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Diet quality as measured by the Diet Quality Index–International is associated with prospective changes in body fat among Canadian children

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Abstract

Objective: To quantify the association of dietary quality with prospective changes in adiposity.

Design: Children participating in the QUALITY (QUebec Adipose and Lifestyle InvesTigation in Youth) study underwent examination at baseline and at 2-year follow-up. Dietary quality was assessed by the Diet Quality Index–International (DQII) using three non-consecutive 24 h diet recalls at baseline. The DQII has four main categories: dietary adequacy, variety, moderation and overall balance. Fat mass index (FMI; [fat mass (kg)]/[height (m)]^2), central FMI (CFMI; [trunk fat mass (kg)]/[height (m)]^2), percentage body fat (%BF; [total fat mass (kg)]/[total mass (kg)]) and percentage central BF (%CBF; [trunk fat mass (kg)]/[total mass (kg)]) were assessed through dual-energy X-ray absorptiometry.

Setting: Children were selected from schools in the greater Montreal, Sherbrooke and Quebec City metropolitan areas between 2005 and 2008, Quebec, Canada.

Subjects: A total of 546 children aged 8–10 years, including 244 girls and 302 boys.

Results: Regression analysis adjusting for age, sex, energy intake, physical activity and Tanner stage revealed that every 10-unit improvement in overall DQII score was associated with lower gain in CFMI ($\beta = -0{\cdot}08$; 95 % CI –0·17, –0·003) and %BF ($\beta = -0{\cdot}55$; 95 % CI –1·08, –0·02). Each unit improvement in dietary adequacy score was associated with lower gain in FMI ($\beta = -0{\cdot}05$; 95 % CI –0·08, –0·008), CFMI ($\beta = -0{\cdot}03$; 95 % CI –0·05, –0·007), %BF ($\beta = -0{\cdot}15$; 95 % CI –0·28, –0·03) and %CBF ($\beta = -0{\cdot}09$; 95 % CI –0·15, –0·02).

Conclusions: Promotion of dietary quality and adequacy may reduce weight gain in childhood and prevent chronic diseases later in life.

Keywords
Dietary quality
Diet Quality Index–International
Longitudinal study
Public health
Adiposity
Children

Chronic diseases in adulthood have their genesis in childhood[1,2]. Obesity in childhood and adolescence, characterized by excessive accumulation of TAG fatty acids within adipose tissue, is a strong risk factor for several chronic diseases in adulthood[3]. Since the 1980s, there has been a remarkable rise in the prevalence of overweight and obesity among children and adolescents in developed countries[4]. In Canada, the prevalence of overweight and obesity among youth aged 12–17 years doubled between 1978/79[5] and 2009–2011[6], and 30 % of children were considered overweight or obese in 2009–2011[6].

Diet composition and energy intake have an important role in the deposition of fat[7,8]. Studies have revealed that adiposity occurs primarily with diets that are high in fat, high in sugar and low in fibre[8–10]. The chronic imbalance between dietary intake and oxidation of fat may lead to increases in the number and size of adipocytes[11]. Conversely, supplementation with multivitamins and minerals has recently been shown to reduce appetite and thereby body weight and fat mass[12,13], highlighting the need to consider a broader spectrum of dietary factors rather than fat, sugar and fibre only.

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Various investigators have sought to capture the broader spectrum of dietary factors into a single index to represent dietary quality[14]. For example, the Healthy Eating Index summarized twelve food components into two dietary categories of adequacy and moderation[15], and was recently updated to align with the key dietary recommendations of the 2010 Dietary Guidelines for Americans[16]. The Diet Quality Index–International (DQII) considers a spectrum of dietary variety, adequacy, moderation and overall balance, and was developed to allow for international comparisons and to assess the risk for chronic disease[17]. Such indices have been utilized in a limited number of studies of dietary quality and adiposity in children and adolescents[18–22]. No study has examined the association of dietary quality and prospective changes in adiposity. For the present study, we hypothesize that children with better dietary quality will gain less body fat over time.

