
Peer-led nutrition education programs for school-aged youth: a systematic review of the literature

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Abstract

To date, the impacts of school-based, peer-led nutrition education initiatives have not been summarized or assessed collectively. This review presents the current evidence, identifies knowledge gaps, and provides recommendations for future research. PubMed, Scopus, ERIC and Google Scholar were searched for refereed Canadian and American primary studies published between January 2000 and November 2013, following Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Seventeen articles (11 programs) from Canada (24%) and the United States (76%) were identified. The results were summarized in terms of the study population, program design and main outcomes. Common outcome measures included healthy eating knowledge ($n = 5$), self-efficacy or attitudes towards healthy eating ($n = 13$), dietary measures ($n = 9$) and body mass index ($n = 4$), all of which tended to improve as a result of the programs. More research is needed to ascertain the effect of improvements in knowledge, self-efficacy and attitudes towards healthy eating on food behaviors. When evaluated, programs were generally well received, while the long-term maintenance of positive impacts was a challenge. Studies of sustainability and feasibility to promote long-term impact are a logical next step.

Introduction

Obesity is a powerful contributor to adverse health outcomes including type 2 diabetes, cardiovascular diseases, osteoarthritis, hypertension, gallbladder disease and several cancers [1, 2], and represents a significant economic burden to healthcare systems [3]. Youth have not been spared from the growing burden of excess weight. Measured rates of overweight and obesity from the 2011–2012 National Health and Nutrition Examination Survey (United States Centers for Disease Control standards) showed that 14.9% and 16.9% of American youth were overweight or obese, respectively [4]. Similarly, the 2009 to 2011 Canadian Health Measures Survey (World Health Organization standards) showed that 19.8% of Canadian youth aged 5–17 years were overweight and 11.7% were obese [5]. Without intervention, prevalence rates will likely continue to escalate.

Childhood is an opportune time to address the growing problem of excess weight. Overweight and obese youth are at a 2-fold or greater risk of becoming overweight or obese adults compared with their normal weight peers [6]. Among the myriad determinants of obesity in youth, dietary intake is a promising factor to target because it is potentially amenable to change [7]. Improving diets prior to and during adolescence is important because food behaviors in adolescence are a significant predictor of diet in the adult years [8]. Moreover,

improvements in diet quality can result in significant health benefits in the absence of weight loss; even minor increases in fruit and vegetable intake can reduce cancer and coronary heart disease risk [9].

The forces that collectively influence the diets of youth are complex, and it is recognized that these should be targeted via multi-level ecological approaches [10]. That said, schools are ideal locales for childhood health promotion because they serve practically all children and youth [11]. Youth spend a large portion of their waking hours in school, presenting an ideal opportunity to support the development of healthy behaviors at an age when youth are beginning to form lifelong habits [6, 12]. Although efforts have been made to increase the availability of healthier food options in schools through policies such as the National School Lunch Program in the United States [13] and school-based food and beverage policies in Canada [14], it has been suggested that more action needs to be taken to improve nutrition education in schools [10]. Nutrition education would be complementary to positive changes in the physical environments of youth because it would provide them with the knowledge and skills to get the most out of these changes [10].

Peer-led approaches to health promotion for youth have been increasing in popularity since the 1990s [15] and are promising because peer interactions exert a powerful social influence on behavior change, especially during the onset of adolescence when peer acceptance is valued [16]. Although there is limited research on the use of peer-led strategies to improve dietary behaviors in youth, qualitative data show that peer-led nutrition education approaches are practical, feasible and well accepted in schools [15, 16].

To the authors' knowledge, there exists no recent review of peer-led nutrition education programs for school-aged youth. Previous work reviewed a small number of studies ($n=13$) that evaluated school health education programs and compared the effect of peers and adults delivering the same material [17]. The review showed that peer-led approaches may be as, if not more effective than adult-led ones, although this finding was hindered by methodological weaknesses [17]. A separate review of the impact of peer

nutrition education initiatives on the dietary behaviors and health outcomes of Latino people living in the United States found that peer-led nutrition education can have a positive influence on dietary behaviors, health outcomes and nutrition knowledge [18]. The purpose of this review was to (i) summarize the results of published, refereed research investigating peer-led nutrition education programs in schools in the United States and Canada, and (ii) identify research gaps and provide recommendations for future research.

Methods

The literature search began in November 2013 and subsequent analyses were performed throughout 2014. The search of peer-reviewed, published literature reporting the results of peer-led school nutrition education programs for youth was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines [19, 20]. The protocol for the review was decided prior to the start of the study, and involved consideration for the study design and validity of methodology. PubMed (Medline), Scopus and Education Resources Information Center (ERIC) databases were selected because of their scope of coverage across disciplines in the life, health, biomedical and social sciences, as well as education. Google Scholar was searched for articles that were not indexed in the aforementioned databases, and reference lists were scanned to retrieve articles that were not previously identified. Records published prior to January 2000 were excluded to avoid historical biases related to changes in schools, demographics and technology in the previous 14 years. The online search strategy is shown in Box 1. Multi-component programs that incorporated a peer component (either same-age or older peers) were eligible, but only results relevant to peer influences were included for the purposes of this review. The setting was restricted to schools in Canada and the United States to limit heterogeneity in school systems.

