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Diet quality, physical activity, body weight and health-related quality of life among grade 5 students in Canada

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Abstract

Objective: To assess how diet quality, physical activity and body weight are related to health-related quality of life (HRQOL) among children in the Canadian province of Alberta.
Design: In 2008, we surveyed 3421 grade 5 students and their parents from 148 randomly selected schools. Students completed the Harvard Food Frequency Questionnaire, questions on physical activities, and had their height and weight measured. The HRQOL of the students was assessed using the EQ-5D-Y. Parents completed questions on socio-economic background and children's lifestyle. We applied multilevel regression methods to examine the importance of children's diet quality, physical activity and weight status for the EQ-5D-Y Visual Analogue Scale and for the EQ-5D-Y dimensions.
Setting: The province of Alberta, Canada.
Subjects: Grade 5 students.
Results: Students with better diet quality, higher physical activity levels and normal body weights were statistically significantly more likely to report better HRQOL than students who ate less healthily, were less active or were overweight or obese.
Conclusions: The importance of diet quality, physical activity and body weight status for HRQOL may help justify broader implementation of school health programmes that promote healthy eating and active living, as these programmes will help reduce the burden of childhood obesity and improve quality of life.

Keywords
Health-related quality of life
Nutrition
Physical activity
Childhood obesity

Excess body weight has become a public health burden in both developing and developed countries[1]. In Canada, 25·7 % of children and adolescents are overweight or obese, and 8·6 % obese[2]. Excess body weight has been widely acknowledged to contribute to various chronic diseases, resulting in diminished life expectancy[3–5]. Overweight or obesity in children and adolescents has also negative consequences for self-esteem, psychosocial health and cognitive development[6–8].

Unhealthy diet, characterized by increased intakes of fat and sugar and inadequate intakes of fruits, vegetables and whole grains[9], as well as insufficient physical activity (PA) have been identified as two fundamental factors leading to overweight and obesity[10,11]. Most childhood obesity strategies therefore include the combination of promotion of healthy eating and active living[12,13]. Such approaches have also been shown to benefit self-esteem and academic performance[6,9,13,14].

The importance of excess body weight for impaired health-related quality of life (HRQOL) in children and adolescents has been documented in both clinical and population-based studies[15–22]. However, only a few studies have looked at the importance of the factors underlying excess body weight – being diet quality and PA – for HRQOL. Moreover, the few that have were conducted were mostly among children and adolescents with chronic diseases or specific health conditions[19,23,24]. Very few studies on diet quality, PA and weight status in relation to HRQOL in children used representative population-based samples[25–26]. Although such studies are important in identifying the undesired dietary and activity patterns and in designing effective intervention strategies, no such studies have been conducted in Canada. The purpose of the present study was therefore to establish the associations of diet quality, PA and weight status with HRQOL among children in Canada.

Methods

The survey

The Raising Healthy Eating and Active Living Kids in Alberta (REAL Kids Alberta) survey was developed to evaluate Alberta Health and Wellness initiatives that promote healthy body weights among children and adolescents. The survey was conducted in 2008 among grade 5 students

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who are primarily 10 to 11 years old. The survey employed a one-stage stratified random sampling design. The sampling frame includes all elementary schools in the province with the exception of private schools (4·7% of all Alberta children), francophone schools (0·6%), on-reserve federal schools (2·0%), charter schools (1·7%) and colony schools (0·8%)[27], leaving primarily public and Catholic schools in the sampling frame. Schools were stratified into three geographies: (i) urban, i.e. Calgary and Edmonton; (ii) cities, i.e. other municipalities with more than 40 000 residents; and (iii) rural, i.e. municipalities with fewer than 40 000 residents. Schools were randomly selected within each of these three strata to achieve a balanced number of schools and students in each stratum.

Of the 184 invited schools, 148 (80·4%) participated in the study. All grade 5 students (*n* 5594) attending these schools received an envelope with a consent form and a survey to take home for their parent/guardian(s) to complete. A total of 3645 students returned the forms and had received parental consent to participate in the study. In total, 3421 students (61·2% of all students) completed the survey when trained assistants visited their schools to administer the surveys and to measure heights and weights. The surveys included questions on nutrition, PA and HRQOL measured by the youth version of the EQ-5D (EQ-5D-Y)[28]. The questionnaires, both for students and parents, are posted online (www.REALKidsAlberta.ca).