Methods

Study population and procedures

Participants were drawn from the QUALITY (QUebec Adipose and Lifestyle InvesTigation in Youth) cohort, a familial study on the biological, genetic, behavioural, psychosocial and environmental determinants of obesity and cardiometabolic risk factors in Caucasian children and their evolution from childhood to adulthood[23]. Families were recruited through schools in the greater Montreal, Sherbrooke and Quebec City metropolitan areas between 2005 and 2008. Eligible families comprised a child aged 8–10 years at cohort inception and biological parents, at least one of whom was obese (BMI $\geq$30·0 kg/m^2 and/or waist circumference $\geq$88 cm for women or $\geq$102 cm for men[24]). Children were excluded if they: (i) had type 1 or 2 diabetes; (ii) had any serious illness, psychological condition or cognitive disorder; (iii) were taking antihypertensive medication or steroids; and (iv) were following a very restricted diet (<2510 kJ/d (<600 kcal/d)). In 2005–2008, 630 children underwent comprehensive baseline examinations at the Clinical Research Units of either the Centre Hospitalier Universitaire (CHU) Sainte-Justine (Montreal) or the Institut universitaire de cardiologie et de pneumologie de Québec (IUCPQ) (Quebec City). In 2008–2011, 564 (89 %) children had their first follow-up study visit.

Measurements

Dietary quality

Dietary intake was assessed through three telephone-administered 24 h diet recalls on non-consecutive days (two weekdays and a weekend day) following the baseline clinic visit. After interviewing the child, trained dietitians asked a parent for details on food preparation and recipes. All three recalls were collected within 12 weeks of the baseline clinic visit; 98 % of participants had three recalls and 2 % had two recalls. Foods reported on the 24 h diet recalls were entered into the CANDAT nutrient analysis software (Godin London Inc., London, ON, Canada) and converted to nutrients using the 2007b Canadian Nutrient File. Data were entered and verified by trained data-entry staff and every tenth entry was audited for accuracy by a research dietitian. Age- and sex-specific dietary recommendations were used to calculate the DQII score[17,25]. The DQII has been used previously as a measure of dietary quality for children in Canada[26–28], the USA[17], China[17] and Korea[28]. It is a summary measure of dietary quality representing four categories of the diet, including variety, adequacy, moderation and overall balance. The overall DQII score constitutes the sum of the scores for each of these four categories and ranges from 0 to 100 (where 0 = the poorest and 100 = the highest dietary quality). Dietary variety (score 0 to 20) captures diversity in food choices and protein sources. Dietary adequacy (score 0 to 40) captures the adequate intake of food groups and nutrients (vegetables, fruit, grains, fibres, proteins, Fe, Ca and vitamin C). Dietary moderation (score 0 to 30) is scored on the basis of intake of total fat, saturated fat, cholesterol, Na and empty calorie foods. Lastly, overall balance (score 0 to 10) captures the proportion of energy from carbohydrates, protein and fat, as well as the fatty acid composition, according to accepted general guidelines for the proportion of energy from carbohydrate, protein, fat, and fat composition. More detail regarding the DQII can be found elsewhere[17].

Adiposity

Fat mass was determined by dual-energy X-ray absorptiometry (Prodigy Bone Densitometer System, DF + 14664; GE Lunar Corporation, Madison, WI, USA)[29]. Measurements were taken with the child in the supine position on the scanning table, beginning at the top of the head and moving in a rectilinear pattern down the body to the feet. None of the participants required sedation. The adiposity measures of total and central body fat were computed as follows: percentage body fat (%BF) = [total fat mass (kg)]/[total mass (kg)] and percentage central body fat (%CBF) = [trunk fat mass (kg)]/[total mass (kg)], respectively[29]. Fat mass index (FMI) = [fat mass (kg)]/[height (m)]^2 and central fat mass index (CFMI) = [trunk fat mass (kg)]/[height (m)]^2 were estimated to account for differences in height[30].

Anthropometrics

Anthropometric measurements were taken with the child dressed in light indoor clothing without shoes, using a calibrated stadiometer for height (measured at maximal inspiration) and an electronic scale for weight. Measurements were performed according to standardized protocols in duplicate or triplicate if the first two measurements differed by more than 0·2 cm for height or 0·2 kg for weight, and the two closest measures were averaged[31,32]. BMI was calculated as [weight (kg)]/[height (m)]^2.

BMI percentiles and Z-scores were calculated according to the 2000 US Centers for Disease Control and Prevention growth chart reference values[33]. A child was categorized as being thin/normal weight, overweight or obese according to the cut-offs for BMI generated by the International Obesity Task Force for 2–18-year-olds[34].