The articles retrieved were initially selected by title and abstract. The full text was then scanned to

| Box I. Online search strategy | |
|---|--|
| Sources | Inclusion Criteria |
| <ul style="list-style-type: none"> ▪ PubMed ▪ Scopus ▪ Education Resource Information Center ▪ Google scholar ▪ Reference lists | <ul style="list-style-type: none"> ▪ included nutrition education that was led by peers (same age or older) ▪ took place in a school (elementary or high school) ▪ investigated outcomes for school-aged youth (5–18 years old) |
| Search terms | Exclusion criteria |
| <ul style="list-style-type: none"> ▪ Child ▪ Kid ▪ Youth ▪ Adolescent ▪ Teen ▪ Nutrition ▪ Diet ▪ Eating habits ▪ Food habits ▪ Feeding behaviors ▪ Peer ▪ Peer led ▪ Peer-led ▪ School | <ul style="list-style-type: none"> ▪ took place in Canada or the United States ▪ reported quantitative results ▪ published in English ▪ published between January 2000 and November 2013 ▪ did not include an intervention or was not led by peers ▪ did not include nutrition education ▪ did not take place in a school ▪ investigated outcomes for individuals <5 or >18 years of age ▪ took place in a country other than Canada or the United States ▪ did not report quantitative results ▪ not published in English ▪ published before January 2000 or after November 2013 ▪ not a peer-reviewed primary study |
| <p>Full PubMed search strategy: (child* or kid* or youth* or adolescen* or teen*) and (nutrition or diet* or eating habit* or food habit* or feeding behavior*) and (peer* or peer led or peer-led) and (school*)</p> | |

confirm the relevance and eligibility of each article for review. To ensure the transparency and accuracy of the search, the search process was repeated in May 2014 by two independent researchers. Any disagreements as to which studies should be included in the review were resolved via discussion until a consensus was reached.

Data from the studies were summarized in terms of the population, the study and program design,

and main outcomes. Only quantitative data related to diet, measures of body size or composition, health indicators (e.g. blood pressure) or those describing the perceptions of the programs were reported. Although some programs reported results related to physical activity levels, these data were beyond the scope of this review and therefore were not reported. The main outcomes of interest were pre-to-post-program changes in the aforementioned variables. No further analyses were performed on the extracted data. With respect to the assessment of the risk of bias, the methodologies of the studies included in the review were accounted for. Based on the sum of the findings from studies included in the review, research gaps were identified and suggestions for areas of future research were described.

Results

The search strategy resulted in the retrieval of 17 articles (Fig. 1) reporting results from 11 unique school-based, peer-led nutrition education initiatives (Table I). Among the articles reviewed, four (24%) evaluated programs implemented in Canadian schools and 13 (76%) evaluated programs in schools in the United States. The majority of studies ($n = 12$, 71%) evaluated outcomes among Kindergarten to grade 6 students, four (24%) evaluated outcomes among grade 7–12 students and one (6%) evaluated outcomes among Kindergarten to grade 12 students. The programs ranged from relatively small-scale initiatives (a minimum of $n = 72$; $n = 1$ school) [21–23] to large initiatives (a maximum of $n = 3503$) in many ($n \geq 20$) schools [11, 24–27].

Of the studies reviewed, 15 (88%) employed a pre-post design. Of these, 10 (67%) evaluated the active intervention phase and five (33%) evaluated the maintenance of the peer-led programs following the initial post-program evaluation (3 months to 2 years). Most studies ($n = 15$, 88%) used a control group to ascertain the effects of the program. Of these, three (20%) used non-participants from the same school and 12 (80%) used nearby non-participating schools as controls. A variety of outcome measures were

