BDA The Association of UK Dietitians
THE OFFICIAL JOURNAL OF THE BRITISH DIETETIC ASSOCIATION
Journal of Human Nutrition and Dietetics

Journal of Human Nutrition and Dietetics

RESEARCH PAPER

Adherence to Canada's Food Guide recommendations among Alberta's multi-ethnic youths is a major concern: findings from the WHY ACT NOW project

F. Kolahdooz,[1] F. Nader,[1] M. Daemi,[1] S. L. Jang,[1] N. Johnston[2] & S. Sharma[1]

[1]Indigenous and Global Health Research Group, Faculty of Medicine & Dentistry, Department of Medicine, University of Alberta, Edmonton, AB, Canada
[2]Alberta Centre for Active Living, Faculty of Kinesiology, Sport, and Recreation, University of Alberta, Edmonton, AB, Canada

Keywords
Canada's Food Guide recommendations, Edmonton, multi-ethnic, urban, youth.

Correspondence
S. Sharma, Capital Health Research Chair in Indigenous Health, Centennial Professor in Indigenous and Global Health Research, Department of Medicine, Faculty of Medicine & Dentistry, University of Alberta, Unit 5–10 University Terrace, 8303–112 Street, Edmonton, AB, T6G 2T4, Canada.
Tel.: +1 780 248 1393
Fax: +1 780 492 3018
E-mail: gita.sharma@ualberta.ca

How to cite this article
Kolahdooz F., Nader F., Daemi M., Jang S.L., Johnston N. & Sharma S. (2018) Adherence to Canada's Food Guide recommendations among Alberta's multi-ethnic youths is a major concern: findings from the WHY ACT NOW project. *J Hum Nutr Diet*.
https://doi.org/10.1111/jhn.12565

Abstract

Background: Dietary habits formed during youth may result in the development of obesity and chronic diseases in adulthood. We aimed to determine the frequency of the consumption of foods and beverages and the degree of adherence to Canada's Food Guide recommendations among multi-ethnic youths.

Methods: Participants were recruited from 12 schools in the Edmonton, Alberta area by use of posters, school newsletters and advertisements. A 30-item food frequency questionnaire was administered by a trained interviewer to assess dietary intake in a convenience sample of 557 (328 females and 229 males) youths aged 11–23 years; for the purpose of the present study, only the 14–18 years age group was considered in the analysis. Participants were divided by sex and self-identified ethnicity into four groups [Indigenous, African & Middle Eastern (AME), Asian, and European]. Statistical analysis of the data was undertaken using *t*-tests, Welch's analysis of variance and Games-Howell tests. $P < 0.05$ was considered statistically significant.

Results: Vegetables and Fruit recommendations were the least likely to be followed, with 90.7–96.8% of participants in all groups not consuming the recommended number of servings day^{-1}. The mean frequency of fruit consumption was lower among Indigenous youths compared to Asian youths (0.90 versus 1.37 times day^{-1}). A greater proportion of males than females (55.9% versus 44.3%) did not meet the minimum recommendations for Meat and Alternatives ($P = 0.016$). The percentage of youths not adhering to recommendations for Milk and Alternatives was 81.7% for Indigenous, 73.3% for AME, 78.6% for Asian and 63.5% for European youths. Indigenous youths more frequently consumed potato chips and soft drinks compared to other ethnic youths. The most frequently consumed beverage was milk (1.25 times day^{-1}).

Conclusions: The majority of youths did not consume minimum daily recommended servings of Vegetables and Fruit, Milk and Alternatives, and/or Meat and Alternatives food groups. Evidence-based dietary interventions and public health strategies are needed.

Introduction

Chronic diseases such as diabetes, cancer and cardiovascular disease (CVD) are the most important contributors to premature death and the high cost of health care in Canada [1]. The estimated total cost, both direct and indirect, of CVD, diabetes, and cancer was almost $20 billion in Canada in 2008 [2]. Poor nutrition is one of the main risk factors for chronic diseases [3–6]. Unhealthy dietary habits formed in childhood may extend into adulthood and result in the development of some chronic diseases [7–9]. Being overweight in childhood or adolescence may increase the likelihood of being overweight and obese, as well as premature mortality, in adulthood [8,10,11].

Healthy eating behaviours during childhood and adolescence are vital for optimal growth and intellectual development and also have long-term health implications [11–13]. One of the practical ways of investigating food intake in youths is to evaluate the adherence to the national dietary recommendations; in this regard, there is little information available on Canadian multi-ethnic youths. Many countries in the world have national food-based dietary guidelines [14]. In the present study, Canada's Food Guide was chosen as a comparative standard for two reasons: (i) the ease of use for both the general population and the target population and (ii) an individual who meets the recommendations of Canada's Food Guide can also be assumed to meet Canadian standards of estimated average requirements or the amount of each vitamin and mineral needed to meet the requirements of half of the population. The 2011 Canada's Food Guide advises the daily consumption of 7–8 servings of Vegetables and Fruit, 6–7 servings of Grain Products, 3–4 servings of Milk and Alternatives, 2–3 servings of Meat and Alternatives, and a small amount of unsaturated oil (30–45 mL) for youths [15]. Understanding such healthy eating recommendations is shown to be associated with healthy eating practices [16]. Despite the importance of healthy eating behaviours during adolescence, the current eating patterns among Canadian adolescents have been found to be inconsistent with the dietary guidelines [17,18]. Newcomer populations are particularly at increased risk of poor nutrition because of a dietary transition towards a poor diet [19]. Determining the differences and similarities of eating patterns across ethnic groups can enable the specific tailoring of dietary interventions in multi-ethnic youths. Furthermore, the current National Health and Nutrition Examination Survey (NHANES) illustrates a gap in multi-ethnic individual adherence to dietary guidelines [20]. Frequent intake of high-fat/high-energy and non-nutrient dense foods (NNDFs), sweetened beverages, and fast foods; a tendency to avoid fresh fruit and vegetables; personal preference for specific foods or vending machine snacks; and unhealthy dietary practices such as dieting, binge-eating, irregular eating and meal skipping (especially breakfast) all comprise predominant dietary concerns among youths [18,21–29]. These behaviours increase the risk of being overweight and obese and experiencing chronic diseases [30–32].

School-based nutritional interventions may improve eating habits among children and youths [33,34]. To address issues around dietary behaviours in children and youths, as well as to design and implement effective interventions, current evidence about eating habits is essential. Various methods exist for assessing dietary intake; food frequency questionnaires (FFQs) are the most feasible and cost-effective means of assessing diet in large-scale studies. Their ease of use and non-invasive approach reduces the burden for participants and makes the FFQ an ideal tool for population-level studies. FFQs can be used to rank individuals according to dietary patterns and also to compare foods and nutrient intakes across different populations [35], including children and adolescents [36–38]. In addition to being inexpensive, the FFQ does not affect eating behaviours and, more importantly, it provides an overall estimate of typical intake from the population.

The population in Edmonton, Alberta, Canada, is widely diverse; foreign-born immigrants comprise 25% of the population, and individuals who identify as Indigenous (First Nations, Métis or Inuit) make up 5%. The diverse communities are also rapidly growing. With median ages lower than the national average, both Indigenous and immigrant populations are comparatively young [39]. Edmonton Public Schools District is the sixth largest school district in Canada [40] and provides a unique opportunity for examining dietary habits among multi-ethnic youths. The information gathered in the present study can be used to improve the health and wellbeing of multi-ethnic youths and develop appropriate strategies for reducing the burden of being overweight and obese in the population. The present study aimed to determine the current situation of food and food group intakes in different ethnic groups and to assess adherence to the 2011 Canada's Food Guide recommendations and the consumption of unhealthy foods; these data can lead to guide interventions because no such data previously existed for the populations. The first phase of the WHY ACT NOW (Wellness and Health in Youth – All Communities in Transition NOW) project collected data to form the basis of a follow-up intervention in the second phase, which entailed a school-based intervention to promote the increased intake of foods that are recommended by Canada's Food

Guide and adherence to these recommendations within each ethnic group.