Potential confounders

Sex and baseline values of age, pubertal maturation, physical activity and total energy intake, as well as changes in pubertal maturation and changes in physical activity between baseline and 2-year follow-up, were considered as potential confounders of the association between diet quality and changes in body fat. Pubertal maturation was assessed by trained nurses, who assigned a Tanner stage according to pubic hair development in boys and breast and pubic hair development in girls[35,36]. Changes in Tanner stage between baseline and 2-year follow-up visits were categorized into two groupings (no change *v.* increase). Physical activity was measured using 7 d accelerometry (ActiGraph LS 7164 activity monitor; ActiGraph LLC, Pensacola, FL, USA) in the week following the clinic visit. Children were instructed to wear the accelerometer during daytime, except during bathing and aquatic activities. Days with observation of 10 h or more of wear time were considered in the analysis[37]. Non-wear time was determined as at least sixty consecutive minutes of zero counts, with allowance for 1 to 2 min of counts between 0 and 100[38]. Moderate-intensity physical activity (2296 to 4011 counts/min) and vigorous-intensity physical activity (≥4012 counts/min) were combined into one single category[37]. Moderate-to-vigorous physical activity (MVPA) was categorized into two categories: <60 min/d *v.* ≥60 min/d of ≥2296 counts/min based on current guidelines[39]. Changes in MVPA between baseline and 2-year follow-up visits were categorized into three groupings (no change, increase to ≥60 min MVPA/d, decrease to <60 min MVPA/d).

Statistical analysis

The present study is based on 546 children who had complete data at baseline and follow-up visits (302 boys and 244 girls). Compared with these 546 children, those lost to follow-up or with incomplete dietary information were similar with respect to total body fat, central body fat and BMI. Differences in children's characteristics between baseline and follow-up were tested using the paired *t* test or the χ^2 test. The distribution of DQII and each of its categories was summarized using means, medians and interquartile ranges. Changes in body fat according to DQII were depicted using the Lowess curves[40] and least-squares regression lines. We analysed the relationship between DQII at baseline and the 2-year change in adiposity and anthropometric outcomes (BMI, FMI, CFMI, %BF, %CBF) using multivariable linear regression models while adjusting for sex, baseline values of age, outcome variables, Tanner stage, total energy intake, physical activity, as well as change in Tanner stage and change in physical activity between baseline and follow-up. All the outcome and exposure variables except for overall balance were analysed as continuous variables. Overall balance scores were positively skewed, with 74 % of the children having a score of 0 and the remainder having a score >2 (there were no children with a sore between 0 and 2). We therefore dichotomized overall balance to compare scores ≥2 with scores <2. All analyses were completed using the statistical software package Stata version 13. Statistical significance was set at $P<0·05$.

Results

Of the 546 participants with complete information, 244 (45 %) were girls and 302 (55 %) were boys. At baseline, children were on average 9·6 years of age and at follow-up 11·6 years of age (Table 1). Body fat indices and BMI increased during the 2-year follow-up. Over 2 years, FMI and CFMI increased on average by 18 % and 22 %, and %BF and %CBF increased by 9 % and 13 %, respectively (Table 1). These increases in total and central body fatness were not reflected in prospective changes in BMI Z-score or the proportion of children classified as thin/normal weight, overweight and obese (Table 1).

Table 1 Characteristics at baseline and 2-year follow-up of 546 Canadian children (244 girls and 302 boys) participating in the QUALITY (QUebec Adipose and Lifestyle InvesTigation in Youth) study

	Baseline		Follow-up	
Variable	Mean	SD	Mean	SD
Age (years)†	9·6***	0·9	11·6***	0·9
BMI Z-score†	0·7	1·0	0·7	1·1
BMI (kg/m^2)†	19·4***	4·2	21·1***	4·9
Fat mass index (kg/m^2)†	5·4***	3·3	6·3***	3·2
Central fat mass index (kg/m^2)†	2·3***	1·7	2·8***	1·9
% Body fat†	26·0***	10·7	28·3***	10·8
% Central body fat†	11·0***	5·6	12·4***	5·7
	n	%	*n*	%
Weight status‡				
Normal	326	59·7	329	60·3
Overweight	131	24·0	133	24·4
Obese	89	16·3	84	15·4
MVPA <60 min/d‡	328***	67·6	343***	79·8
Tanner stage§ >1‡				
Girls	87***	35·7	200***	82·3
Boys	24***	7·9	163***	5·5
Total energy intake (kJ/d)	7073	1663	NA‖	
Total energy intake (kcal/d)	1690·5	397·4	NA‖	

MVPA, moderate-to-vigorous physical activity; NA, not assessed.
*$P<0·001$.
†Differences between baseline and 2-year follow-up tested using the paired *t* test.
‡Differences between baseline and 2-year follow-up tested using the χ^2 test.
§Tanner stage values ranged from 1 to 4 at baseline and from 1 to 5 at follow-up.
‖Data were not available at follow-up.

