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REVIEW

The diets of school-aged Aboriginal youths in Canada: a systematic review of the literature

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Abstract

Background: Most national surveys examining diet leave large segments of the Aboriginal population under-represented. The present study aimed to: (i) review primary research studies that investigated the dietary intakes of Canadian school-aged Aboriginal youths; (ii) summarise the tools and methodologies currently used to measure diet in this population; and (iii) identify knowledge gaps and suggest areas of future research.
Methods: A systematic review of research published between January 2004 and January 2014 related to the diets of Canadian school-aged (6–18 years) Aboriginal youths was undertaken, including Medline, Scopus, ERIC, Web of Science and Google Scholar databases. Studies were summarised based on purpose, year, sample population, setting, dietary assessment method and main findings.
Results: Twenty-four studies were reviewed, all of which were cross-sectional in design. Most (n = 16; 67%) were from Ontario or Quebec, investigated the diets of First Nations (n = 21; 88%) youths and took place in remote or isolated settings (n = 18; 75%). Almost all of the studies used the 24-h recall to assess intake (n = 19; 79%), of which 89% used a single recall. The findings suggest that the diets of Aboriginal youths could be improved. Of particular concern are inadequate intakes of vegetables and fruit, milk and alternatives, fibre, folate, vitamin A, vitamin C, calcium and vitamin D, concomitant with an excess consumption of sugar sweetened beverages, snacks and fast foods. Traditional foods remain important but tend to be consumed infrequently.
Conclusions: The diets of Canadian Aboriginal youths are energy-dense and nutrient-poor. The diets of Inuit and Métis youths, in particular, and perceptions of a balanced diet warrant further investigation.

Introduction

Spread across 70 countries worldwide, there are more than 370 million Indigenous people, defined as the descendants of those who inhabited a geographical area prior to the arrival of people of different cultures and ethnic origins (United Nations, 2014). In Canada, the term 'Aboriginal peoples' includes First Nations (FN), Métis and Inuit peoples, as defined by the Constitution (Aboriginal Affairs & Northern Development Canada, 2012). According to the 2011 National Household Survey, 1 400 685 Canadians identified as Aboriginal, comprising 4.3% of the total population (Statistics Canada, 2013a). For Canadian Aboriginal people, a history of colonialism and the residential school system left indelible scars on the >150 000 who were forced to attend and continues to negatively affect the generations that have followed (Truth & Reconciliation Commission of Canada, 2014). To this day, Aboriginal people, in general, suffer poorer health outcomes and experience shorter life expectancies compared to the non-Aboriginal population (King *et al.*, 2009; Statistics Canada, 2012; Gionet & Roshanafshar,

2013). Aboriginal Canadians also experience poorer educational attainment, higher rates of unemployment, poverty and food insecurity, and poorer living conditions than non-Aboriginal people (Power, 2008; Leach, 2010; Wilson & MacDonald, 2010; Zietsma, 2011; Statistics Canada, 2012; Gionet & Roshanafshar, 2013; Pal *et al.*, 2013).

Of particular concern are the high and rising prevalence rates of being overweight and obesity among Aboriginal youths. The most recent estimates from the 2004 Canadian Community Health Survey (CCHS) put the rates of overweight and obesity at 21% and 20%, respectively for Aboriginal youths, compared to 8% and 18% for the general population (Shields, 2006). Because the Aboriginal population in Canada is young, with 36.1% being under the age of 19 years and a median age of 27.7 years (compared to 21.3% and 40.6 years, respectively, for the general population), targeting youths in initiatives promoting healthy weights represents a promising approach that has been supported by experts in Aboriginal health (Willows *et al.*, 2012; Statistics Canada, 2013a).

For Canadian Aboriginal youths, the aetiology of being overweight or obese is complex and multifactorial. Beyond the very simple view that the accretion of excess body fat is the result of a positive energy balance, it is acknowledged that what and how much a person chooses to eat and the types and amounts of activities that they choose to partake in are affected by myriad factors (Van Der Horst *et al.*, 2007; Story *et al.*, 2002a; Willows *et al.*, 2012). Based on the ecological model developed by Willows *et al.* (2012), the development of obesity is linked to societal influences (e.g. policies, media), the built environment (e.g. neighbourhood safety, availability of healthy foods in stores), community, home and sociocultural environments (e.g. household socioeconomic status, geographical remoteness), interpersonal factors (e.g. peer support, family feeding practices) and individual factors (e.g. knowledge, attitudes), all of which are influenced by historical contextual factors (e.g. colonisation, dispossession of lands, assimilation policies) which are unique to Aboriginal people. That being said, diet is a potentially modifiable contributor, and may be tied back to all levels of the model.

It has been established that the diets of Aboriginal people have shifted away from the traditional foods from which they historically obtained 100% of their energy to favouring store-bought (i.e. market) foods, generally of lower nutritional quality (Kuhnlein *et al.*, 2004; Willows, 2005; Haman *et al.*, 2010). National surveys examining the health of Canadians provide some further insight into the diets of Aboriginal people; however, such surveys often exclude large proportions of the population (Garriguet, 2008). Also, they may not always report on the diets of school-aged youths. This gap has somewhat been filled by the First Nations Regional Longitudinal Health Survey, Aboriginal Peoples Survey and Aboriginal Children's Survey, which include child and youth data [Statistics Canada, 2008; First Nations Information Governance Centre (FNIGC), 2012; Statistics Canada, 2013b]. However, these surveys were not designed to comprehensively examine diet (Statistics Canada, 2008; FNIGC, 2012; Statistics Canada, 2013b). At this time, no comprehensive data exist on the diets of Aboriginal Canadian youths as a whole that are comparable to data from the general population.

To our knowledge, no review of studies exists investigating the dietary intakes of school-aged Aboriginal youths residing in Canada. The present study aimed to: (i) summarise primary research studies that investigated the dietary intakes of school-aged Aboriginal youths residing in Canada; (ii) summarise the tools and methodologies currently used to measure diet in this population; and (iii) identify knowledge gaps and suggest areas of future research.