Materials and methods

Participant recruitment and data collection

In the previously completed study, WHY ACT NOW, 12 schools and institutions in Edmonton with large numbers of Indigenous and/or new Canadian students were selected. Posters, school newsletters and advertisements were used to recruit a convenience sample of 557 multi-ethnic youths between the ages of 11 and 23 years. There were 16 participants in the 'children' group (11–13 years old), 461 participants in the 'teens' group (14–18 years old) and 75 participants in the 'adult' group (19–23 years old). For the purpose of the present study, we excluded the 'children' and 'adult' groups as a result of the small sample sizes and focused on the 'teens' group to allow more meaningful sub-analyses.

Between October 2013 and March 2014, study participants were interviewed individually, using a specifically designed questionnaire (available upon request from the corresponding author). This questionnaire was composed of sections referring to demographics, socio-economic status, ethnicity, family environment, physical activity and supplement intake. Pregnant and breastfeeding youths have different dietary and nutritional requirements and were thus excluded. To ensure standardisation, the project coordinator trained staff in questionnaire administration and anthropometric measurements. All questionnaires were interviewer-administered and data were examined afterwards by the project coordinator. If any data set was incomplete, the participants were re-contacted by the interviewer to obtain the missing information. Five participants were excluded from the final analyses as a result of an incomplete FFQ.

An FFQ was used to assess usual dietary intakes of food/drink items: 'fresh or frozen fruit', 'dried fruit', '100% fruit juice', 'vegetables (not including potatoes or vegetables in soup, stew or salad)', 'salad (green salad)', 'milks', 'cheese or yogurt', 'whole grain products', 'white grain products', 'meat (chicken, beef, pork, lamb and poultry, excluding fish and processed meat)', 'processed meat (lunch meats, sausages, hot dog, bacons)', 'fish (canned, fresh, smoked or frozen), 'beans or lentils', 'nuts or nut butters', 'eggs', 'sweets (candy or chocolate)', 'ice cream', 'cakes, pastries, donuts, muffins or cookies', 'potatoes (boiled, mashed, baked), 'French fries', 'potato chips', 'regular soft drinks', 'diet/sugar-free soft drinks', 'fruit drinks: not 100% fruit juice', 'energy drinks', 'sport drinks', 'hamburgers' and 'pizza'. In this list, foods that are known for containing high fat, sugar and sodium, and low nutritional values, were considered as NNDFs; these foods include processed meat, sweets, pastries, French fries, soft drinks, fruit drinks, and energy and sports drinks, as well as alcohol. Participants reported the frequency of consumption of these food items for a 7-day period, with responses ranging from 'never' to '≥4 per day'. To allow comparison with Canada's Food Guide recommendations [15], each individual's frequency of food intakes was computed by calculating the frequency across food items in each food group.

Height and weight were measured by a stadiometer (model 213; Seca GmbH, Hamburg, Germany) and a scale (Taylor Precision Products Inc., Oakbrook, IL, USA) to the nearest 0.1 cm and 1 kg, respectively. Measurements were obtained three times only if first and second attempts were more than 0.5 cm (for height) or 0.5 kg (for weight) apart. If participants declined to be measured, self-reported measurements were recorded (for height $n = 18$ and for weight $n = 24$). Data were collected in winter in Canada and, before measuring, interviewers asked participants to remove heavy clothing and shoes. By noting the heaviness of clothing (after removing shoes and coats), weight was adjusted by subtracting 1 kg for light, 1.5 kg for medium and 2 kg for heavy clothing from the measurement. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Age- and sex-specific BMI *Z*-scores were computed based on the World Health Organization growth reference for BMI [41]; participants were categorised as underweight (BMI <-2 standard deviation (SD)), normal weight (-2 SD $\leq$ BMI $\leq$ 1 SD), overweight (1 SD $<$ BMI $\leq$ 2 SD) or obese (BMI $>$ 2 SD).

Research Ethics Board approval was obtained from the Health Research Ethics Board at the University of Alberta. The project was approved to work within Edmonton Public Schools by the Cooperative Activities Program with the University of Alberta, Faculty of Education, and the Research Proposal Review Committee with Edmonton Public Schools. Written informed consent was provided by all of the participants before the interviews began and all participation was voluntary. Parental consent was given for all participants below the age of 18 years.

Statistical analysis

The mean, SD, and median of the frequency of daily consumption of the food items were determined for each food and beverage listed on the FFQ. For a comparison with Canada's Food Guide, it was assumed that each daily frequency of consumption was equivalent to each serving size in the guide [15]. This was based on the data around the quantity of food or beverage consumed collected via 24-h dietary recalls, which was administered as part of the questionnaire. For further analyses,

participants were divided by self-identified sexes (males and females) and ethnicity into four ethnic groups [Indigenous, African & Middle Eastern (AME), Asian and European]. Student's *t*-test was applied to determine statistically significant differences in the mean daily frequency of food and beverage consumption between sexes. A one-way analysis of variance (ANOVA) test was utilised to compare the mean daily frequency of intake of foods and beverages among different ethnic groups. A multiple comparison test (Tukey–Kramer) was employed to determine whether the means of the four ethnic groups differed significantly in an ANOVA. The SDs of daily frequency of intake for some food and beverages were heterogeneous (detected by Levene's test) among different ethnic groups; Welch's ANOVA and Games-Howell tests was therefore applied instead of one-way ANOVA and Tukey–Kramer tests. Pearson chi-squared tests were performed to estimate the measures of associations between adherence to Canada's Food Guide recommendations and sex (males and females) and ethnicity (Indigenous, AME, Asian and European). $P < 0.05$ (two-sided) was considered statistically different. SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) was used to analyse data.

Results

The demographics of the included participants are presented in Table 1. The total number of participants in the final analyses was 461, including 282 females (61.2%) and 179 males (38.8%). When categorised by ethnicity, 17.8% were Indigenous, 16.3% were AME, 27.3% were Asian and 38.6% were European. 90.0% of participants lived with parents, 0.9% lived alone, 5.5% lived with relatives or siblings and 3.7% lived with others. Furthermore, 72.6% had a BMI in the normal range, whereas 3.4% were underweight, 15.7% were overweight and 8.2% were obese. Compared to youths of other ethnicities, Indigenous youths showed higher proportions of not living with parents (26.2% compared to 0–9.5%) and being obese (15% compared to 4.2–7.6%).

Table 2 presents the percentage of participants who consumed each food and the mean daily frequency of consumption by sex in the order of the most to least commonly consumed foods and beverages among study participants. Overall, the most frequently consumed food items were fruit (1.22 times day^{-1}), meats (1.12 times day^{-1}) and whole grain products (1.05 times day^{-1}). Whole grain products were consumed more often than refined grain products (0.97 times day^{-1}). The mean daily frequency of consumption of meats, refined grain products, processed meats, pizza and hamburgers was higher among males than females ($P < 0.05$). The mean daily frequency of consumption of salads was higher among females than males (0.43 versus 0.32 times day^{-1}; $P < 0.05$). The most frequently consumed beverages among both sexes were milk, at 1.25 times day^{-1}, followed by unsweetened fruit juices (0.60 times day^{-1}), sweetened juices (0.43 times day^{-1}) and regular soft drinks (0.41 times day^{-1}). Energy drinks were the least frequently consumed at 0.03 times day^{-1}. Compared to females, males had higher mean daily frequencies of consumption of milk (1.48 versus 1.11 times day^{-1}), unsweetened fruit juices (0.77 versus 0.49 times day^{-1}), regular soft drinks (0.54 versus 0.32 times day^{-1}) and sport drinks (0.22 versus 0.07 times day^{-1}; $P < 0.05$).