Assessments

Diet quality assessment

The Harvard Food Frequency Questionnaire for Youth and Adolescents (YAQ) is a validated food frequency instrument that is suitable for grade 5 students[29,30]. The YAQ provides detailed information on the frequency and kinds of foods that children and adolescents consume[29]. On the basis of students' responses to the YAQ and Canadian Nutrient Files[31], we calculated intakes of nutrients and energy for each participant. On the basis of these intakes we determined the diet quality using the Diet Quality Index–International (DQI-I) composite measure. The DQI-I encompasses variety, adequacy, moderation and overall balance of the diet[32]. We divided the DQI-I scores into tertiles for the purpose of our analysis.

Physical activity assessment

Students and their parent/guardian(s) responded to questions on: (i) travel to and from school; (ii) time spent to get to and from school; (iii) frequency of child's activities outside school hours; (iv) activities at morning and lunch recess in the past 7 d; and (v) frequency of involvement in sports and physical activities in the past 7 d. These questions, containing twenty-nine items, were largely adopted from the Physical Activity Questionnaire for Children (PAQ-C) which has been demonstrated to be valid and have high reliability[33,34]. We derived a composite score ranging from 0 to 5 based on the score given to the twenty-nine items.

Overweight and obesity assessment

Standing height was measured to the nearest 0·1 cm without shoes and body weight to the nearest 0·1 kg on calibrated digital scales. BMI was calculated by dividing weight (in kilograms) by the square of height (in metres). Body weight was categorized as normal weight, overweight and obese using the BMI cut-off points for children and adolescents by the International Obesity Taskforce[35]. These cut-offs are based on adult definitions of overweight (25 kg/m^2 or more) and obesity (30 kg/m^2 or more), adjusted to specific age and gender groups for children.

Outcome measures

HRQOL was assessed by the EQ-5D-Y (youth) where the language of the EQ-5D instrument for adults is modified so that children can better understand it. The HRQOL instrument consists of a five-dimensional descriptive system asking whether children have (i) no problems, (ii) some problems or (iii) a lot of problems with: (i) walking; (ii) looking after myself; (iii) doing usual activities; (iv) having pain or discomfort; and (v) feeling worried, sad or unhappy, respectively[28]. The instrument also includes a Visual Analogue Scale (VAS) which is anchored at 100 (best imaginable health) and 0 (worst imaginable health) to capture self-rated values of health status in children. The EQ-5D-Y has been validated for several languages and countries[36]. The main advantages of the instrument are that it is short and simple, can be completed within 10 min by children, and can be used to estimate a single index score to be analysed subsequently in economic evaluation studies[28].

Analytical methods

We applied the χ^2 test to examine differences in the prevalence of reported health problems for each of the five EQ-5D-Y dimensions by the observed predictors. As very few students reported 'a lot of problems', we combined this with 'some problems' to create a dichotomous outcome (no problems *v.* with any problems). We described generic HRQOL by different groups of diet quality, PA and weight status as measured by the EQ-5D-Y VAS score. We applied multilevel multivariable linear regression to assess the association of diet quality, PA and body weight with the generic HRQOL. We applied multilevel multivariable logistic regression to examine the effect of diet quality, PA and body weight for the EQ-5D-Y dimensions. These regression models accommodated the hierarchical data structure in that student observations are nested within their schools. The regression analyses were adjusted for the confounding influence of gender, place of residence, household income and parental education.

The EQ-5D-Y descriptive system was fully completed by 3406 students (99·6%) and 3379 students (98·8%)

answered the VAS. These missing outcomes were not considered in the analyses. Of all participating students, 3340 parents completed a survey on educational attainment, household income, place of residency (urban, town, rural) and their child's PA. Missing values for education and income were considered as separate categories in the analysis but the estimates are not presented. All analyses were weighted to accommodate the design effect such that all estimates pertain to the population of grade 5 students in Alberta. Data were analysed using the STATA statistical software package version 11·0 (StataCorp, College Station, TX, USA). The study programme was approved by Health Research Ethics Board of the University of Alberta.

Results

Students who were physically inactive reported significantly more HRQOL problems relative to their peers who were physically active on four of the five dimensions: 'looking after myself', 'doing usual activities', 'having pain or discomfort', and 'feeling worried, sad or unhappy'. Compared with the normal weight group, obese students had significantly more HRQOL problems on the 'looking after myself' and 'feeling worried, sad or unhappy' dimensions. Furthermore, across diet quality tertiles, statistically significant differences were reported with respect to 'having pain or discomfort' (Table 1). Mean HRQOL score for students in the highest tertile of diet quality, with physically active lifestyle and with healthy weight was 82·2, 84·2 and 81·5, respectively (Table 1).