Materials and methods

A systematic review of online, published literature was undertaken in January 2014 in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Liberati *et al.*, 2009; Moher *et al.*, 2009). Before the start of the study, the review protocol was decided upon. The online search strategy including sources, search terms, inclusion and exclusion criteria and a sample search, is outlined in Table 1. For all databases, studies were first screened by title and abstract. Those selected were then further screened by full text for relevance. To ensure transparency and to identify any articles that had been overlooked, the search was repeated in March 2014 by a second, independent researcher. Any disagreements between the two researchers regarding which studies should be included were resolved via discussion until an agreement was reached.

Data were extracted from each of the studies identified by two independent researchers to ensure accuracy. If any disagreement was identified between the findings of the researchers, data were independently extracted again until an agreement was reached. Each study was summarised in terms of: purpose, study year, setting, sample population (FN, Inuit or Métis; age; sample size; percentage female), dietary assessment method used and main findings related to the intake of micro- and macronutrients, foods and/or food groups. Descriptive statistics, including mean and median nutrient or food group consumption and proportions of youths with intake levels falling below or above current dietary standards, were the main

Table 1 Online search strategy including sources, search terms, inclusion criteria and exclusion criteria

Sources*	Inclusion criteria
Pubmed (Medline)†	a. Studies reported quantitative results with respect to dietary intake (food groups, specific foods and/or nutrients).
Scopus	
ERIC	
Web of Science	b. Studies reported results based on non-invasive measurement(s) of food consumption behaviour (e.g. 24-h recall, food diaries)
Google Scholar	
Reference lists	
	c. The population of interest included First Nation, Inuit or Métis youth of school age (6–18 years old)
	d. The population of interest resided in Canada.
	e. The study was published in the English language
	f. The study was published between January 2004 and January 2014†
	g. The study was peer reviewed
Search terms	**Exclusion criteria**
Nutrition	a. The study reported only qualitative findings.
Diet	b. The study reported only invasive measures of diet quality or dietary adequacy (e.g. laboratory values).
Food	
Aboriginal	
First Nation	c. The population of interest was <6 years or >18 years of age.
Indigenous	
Native	d. The population of interest did not reside in Canada or was not defined as being Aboriginal.
Inuit	
Métis	
Arctic	e. The study was published in a language other than English.
Child	
Adolescent	f. The study was published before January 2004 or after January 2014‡.
Youth	
Teen	g. The study was not peer reviewed

*Includes life, health and biomedical sciences databases. ERIC, an education database, was included for possible results of nutrition education programmes. Google Scholar was searched for articles that were not indexed. Reference lists were searched for any studies not identified in the original search.

†PubMed (Medline) search: 'Canad* and (nutrition* or diet* or food*) and (Aboriginal or First Nation* or indigenous or native or Inuit or Metis or Métis or arctic) and (child* or youth or adolescent* or teen*)', limited to articles published since January 2004.

‡Studies published earlier than January 2004 may no longer be relevant as a result of historical bias. The last date searched was 4 March 2014. All searches were limited to the last 10 years (since January 2004).

outcomes of interest. Results regarding associations between dietary intakes and different associated factors (e.g. body mass index, meals away from home, central adiposity) are beyond the scope of the present study and were therefore not reported. In the case of studies reporting the results of school or community-level nutrition interventions, only baseline dietary intake data are reported because these are reflective of 'natural' intakes without intervention. The setting of each study was described as it was listed in each respective article (e.g. rural, isolated). As a result of the nature of the outcomes of interest, the main source of bias within each individual study was the method used to measure dietary intake among participants (e.g. self-reported methods may be susceptible to social desirability and recall biases). The measure used was reported as described in the study and verified by the second researcher. Other potential sources of bias were not considered in the context of the present study. Based on the conglomerate findings of the studies reviewed, key research gaps were identified and recommendations for future research were provided.

Results

The literature search revealed 24 studies investigating the dietary intakes of school-aged Canadian Aboriginal youths that met the inclusion criteria (Fig. 1). A summary of the main findings from each study is provided in Table 2. All of the studies reviewed were cross-sectional in design, and reported on the results from data collected from 1994 to 2010. The vast majority of the studies were from either Quebec (n = 6; 25%) or Ontario (n = 10; 42%). Research from British Columbia (n = 2; 8%), Prince Edward Island (n = 1; 4%) and Yukon and Northwest Territories (n = 3; 13%) was less prevalent, whereas two studies (8%) reported on the results of national surveys. Most studies (n = 21; 88%) reported on the diets of FN youths, whereas only five studies reported on the diets of Métis (n = 4; 17%) or Inuit (n = 1; 4%) youths. Most research took place in either isolated or remote communities (n = 18; 75%). The most commonly used dietary assessment method was the 24-h recall (n = 19; 79%); of the studies using this method, 89% used a single recall, whereas the remaining 11% (two studies) used three recalls. The remaining studies used food frequency questionnaires (with some using both food frequency questionnaires and 24-h recalls; n = 7; 29%).

Of the 14 studies reporting on vegetable and fruit intakes, all found that intakes fell within the 'needs improvement' range [52–100% of youths falling below Canada's Food Guide (CFG) recommendation; Health Canada, 2007]. Similarly, of the 13 studies reporting on dairy, milk or milk and alternatives intakes, all revealed that intakes could be improved (51–95% of youths falling below CFG recommendation; Health Canada, 2007). Furthermore, data from the CCHS showed that the intakes of vegetables, fruit and dairy products were lower for Aboriginal youths compared to their non-Aboriginal peers (Ng *et al.*, 2010). Beyond food group data, the general trend was for diets that were energy-dense and