Table 3 presents the most frequently consumed foods and beverages among youths by ethnicity. Meat was the most frequently consumed food item among Indigenous and AME youths, with mean daily frequencies of 0.97 and 1.18 times day^{-1}, respectively. The foods most frequently consumed by Asian and European youths were fruit, at 1.37 and 1.32 times day^{-1}, respectively, which was significantly higher than Indigenous youths (0.90 times day^{-1}; $P < 0.05$). Asian youths consumed refined grain products (1.26 times day^{-1}; $P < 0.05$ compared to all other ethnic groups) and fish (0.28 times day^{-1}; $P < 0.05$ compared to Indigenous and European groups) significantly more frequently, as well as salad significantly less frequently than other ethnic peers (0.25 times day^{-1}; $P < 0.05$). Eating cheese or yogurt was most frequently reported by European youths (0.99 times day^{-1}; $P < 0.05$). On average, Indigenous youths consumed potato chips (0.31 times day^{-1}) more frequently than the other three ethnic groups and legumes (0.06 times day^{-1}; $P < 0.05$ compared to Asian and European groups) and whole grain products (0.67 times day^{-1}; $P < 0.05$ compared to AME and European groups) less frequently. Indigenous youths also had the lowest mean daily frequency of consuming fruit (0.90 times day^{-1}). There was no significant difference in the mean frequency of intake of meats, vegetables, sweets, processed meat, potatoes, eggs, pastries, hamburgers, pizza, dried fruit and ice cream between ethnic groups. Milk was the most frequent beverage among all ethnic groups; Indigenous youths (0.98 times day^{-1}) reported a significantly lower mean frequency compared to European youths (1.42 times day^{-1}; $P < 0.05$). Indigenous youths showed a significantly greater frequency of consumption of regular soft drinks than the other ethnic groups, as well as of sweetened fruit juices compared to AME and European youths ($P < 0.05$). The mean frequency of consumption of alcohol among 18-year old youths was low among AME (0.03 times day^{-1}) and Asian youths (0.08 times day^{-1}) compared to Indigenous and European youths (both at 0.12 times day^{-1}), with a significant difference between AME and European youths ($P < 0.05$).

Table 1 Demographic characteristics of multi-ethnic youths and adolescents (age 14–18 years) in Edmonton, Canada

Variables *n* (%)	Indigenous *n* = 82 (17.8)	African & Middle Eastern *n* = 75 (16.3)	Asian *n* = 126 (27.3)	European *n* = 178 (38.6)	Total *n* = 461 (100)
Sex					
Female	50 (61.0)	49 (65.3)	72 (57.1)	111 (62.4)	282 (61.2)
Male	32 (39.0)	26 (34.7)	54 (42.9)	67 (37.6)	179 (38.8)
Living status					
With parent(s)	59 (73.8)	75 (100.0)	114 (90.5)	164 (92.7)	412 (90.0)
Alone	4 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (0.9)
With relatives/siblings	13 (16.2)	0 (0.0)	4 (3.2)	8 (4.5)	25 (5.5)
With others	4 (5.0)	0 (0.0)	8 (6.3)	5 (2.8)	17 (3.7)
BMI (kg m^{-2})					
Underweight	1 (1.2)	2 (2.8)	10 (8.4)	2 (1.2)	15 (3.4)
Normal	55 (68.7)	45 (62.5)	83 (69.7)	135 (80.8)	318 (72.6)
Overweight	12 (15.0)	22 (30.6)	17 (14.3)	18 (10.8)	69 (15.7)
Obese	12 (15.0)	3 (4.2)	9 (7.6)	12 (7.2)	36 (8.2)

Body mass index (BMI) was calculated as weight (kg) divided by height $(m)^2$. Age- and sex-specific BMI *Z*-scores were computed based on the World Health Organization growth reference for age 5–19 years [36]; participants were categorised as underweight (BMI < −2 SD), normal weight (−2 SD ≤ BMI ≤ 1 SD), overweight (1 SD < BMI ≤ 2 SD) or obese (BMI > 2 SD).

To compare these dietary patterns with Canada's Food Guide, Table 4 shows the percentage of participants who consumed below the Canada's Food Guide recommendations for three food groups and the mean frequency of consumption by sex and ethnicity. In most cases, over 50% of participants in the ethnic groups did not meet the recommendations for any of the three food groups (except for Asian and European ethnic groups for the Meat and Alternatives food group). Among the three food groups, the Vegetables and Fruit recommendations (7–8 servings day^{-1}) were the least likely to be met for all sex and ethnic groups (94.4% of males and 92.2% of females). A greater proportion of males (55.9%) compared to females (44.3%) did not meet the minimum recommendation for Meat and Alternatives (2–3 servings day^{-1}; $P = 0.016$); in contrast, a greater percentage of females were below the recommendation for Milk and Alternatives (3–4 servings day^{-1}) (75.9% versus 67.0%, $P = 0.038$). The percentage of Indigenous youths (81.7%) who were not adhering to the recommendations for Milk and Alternatives was greater compared to other ethnic groups (AME = 73.3%, Asian = 78.6% and European = 63.5%; $P = 0.005$). The mean intake of the Milk and Alternatives food group was significantly higher among European youths (2.50 times day^{-1}) compared to Indigenous (1.76 times day^{-1}) and Asian (1.86 times day^{-1}) youths ($P < 0.05$). Similarly, the mean consumption of Vegetables and Fruit was significantly higher among European (3.91 times day^{-1}) than Indigenous (3.10 times day^{-1}) youths ($P < 0.05$). There was no significant difference in the percentage of youths not adhering to the Vegetables and Fruit and Milk and Alternatives recommendations sex and ethnicity.

Discussion

Using the current evidence, Canada's Food Guide helps Canadians plan healthy food choices, achieve the optimal number of servings, and meet nutrient requirements (from the Dietary Reference Intakes) [42]. Canada's Food Guide has information on healthy eating options, serving sizes, tips for healthy food preparation, and ways to include different ethnic foods; these recommendations represent the current scientific evidence for promoting health and preventing nutrition-related chronic diseases [15]. Information on commonly consumed foods and beverages and adherence to Canada's Food Guide recommendations among multi-ethnic Canadian youths is limited; hence, the present study gives a greater understanding of food habits within this population. There is increasing recognition that intervention efforts may improve dietary patterns and reduce the risks associated with micronutrient inadequacies, obesity and diet-related chronic diseases [43,44]. Prior to implementing any interventions, particularly our WHY ACT NOW program in Edmonton, it is necessary to obtain ethnicity-specific dietary information to ensure relevance to the population [45]. Determining similarities and differences in dietary habits across different ethnicities allows for the development of dietary interventions specifically tailored for the needs of multi-ethnic populations. Particularly, Indigenous youths in the present study showed overall poor diets, as indicated by the higher proportion of Indigenous youths not meeting the dietary guidelines and consuming more NNDFs compared to other ethnic groups. The need for improving the diets of Indigenous Canadian youths has

Table 2 Percentage of consumers of each food and beverage and mean daily frequency of consumption (times day^{-1}) of foods and beverages by youths (age 14–18 years males and females) in Edmonton, Canada