Overall DQII score ranged from 34 to 75 and was approximately the same among boys and girls (58 *v.* 57, respectively). Table 2 shows that, on average, participants had relatively high scores for dietary variety (15 out of 20) and adequacy (30 out of 40) but had substantially lower scores for moderation (12 out of 30) and overall balance (1 out of 10). These striking differences in the distribution of the overall DQII score and its categories, expressed as percentages, are depicted in Fig. 1.

Table 2 Average Diet Quality Index–International (DQII) scores in 546 Canadian children (244 girls and 302 boys) participating in the QUALITY (QUebec Adipose and Lifestyle InvesTigation in Youth) study

DQII category/component	Score range	Mean	SD
Overall DQII	0–100	57·9	7·2
Variety	0–20	15·5	3·3
Overall food group variety	0–15	12·4	2·6
Within-group variety for protein sources	0–5	3·1	1·2
Adequacy	0–40	29·7	3·7
Vegetables group	0–5	2·3	1·3
Fruit group	0–5	3·4	1·6
Grains group	0–5	3·7	1·0
Fibres	0–5	2·3	0·7
Proteins	0–5	5·0	0·1
Fe	0–5	4·9	0·3
Ca	0–5	3·2	1·0
Vitamin C	0–5	4·9	0·6
Moderation	0–30	11·9	4·4
Total fat	0–6	1·0	1·4
Saturated fat	0–6	0·9	1·5
Cholesterol	0–6	5·4	1·4
Na	0–6	4·3	2·0
Empty calorie foods	0–6	0·3	0·9
Overall balance	0–10	0·7	1·4
Macronutrient ratio	0–6	0·5	1·1
Fatty acid ratio	0–4	0·2	0·7

Figure 2 presents scatter plots of DQII scores in relation to changes in adiposity and reveals smaller 2-year increases in body fat for participants with higher baseline DQII scores. The gradient seems to approximate linearity because the depicted Lowess curves and least-squares regression lines are similar (Fig. 2). Table 3 presents the estimated magnitude of the changes in adiposity for every 10-unit improvement in the overall DQII score and 1-unit improvement in DQII categories. After adjusting for all confounders, every 10-units improvement in the overall DQII score was associated with lower gain in CFMI ($\beta = -0{\cdot}08$; 95 % CI –0·17, –0·003) and %BF ($\beta = -0{\cdot}55$; 95 % CI –1·08, –0·02) Dietary adequacy was associated with all body fat indicators after adjusting for confounders. Every unit improvement in dietary adequacy score was associated with lower gain in FMI ($\beta = -0{\cdot}05$; 95 % CI –0·08, –0·008), CFMI ($\beta = -0{\cdot}03$; 95 % CI –0·05, –0·007), %BF ($\beta = -0{\cdot}15$; 95 % CI –0·28, –0·03) and %CBF ($\beta = -0{\cdot}09$; 95 % CI –0·15, –0·02). None of the other DQII categories (variety, moderation and overall balance) were associated with 2-year changes in adiposity. Finally, neither the DQII nor any of its categories were associated with changes in BMI over 2 years.