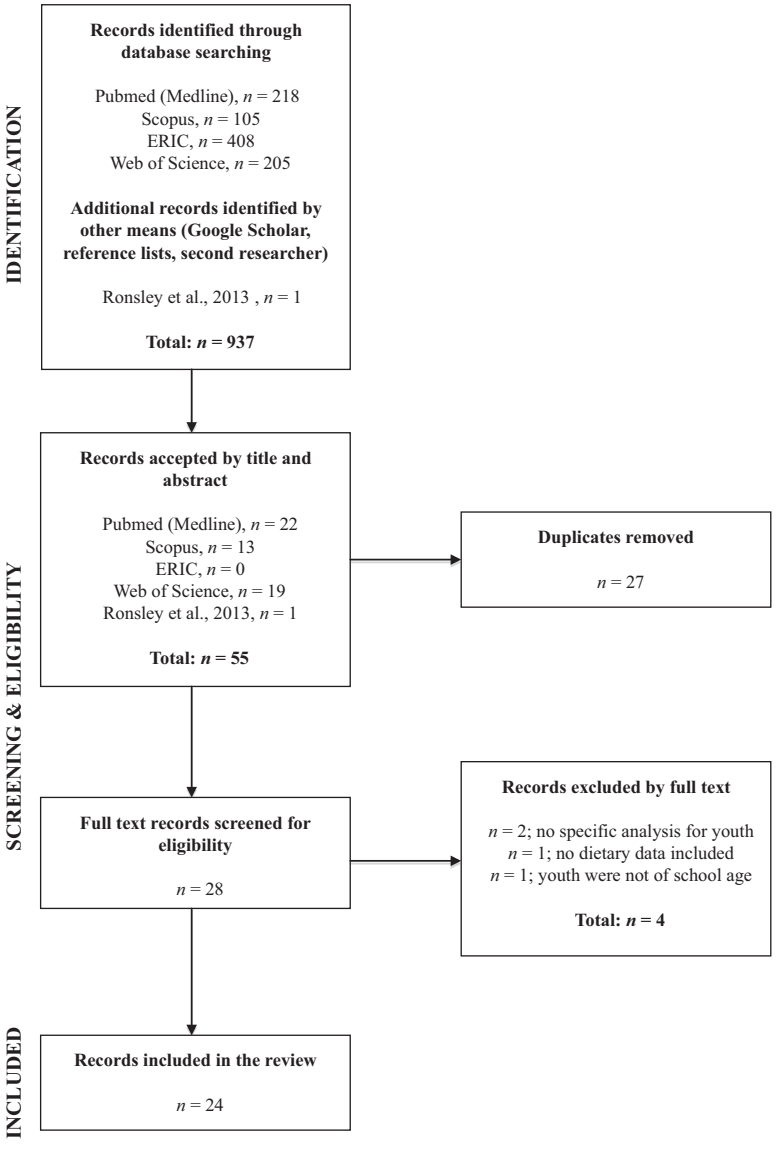

Figure 1 Flow diagram of the study selection based on the predetermined inclusion and exclusion criteria.

nutrient poor; sugar sweetened beverage, snack and fast food consumption was high, whereas intakes of fibre ($n = 7$), folate ($n = 3$), vitamin A ($n = 6$), vitamin C ($n = 2$), calcium ($n = 6$) and vitamin D ($n = 6$) were of particular concern across multiple studies.

Few studies ($n = 7$; 29%) reported on traditional food consumption. Of those that did, it was clear that traditional foods still played an important role in the diets of Aboriginal youths, at least in some communities. Traditional foods were found to contribute significantly to intakes of iron, zinc, copper, magnesium, phosphorus, potassium, vitamin E, riboflavin and vitamin B_6. That being said, in most studies, although traditional foods may still be consumed on occasion by the majority of youths, intake levels were typically quite low in terms of frequency per month or contribution by percentage energy.

Discussion

The present study reviewed 24 peer-reviewed journal articles published between January 2004 and January 2014, reporting on the dietary intakes of FN, Inuit and/or Métis youths of school age residing in Canada. Overall, the research revealed diets that were nutrient-poor and high in 'other foods' (e.g. sugar-sweetened beverages, snack foods, fast foods); intakes of important micronutrients, most notably fibre, folate, vitamin A, vitamin C, calcium and vitamin D, were of concern, which is not unexpected given a general trend toward intakes of vegetables and

Table 2 Summary of primary research studies on the diets of Canadian Aboriginal youth of school age, published from January 2004 to January 2014

Reference	Purpose (year) and setting	Sample	Assessment method	Main findings
Adams *et al.* (2005)	To assess relationships among healthy lifestyle indicators (1994) Urban	150 grade 4–6 Mohawk (FN) youth from Kahnawake, Quebec (53% female, mean age 9.9 years)	Single 24-h recall	52% <CFG recommendation for VF Sugared beverages were a major source of energy and sucrose As daily intake of sucrose increased, milk consumption decreased and soft drink intake increased ($P < 0.001$)
Downs *et al.* (2009)	To explore the relationship between diet quality, weight and food environment (2004 & 2005) Isolated	201 grade 4–6 Cree (FN) youth from northern Quebec	Three 24-h recalls	80.9% and 98.5% <CFG recommendation for MMA and VF, respectively Game meats contributed 16.7% Fe and 16.8% Zn intake (but only 3% total energy) Youth were at risk of inadequacies in Zn, Ca and vitamin D Sweetened beverages contributed the highest amount to total energy (8.9%) and snack foods contributed the most to energy from fat (11.7%) 77.6% consumed ≥1 restaurant/take-out meal
Downs *et al.* (2008)	To determine whether behavioural lifestyle factors were associated with CA (2004 & 2005) Isolated	178 grade 4–6 Cree (FN) youth from northern Quebec [no CA: $n = 85$, 49.4% female, mean age 10.5 (1.1) years; CA: $n = 93$, 60.2% female, mean age 10.9 (1.0) years]	Three 24-h recalls	83.7% <3 servings of VF per day Children with CA consumed fewer VF ($P = 0.012$) No CA: VF (#): 1.7 (1.3); Milk (mL): 360 (279); Sweetened beverages (mL): 495 (344) CA**:** kJ: 9213 (2515); VF (#): 1.3 (1.1); Milk (mL): 295 (201); Sweetened beverages (mL): 473 (340)
First Nations Information Governance Centre [FNIGC] (2012)	To assess the health of on-reserve FN youth in Canada (2008–2010) Varied on-reserve locations	2837 on-reserve FN youth from 216 communities across Canada (12–17 years)	Two food frequency questionnaires	67.6%, 56.0% and 67.3% consumed MMA, vegetables, and fruit, respectively, ≥daily, whereas 5.1%, 8.3% and 2.1% never or hardly ever consumed MMA, vegetables, and fruit, respectively 79.5% and 53.3% consumed juice and soft drinks/pop, respectively, ≥daily 56.5% and 63.2% consumed fast food and sweets, respectively, ≥ a few times per week 23.0%, 15.4%, 19.5% and 40.2% 'often' consumed land based animals, freshwater fish, berries or other wild vegetation and bannock, respectively