	Males		Females			Total	
Foods and beverages	Consumed, *n* (%)	Mean (SD)*	Consumed, *n* (%)	Mean (SD)*	*P*-value†	Consumed, *n* (%)	Mean (SD)*
Fruit‡	166 (92.7)	1.18 (1.04)	269 (95.4)	1.24 (1.03)	0.541	435 (94.4)	1.22 (1.03)
Meats§	173 (96.6)	1.38 (1.05)	265 (94.0)	0.96 (0.73)	<0.000	438 (95.0)	1.12 (0.89)
Whole grain products	150 (83.8)	0.97 (0.95)	246 (87.2)	1.10 (1.02)	0.171	396 (85.9)	1.05 (1.00)
Vegetables¶	156 (87.1)	0.94 (0.88)	253 (89.7)	1.00 (0.96)	0.513	409 (88.7)	0.97 (0.93)
Refined grain products	158 (88.3)	1.09 (1.03)	233 (82.6)	0.85 (0.98)	0.0134	391 (84.8)	0.94 (1.01)
Cheese or yogurt	151 (84.4)	0.75 (0.92)	249 (88.3)	0.81 (0.81)	0.449	400 (86.8)	0.79 (0.86)
Sweets**	148 (82.7)	0.71 (1.10)	230 (81.6)	0.60 (0.84)	0.242	378 (82.0)	0.64 (0.95)
Nuts††	120 (67.0)	0.41 (0.61)	195 (69.1)	0.40 (0.58)	0.879	315 (68.3)	0.41 (0.59)
Processed meats	139 (77.7)	0.47 (0.61)	179 (63.5)	0.35 (0.49)	0.0268	318 (69.0)	0.40 (0.55v
Salad‡‡	118 (65.9)	0.32 (0.41)	221 (78.4)	0.43 (0.45)	0.010	339 (73.5)	0.39 (0.43)
Eggs	142 (79.3)	0.38 (0.36)	211 (74.8)	0.36 (0.42)	0.486	353 (76.6)	0.37 (0.40)
Potatoes§§	133 (74.3)	0.31 (0.33)	208 (73.8)	0.30 (0.44)	0.727	341 (74.0)	0.31 (0.40)
Pastries¶¶	123 (68.7)	0.26 (0.43)	206 (73.0)	0.30 (0.41)	0.434	329 (71.4)	0.28 (0.42)
Legumes***	89 (49.7)	0.19 (0.37)	131 (46.4)	0.17 (0.33)	0.532	220 (47.7)	0.18 (0.34)
Fish	93 (52.0)	0.20 (0.35)	129 (45.7)	0.15 (0.26)	0.069	222 (48.2)	0.17 (0.30)
Potato chips	93 (52.0)	0.19 (0.40)	124 (44.0)	0.14 (0.29)	0.197	217 (47.1)	0.16 (0.34)
Dried fruit	59 (33.0)	0.15 (0.38)	80 (28.4)	0.15 (0.40)	0.913	139 (30.1)	0.15 (0.39)
French fries	102 (57.0)	0.18 (0.23)	132 (46.8)	0.13 (0.23)	0.064	234 (50.8)	0.15 (0.23)
Pizza	107 (59.8)	0.20 (0.50)	148 (52.5)	0.10 (0.13)	0.012	255 (55.3)	0.14 (0.33)
Hamburgers	91 (50.8)	0.18 (0.24)	103 (36.5)	0.08 (0.14)	<0.000	194 (42.1)	0.12 (0.19)
Ice cream	78 (43.6)	0.12 (0.19)	99 (35.1)	0.10 (0.26)	0.517	177 (38.4)	0.11 (0.24)
Milk	167 (93.3)	1.48 (1.29)	254 (90.1)	1.11 (1.11)	0.002	421 (91.3)	1.25 (1.19)
Unsweetened fruit juices	121 (67.6)	0.77 (1.03)	194 (68.8)	0.49 (0.63)	0.001	315 (68.3)	0.60 (0.82)
Sweetened fruit juices	94 (52.5)	0.42 (0.76)	154 (54.6)	0.43 (0.77)	0.832	248 (53.8)	0.43 (0.77)
Regular soft drinks	137 (76.5)	0.54 (0.83)	149 (52.8)	0.32 (0.72)	0.004	286 (62.0)	0.41 (0.77)
Sport drinks	71 (39.7)	0.22 (0.49)	55 (19.5)	0.07 (0.18)	<0.000	126 (27.3)	0.13 (0.34)
Alcohol†††	18 (34.0)	0.10 (0.16)	13 (28.9)	0.08 (0.15)	0.513	31 (31.6)	0.09 (0.16)
Diet/sugar-free pop	24 (13.4)	0.05 (0.22)	29 (10.3)	0.05 (0.23)	0.674	53 (11.5)	0.05 (0.23)
Energy drinks	26 (14.5)	0.05 (0.22)	16 (5.7)	0.02 (0.16)	0.157	42 (9.1)	0.03 (0.19)

*Mean frequency of intakes among all youths, not just consumers.
†Student's *t*-tests were performed to determine statistically significant differences between sexes.
‡Fresh or frozen fruit.
§Including chicken, beef, pork, lamb and goose (excluding fish and processed meat).
¶Not including potatoes or vegetables in soup, stew or salad.
**Including candy or chocolate.
††Nuts or nut butters.
‡‡Any green salad.
§§Boiled, mashed or baked.
¶¶Cakes, donuts, muffins or cookies.
***Beans or Lentils, excluding green beans.
†††Asked only from participants 18 years old.

already been identified [17] and our findings reinforce such previous research.

Previous studies reveal poor eating habits among Canadian children and adolescents. Jessri *et al.* [46] found that most participants (2–18 years old) did not meet the Canada's Food Guide recommendations, with almost one-third of daily energy coming from foods and beverages that are not recommended by Canada's Food Guide. The majority of grade 5–12 children and youths in the study of Lillico *et al.* [47] reported unhealthy eating habits such as eating at a fast-food restaurant at least once a week, suggesting a need for dietary and lifestyle interventions. The present study illustrated clear differences in the degree to which ethnic groups meet the dietary recommendations; in particular, a greater proportion of Indigenous youths did not meet the recommended servings for

Table 3 Percentage of consumers of each food and beverage and mean daily frequency of consumption (times day^{-1}) of foods and beverages by multi-ethnic youths (age 14–18 years) in Edmonton, Canada