Table 2 shows multivariate-adjusted associations of HRQOL with diet quality, PA and body weight status. The VAS value was statistically significantly higher for students who were physically active, normal weight and in the highest DQI-I tertile relative to students who were not physically active, overweight or obese and in the lowest DQI-I tertile.

Table 3 presents the adjusted odds ratio of reporting problems on the EQ-5D-Y dimensions. Diet quality, body weight status and PA significantly affected one, two and four of the five dimensions, respectively, after accounting for the effect of sociodemographic variables. The results are very similar to the unadjusted results in Table 1.

Discussion

The present study reveals that diet quality, PA and body weight are associated with HRQOL in grade 5 students. These associations were independent of gender and sociodemographic factors. The study further reveals an association of diet quality with the VAS score whereby children with better diet quality reported better HRQOL. Students who were physically inactive, overweight or obese had reportedly a lower HRQOL.

The relationship between PA and HRQOL has been well described in adults relative to younger populations. An association of higher HRQOL scores with higher PA levels has been consistently documented in healthy adults[37]. Our observations that physically active children have significantly higher HRQOL scores than those in the inactive group support the previous findings in both adult[37] and the few child and adolescent studies[25,26,38,39]. A systematic review of HRQOL among children and adolescents reported that excess body weight had a moderate to strong negative influence on HRQOL, whereas the role of psychosocial, emotional and school functioning on HRQOL had been inconsistent[40]. Our observation in a large population-based sample of grade 5 students confirms this relationship of excess body weight with lower quality of life. We also showed that children from parents who received

Table 1 Prevalence of problems in the EQ-5D-Y dimensions and mean VAS score by diet quality, physical activity and weight status: grade 5 students aged 10–11 years (*n* 3421), Alberta, Canada, 2008

		Percentage of students reporting having problems with:					VAS score*	
Variable	Percentage (*n* 3421)	Walking	Looking after myself	Doing usual activities	Having pain or discomfort	Feeling worried, sad or unhappy	Mean	95 % CI
All grade 5 students	100·0	8·1	6·5	11·9	46·1	37·7	80·4	79·8, 81·1
DQI-I		$P = 0·894$	$P = 0·698$	$P = 0·274$	$P = 0·049$	$P = 0·388$		
Lowest tertile	–	8·4	7·0	13·1	49·2	39·4	78·5	77·4, 79·5
Middle tertile	–	8·2	6·4	11·7	43·6	36·4	80·5	79·4, 81·6
Highest tertile	–	7·8	6·0	10·8	45·6	37·3	82·2	81·1, 83·2
Physical activity		$P = 0·112$	$P = 0·005$	$P < 0·001$	$P = 0·003$	$P < 0·001$		
Not active	73·9	8·6	7·3	13·4	47·7	39·9	79·1	78·3, 79·8
Active	26·1	6·8	4·4	7·6	41·5	31·4	84·2	83·1, 85·2
Weight category		$P = 0·146$	$P = 0·009$	$P = 0·170$	$P = 0·440$	$P = 0·035$		
Obese	7·0	10·8	11·7	15·8	49·8	46·0	75·4	73·1, 77·8
Overweight (excluding obese)	21·7	9·2	6·3	12·2	47·1	38·3	78·5	77·1, 79·9
Normal weight	71·3	7·6	6·1	11·4	45·5	36·7	81·5	80·8, 82·2

VAS, Visual Analogue Scale; DQI-I, Diet Quality Index–International.
The χ^2 test was used to obtain the *P* values where weighted percentages of students with problems in different dimensions are presented.
*The EQ-5D-Y VAS score ranged from 0 to 100, where 100 is best imaginable health.

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Table 2 Associations of diet quality, physical activity, body weight status and sociodemographic factors with VAS score*: grade 5 students aged 10–11 years (*n* 3421), Alberta, Canada, 2008

Variable	Regression coefficient	95 % CI	*P* value
Constant	75·97	73·43, 78·52	<0·001
DQI-I (reference: lowest tertile)			
Middle tertile	1·47	−0·22, 3·15	0·088
Highest tertile	2·76	1·26, 4·26	<0·001
Physical activity (reference: not active)			
Active	4·49	2·98, 6·00	<0·001
Weight status (reference: normal weight)			
Overweight (excluding obese)	−2·48	−4·00, −0·96	0·001
Obese	−5·39	−7·64, −3·13	<0·001
Gender (boys relative to girls)	0·47	−0·96, 1·90	0·517
Residential area (reference: urban)			
Town	0·22	−1·95, 2·40	0·840
Rural	1·45	−0·28, 3·19	0·100
Parents' education (reference: secondary or below)			
Post-secondary or college	1·18	−0·41, 2·76	0·147
University or above	2·42	0·76, 4·09	0·004
Household income (reference: ≤$CAN 50 000)			
$CAN 50 001–75 000	−0·84	–3·45, 1·76	0·524
$CAN 75 001–100 000	0·80	–1·33, 2·92	0·462
>$CAN 100 000	1·41	–0·46, 3·28	0·139