Table 2 *(Continued)*

Reference	Purpose (year) and setting	Sample	Assessment method	Main findings
Gates *et al.* (2013a)	To evaluate the impact of a school nutrition programme on MMA intake (2009) Isolated, remote	30 grade 6–8 FN youth from Fort Albany, Ontario (67% female, median age 13 years)	Single, validated web-based 24-h recall	86.7% <CFG recommendation for MMA Mean MMA: 1.8 (1.1) servings Mean Ca intake <EAR [785.4 (423.5) mg] Mean vitamin D intake <EAR [2.7 (2.4) μg]
Gates *et al.* (2012a)	To describe the intakes of MMA, calcium and vitamin D (2003–2010) Isolated and/or remote	443 FN youth from seven communities in northern and southern Ontario (9–18 years old, 52% female)	Single, validated web-based 24-h recall	79.9% boys 9–13 years and 72.6% boys 14–18 years <CFG recommendation for MMA 83.8% girls 9–13 years and 84.7% girls 14–18 years <CFG recommendation for MMA 86.3% boys 9–13 years and 75.3% boys 14–18 years <RDA for Ca 86.7% of girls 9–13 years and 98.3% of girls 14–18 years <RDA for Ca 98.6% boys 9–13 years and 90.4% boys 14–18 years <RDA for vitamin D 96.5% of girls 9–13 years and 98.3% of girls 14–18 years <RDA for vitamin D
Gates *et al.* (2012b)	To establish baseline nutrient intakes and feasibility of a pilot school snack programme (2009) Isolated, remote	43 grade 6–8 FN youth from Kashechewan, Ontario [40% female, mean age 13.1 (0.9) years]	Single, validated web-based 24-h recall	95.3% <CFG recommendation for VF 100% <AI for fibre 55.8%, 76.7% and 48.8% <EAR for folate, vitamin A and vitamin C, respectively
Gates *et al.* (2013b)	To assess the impact of school food provision programmes on MMA intakes (2009) Isolated, remote	113 grade 6–8 FN youth from Kashechewan and Attawapiskat, Ontario (Kashechewan**:** 40% female; median age 13 years; Attawapiskat**:** 64% female, median age 12 years)	Single, validated web-based 24-h recall	74.4% and 82.9% <CFG recommendation for MMA in Kashechewan and Attawapiskat, respectively Ca and vitamin D intakes were low; >80% youth did not meet the AI for each nutrient
Gates *et al.* (2012c)	To describe the intakes of VF, 'other foods' and relevant nutrients (2004–2009) Isolated and/or remote	9–18 year-old FN youth from seven communities in northern and southern Ontario 52% female, mean age 13.0 (1.6) years]	Single, validated web-based 24-h recall	Mean intakes of VF, fibre and folate were less than recommended (<CFG, EAR or AI) Mean servings of 'other foods' >mean servings of VF Mean intake of vitamin A was less than recommended for girls 14–18 years
Hlimi *et al.* (2012)	To investigate the factors influencing traditional food consumption (2004–2009) Isolated, remote	262 grade 6–12 Cree (FN) youth from five subarctic communities in Ontario (50% female)	Web-based food frequency questionnaire, adapted for use in FN youth	90% of schoolchildren reported eating game meats
Kakekagumick *et al.* (2013)	To evaluate the impact of a community health programme on dietary intakes (1998 & 2005). Isolated, remote	122 Ojibway-Cree (FN) youth from Sandy Lake First Nation, Ontario	Single 24-h recall One-on-one interviews	Mean fibre intake: 11.6 (8.0) g Mean fat intake: 86.4 (51.4) g Mean milk intake: 0.3 (0.1) servings Mean grains intake: 1.2 (0.2) servings 30% of energy intake was from sugar

Table 2 *(Continued)*

Reference	Purpose (year) and setting	Sample	Assessment method	Main findings
Khalil *et al.* (2010)	To describe the dietary habits of youth in three communities (2005 & 2007) Isolated, remote	125 Cree (FN) youth from northern Quebec [9–18 years old, 51% female, mean age 13.2 (2.8) years]	Two food frequency questionnaires Single 24-h recall; repeat recalls on 20% participants	98.1% consumed saturated fat >10% total energy 92.8% consumed high-sugar foods (12.8% of daily energy intake) 96.8% consumed high-fat foods (39.3% of daily energy intake) Diet quality scores were low; 95% <recommended score of ≥80 63%, 95%, 81% and 32% <CFG recommendation for VF, MMA, GP and MA, respectively Traditional food consumption as days per month was low, but 50% consumed these foods weekly 83.2% consumed fish <0.5 times per week, 65.6% consumed traditional meat <0.5 times per week
Kuhnlein & Receveur (2007)	To identify dietary food sources in Yukon and Northwest Territories (2000–2001) Remote	409 Dene/Métis youth (10–12 years old) and 34 Inuit youth (15–19 years old) from Yukon and Northwest Territories	Single 24-h recalls in two seasons Frequency interviews of traditional food species	Dene/Métis and Inuit youth consumed 4.5% and 15% of energy from traditional foods, respectively; younger generations consumed less traditional foods than older ones Diets containing traditional foods had more protein, Fe, Zn, Cu, Mg, P, K, vitamin E, riboflavin, vitamin B_6 Grains and 'other foods' usually >90% daily energy intake Approximately 55% of energy derived from foods identified as fat (21%), sweet (20%) and mixed savoury dishes (14%)
Nakano *et al.* (2005a)	To describe food use of Dene/Métis and Yukon youth (2000–2001) Remote	222 Dene/Métis youth (10–12 years old) from five Yukon and Northwest Territories communities (58% female)	Single 24-h recalls in two seasons with repeat recalls with 84% participants	Traditional foods contributed to 4.5% of total energy intake 55% of energy intake from store-bought foods did not fit into CFG Those with traditional foods consumed significantly more Fe, Zn, Cu, Mg, P, vitamin E, riboflavin and vitamin B_6 and protein North and central regions had significantly higher traditional food, Fe, Cu and vitamin B_6 intakes, and lower Na intakes; those in south region ate less traditional foods and more store-bought food sources of fat Intakes of store-bought MMA and GP were higher for children without traditional foods