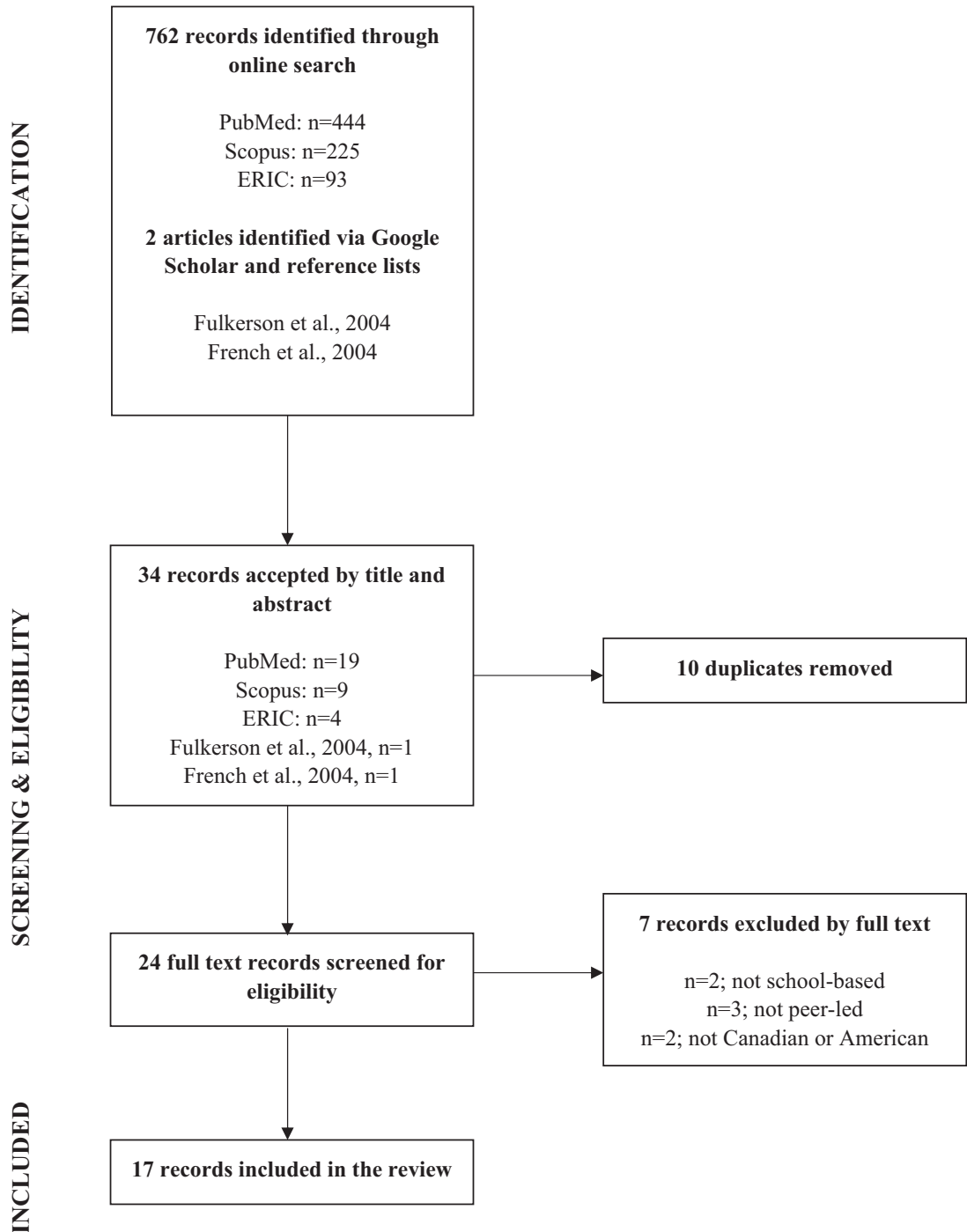


Fig. 1. Flow diagram of study selection for inclusion in the review.

Table 1. Peer-led nutrition education programs for school-aged youth published between January 2000 and November 2013^a

