analysis with dietary quality as the outcome variable and eating occasions in 5 categories (1 to <5, ≥5 to <6, ≥6 to <7.5, ≥7.5 to <9.5, >9.5) indicated that two categories were associated with improved dietary quality compared with the reference category of 1 to <5 eating occasions/day. Reporting ≥7.5 to <9.5 eating occasions/day was positively associated with dietary quality, increasing the score by 4.6 points (95% CI 1.7, 7.5; p<0.01) and reporting more than 9.5 eating occasions/day was positively associated with dietary quality, increasing the score by 4.9 points (95% CI 1.8, 8.0; p<0.001) (Fig 1) compared with the reference group. However, none of the categories were significantly different from the reference category in terms of dietary quality when eating occasions of less than 210KJ (50kcal) were excluded (Fig 1).

In the DQI-A, 3 components were positively associated with frequency of eating occasions. For each extra eating occasion the DQc score increased by 1.0 points (95% CI 0.4, 1.7; p<0.01), DDc score increased by 0.7 points (95% CI 0.4, 0.9; p<0.01), and DEc increased by 0.5 points (95% CI 0.3, 0.7; p<0.01). The relationship between the 3 components of DQI-A and number of eating occasions based on the second method excluding eating events containing fewer than 210kJ(50Kcal), revealed no significant associations (data not shown).

Relationship between snacks and dietary quality

The analysis of the effect of snacks on dietary quality, defining snacks by the first method which considered all food and beverages showed a positive relationship between dietary quality and number of snacks/day. An increase of one snack/day increased the dietary quality score by an average of 0.55 points (95% CI -2.24, 1.33; p=0.17), although this was not statistically significant. If low energy snacks less than 210KJ (50kcal) were excluded, the positive association was reversed. In this case, each increase of one snack decreased the dietary quality score by 1.2 points (95%CI -2.06,-0.26; p=0.01). Furthermore, specific associations were observed with components of the DQI-A: a) the DQc score; which assesses the optimal food quality choices within food groups reflecting dietary recommendations, was negatively associated with number of snacks/day considering snacks containing more than 210KJ (50kcal). For each extra snack the DQc score decreased by -5.0 points (95% CI -7.0, -3.1; p<0.01), b) The DDc; which expresses the variation in the diet by adherence to the 9 recommended food groups, was positively associated with snacks/day using both definitions. However, the DEc, which assesses the achievement in obtaining the minimum and the maximum recommended intakes of each food group, was not associated with number of snacks/day. The regression analysis with dietary quality as the outcome variable and snacks in 4 categories (<1.5, ≥1.5 to <2.5, ≥2.5 to <3.5, ≥3.5) indicated that two categories (considering all food and beverages definition) were associated with improved dietary quality compared with the reference category of <1.5 snacks/day. Reporting ≥1.5 to <2.5 snacks/day was positively associated with dietary quality, increasing the score by 4.1 points (95% CI 1.2, 7.1; p<0.01) and reporting more than 3.5 snacks/day was positively associated with dietary quality, increasing the score by 3.5 points (95% CI 0.4, 6.6; p=0.03) (Fig 2) compared with the reference group. However, considering only snacks with more than 50kcal, two categories were associated with a worse dietary quality compared with the reference category of <1.5 snacks/day. Reporting ≥2.5 to <3.5 snacks/day was negatively associated with dietary quality, decreasing the score by 2.8 points (95% CI -5.4, -0.3; p=0.03) and reporting more than 3.5 snacks/day was negatively associated with dietary quality, decreasing the score by 3.6 points (95% CI -7.0, 0.3; p=0.03) compared with the reference group (Fig 2).

The ten foods and beverages most often consumed in different snacking occasions are represented by the name of the food (frequency and percent of adolescents who consume this snack) : tap water (n=406, 45.9%), white bread (not high fibre, not multi-seed bread) (n=397, 44.9%), savoury sauces such as gravy (n=392, 44.3%), semi skimmed milk (n=373, 42.2%), biscuits (n=311, 35.2%), crisps and savoury snacks (n=310, 35.1%), soft drinks not low calorie (n=286, 32.4%), other chicken/turkey including homemade recipes dishes (n=268, 30.3%), chocolate confectionary (n=251, 28.4%) and sugar (n=238, 26.9%).