VAS, Visual Analogue Scale; DQI-I, Diet Quality Index–International.
The regression analysis was mutually adjusted for variables in the table. All estimates were weighted to represent population estimates.
*The EQ-5D-Y VAS score ranged from 0 to 100, where 100 is best imaginable health.

less education had lower quality of life. Identifying determinants for different aspects of the HRQOL is essential to developing public health intervention strategies and targets. Our study revealed that PA has a significant impact on each of the five EQ-5D-Y dimensions except 'walking'. This is consistent with the few previous studies that have demonstrated that physically active children exhibit better physical and psychological quality of life[26], better self-esteem[41] and better psychosocial quality of life[19,41]. We observed that overweight and obese children were reportedly more worried, sad or unhappy, which seems consistent with HRQOL studies reporting that obesity is associated with impaired psychosocial functioning[17,18,21,22], lower physical functioning[40], lower emotional functioning[16,22] and lower self-esteem[17,22].

Relative to studies in other countries using the EQ-5D-Y, children in Alberta reported a higher prevalence of health problems in the dimension of pain or discomfort (46·0 %). High percentage of any health problems in pain or discomfort (43·6 %) was also presented in a general population sample of adults in Alberta using the EQ-5D[42]. A possible explanation for this finding in our study may be that response to the EQ-5D-Y descriptive system could be culturally different across different countries or in geographic areas within a country. Further analysis using the EQ-5D-Y in other provinces in Canada and in other countries may help to ascertain the origin of this finding.

In addition, it is also important to examine the magnitude of the differences to estimate minimally important differences (MID) in HRQOL scores between comparison groups[43]. MID for the EQ-5D index and the EQ-5D VAS have been previously estimated for some disease conditions[44,45]. We have not identified any study demonstrating a MID value for the EQ-5D-Y VAS or index. Estimation of MID in HRQOL scores requires a variety of approaches, both distribution-based and anchor-based[46], and a rigorous examination of various factors that may affect the degree of minimal differences[47]. Future research is warranted to investigate the magnitude and direction of differences/changes in HRQOL to establish MID cut-off points for the EQ-5D-Y for the general population of children and adolescents.

In the present study we did not estimate an index score for EQ-5D-Y as we were interested in quality of life that was measured and described by children themselves. Since no EQ-5D-Y tariff is available for use in younger populations, several previous studies in quality of life assessment in children and adolescents using the EQ-5D or EQ-5D-Y have reported on utility indices generated from the existing US or UK EQ-5D tariffs[48,49]. There is a debate about the applicability of the existing social tariffs for adults to children[36]. Current research interest in the field is to establish a child-specific value set for the EQ-5D-Y for use in population health research and economic evaluation studies[36].

The present study is the first to reveal the associations of diet quality, PA and body weight with HRQOL among preteen children. Specifically, the study contributes to the evidence of positive associations between diet quality, PA and HRQOL in schoolchildren, independently of weight status and sociodemographic characteristics. These findings suggest that school-based programmes promoting healthy eating and active living may not only help to prevent children from becoming overweight, but may also benefit their HRQOL regardless of weight status. The differences in HRQOL outcomes by diet quality specifically

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Table 3 Odds ratio of reporting problems in the EQ-5D-Y dimensions by diet quality, physical activity, weight status and sociodemographic factors: grade 5 students aged 10–11 years (*n* 3421), Alberta, Canada, 2008