Table 2 *(Continued)*

Reference	Purpose (year) and setting	Sample	Assessment method	Main findings
Nakano *et al.* (2005b)	To describe the nutrient intakes and anthropometry of youth in the Arctic (2000–2001) Remote	222 Dene/Métis youth (10–12 years old) from five Yukon and Northwest Territories communities (58% female)	Single 24-h recalls in two seasons with repeat recalls with 84% participants	>50% had intakes of Mg, P, vitamin A and vitamin E <EAR Mean values of Ca, vitamin D, fibre, omega-6 fatty acids and omega-3 fatty acids were <AI <10% had intakes of CHO, protein, Fe, Cu, vitamin C, riboflavin, vitamin B_6, Se and Zn <EAR Mean Mn intake >AI >20% and >30% were not within AMDR for CHO and fat, respectively
Ng *et al.* (2010)	To determine associations of diet, physical activity and television viewing with obesity (2004) Varied settings	198 Aboriginal (off-reserve FN, Métis or Inuit) youths from the 2004 CCHS [49% female, mean age 14.0 years (95% CI 13.6–14.3 years)]	Single 24-h recall using the computer-based automated multiple-pass method to aid recall	Except for consuming less dairy products and vegetables, Aboriginal youth did not differ from non-Aboriginal youth in terms of any nutrient or food group intakes, nor E intake Mean % of energy from saturated fat: 9.7 Mean sugar intake: 143.4 g (95% CI 137.1–149.6 g) Mean fibre intake: 14.9 g (95% CI 14.1–15.8 g) Mean Na intake: 3393.9 mg (95% CI 3139.1–3648.6 mg) Mean Ca intake: 926.0 mg (95% CI 870.7–981.3 mg)
Paradis *et al.* (2005)	To assess the impact of a school health programme on dietary intakes (1994) Urban	458 grade 1–6 Mohawk (FN) youth from Kahnawake, Quebec	7-day, 51 item food frequency questionnaire, adapted for Kahnawake, completed by parents or youth	Three-item subscales to create indicators of consumption of key foods; scored from 0 (did not eat) to 7 (every day): Sugar consumption index: 2.22 (0.07), fat consumption index: 1.28 (0.05), fruit and vegetable consumption index: 2.91 (0.07)
Receveur *et al.* (2008)	To identify differences in diet quality and quantity across body mass index categories (1994, 1998 & 2002) Urban	444 Grade 4–6 Mohawk (FN) youth from Kahnawake, Quebec (50% female)	Single 24-h recalls in 3 years (all in October)	Mean intakes of common foods did not differ across weight categories except for French fries [116 (69) g for at risk of overweight, 132 (92) g for overweight, $P = 0.027$] after adjustment for age Frequency of consumption of common foods did not differ across weight categories except for crackers (16% for normal weight, 4% for at risk of overweight, 13% for overweight, $P = 0.015$) and potato chips (13% for normal weight, 24% for at risk of overweight, 6% for overweight, $P = 0.001$)
Ronsley *et al.* (2013)	To evaluate the impact a school health programme on health, behaviour and knowledge (2009–2010) Remote	118 Kindergarten to grade 12 FN youth from Tsimshian FN on the northern Pacific Coast of British Columbia [39% female, mean age 10.9 (3.5) years]	Validated food frequency questionnaire, adapted from the Eating at America's Table Study Quick Food Scan	Mean soda pop intake: 1526.5 (2044.9) mL per week Mean sugar sweetened beverage intake: 6497.4 (6906.6) mL per week

Table 2 *(Continued)*

Reference	Purpose (year) and setting	Sample	Assessment method	Main findings
Saksvig *et al.* (2005)	To evaluate the impact of a community health initiative on dietary intakes (1998) Isolated, remote	122 grade 3–5 FN youth from Sandy Lake First Nation, Ontario (45% female, age range 7–14 years)	Single 24-h recalls over 3 weeks 1-day nonquantitative food diary	Mean macronutrient intakes fell within AMDR 32% ate ≤30% of energy from fat Mean fibre intake: 11.6 (8.0) g
Skinner *et al.* (2012a)	To evaluate the impact of a school nutrition programme on dietary intakes (2004) Isolated, remote	63 grade 6–10 FN youth from Fort Albany, Ontario [55.6% female, mean age 13.5 (1.6) years]	Single, validated web-based 24-h recall	78%, 53%, 90% and 28% <CFG recommendation for VF, GP, MMA and MA, respectively 13% <DRI for carbohydrates 45%, 60%, 33%, 88%, 88% and 15% <EAR for vitamin A, folate, vitamin C, calcium, vitamin D and Fe, respectively
Skinner *et al.* (2012b)	To plan community-driven health promotion strategies for healthy eating and physical activity (2004–2005) Isolated, remote	66 grade 6–11 FN youth from Fort Albany, Ontario [58% female, mean age 14.1 years (boys), 13.0 years (girls)]	Single, validated web-based 24-h recall	Median intake of VF, GP and MMA <CFG recommendation Median Ca, vitamin D and fibre intakes <AI Mean game intake: 2.6 (girls) and 4.0 (boys) servings per week Youth consumed a mean of 6.6–7.0 servings of cola-type pop, 5.0 servings of French fries, 5.9–6.1 servings of salty snacks, 3.4–3.7 servings of pizza, and 5.8–6.5 servings of candy/chocolate bars per week
Taylor *et al.* (2007)	To assess food consumption among on-reserve youth (2002) Rural (reserves)	55 Mi'kmaq (FN) youth from Prince Edward Island (8–18 years old, 60% female)	Validated 27-item food frequency questionnaire and Eating Behaviour Survey	51% and 100% <CFG recommendation for MMA and VF, respectively 48% ate ≥3 snack foods pere day 71% consumed milk daily >50% had fruit or juice daily 14% had no vegetables other than salad in past 7 days 61% did not have salad in past 7 days
Tomlin *et al.* (2012)	To evaluate the impact of a school health programme on diet (2007) Rural, remote	133 grade 4–12 FN youth northwestern British Columbia [47% female, mean age 12.4 (2.2) years]	Single, validated 24-h recall	Macronutrient intakes fell within AMDRs Mean VF servings <CFG recommendation [2.75 (2.45)] Mean sugar sweetened beverage intake was high [835.4 (725.5) mL per day]