DISCUSSION

This analysis of cross-sectional data reveals that the dietary quality score in UK adolescents is 31% on a scale of -33 to 100%, which reflects an intermediate adherence to dietary recommendations. Analysis of data on the frequency of eating occasions and snacks revealed interesting associations with dietary quality. Results from the analysis of all eating occasions, including low energy meals or snacks, indicated that increasing the number of eating occasions improved dietary quality; however when low energy events were excluded this improvement was attenuated and no longer statistically significant. For snacks, analysis of all snacks had no significant association with dietary quality; however when low energy snacks were excluded the association was negative with each extra snack reducing the dietary quality score by approximately 1 point. The number of eating occasions associated with the highest dietary quality score was more than 7.5 per day; but this was only the case if all eating events were included and was no longer important if low energy eating events were excluded.

Comparing the dietary quality of UK adolescents with European adolescents indicated that UK adolescents have a poor quality diet. A score of 31% is 18% lower than the mean dietary quality score of Central and Northern European adolescents (Germany, Belgium, France, Hungary, Sweden and Austria) which was reported to be 49%; and 30% lower than Southern European Adolescents (Greece, Italy and Spain) which was reported to be 61% on average [24]. These results suggest that considerable differences exist between European countries [24] and dietary improvements are particularly needed in British adolescents [7].

There are many indices to assess dietary quality [7] which provide a single value to represent the complexity of human diets, having taken into account the interactions between nutrients, food preparation methods and eating patterns [8]. There is no universally agreed gold standard and significant variations exist in the calculation of dietary quality, although these differences do not result in large inconsistencies in the predictions of health-related outcomes [6]. Nevertheless, it is necessary to validate an international dietary quality index as a dietary quality assessment tool that is able to compare between different populations is currently unavailable. As well as including the composition of the adolescents' diet, the DQI-A also incorporates the dietary variation in food groups throughout the day, and the balance between healthy and unhealthy food groups which are strengths of this index [8].

The number of snacks was negatively associated with the DQc of the DQI-A tool, and UK adolescents who snacked frequently were more likely to have a lower dietary quality, which suggests that the quality of food between meals is worse than at mealtimes. This was also clear from the type of food adolescents were most likely to consume as snacks. However, a higher frequency of snacks was positively associated with the DDc of the DQI-A tool, indicating that when adolescents increased the number of snacks eaten, they ate a more varied diet over the whole day. Consequently, it seems to be easier for adolescents to achieve the minimum recommended intake of each food group with a higher snacking intake. Furthermore, dietary quality and daily energy intake were negatively associated, suggesting that adolescents with excessive energy intakes did not necessarily obtain a higher dietary quality score [8].

Snacking is observed at any time of the day in adults, children or adolescents in various parts of Europe and the USA [25]. Data from Northern Ireland and Britain indicate that energy intake and portion size of snacks have increased between 1997 and 2005, but not the frequency [13]. The number of eating occasions is reported to be associated with some specific nutrients and with some adiposity measures in children and adolescents [20, 26]. A recent review and meta-analysis concluded that more frequent eating occasions are associated with lower body weight status in children and adolescents, although this was mainly in boys [26] while energy provided by snacks was not recommended. However, a recent study with NDNS data (collected in 1997) showed that a higher number of eating occasions was associated with a higher Body Mass Index (BMI), BMI z-score and lower HDL-cholesterol concentrations in British adolescents [20]. When restricted to the adult population, research has shown that a higher number of eating occasions is positively associated with BMI and waist circumference [27], and beneficially associated with cardiovascular risk factors and subclinical atherosclerosis [28]. One study that analysed the relationship between number of snacks and dietary quality in an American adult population concluded that the number of snacks was associated with a more nutrient dense diet, and a positive association with dietary quality [17], as we observed in the present study when all snacks were included. Another study in American adolescents reported a negative relationship between dietary quality and number of snacks and discussed the autonomy of adolescents in choosing unhealthy snack foods [18]. In this present study, the negative effects of snacks on dietary quality were only apparent when low energy snacks were excluded pointing to the importance of the type of snack consumed. Many (but not all) of the snacks consumed by this population are energy-dense foods such as savoury snacks and confectionery [13]. However, our findings suggest that eating more often than three times per day improves dietary quality, provided nutrient rich foods are consumed both at and between meals and when some low energy snacks are consumed such as fruit, vegetables or water. These findings do not provide strong evidence of a benefit in recommending that adolescents increase their frequency of snacks and eating occasions in a day as high-fat, high-sugar snacks could cause a negative effect on dietary quality and body adiposity [25].