	Indigenous		African and Middle Eastern		Asian		European		
Foods and beverages	Consumed, *n* (%)	Mean (SD)*	Consumed, *n* (%)	Mean (SD)*	Consumed, *n* (%)	Mean (SD)*	Consumed, *n* (%)	Mean (SD)*	*P*-value[†]
Meats[‡]	78 (95.1)	0.97 (0.76)	73 (97.3)	1.18 (0.93)	120 (95.2)	1.20 (0.87)	167 (93.8)	1.11 (0.95)	0.282
Fruit[§]	73 (89.0)	0.90 (0.88)	71 (94.7)	1.08 (0.86)	122 (96.8)	1.37 (1.08)	169 (94.9)	1.32 (1.10)	0.001[bc]
Vegetables[¶]	68 (82.9)	0.77 (0.94)	65 (86.7)	0.90 (0.88)	112 (88.9)	1.05 (0.94)	164 (92.1)	1.05 (0.93)	0.093
Refined grain products	67 (81.7)	0.78 (0.93)	62 (82.7)	0.82 (0.99)	117 (92.9)	1.26 (1.05)	145 (81.5)	0.84 (0.97)	<0.000[bdf]
Whole grain products	59 (71.9)	0.67 (0.75)	68 (90.7)	1.13 (1.12)	107 (84.9)	1.00 (0.98)	162 (91.0)	1.23 (1.00)	<0.000[ac]
Sweets**	68 (82.9)	0.67 (1.07)	60 (80.0)	0.71 (1.14)	95 (75.4)	0.63 (0.94)	155 (87.1)	0.61 (0.81)	0.895
Cheese or yogurt	66 (80.5)	0.68 (0.78)	66 (88.0)	0.79 (0.92)	101 (80.2)	0.58 (0.70)	167 (93.8)	0.99 (0.93)	0.000[cef]
Processed meats	61 (74.4)	0.46 (0.57)	38 (50.7)	0.27 (0.35)	85 (67.5)	0.37 (0.59)	134 (75.3)	0.44 (0.56)	0.086
Potatoes[††]	65 (79.3)	0.38 (0.43)	47 (62.7)	0.28 (0.61)	86 (68.2)	0.25 (0.31)	143 (80.3)	0.33 (0.32)	0.085
Salad[‡‡]	58 (70.7)	0.40 (0.43)	57 (76.0)	0.53 (0.59)	81 (64.3)	0.25 (0.35)	143 (80.3)	0.43 (0.39)	<0.000[bdf]
Eggs	63 (76.8)	0.36 (0.39)	57 (76.0)	0.38 (0.47)	94 (74.6)	0.42 (0.48)	139 (78.1)	0.32 (0.30)	0.196
Nuts[§§]	56 (68.3)	0.41 (0.72)	44 (58.7)	0.32 (0.48)	77 (61.1)	0.30 (0.45)	138 (77.5)	0.52 (0.65)	0.006[f]
Potato chips	55 (67.1)	0.31 (0.44)	32 (42.7)	0.11 (0.17)	46 (36.5)	0.10 (0.18)	84 (47.2)	0.16 (0.40)	<0.000[abc]
Pastries[¶¶]	56 (68.3)	0.25 (0.34)	56 (74.7)	0.28 (0.35)	81 (64.3)	0.29 (0.51)	136 (76.4)	0.30 (0.41)	0.836
Hamburgers	37 (45.1)	0.16 (0.23)	27 (36.0)	0.11 (0.20)	50 (39.7)	0.12 (0.20)	80 (44.9)	0.10 (0.15)	0.179
French fries	50 (61.0)	0.19 (0.23)	39 (52.0)	0.19 (0.36)	55 (43.6)	0.11 (0.17)	90 (50.6)	0.14 (0.20)	0.047[b]
Pizza	50 (61.0)	0.17 (0.23)	39 (52.0)	0.13 (0.17)	60 (47.6)	0.14 (0.42)	106 (59.5)	0.14 (0.35)	0.828
Dried fruit	14 (17.1)	0.14 (0.49)	26 (34.7)	0.14 (0.28)	47 (37.3)	0.16 (0.34)	52 (29.2)	0.15 (0.42)	0.956
Ice cream	28 (34.1)	0.09 (0.19)	25 (33.3)	0.13 (0.34)	53 (42.1)	0.13 (0.28)	71 (39.9)	0.09 (0.16)	0.498
Fish	21 (25.6)	0.05 (0.09)	37 (49.3)	0.17 (0.25)	83 (65.9)	0.28 (0.39)	81 (45.5)	0.14 (0.27)	<0.000[abf]
Legumes***	18 (21.9)	0.06 (0.15)	42 (56.0)	0.19 (0.27)	61 (48.4)	0.21 (0.42)	99 (55.6)	0.21 (0.37)	0.008[bc]
Milk	66 (80.5)	0.98 (1.27)	70 (93.3)	1.33 (1.11)	117 (92.9)	1.15 (1.08)	168 (94.4)	1.42 (1.25)	0.029[c]
Unsweetened fruit juices	54 (65.8)	0.54 (0.81)	50 (66.7)	0.58 (0.73)	84 (66.7)	0.54 (0.71)	127 (71.3)	0.67 (0.93)	0.487
Sweetened fruit juices	59 (71.9)	0.68 (1.01)	43 (57.3)	0.32 (0.48)	57 (45.2)	0.43 (0.92)	89 (50.0)	0.36 (0.77)	0.034[ac]
Regular soft drinks	66 (80.5)	0.78 (1.16)	35 (46.7)	0.25 (0.47)	73 (57.9)	0.28 (0.57)	112 (62.9)	0.38 (0.73)	0.001[abc]
Sport drinks	31 (37.8)	0.13 (0.22)	22 (29.3)	0.13 (0.34)	19 (15.1)	0.09 (0.35)	54 (30.3)	0.15 (0.38)	0.647
Energy drinks	15 (18.3)	0.07 (0.30)	6 (8.0)	0.02 (0.07)	6 (4.8)	0.02 (0.10)	15 (8.4)	0.04 (0.16)	0.121
Alcohol[†††]	8 (42.1)	0.12 (0.19)	3 (13.0)	0.03 (0.09)	4 (19.0)	0.08 (0.19)	16 (45.7)	0.12 (0.14)	0.164[e]
Diet/sugar-free pops	7 (8.5)	0.02 (0.07)	9 (12.0)	0.03 (0.08)	9 (7.1)	0.04 (0.24)	28 (15.7)	0.08 (0.30)	0.123

*Mean frequency of intakes among all youths, not just consumers.

[†]One-way analysis of variance (ANOVA) or Welch's ANOVA and multiple comparison tests (Turkey–Kramer or Games-Howell) were performed to determine significant differences in mean intake ([a]Significant difference between Indigenous and African & Middle East youths; [b]significant difference between Indigenous and Asian youths; [c]significant difference between Indigenous and European youths; [d]significant difference between African & Middle East and Asian youths; [e]significant difference between African & Middle East and European youths; [f]significant difference between Asian and European youths.).

[‡]Including chicken, beef, pork, lamb and goose (excluding fish and processed meat).

[§]Fresh or frozen fruit.

[¶]Not including potatoes or vegetables in soup, stew or salad.

**Including candy or chocolate.

[††]Boiled, mashed or baked.

[‡‡]Any green salad.

[§§]Nuts or nut butters.

[¶¶]Cakes, donuts, muffins or cookies.

***Beans or Lentils, excluding green beans.

[†††]Asked for participants 18 years.

Table 4 Mean frequency of food group consumption (times day^{-1}) and percentage of multi-ethnic youths (age 14–18 years) Not Meeting (NM) the recommended number of the Canada's Food Guide servings* in Edmonton, Canada

	Fruit and vegetables		Milk and alternatives		Meat and alternatives†	
Variables	NM, *n* (%)	Mean (SD)	NM, *n* (%)	Mean (SD)	NM, *n* (%)	Mean (SD)
Total	429 (93.1)	3.62 (2.30)	334 (72.5)	2.15 (1.59)	225 (48.8)	2.74 (1.74)
Sex						
Males	169 (94.4)	3.64 (2.38)	120 (67.0)	2.35 (1.66)	100 (55.9)	3.20 (1.93)
Females	260 (92.2)	3.60 (2.24)	214 (75.9)	2.03 (1.54)	125 (44.3)	2.46 (1.54)
P-value‡	0.362	0.647	0.038	0.190	0.016	0.004
Ethnicity						
Indigenous	75 (91.5)	3.10 (2.51)	67 (81.7)	1.76 (1.66)	46 (56.1)	2.47 (1.65)
African and Middle Eastern	68 (90.7)	3.49 (2.35)	55 (73.3)	2.25 (1.48)	40 (53.3)	2.62 (1.65)
Asian	122 (96.8)	3.61 (1.92)	99 (78.6)	1.86 (1.44)	56 (44.4)	2.89 (1.74)
European	164 (91.3)	3.91 (2.38)	113 (63.5)	2.50 (1.64)	83 (46.6)	2.82 (1.81)
P-value‡	0.263	0.061[a]	0.005	0.0004[ab]	0.301	0.301

*Canada's Food Guide advises a daily consumption of seven (female) to eight (male) servings of fruit and vegetables, three to four (both female and male) servings of milk and alternatives, and two (female) to three (male) servings of Meat and Alternatives for ages 14–18 years [13].