Data are the mean (SD).

AI, adequate intake (Health Canada, 2006); AMDR, acceptable macronutrient distribution range (Health Canada, 2006); CA, central adiposity; CFG, Canada's Food Guide (Health Canada, 2007); CI, confidence interval; DRI, dietary reference intake; EAR, estimated average requirement (Health Canada, 2006); FN, First Nation; GP, grain products (Health Canada, 2007); MA, meat and alternatives (Health Canada, 2007); MMA, milk and milk alternatives (Health Canada, 2007); RDA, recommended dietary allowance (Health Canada, 2006); VF, vegetables and fruit (Health Canada, 2007).

fruit and milk and alternatives below the recommendations of CFG (Adams *et al.*, 2005; Nakano *et al.*, 2005a,b; Paradis *et al.*, 2005; Saksvig *et al.*, 2005; Taylor *et al.*, 2007; Downs *et al.*, 2008, 2009; Khalil *et al.*, 2010; Ng *et al.*, 2010; FNIGC, 2012; Gates *et al.*, 2012a,b,c; Skinner *et al.*, 2012a,b; Tomlin *et al.*, 2012; Gates *et al.*, 2013a,b; Kakekagumick *et al.*, 2013; Ronsley *et al.*, 2013). Nutrient-dense traditional foods, contributing significantly to intakes of iron, zinc, copper, magnesium, phosphorus, potassium, vitamin E, riboflavin and vitamin B_6, did not

tend to be consumed with great frequency (Nakano *et al.*, 2005a; Kuhnlein & Receveur, 2007; Downs *et al.*, 2009; Khalil *et al.*, 2010). Traditional foods do, however, remain important because most youths still consume them; that being said, the majority of energy intake tended to be consumed via store-bought foods (Nakano *et al.*, 2005a; Kuhnlein & Receveur, 2007; Khalil *et al.*, 2010; Hlimi *et al.*, 2012). Compared to youths in the general population, Aboriginal youths face similar concerns in terms of nutrient inadequacy (Ng *et al.*, 2010; Health Canada, 2012). Nevertheless, the results from the 2004 CCHS showed that Aboriginal youths consumed significantly less dairy products and vegetables compared to their non-Aboriginal peers (although the data excluded on-reserve FN youths) but did not differ significantly for other nutrients or food groups (Ng *et al.*, 2010). Nevertheless, it remains clear that, in specific subpopulations of Aboriginal youths, especially those living in rural, remote, isolated and/or northern regions where adequate, consistent access to affordable healthy foods is uncertain (Haman *et al.*, 2010; Gates *et al.*, 2011), adequacy in food groups and nutrients is a concern.

Comparison with other Indigenous populations

It is recognised that the historical and present-day factors affecting the food behaviours of each Aboriginal community are unique. That being said, the findings of the present study warrant comparison with other Indigenous populations worldwide, which share some of the same challenges and barriers to healthy eating as Canadian Aboriginal ones. Although each Indigenous community has a distinct past, the transition to more Western lifestyles, as well as the inclusion of an increasing proportion of energy-dense, nutrient poor store-bought foods in the diet, has affected many native communities. A study of the school lunches and breakfasts of American Indian schoolchildren found high energy intakes from fat and saturated fat for both meals, along with inadequate intakes of folate (Story *et al.*, 2002b). A study of Mohawk (Native American) youths of school age found that the diets included few naturally occurring sources of iron, zinc and folate (Ravenscroft *et al.*, 2013). Furthermore, sugar sweetened beverages were the second highest contributors to vitamin C intakes (Ravenscroft *et al.*, 2013). Similar to the Canadian context, the diets of American Indian people as a population have been characterised by increased intakes of high-energy, low-nutrient-dense foods and described as obesogenic (Compher, 2006). In Australia, research with 5–17-year-old Indigenous youths from the Torres Strait found that 52% and 49% of participants, respectively, consumed one or less serving of fruits and vegetables daily (Valery *et al.*, 2012). Takeaway foods (i.e. fast foods) were consumed with great frequency, with one quarter of youths consuming them two or more times per week (Valery *et al.*, 2012). Almost all (97%) youths reported consuming energy dense foods and beverages at least daily (Valery *et al.*, 2012). It is clear that the food behaviours of Canadian Aboriginal youths are not entirely unique and share many characteristics with the diets of Indigenous youths in other industrialised nations. However, the findings of the present study should not be generalised to all Indigenous populations because Indigenous groups exist worldwide where stunting and being underweight (as opposed to overweight and obese) remain the dominant concern in terms of dietary adequacy (Horta *et al.*, 2013).