The present study has some limitations. First of all, the lack of universally accepted definitions of snacks and eating occasions, make it difficult to precisely calculate these figures, thereby complicating the interpretation of the results; both those obtained in our study as well as those of other studies used for comparison [12]. The definition of a snack is particularly ambiguous as some people consume snacks at times that might be regarded as mealtimes. Alternatively, some people have meals outside traditional meal occasions; in fact adolescents may be more likely to have a chaotic eating pattern [29]. The fact that the NDNS survey did not report the classification of eating events as meals or snacks, is a limitation for our study. However, many eating events may be difficult to define, even by participants themselves, and therefore this information would not necessarily have reduced bias. Furthermore, although the DQI-A is a validated tool applicable in large populations of different ethnicities it did present some issues. The lack of information on particular foods such as soya products, battered fish, and other foods commonly consumed in the UK could represent a limitation. The DQI-A score is composed of three separate components. The DDc is calculated by taking the serving definition into consideration and the recommended serving for various foods varies between European countries which could reduce its validity in certain populations. Furthermore, limitations exist with the NDNS which is cross-sectional data. Under-reporting is a problem with all dietary assessment tools and is likely to be considerable in this sample [30]. Also, the NDNS data does not include information on physical activity known to be an important confounder for energy. Stronger evidence for the presence or absence of an association between snacks and dietary quality or BMI could be obtained from longitudinal cohort rather than cross-sectional data in order to compare with current studies in similar populations [31].

Despite these limitations, there are very few published studies in adolescents reporting the relationships between frequency of eating and snacking on dietary quality. The data used in this analysis included dietary data from a large and nationally representative sample of British adolescents. These findings therefore provide much needed information on dietary patterns in adolescents which could be used to shape policy interventions for the adolescent population in the UK. These results suggest that replacing high energy snacks with fruit or other low energy alternatives may result in a better dietary quality for adolescents.

CONCLUSION

In summary, British adolescents have some of the worst quality diets in Europe. Analysis of national data revealed that increases in eating occasions improved dietary quality when these eating occasions included low energy eating events. However an increase in snacking when snacks contained more than 210KJ (50Kcal) reduced dietary quality. More prospective studies are needed to confirm the associations between number of eating occasions and snacks on dietary quality in this age group. Nevertheless it is likely that replacing higher energy snacks with lower-energy alternatives will result in a higher quality diet in British adolescents. In order to improve dietary quality, adolescents need encouragement to choose, purchase and consume healthier snacks and beverages. This will require changes in the environment through local and national policies in order to improve availability, access and pricing of healthier foods.

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CONFLICT OF INTEREST

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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FIGURE LEGENDS

Fig 1 Relationship between Diet Quality Index for Adolescents (DQI-A) and eating occasions by categories using two definitions: a) including all foods and beverages, and b) deleting eating occasions with <50kcal) compared with the reference group * P<0.05