Discussion

In the present study, we demonstrated that children with poor dietary quality and particularly poor dietary adequacy were on a trajectory of greater adiposity gain relative to children with better dietary quality. We observed associations of dietary quality with CFMI and %BF, independent of sex, age, total energy intake, physical activity and Tanner stage, but not with FMI, %CBF and

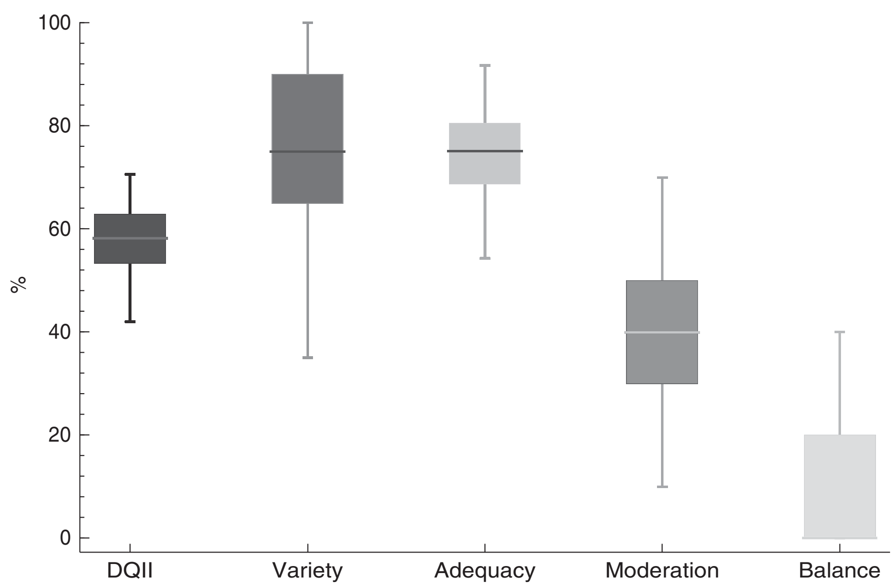

Fig. 1 Box plots of overall Diet Quality Index–International (DQII) and its categories in 546 Canadian children (244 girls and 302 boys) participating in the QUALITY (QUebec Adipose and Lifestyle InvesTigation in Youth) study. The line within the boxes represents the median, the height of the boxes shows the interquartile range, and the whiskers extend to the 2·5 and 97·5 percentiles of the distribution

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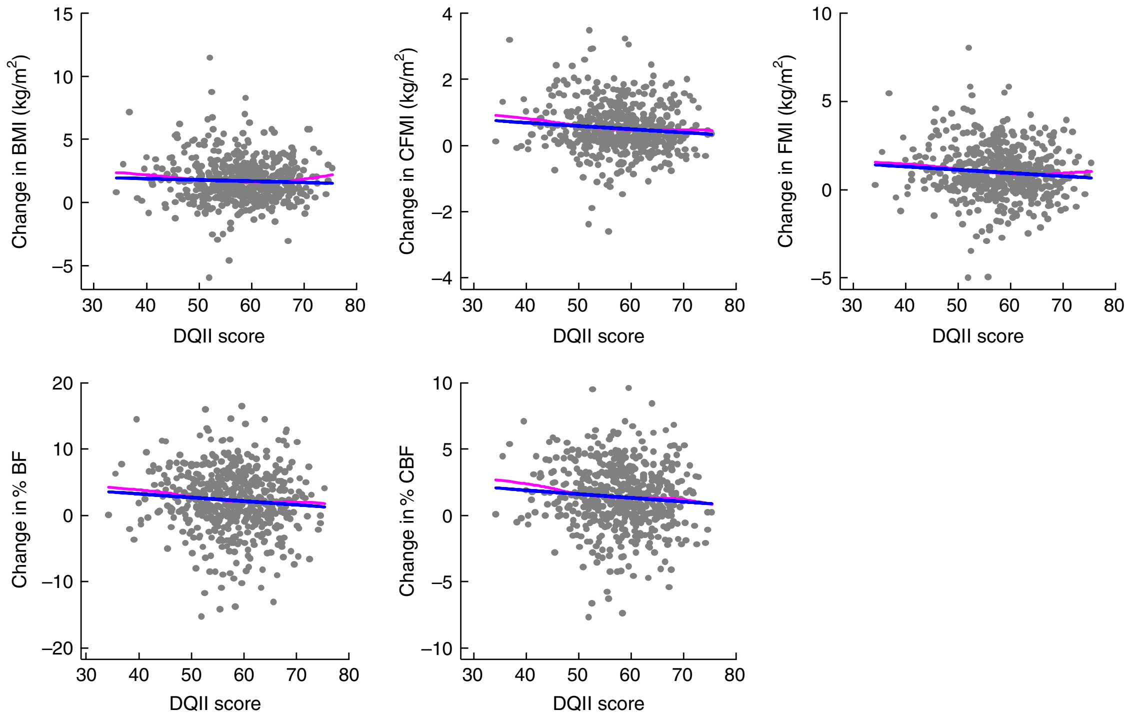