Findings in the context of disease risk

The quality of the diets revealed in the present study are concerning given the relationship between dietary intake and disease risk. There is convincing evidence for an association between increasing vegetable and fruit consumption and a decreased risk for hypertension, coronary heart disease and stroke in adults (Boeing *et al.*, 2012). Furthermore, dairy food intake, calcium and vitamin D are important for bone growth and development, particularly at northern latitudes where endogenous vitamin D production via sun exposure is inadequate to meet needs for at least 6 months of the year (Zhang & Naughton, 2010). Vegetable and fruit intake patterns in the formative years are also likely to persist through to adulthood, whereas milk and dairy food intake tend to decrease with age (Lake *et al.*, 2006), meaning that the promotion of healthy habits is especially important during childhood. Similar to youths, investigations into the food behaviours of Aboriginal adults have noted an inadequate consumption of vegetables and fruit, milk and alternatives, fibre, folate, calcium, vitamin A and vitamin D, concomitant with the excess consumption of nutrient-poor, store-bought 'other' foods (Hopping *et al.*, 2010; Bruner & Chad, 2014). Furthermore, diet quality has been found to be independently associated with body fat and waist circumference in school-aged youths (Jennings *et al.*, 2011). This is especially relevant given that Aboriginal youths are disproportionately affected by being overweight or obese, and FN youths, in particular, are at a heightened risk for the development of type 2 diabetes (Young *et al.*, 2000; Shields, 2006; Public Health Agency of Canada, 2011). Given that childhood weight tends to persist into adulthood (Singh *et al.*, 2008) and that the Aboriginal population is young compared to the non-Aboriginal one (Statistics Canada, 2013a), targeting the diets of youths (e.g. via school programmes) is a popular approach for addressing obesity. Such an approach provides the oppor-

tunity to improve not only child and youth health, but also adult morbidity and mortality.

Health promoting initiatives

Given the diet quality of many Aboriginal youths, a number of studies have reported on the impact of community and school-based initiatives aiming to improve diet quality in this population. Most notably, the Kahnawake Schools Diabetes Prevention Project (KSDPP), Sandy Lake School-based Diabetes Prevention Program, Healthy Buddies™ and Action Schools! BC are initiatives promoting healthier diets, physical activity and diabetes prevention for FN youths that have been met with limited success in terms of improved diet quality (Adams *et al.*, 2005; Paradis *et al.*, 2005; Saksvig *et al.*, 2005; Tomlin *et al.*, 2012; Kakekagumick *et al.*, 2013). Some smaller food provision programmes, namely those providing healthier store-bought foods to youths during school hours, have also been marginally successful. Research by *Gates et al.* (2012b, 2013b) investigated the impact of school food provision programmes in two remote FN communities and noted moderate improvements in diet over the short term; however, longer-term success was impeded by multiple community-level barriers. Nevertheless, 4 years after implementation, the dedication of community members facilitated significant increases in vegetables and fruit and milk and alternatives consumption (Gates *et al.*, 2014). Similarly, Skinner *et al.* (2012a) investigated the diets of youths participating in a long-standing (>15 years) school breakfast and snack programme in a northern, remote FN community in Ontario. Programme attendees reported higher intakes of vegetables and fruit, milk and alternatives, folate, fibre, vitamin C, vitamin A, calcium, vitamin D and iron, as well as lower intakes of energy-dense, nutrient-poor 'other foods' (Skinner *et al.*, 2012a). These case studies show that, at least over the long term (multiple years), school food provision programs may be able to improve diet quality.

Methodological considerations

Methodologically, Burrows *et al.* (2010) identified the most accurate technique for measuring self-reported diet in youths as the 3-day, multiple-pass 24-h recall, including both weekdays and weekend days and using parents as proxy-reporters. In the present study, a minority of studies employed this method, which may have led to inaccuracies in results. Ideally, future research would employ the most accurate technique for measuring self-reported diet; however, the challenges of doing so must be taken into consideration (Campbell *et al.*, 1994). Data collection and travel to remote communities may be time- and resource-intensive. Moreover, it must be scheduled as to not interfere with school learning hours. When technological resources allow, web-based recalls may provide for a time- and cost-effective solution (Illner *et al.*, 2012). Community members can be trained to administer the recalls, thereby contributing to community-based research capacity. Furthermore, the cultural relevance of the data collection method needs to be considered, such that accurate data are available for the traditional foods typically consumed in each community.

It also cannot be overlooked that much of the research into the diets of Aboriginal youths has employed relatively small sample sizes; six studies had sample sizes of $n \leq 100$ (Taylor *et al.*, 2007; Gates *et al.*, 2012a,b; Skinner *et al.*, 2012a,b; Gates *et al.*, 2013b), whereas another six had samples sizes of $n > 100$ to $n \leq 150$ (Adams *et al.*, 2005; Saksvig *et al.*, 2005; Khalil *et al.*, 2010; Tomlin *et al.*, 2012; Kakekagumick *et al.*, 2013; Ronsley *et al.*, 2013). This is a reality of research with Aboriginal communities and, although the validity and generalisability of the results are therefore compromised, it is possible that, even if a sample is small, it may represent almost all of the youths residing in a community (i.e. close to 100% response rate; Gates *et al.*, 2012c). In planning for locally relevant health-promoting initiatives, these small samples may be adequate.