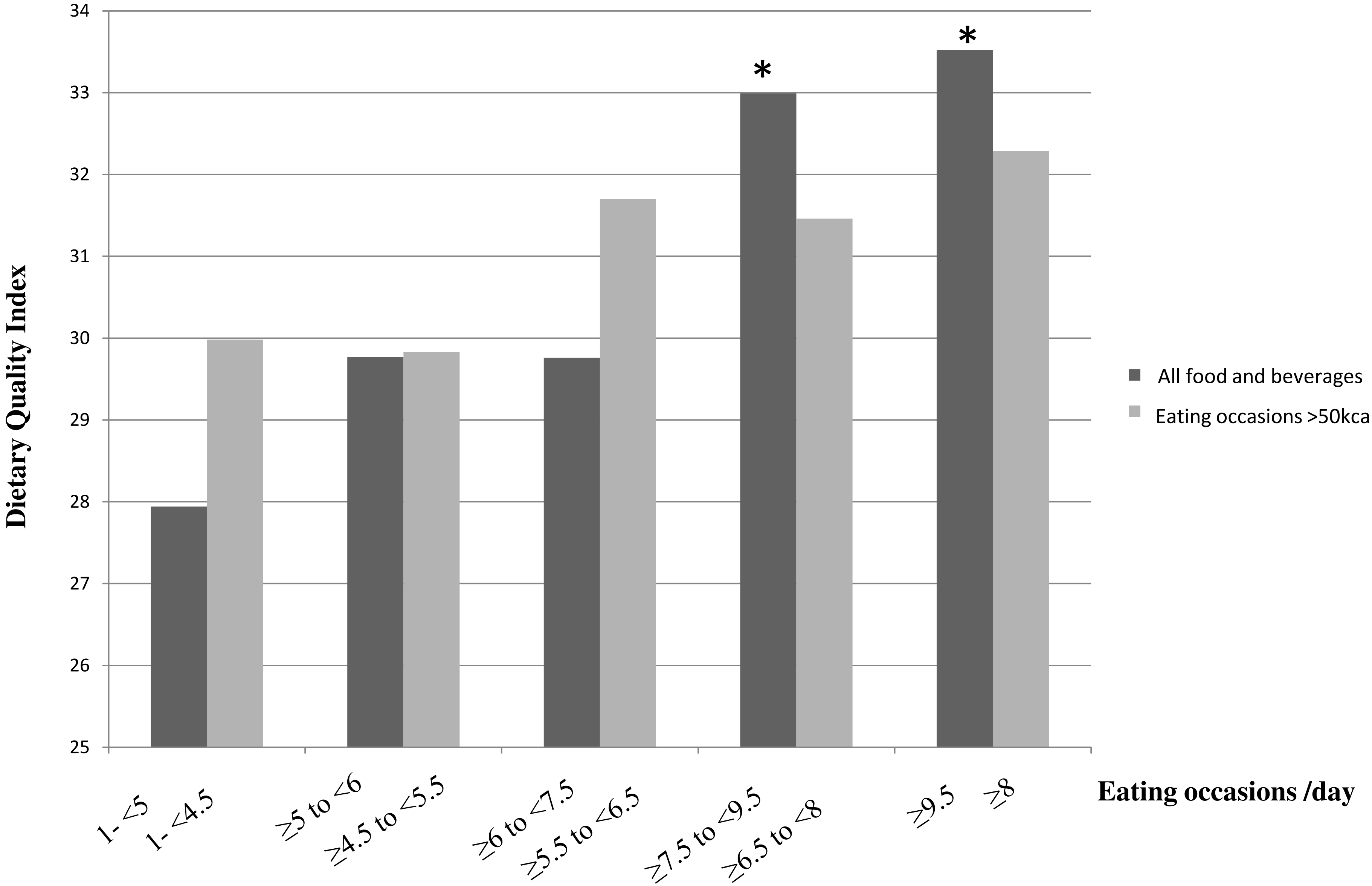
Fig 2 Relationship between Diet Quality Index for Adolescents (DQI-A) and snacks by categories using two definitions: a) including all foods and beverages, and b) deleting snacks with <50kcal compared with the reference group * P<0.05