Variable	Walking			Looking after myself			Doing usual activities			Having pain or discomfort			Feeling worried, sad or unhappy		
	OR	95 % CI	*P* value	OR	95 % CI	*P* value	OR	95 % CI	*P* value	OR	95 % CI	*P* value	OR	95 % CI	*P* value
DQI-I (reference: lowest tertile)															
Middle tertile	1·01	0·70, 1·46	0·941	0·94	0·67, 1·31	0·710	0·92	0·70, 1·21	0·538	0·81	0·68, 0·98	0·026	0·88	0·73, 1·07	0·193
Highest tertile	0·98	0·68, 1·41	0·918	0·89	0·63, 1·25	0·495	0·84	0·63, 1·12	0·234	0·90	0·75, 1·08	0·254	0·92	0·77, 1·11	0·393
Physical activity (reference: active)															
Not active	1·29	0·92, 1·81	0·140	1·71	1·21, 2·43	0·002	1·82	1·37, 2·42	<0·001	1·29	1·06, 1·58	0·012	1·31	1·11, 1·54	0·001
Weight category (reference: normal weight)															
Overweight	1·20	0·90, 1·59	0·210	1·04	0·70, 1·53	0·860	1·02	0·79, 1·31	0·901	1·04	0·84, 1·28	0·735	1·04	0·87, 1·26	0·654
Obesity	1·38	0·91, 2·07	0·128	2·05	1·20, 3·50	0·009	1·34	0·94, 1·91	0·104	1·11	0·82, 1·50	0·499	1·47	1·10, 1·98	0·010
Gender (boys relative to girls)	1·07	0·81, 1·41	0·633	1·36	1·02, 1·82	0·038	0·85	0·66, 1·10	0·219	1·05	0·91, 1·22	0·493	0·57	0·48, 0·67	<0·001
Residential area (reference: urban)															
Town	1·18	0·87, 1·61	0·297	0·92	0·59, 1·43	0·702	1·61	1·22, 2·13	0·001	1·11	0·93, 1·33	0·256	1·00	0·80, 1·24	0·968
Rural	1·33	0·99, 1·77	0·055	0·78	0·54, 1·13	0·197	1·37	1·03, 1·82	0·031	1·22	1·04, 1·43	0·013	1·05	0·86, 1·28	0·661
Parents' education (reference: secondary or below)															
Post-secondary or college	0·88	0·65, 1·18	0·396	0·97	0·68, 1·39	0·860	0·84	0·64, 1·12	0·234	0·89	0·75, 1·06	0·179	0·86	0·70, 1·04	0·124
University or above	0·76	0·52, 1·11	0·150	1·19	0·77, 1·81	0·434	0·90	0·66, 1·23	0·509	0·79	0·65, 0·97	0·025	0·80	0·66, 0·97	0·026
Household income (reference: ≤$CAN 50 000)															
$CAN 50 001–75 000	1·43	0·91, 2·23	0·120	1·88	1·10, 3·20	0·021	1·41	0·95, 2·10	0·090	1·39	1·06, 1·83	0·017	0·99	0·73, 1·34	0·962
$CAN 75 001–100 000	0·89	0·57, 1·40	0·618	1·55	0·89, 2·70	0·120	0·81	0·53, 1·23	0·321	1·18	0·92, 1·50	0·189	0·91	0·69, 1·22	0·539
>$CAN 100 000	0·89	0·57, 1·37	0·588	1·08	0·63, 1·85	0·769	0·73	0·51, 1·03	0·073	1·03	0·84, 1·27	0·781	0·90	0·69, 1·16	0·409

DQI-I, Diet Quality Index–International.
All analyses were mutually adjusted for variables in the table. All estimates were weighted to represent population estimates.

suggest the importance of nutrition programmes focusing on improving diet quality among children in the development of school health promotion. One Canadian study has shown that nutrition programmes that are based on comprehensive school health exhibit a greater positive effect on students' diets, PA and overweight reduction than a single nutrition programme[13]. More research is needed to examine whether such comprehensive school health approaches that integrate nutrition education, nutrition policy, healthy food services, environmental support and various PA strategies into a whole school model will result in an improvement of HRQOL among children. This may justify broader investments in school programmes to the benefits of health and quality of life among children[13,50].

Major strengths of the present study include the use of a large population-based sample of students, the use of objective measurement of height and weight, the adjustment for sociodemographic factors in the analysis, the use of a validated generic multidimensional HRQOL measure for children, and the application of multilevel regression to account for hierarchical data structure and with weighted analysis to accommodate the survey design effect. Limitations of the study should also be clarified. The observed associations of diet quality, PA and body weight with HRQOL could not be inferred as causality based on the cross-sectional survey design. Since participation in the survey was voluntary, selection bias may have occurred due to possible differences in characteristics between the participants and the non-participants. Our study was conducted in a sample of grade 5 students, which limits the generalizability of the results to other age groups of children. PA and diet assessments in the current study were based on measurement of self-report, and may have been affected by measurement error. The use of objective measures of PA (e.g. pedometers) would allow for more accurate evaluation of PA of students, although this may pose challenges in financial and resource support in large-scale population-based studies[51].

Conclusions

The present study demonstrated the importance of diet quality, PA and body weight status for HRQOL which will help justify broader implementation of school health programmes that promote healthy eating and active living, as these programmes will help reduce the burden of childhood obesity and improve quality of life.

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