Knowledge gaps and areas of future research

Much of the published research reporting on the food and nutrient consumption of Aboriginal youths has focused on FN youths and those residing in remote, isolated communities in Ontario and Quebec. For this reason, little is specifically known about the diets of Métis and Inuit youths, FN youths living off-reserve or in urban areas, and Aboriginal youths living in the remaining provinces and territories. Although data on the diets of very young Inuit and Métis children are available through the Inuit Child Health Survey (3–5-year-old Inuit children; Egeland *et al.*, 2009) and Aboriginal Children's Survey (<6-year-old Inuit, Métis and off-reserve FN children; Statistics Canada, 2008), the diets of school-aged Inuit and Métis youths, in particular, remain largely indeterminate. Because each Aboriginal community is unique, more detailed information about a wider range of communities is necessary, especially if programmes and policies aiming to improve diet quality are to be established. The diets of Aboriginal youths may be affected by a number of factors that are unique to each community, including, but not limited to, degree of remoteness and/or isolation; geographical location (e.g. latitude); availability of grocery stores and the cost and availability of healthy foods;

accessibility of traditional hunting, trapping and harvesting practices; the lasting impact of acculturation; and the presence (or lack of) local programming promoting or discouraging healthy eating (Skinner *et al.*, 2006; Haman *et al.*, 2010; Gates *et al.*, 2011; Willows *et al.*, 2012). The present review only located one study specifically investigating the diets of Inuit youths and three for Métis (Nakano *et al.*, 2005a,b; Kuhnlein & Receveur, 2007). For that reason, the findings cannot be generalised to those populations. Nevertheless, it remains clear that, as a whole, the food and nutrient consumption of the population could stand to be improved to meet current Canadian dietary guidelines as defined by CFG for FN, Inuit and Métis for food groups and Dietary Reference Intakes for nutrients.

Clearly, many of the current initiatives attempting to improve the diet quality of Aboriginal youths in Canada have not been optimal. Although school food provision may provide for some dietary improvement over the long term, such programmes are insufficient to bring the majority of youths into the range of adequacy for food groups and nutrients (Gates *et al.*, 2012b, 2013b; Skinner *et al.*, 2012a). Furthermore, many communities do not have access to programming aimed at improving the diet quality of their youths. In some communities, especially northern ones, making healthy choices may not even be an option; nutrient-dense foods such as vegetables and fruit, low-fat dairy products, whole grains and lean meats may be available only sporadically, as well as exorbitantly expensive and of poor quality upon their arrival within communities (Gates *et al.*, 2011; Socha *et al.*, 2011). Consequently, although education initiatives may improve knowledge and intentions for healthier eating, numerous barriers must be overcome before youths would be able to put this knowledge into action (Saksvig *et al.*, 2005; Gates *et al.*, 2011, 2013a). To provide for lasting improvements in diet quality and to ensure dietary adequacy for a larger proportion of Aboriginal youths, multilevel approaches and a greater understanding of why youths eat what they do is required. Up-and-coming methods, such as PhotoVoice, may provide an effective way to help determine the food-related experiences of Aboriginal youths (Martin *et al.*, 2010; Young *et al.*, 2013).

Relatively little is known about the perceptions of health and nutritious diets, and the importance of traditional foods for Aboriginal youths. Research has shown that some Aboriginal youths may have body weight perceptions that differ from the traditional Western ideal and some populations may not view obesity as being problematic (Davis *et al.*, 2000). Given the more holistic view of health in many Aboriginal cultures, and more specifically the spiritual and cultural importance of traditional foods, Aboriginal youths likely also differ in terms of their perceptions of what would constitute a nutritious diet. To our knowledge, these perceptions largely remain to be determined. A greater understanding of the meanings of different foods and conceptions of a healthy diet would allow for culturally relevant initiatives to promote dietary adequacy. Given relatively recent declines in traditional food consumption, and knowing the cultural and dietary importance of traditional foods (Kuhnlein *et al.*, 2004; Nakano *et al.*, 2005a,b; Kuhnlein & Receveur, 2007), programmes supporting harvesting, hunting, gathering and harvest sharing, with a focus on passing these skills on through the generations, may hold promise. Similar to youths, it has been reported that Aboriginal adults also consume diets that are simultaneously high in 'other' foods and below recommended levels of vegetables and fruit, as well as milk and alternatives, yet higher in traditional foods (Bruner & Chad, 2014). Adult nutrient intakes in arctic regions have also been described as being inadequate in fibre, calcium, folate, vitamin A, vitamin D and vitamin E (Hopping *et al.*, 2010). Parental influences and the influences of other adult role models on the diets of youths warrant further investigation, and it is likely that whole-community and whole-family approaches to dietary improvement will be more successful than those solely targeting youths.

Conclusions

The diets of school-aged Aboriginal Canadians are in need of improvement; many are inadequate in important food groups and micronutrients, at the same time as being higher in energy-dense, nutrient-poor store-bought foods. School-based nutrition programmes have only been met with marginal success. Looking toward the future, research is required to determine the dietary habits and dietary adequacy of school-aged Inuit and Métis youths in particular. Furthermore, balancing methodological rigor and cultural appropriateness, at the same time as taking the opportunity to promote community-based research capacity, is important when conducting research in this vulnerable population. Future investigations should also focus on the health perceptions of Aboriginal youths and their perceptions of a nutritious diet, in particular, because these may differ from typical Western norms. Knowledge gained may be used to target initiatives to improve diet quality. Given the known benefits of traditional food consumption, both nutritional and cultural, initiatives promoting harvest sharing and skill development for the hunting and gathering of such foods may be effective in conjunction with programming improving the affordability and availability of healthier store-bought foods.

Limitations

Because few data on the diets of Inuit and Métis youths exist, it is likely that the findings of the present study are not generalisable to those populations. Many of the studies reviewed utilised relatively small sample sizes, which may have impacted upon the accuracy of the findings. It should be noted that all of the studies reviewed utilised self-reported methods of measuring dietary intake, which are susceptible to social desirability and recall biases. Only one study used three 24-h recalls, which is the most accurate method of measuring self-reported intake (Burrows *et al.*, 2010). Furthermore, this review did not report on associations between dietary intake and demographic factors, health behaviours or weight status. Further studies aiming to review published data on such associations are recommended and would fill a gap in current knowledge, specifically for Aboriginal youths. It is possible that relevant studies were missed during the literature search; however, duplication of the search and data extraction by a second, independent researcher has minimised the likelihood that relevant studies would have been excluded.

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Conflict of interests, source of funding and authorship

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AG was involved in performing the search and summarising the findings. KS was responsible for the original concept of the manuscript. MG replicated the search for transparency. AG, KS and MG were all involved in designing the search strategy, contributing to the manuscript content and preparing the manuscript for publication. KS and MG contributed equally. All authors critically reviewed the manuscript and approved the final version submitted for publication.

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