TABLES

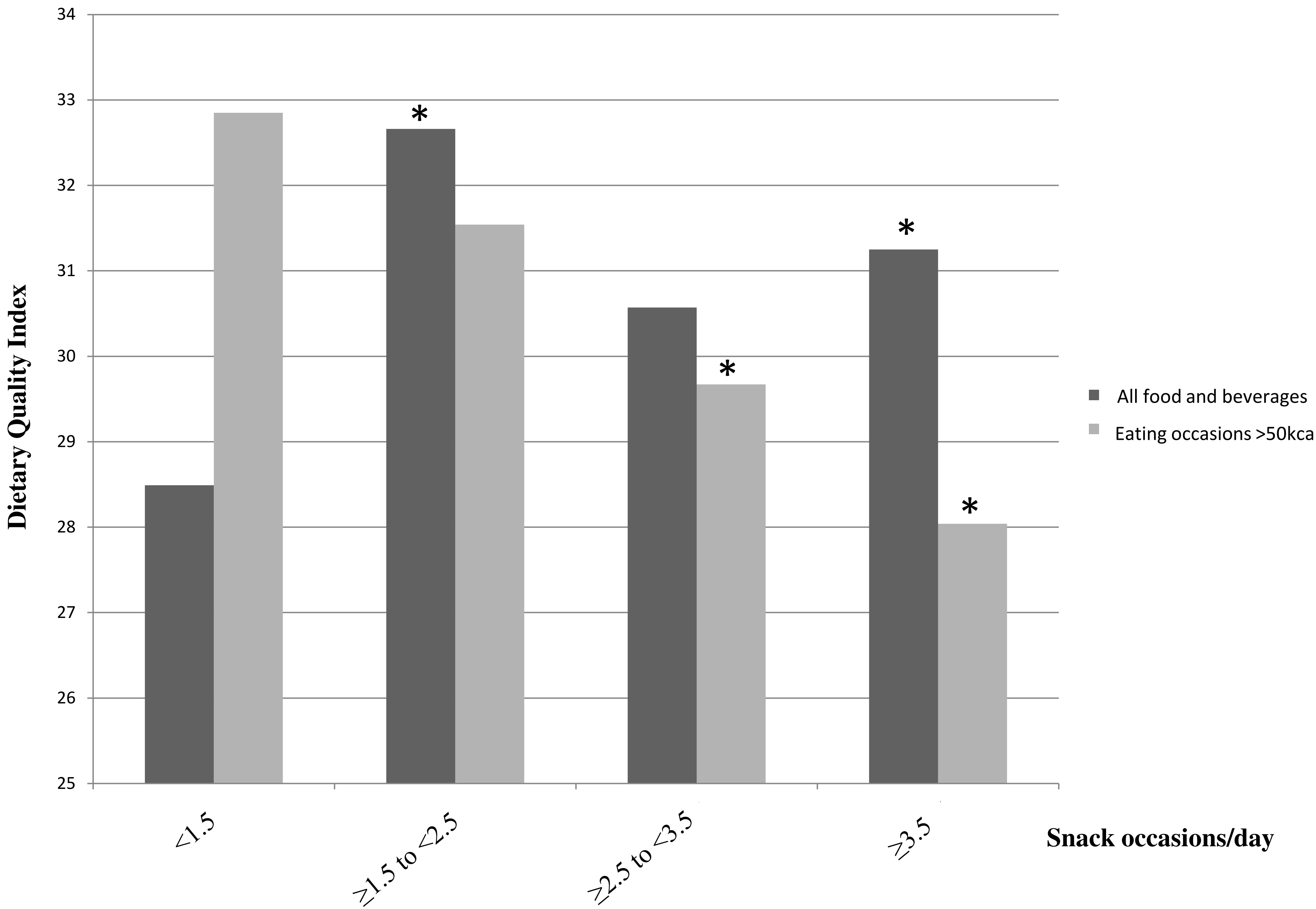
Table 1 Description of Diet Quality Index for Adolescents (DQI-A) scores in UK adolescents

	Total		Males		Females		Between genders
	n=884		n= 445		n= 439		
	Mean	95% CI	Mean	95% CI	Mean	95% CI	*p-value
Age	14.5	14.4, 14.7	14.4	14.2, 14.6	14.6	14.4, 14.8	0.17
Energy (Kcal/d)	1785	1751, 1820	1984.1	1934, 2034	1584	1545, 1623	<0.01
Fat% energy	33.8	16.0, 48.0	33.6	18.9, 47.9	34	16.0, 48.0	0.24
Protein% energy	14.9	6.3, 32.3	15.2	6.3, 32.3	14.7	6.4, 31.5	0.02
CH% energy	50.6	50.2, 51.0	50.5	50.0, 51.0	50.7	50.1, 51.2	0.70
White% Ethnic Group	87.9		88.09		87.7		
DQI-A overall	31.1	30.2, 32.0	30.8	29.4, 32.2	31.4	30.2, 32.6	0.51
Diet Quality component (DQc)	2.1	0.1, 4.1	-1.3	- 4.2, 1.6	5.6	2.8, 8.4	0.01
Diet Diversity component (DDc)	54.9	54.1, 55.6	57.2	56.1, 58.3	52.5	51.5, 53.5	<0.01
Diet Equilibrium component(DEc)	36.3	35.6, 36.9	36.5	35.5, 37.4	36.1	35.2, 36.9	0.51
Diet Adequacy sub-component (DA)	51.0	50.3, 51.7	53.1	52.1, 54.1	48.8	47.9, 49.7	<0.01
Diet Excess sub-component (Dex)	14.7	14.3, 15.1	16.6	16.0, 17.2	12.8	12.2, 13.3	<0.01

[a]95% CI: 95% Confidence Interval
[b]DQI-A: Diet quality Index for Adolescence
* Ttest analysis between gender



Dietary Quality Index
34
33
32
31
30
29
28
27
26
25
*
*
All food and beverages
Eating occasions >50kcal
1- <5
1- <4.5
≥5 to <6
≥4.5 to <5.5
≥6 to <7.5
≥5.5 to <6.5
≥7.5 to <9.5
≥6.5 to <8
≥9.5
≥8
Eating occasions /day



Dietary Quality Index
34
33
32
31
30
29
28
27
26
25
*
*
*
*
<1.5
≥1.5 to <2.5
≥2.5 to <3.5
≥3.5
Snack occasions/day
All food and beverages
Eating occasions >50kcal