Fig. 2 Association of Diet Quality Index–International (DQII) score with changes in adiposity between baseline and 2-year follow-up in 546 Canadian children (244 girls and 302 boys) participating in the QUALITY (QUebec Adipose and Lifestyle InvesTigation in Youth) study: ——, Loess (local regression of the association between diet quality and changes in adiposity and BMI); ——, linear least-squares regression of the association between diet quality and changes in adiposity and BMI (CFMI, central fat mass index; FMI, fat mass index; %BF, percentage body fat; %CBF, percentage central body fat)

BMI. We observed statistically significant associations of dietary adequacy, but not of dietary variety, moderation and balance, with FMI, CFMI, %BF and %CBF.

With an average DQII score of 58, the dietary quality of the children participating in the QUALITY study appeared slightly lower than that reported in prior studies that have used this measure. The DQII scores of 61 and 62 were observed for grade 5 students in the Canadian provinces of Nova Scotia[26] and Alberta[27], respectively. Further, average DQII scores of 67, 60 and 59 have been reported for elementary students in Korea[28] and for nationally representative samples of children in China and the USA[17], respectively. The relatively poor dietary quality seems consistent with the observation that QUALITY participants are more likely overweight or obese and more likely to have a poor lipid profile relative to a representative sample of Quebec children[23]. This is likely a consequence of the inclusion criterion that limited study eligibility/enrolment to children of obese parents. The relatively high values for dietary variety and adequacy in comparison with the low values for dietary moderation and overall balance in the present study (Fig. 1) were also reported for the American population[17].

The relationship of dietary quality and adiposity has not been extensively investigated among children. A prospective study in the UK found a strong association between poor dietary quality and higher total fat mass *Z*-scores among children below the age of 6 years[19]. A cross-sectional US study among adolescents utilized the Healthy Eating Index and reported negative associations with both %BF and percentage abdominal fat[21]. A Greek cross-sectional study utilized the E-KINDEX tool to assess dietary quality among children (mean age: 10·7 years) and reported higher dietary quality to be associated with lower %BF[22]. With respect to BMI, three studies, including a cohort study in Australia[18] that followed participants from birth to adolescence, the prospective UK study[19] and a cross-sectional study among grade 5 children in Nova Scotia[20], reported no associations of dietary quality with BMI or excess body weight. An Australian cohort study among children (5–12 years at baseline) in socio-economically disadvantaged neighbourhoods revealed an association between dietary quality and BMI *Z*-scores among those children who were overweight but not among those with normal body weight[41]. Similarly, previous studies[19,21,22] reported associations of dietary quality with actual measures of body fat rather than BMI in childhood or adolescence. Two years of follow-up may be too short to expect changes in body fat to translate into differences in body weight categories or BMI in this age group. Studies with longer follow-up may reveal such differences.

The present study examined the importance of dietary quality for prospective changes in adiposity, which had not been previously reported in children and youth. Our findings are consistent with the studies conducted in the UK[19], USA[21] and Greece[22], with an additional finding

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Table 3 The impact of Diet Quality Index–International (DQII) score and its categories on changes in adiposity between baseline and 2-year follow-up in 546 Canadian children (244 girls and 302 boys) participating in the QUALITY (QUebec Adipose and Lifestyle InvesTigation in Youth) study