†Including chicken, beef, pork, lamb, goose, fish, processed meat, legumes and nuts.

‡Student's *t*-test was performed to determine significant differences in mean intake of foods between sexes. One-way analysis of variance and multiple comparison (Turkey–Kramer) tests were performed to determine significant differences in mean intake of foods by ethnicity groups. Pearson chi-squared tests were performed to estimate the measures of associations between adhering to the Canada's Food Guide recommendations by sex and ethnicity groups ([a]Significant difference between Indigenous and European youths; [b]significant difference between Asian and European youths).

the Milk and Alternative food group compared to other ethnic groups. The NHANES study showed that a large ethnic gap exists in adherence to food-based dietary guidelines [20]. Our data also revealed a high consumption of NNDFs among multi-ethnic youths. This dietary pattern among youths may lead to a greater burden of obesity and chronic diseases among the Canadian population. In the present study, the top five foods consumed were: milk, fruit, meats, whole grain products and vegetables; however, the majority of youths did not meet the minimum daily recommendations of either the Vegetables and Fruit or Milk and Alternatives food groups.

In addition to the gap that exists across differing ethnicities in terms of adherence to food-based dietary guidelines, it has also been shown previously that there are differences in adherence between sexes. Females are more likely than males to report following healthy eating guidelines, which, in the long term, can have a great impact on health outcomes [48]. Similarly, females in the present study significantly less frequently consumed processed meats, refined grain products, regular soft drinks, sport drinks and energy drinks than males. These results were expected, especially with regard to males, who had a higher consumption than females in almost every category, which can be attributed to a higher energy requirement in this sex group. A national dietary surveillance conducted through the Canadian Community Health Survey in 2004 among Canadians of all ethnic backgrounds reported that 61% of males and 83% of females between the ages of 10 and 16 years did not meet the minimum recommendation for Milk and Alternatives [49]; in the present study, the analysis of diets among 14–18 years old found that 67.0% of males and 75.9% of females did so. Additionally, consumption in the Vegetables and Fruit food group often fell short of the daily 7–8 servings recommended by Canada's Food Guide for youths and young adults of both sexes [49]. These observations suggest that interventions may need to be tailored with sex considerations and target sex-specific dietary habits.

Previous studies demonstrated that adherence to food-based dietary guidelines reduced the risk of CVD [50] and adiposity [51]. Therefore, understanding the factors influencing adherence to dietary guidelines, such as health literacy, nutrition knowledge, culture, food environment, and level of readiness to change, is important for tackling disparities in adherence to dietary guidelines among ethnic groups [52,53]. It is also reported that consuming a wide variety of foods decreases the potential risk of nutrient inadequacies in some communities [54–56]. Youths may have limited access to a variety of foods or limited knowledge about the importance of having diverse foods to ensure nutrient adequacy. However, including more variation in the diet may, in all likelihood, increase food expenditures. A study conducted in South Africa found a significant relationship between food security and dietary

diversity [55]. Other studies also confirmed that the dietary diversity score was lower for low income populations [57–59]. A study in Canadian Arctic territories found a high expenditure on NNDFs (34% of total food expenditure) among participants [60], which may be because NNDFs are inexpensive sources of energy and the high fat and sugar contents increase palatability. The same study also found a decreasing trend for NNDFs with increasing age, suggesting a higher expenditure on NNDFs among younger, relative to older, adults [60]. Although no difference in patterns of food expenditure based on socio-economic status was found [60], other studies reported that low-income individuals spend more on low-cost NNDFs [61,62]. School, family and neighbourhood food environments have a significant impact on the eating behaviours of adolescents [11,63–65]. The implementation of sustainable nutrition policies in education systems, school-based healthy eating interventions [66–68] and strategies aimed at improving access to nutritious food in a school setting are all needed. The broad scope of these findings can inform sustainable nutrition policies in these areas for multi-ethnic youths, both nationally and internationally. Although our data were locally gathered, the degree of multi-ethnicity is growing in North America and Europe, such as in Canada and the UK [69,70]. As international migration continues to increase [71], our findings may inform the need for surveillance and interventions.

The ethnic variations in dietary habits need to be acknowledged in terms of the potential presence of other confounding factors, such as socio-economic status [20,27,53,72–76]. Investigating factors that affect dietary patterns, such as parental income and educational attainment, as well as students' income and socialisation with peers in terms of eating environment, is guaranteed in future studies with respect to informing effective interventions for the population. As a result of the voluntary process of participation, selection bias may have been introduced. However, there is no evidence that the studied groups are not a representative sample. We examined dietary patterns of urban youths in terms of ethnicity. Other socio-economic factors such as parental income and education level or student income may also play a role in determining youth's dietary habits, although these were not investigated in the present study. This is a limitation of the present study and represents a consideration for future research in this area. Recall bias may be a factor as a result of the variety of foods available from which to choose to report past food consumption. Participant error is also a likely limitation because participants may under- or over-report the consumption of certain foods. Portion sizes could not be assessed via the FFQ because this was not a quantitative FFQ; we therefore assumed that the frequency of consuming certain foods represented each serving size of Canada's Food Guide. This assumption is inevitably a limitation in the present study. However, assessing portion size in an FFQ for adolescents is unlikely to improve the estimation of nutrient and food intakes in this population and, indeed, excluding portion size estimates when using an FFQ among adolescents may be more advantageous [77].

Conclusions

The present study assessed the frequency of food and beverage consumption among multi-ethnic urban youths in Edmonton, a city in which rates of being overweight and obese among youths are increasing [78]. Our data showed that, among three food groups, the Vegetables and Fruit recommendations were the least likely to be met for all ethnic and sex groups, whereas a high mean daily frequency consumption of NNDFs was seen especially among Indigenous youths. Considerable health gains may be obtained through improved culturally-appropriate dietary interventions. These findings provide some evidence on dietary intake and show disparities in food intake among different ethnic groups.

Transparency statement

The lead author affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The reporting of this work is compliant with STROBE guidelines. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned have been explained.

Acknowledgments

The authors are very grateful to the Alberta Diabetes Foundation and the Agriculture Funding Consortium for funding the analyses included in the present study. We would also like to thank Alberta Health, the Public Health Agency of Canada, Royal Alexandra Hospital Foundation, Alberta Diabetes Institute, Department of Health and Social Services, Government of the Northwest Territories, Edmonton Community Foundation, Edmonton Oilers Community Foundation, The Stollery Charitable Foundation, and the United Way of the Alberta Capital Region for funding the WHY ACT NOW project. We also very grateful for the support and assistance of Edmonton Public Schools, Inner City High, Boys & Girls Clubs Big Brothers Big Sisters of Edmonton and Area and NorQuest College.

Conflict of interests, source of funding and authorship

The authors declare they have no conflicts of interest.
No funding declared.
SS developed the conception and design and led the project. SS and FK were responsible for developing the questionnaires, overseeing all data collection and ensuring that all protocols were followed. MD and FK analysed the data and interpreted the results. FN and SLM drafted the manuscript and assisted with the interpretation of the results. FK, MD, NJ and SS assisted in the writing of the manuscript. All authors critically reviewed and approved the final version of the manuscript submitted for publication.