	Overall DQII		Variety		Adequacy		Moderation		Balance†	
Change in	β coefficient‡	95 % CI	β coefficient	95 % CI	β coefficient	95 % CI	β coefficient	95 % CI	β coefficient	95 % CI
BMI										
Unadjusted	−0·09	−0·30, 0·10	−0·01	−0·06, 0·03	−0·04*	−0·08, −0·007	0·02	−0·01, 0·05	−0·10	−0·43, 0·23
Adjusted§	−0·06	−0·26, 0·14	−0·003	−0·05, 0·04	−0·02	−0·07, 0·02	0·006	−0·03, 0·04	−0·11	−0·44, 0·21
Fat mass index										
Unadjusted	−0·18*	−0·35, −0·009	−0·03	−0·06, 0·009	−0·05**	−0·08, −0·02	0·01	−0·02, 0·04	−0·08	−0·36, 0·20
Adjusted§	−0·16	−0·33, 0·01	−0·02	−0·06, 0·02	−0·05*	−0·08, −0·008	−0·003	−0·04, 0·03	−0·10	−0·37, 0·17
Central fat mass index										
Unadjusted	−0·10*	−0·18, −0·01	−0·01	−0·03, 0·002	−0·03**	−0·04, −0·01	0·006	−0·007, 0·02	−0·04	−0·18, 0·10
Adjusted§	−0·08*	−0·17, −0·003	−0·01	−0·03, 0·006	−0·03**	−0·05, −0·007	−0·001	−0·02, 0·01	−0·04	−0·17, 0·09
% Body fat										
Unadjusted	−0·55	−1·11, 0·01	−0·09	−0·21, 0·03	−0·13*	−0·24, −0·02	0·008	−0·08, 0·10	0·21	−0·70, 1·13
Adjusted§	−0·55*	−1·08, −0·02	−0·08	−0·21, 0·04	−0·15*	−0·28, −0·03	−0·03	−0·13, 0·07	0·03	−0·82, 0·90
% Central body fat										
Unadjusted	−0·28*	−0·57, −0·0003	−0·06	−0·12, 0·002	−0·07**	−0·13, −0·02	0·01	−0·03, 0·06	0·15	−0·31, 0·62
Adjusted§	−0·28	−0·55, 0·0007	−0·05	0·11, 0·01	−0·09**	−0·15, −0·02	−0·008	−0·06, 0·04	0·07	−0·38, 0·52

* $P<0·05$, ** $P<0·01$.
†Balance was entered into the analysis as dichotomous variable: score ≥2 *v.* score <2.
‡Coefficients represent the change in adiposity outcomes per 10-unit change in overall DQII.
§Linear regression model adjusted for sex and baseline values of age, outcome variables, Tanner stage, total daily energy intake and physical activity, as well as change in Tanner stage and change in physical activity between baseline and follow-up.

of an association of dietary quality with central body fat. The magnitude of changes in total and central body fat that were associated with the overall DQII score seems comparable with those of others[18]. Although the magnitude of changes is small, the cumulative impact over time may be substantial.

Dietary adequacy captures the adequate consumption of fruit and vegetables, grains, protein, fibre, Fe, Ca and vitamin C[17,42]. The present study revealed that dietary adequacy was associated with all adiposity indicators. This observation seems consistent with the concept that adequacy of multiple micronutrients and macronutrients, rather than adequacy of a single nutrient, is essential to good health[14]. In the present study, we did not reveal significant associations of dietary variety, moderation and balance with adiposity. The explanation of this may be twofold. First, the association between dietary quality and adiposity was mostly driven by adequacy. Second, nutrition research has a long history of studying adequacy[43], which has led to good definitions and quantifications of adequacy[44]. Inaccuracies in the definitions and quantifications of variety, moderation and balance may have hampered our ability to observe statistically significant associations.

Strengths and limitations

The present study benefits from several strengths including high retention rate at follow-up (89 %), objective measurement of body fat through dual-energy X-ray absorptiometry and physical activity through accelerometer, as well as directly measured height and weight. Dual-energy X-ray absorptiometry is increasingly accepted as a reference method to measure body composition[45]. Each participant completed two or three 24 h dietary recalls as a single recall may fail to capture the usual intake of individuals[46]. However, our study has some limitations. It is not known how representative changes over a period of 2 years are for longer-term weight gain and risk of chronic diseases. The generalizability of our findings may be limited to Caucasian children with a parental history of obesity, higher socio-economic status, and who are at risk for overweight or obesity. No dietary data were collected at the 2-year follow-up visit which prevented us from examining changes in dietary intake over time.

Conclusion

We observed an inverse association of dietary quality and dietary adequacy with changes in total body fat and central body fat independent of sex, age, total energy intake, physical activity and Tanner stage among children. Therefore, the present findings support preventive initiatives aimed at enhancing the quality of the diet and particularly the adequate intakes of nutrients as a means to reduce the societal burden of excess body weight. Health promotion to date has mostly focused on the reduction of dietary fat and added sugar as strategies to promote healthy body weight. The observations of the present study make a case for the promotion of dietary quality and adequacy as a strategy to achieve healthier body weight and reduce the development of chronic diseases in the long term[47,48].

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