References

1. Public Health Agency of Canada (2009) Tracking Heart Disease and Stroke in Canada: Public Health Agency of Canada; 2009. Available at: http://www.phac-aspc.gc.ca/publicat/2009/cvd-avc/index-eng.php (accessed July 2017).
2. Public Health Agency of Canada (2014) Economic Burden of Illness in Canada 2005–2008: Protecting Canadians from Illness: Public Health Agency of Canada; 2014. Available at: http://www.phac-aspc.gc.ca/publicat/ebic-femc/2005-2008/index-eng.php (accessed June 2016).
3. Divisi D, Di TS, Salvemini S *et al.* (2006) Diet and cancer. *Acta Biomed* **77**, 118–123.
4. Weisburger JH (1997) Dietary fat and risk of chronic disease: mechanistic insights from experimental studies. *J Am Diet Assoc* **97**(7 Suppl.), S16–S23.
5. Weisburger JH (2000) Eat to live, not live to eat. *Nutrition* **16**, 767–773.
6. Stoeckli R & Keller U (2004) Nutritional fats and the risk of type 2 diabetes and cancer. *Physiol Behav* **83**, 611–615.
7. Movassagh EZ, Baxter-Jones ADG, Kontulainen S *et al.* (2017) Tracking dietary patterns over 20 years from childhood through adolescence into young adulthood: the Saskatchewan pediatric bone mineral accrual study. *Nutrients* **9**, 990.
8. Serdula MK, Ivery D, Coates RJ *et al.* (1993) Do obese children become obese adults? A review of the literature. *Prev Med* **22**, 167–177.
9. Health Canada (2012) *Healthy Eating After School: Integrating Healthy Eating Into After-school Physical Activity Initiatives*. Ottawa, ON: Minister of Health.
10. Epstein LH, Wing RR & Valoski A (1985) Childhood obesity. *Pediatr Clin North Am* **32**, 363–379.
11. Centers for Disease Control and Prevention (2011) School health guidelines to promote healthy eating and physical activity. Atlanta; 9/16/2011. Report No.: 60.
12. Nicklas T & Johnson R (2004) Position of the American Dietetic Association: dietary guidance for healthy children ages 2 to 11 years. *J Am Diet Assoc* **104**, 660–677.
13. O'Loughlin JL & Tarasuk J (2003) Smoking, physical activity, and diet in North American youth: where are we at? *Can J Public Health* **94**, 27–30.
14. Sharma S, Sheehy T & Kolahdooz F (2015) *Nutrition at a Glance* (2 edn). Oxford: Wiley-Blackwell.
15. Health Canada. Eating well with Canada's Food Guide 2011. Available at: http://www.hc-sc.gc.ca.login.ezproxy.library.ualberta.ca/fn-an/food-guide-aliment/index-eng.php (accessed July 2014).
16. Appleton KM, Krumplevska K, Smith E *et al.* (2018) Low fruit and vegetable consumption is associated with low knowledge of the details of the 5-a-day fruit and vegetable message in the UK: findings from two cross-sectional questionnaire studies. *J Hum Nutr Diet* **31**, 121–130.
17. Gates A, Skinner K & Gates M (2014) The diets of school-aged Aboriginal youths in Canada: a systematic review of the literature. *J Hum Nutr Diet* **28**, 246–261.
18. Phillips S, Jacobs SL & Gray-Donald K (2004) Food habits of Canadians: food sources of nutrients for the adolescent sample. *Can J Diet Pract Res* **65**, 81–84.
19. Sanou D, O'Reilly E, Ngnie-Teta I *et al.* (2014) Acculturation and nutritional health of immigrants in canada: a scoping review. *J Immigr Minor Health* **16**, 24–34.
20. Kirkpatrick SI, Dodd KW, Reedy J *et al.* (2012) Income and race/ethnicity are associated with adherence to food-based dietary guidance among US adults and children. *J Acad Nutr Diet* **112**, 624–635.
21. Briefel RR, Wilson A & Gleason PM (2009) Consumption of low-nutrient, energy-dense foods and beverages at school, home, and other locations among school lunch participants and nonparticipants. *J Am Diet Assoc* **109**(2 Suppl.), S79–S90.
22. Bull NL (1992) Dietary habits, food consumption, and nutrient intake during adolescence. *J Adolesc Health* **13**, 384–388.
23. Cohen B, Evers S, Manske S *et al.* (2003) Smoking, physical activity and breakfast consumption among secondary school students in a southwestern Ontario community. *Can J Public Health* **94**, 41–44.
24. Herpertz-Dahlmann B (2015) Adolescent eating disorders: update on definitions, symptomatology, epidemiology, and comorbidity. *Child Adolesc Psychiatr Clin N Am* **24**, 177–196.
25. Kerver JM, Yang EJ, Obayashi S *et al.* (2006) Meal and snack patterns are associated with dietary intake of energy and nutrients in US adults. *J Am Diet Assoc* **106**, 46–53.
26. Kit BK, Fakhouri TH, Park S *et al.* (2013) Trends in sugar-sweetened beverage consumption among youth and adults in the United States: 1999–2010. *Am J Clin Nutr* **98**, 180–188.

27. Minaker LM, McCargar L, Lambraki I *et al.* (2006) School region socio-economic status and geographic locale is associated with food behaviour of Ontario and Alberta adolescents. *Can J Public Health* **97**, 357–361.
28. Neumark-Sztainer D, Story M, Perry C *et al.* (1999) Factors influencing food choices of adolescents: findings from focus-group discussions with adolescents. *J Am Diet Assoc* **99**, 929–937.
29. Paeratakul S, Ferdinand DP, Champagne CM *et al.* (2003) Fast-food consumption among US adults and children: dietary and nutrient intake profile. *J Am Diet Assoc* **103**, 1332–1338.
30. Daniels SR, Arnett DK, Eckel RH *et al.* (2005) Overweight in children and adolescents: pathophysiology, consequences, prevention, and treatment. *Circulation* **111**, 1999–2012.
31. Deckelbaum RJ & Williams CL (2001) Childhood obesity: the health issue. *Obes Res* **9**(Suppl. 4), 239S–243S.
32. Kaur H, Hyder ML & Poston WS (2003) Childhood overweight: an expanding problem. *Treat Endocrinol* **2**, 375–388.
33. Silveira JA, Taddei JA, Guerra PH *et al.* (2013) The effect of participation in school-based nutrition education interventions on body mass index: a meta-analysis of randomized controlled community trials. *Prev Med* **56**, 237–243.
34. Van CE, Maes L, Spittaels H *et al.* (2010) Effectiveness of school-based interventions in Europe to promote healthy nutrition in children and adolescents: systematic review of published and 'grey' literature. *Br J Nutr* **103**, 781–797.
35. Sharma S (2011) Development and use of FFQ among adults in diverse settings across the globe. *Proc Nutr Soc* **70**, 232–251.
36. Rockett HR, Wolf AM & Colditz GA (1995) Development and reproducibility of a food frequency questionnaire to assess diets of older children and adolescents. *J Am Diet Assoc* **95**, 336–340.
37. Sluyter JD, Schaaf D, Metcalf PA *et al.* (2010) Dietary intakes of Pacific, Maori, Asian and European adolescents: the Auckland High School Heart Survey. *Aust N Z J Public Health* **34**, 32–37.
38. Speck BJ, Bradley CB, Harrell JS *et al.* (2001) A food frequency questionnaire for youth: psychometric analysis and summary of eating habits in adolescents. *J Adolesc Health* **28**, 16–25.
39. City of Edmonton (2014) City Government: The City of Edmonton. Available at: http://www.edmonton.ca/city-government.aspx (accessed July 2017).
40. Edmonton Public Schools (2015) Facts and Stats: Edmonton Public Schools. Available at: https://www.epsb.ca/ourdistrict/facts/ (accessed June 2016).
41. World Health Organization (2016) Growth Reference 5–19 Years: BMI-for-Age (5–19 Years): World Health Organization. Available at: http://www.who.int/growthref/who2007_bmi_for_age/en/ (accessed April 2016).
42. Bush MA, Martineau C, Pronk JA *et al.* (2007) Eating well with Canada's Food Guide: 'A tool for the times'. *Can J Diet Pract Res* **68**, 92–96.
43. Becque MD, Katch VL, Rocchini AP *et al.* (1988) Coronary risk incidence of obese adolescents: reduction by exercise plus diet intervention. *Pediatrics* **81**, 605–612.
44. Saksvig BI, Gittelsohn J, Harris SB *et al.* (2005) A pilot school-based healthy eating and physical activity intervention improves diet, food knowledge, and self-efficacy for native Canadian children. *J Nutr* **135**, 2392–2398.
45. Trifonopoulos M, Kuhnlein HV & Receveur O (1998) Analysis of 24-hour recalls of 164 fourth- to sixth-grade Mohawk children in Kahnawake. *J Am Diet Assoc* **98**, 814–816.
46. Jessri M, Nishi SK & L'Abbe MR (2016) Assessing the nutritional quality of diets of Canadian children and adolescents using the 2014 Health Canada Surveillance Tool Tier System. *BMC Public Health* **16**, 381.
47. Lillico HG, Hammond D, Manske S *et al.* (2014) The prevalence of eating behaviors among Canadian youth using cross-sectional school-based surveys. *BMC Public Health* **14**, 323.
48. Wardle J, Haase AM, Steptoe A *et al.* (2004) Gender differences in food choice: the contribution of health beliefs and dieting. *Ann Behav Med* **27**, 107–116.
49. Garriguet D (2007) Canadians' eating habits. *Health Rep* **18**, 17–32.
50. McCullough ML, Feskanich D, Stampfer MJ *et al.* (2000) Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in women. *Am J Clin Nutr* **72**, 1214–1222.
51. Bailey BW, Perkins A, Tucker LA *et al.* (2015) Adherence to the 2010 Dietary Guidelines for Americans and the relationship to adiposity in young women. *J Nutr Educ Behav* **47**, 86–93.
52. Wang Y & Chen X (2011) How much of racial/ethnic disparities in dietary intakes, exercise, and weight status can be explained by nutrition- and health-related psychosocial factors and socioeconomic status among US adults? *J Am Diet Assoc* **111**, 1904–1911.
53. Zhang Q & Wang Y (2012) Socioeconomic and racial/ethnic disparity in Americans' adherence to federal dietary recommendations. *J Acad Nutr Diet* **112**, 614–616.
54. Kennedy G, Berardo A, Papavero C *et al.* (2010) Proxy measures of household food consumption for food security assessment and surveillance: comparison of the household dietary diversity and food consumption scores. *Public Health Nutr* **13**, 2010–2018.
55. Labadarios D, Steyn NP & Nel J (2011) How diverse is the diet of adult South Africans? *Nutr J* **10**, 33.
56. Tontisirin K, Nantel G & Bhattacharjee L (2002) Food-based strategies to meet the challenges of micronutrient malnutrition in the developing world. *Proc Nutr Soc* **61**, 243–250.

57. Faber M, Schwabe C & Drimie S (2009) Dietary diversity in relation to other household food security indicators. *Int J Food Safety Nutr Pub Health* **2**, 157–171.
58. Vega-Macedo M, Shamah-Levy T, Peinador-Roldan R *et al.* (2014) Food insecurity and variety of food in Mexican households with children under five years. *Salud Publica Mex* **56**(Suppl. 1), s21–s30.
59. Oldewage-Theron WH & Kruger R (2008) Food variety and dietary diversity as indicators of the dietary adequacy and health status of an elderly population in Sharpeville, South Africa. *J Nutr Elder* **27**, 101–133.
60. Pakseresht M, Lang R, Rittmueller S *et al.* (2014) Food expenditure patterns in the Canadian Arctic show cause for concern for obesity and chronic disease. *Int J Behav Nutr Phys Act* **11**, 51.
61. Drewnowski A & Specter SE (2004) Poverty and obesity: the role of energy density and energy costs. *Am J Clin Nutr* **79**, 6–16.
62. Lambden J, Receveur O, Marshall J *et al.* (2006) Traditional and market food access in Arctic Canada is affected by economic factors. *Int J Circumpolar Health* **65**, 331–340.
63. Van HA, Barnett TA, Gauvin L *et al.* (2012) Associations between children's diets and features of their residential and school neighbourhood food environments. *Can J Public Health* **103**(9 Suppl. 3), eS48–eS54.
64. Hanson NI, Neumark-Sztainer D, Eisenberg ME *et al.* (2005) Associations between parental report of the home food environment and adolescent intakes of fruits, vegetables and dairy foods. *Public Health Nutr* **8**, 77–85.
65. Laska MN, Hearst MO, Forsyth A *et al.* (2010) Neighbourhood food environments: are they associated with adolescent dietary intake, food purchases and weight status? *Public Health Nutr* **13**, 1757–1763.
66. Brown T & Summerbell C (2009) Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence. *Obes Rev* **10**, 110–141.
67. De Bourdeaudhuij I, Van CE, Spittaels H *et al.* (2011) School-based interventions promoting both physical activity and healthy eating in Europe: a systematic review within the HOPE project. *Obes Rev* **12**, 205–216.
68. Gonzalez-Suarez C, Worley A, Grimmer-Somers K *et al.* (2009) School-based interventions on childhood obesity: a meta-analysis. *Am J Prev Med* **37**, 418–427.
69. Statistics Canada (2013) Immigration and Ethnocultural Diversity in Canada. In: Minister of Industry, editor.
70. Ethnicity and National Identity in England and Wales: 2011 [Internet]. 2012. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/culturalidentity/ethnicity/articles/ethnicityandnationalidentityinenglandandwales/2012-12-11 (accessed December 2017).
71. UN Department of Economic and Social Affairs (2017) International Migration Report 2017: Highlights. United Nations.
72. Crawford PB, Obarzanek E, Schreiber GB *et al.* (1995) The effects of race, household income, and parental education on nutrient intakes of 9- and 10-year-old girls. NHLBI Growth and Health Study. *Ann Epidemiol* **5**, 360–368.
73. Kimm SY, Obarzanek E, Barton BA *et al.* (1996) Race, socioeconomic status, and obesity in 9- to 10-year-old girls: the NHLBI Growth and Health Study. *Ann Epidemiol* **6**, 266–275.
74. Kronsberg SS, Obarzanek E, Affenito SG *et al.* (2003) Macronutrient intake of black and white adolescent girls over 10 years: the NHLBI Growth and Health Study. *J Am Diet Assoc* **103**, 852–860.
75. Lytle LA, Himes JH, Feldman H *et al.* (2002) Nutrient intake over time in a multi-ethnic sample of youth. *Public Health Nutr* **5**, 319–328.
76. Simon JA, Schreiber GB, Crawford PB *et al.* (1993) Income and racial patterns of dietary vitamin C intake among black and white girls. *Public Health Rep* **108**, 760–764.
77. Mendes V (2014) Assessing dietary intake in adolescents: the role of food portion size evaluation in food frequency questionnaires (master's dissertation). Available at: https://sigarra.up.pt/fcnaup/pt//pub_geral.show_file?pi_gdoc_id=548753 (accessed June 2016) [Portuguese].
78. Edmonton Community Foundations, Council ESP (2014) Vital Signs Report. Edmonton. Available at: www.ecfoundation.org/uploads/Final-Vital-Signs-Report-2014.pdf (accessed December 2017)