| Program name ^b Reference | Population | Program design | Main outcomes |
|---|--|---|--|
| An 'edutainment' and teen modeling program Bergmann <i>et al.</i> (2010) | >800 Kindergarten to grade 6 youth from five schools in California, United States | 40 high school peers developed and performed 20-min nutrition education performances in primary schools (performed for all grades at two schools and only for grade 5 students at three schools) based on social cognitive theory under the supervision and guidance of two nutrition professionals. The content was informed by discussions with 70 Kindergarten to grade 6 youth. The evaluation was conducted by performers and guided by an interview script. Intervention: a 6-session (45 min each over 6 weeks) interactive nutrition education program based on the constructivist theory of learning. Saskatoon: delivered by six trained same-age peers, two older peers and five University of Saskatchewan undergraduate students Prince Albert: delivered by an older peer (registered dietitian) | 73% of youth responded positively to the performance and only 3% did not like it 66% of youth reported planning to make healthy changes after the performance and only 13% did not Most common planned changes included cutting back on 'junk food', eating more healthful foods (e.g. vegetables, fruit) and engaging in more exercise or active play outside |
| Fluids used effectively for living Lo <i>et al.</i> (2008) | 113 grade 9 students from two high school classes in Saskatoon and two classes in Prince Albert, Saskatchewan, Canada One intervention and one control class per locale | Control: handouts (self-taught) Outcomes included milk, juice, carbonated sugary beverage and total sugary beverage intake, and were measured at 3 months and 1 year post-intervention Intervention: a 12-session (12-weeks) goal-setting and life-skills program taught by trained high school students (supervised by project staff). The program measured impact on self-efficacy and knowledge related to healthy eating using trained survey administrators. Control: intervention | Saskatoon intervention: decrease in sugary beverage intake at 3-month follow-up ($P < 0.02$); higher level of satisfaction than control ($P < 0.05$) Saskatoon control: increase in juice intake at 3-month follow-up ($P < 0.02$) Prince Albert control: decrease in carbonated sugary beverage intake 1-week post-intervention ($P < 0.02$), returned to baseline after 3 months All other outcomes measured were not significant. |
| Goals for health Fomeris <i>et al.</i> (2010) | 2120 grade 6 students from 23 rural middle schools in Virginia and New York, United States 12 intervention and 11 control schools | Intervention students: increase in self-efficacy for healthy eating ($P = 0.05$) at 3-months, decreased to level of control at 2 years Increase in fat and fibre knowledge scores ($P < 0.003$, greater than control) at 3-months, maintained for 1 year ($P = 0.04$) but at 2 years was not different than control Both groups saw no change in fat food intake at 3-months, reduced intake from 3-months to 1 year, and saw no change between 1 and 2 years ($P < 0.001$); fruit and vegetable intake decreased over time ($P < 0.001$) for both groups. | Intervention students: increase in self-efficacy for healthy eating ($P = 0.05$) at 3-months, decreased to level of control at 2 years Increase in fat and fibre knowledge scores ($P < 0.003$, greater than control) at 3-months, maintained for 1 year ($P = 0.04$) but at 2 years was not different than control Both groups saw no change in fat food intake at 3-months, reduced intake from 3-months to 1 year, and saw no change between 1 and 2 years ($P < 0.001$); fruit and vegetable intake decreased over time ($P < 0.001$) for both groups. |

(continued)

Table 1. Continued

| Program name ^a Reference | Population | Program design | Main outcomes |
|---|---|--|---|
| Healthy Buddies Campbell <i>et al.</i> (2012) | 1280 Kindergarten (K) to grade 7 students from eight schools in British Columbia, Canada Six intervention and two control schools | Intervention: a 21-lesson (1 academic year) teacher- guided, peer-led initiative focused on physical ac- tivity, healthy eating and positive body image. Each week, grade 4–7 students received a 45-min lesson from a teacher, and then taught K to grade 3 peers in a 30-min lesson. Control: no intervention Outcomes included knowledge, habits, attitudes and behaviors towards healthy eating measured using questionnaires. Student and teacher satisfaction were measured using surveys. Height, weight and BMI were measured only in the intervention. | K to grade 3: improvement in health knowledge ($P < 0.001$, no change in control) and healthy habits scores ($P < 0.001$, no change in control); greater increase in behavior scores compared with control ($P < 0.001$) Grade 4–7: improvement in health knowledge ($P < 0.001$, greater than control); increase in healthy habits scores in both intervention and control ($P < 0.001$) All youth: improvement in all five attitude ques- tions in intervention ($P \leq 0.002$), but only two questions improved in the control Program positively received by most students and teachers, made students feel healthier and enjoy working with a buddy The impact of the program on height, weight and BMI could not be estimated because physical measures were not taken in the control schools. K to grade 3: no change in systolic blood pressure in intervention, but increased in control ($P = 0.025$); greater increase in health know- ledge ($P < 0.001$) and health attitude ($P = 0.043$) scores compared with control; in- crease in health behavior in both intervention and control (each $P < 0.001$) Grade 4–7: smaller increase in weight and BMI in intervention school versus control school ($P < 0.008$); no change in systolic blood pres- sure with intervention, but increased in control ($P = 0.006$); greater increase in health know- ledge scores ($P < 0.001$) and health behavior scores ($P = 0.025$) in intervention compared with control; healthy attitudes scores increased ($P < 0.001$, no change in control) |
| Healthy Buddies Stock <i>et al.</i> (2007) | 360 Kindergarten (K) to grade 7 students from 2 schools in British Columbia, Canada 1 intervention and 1 control school | Intervention: a 21-lesson (21 weeks) teacher-guided, peer-led initiative focusing on healthy eating, physical activity and body image. Each week, grade 4–7 students received a 45-min lesson from a teacher and then taught their K to grade 3 peers in a 30-min lesson. Control: no intervention Anthropometric measures were taken by volunteer physicians and all other outcomes were measured by trained volunteers using self-report questionnaires. | (continued) |

Table 1. Continued

| Program name ^b Reference | Population | Program design | Main outcomes |
|--|---|--|---|
| Healthy Buddies (tailored for First Nations youth) Ronsley <i>et al.</i> (2013) | 179 Kindergarten (K) to grade 12 students from three schools in remote First Nations communities in British Columbia, Canada | Intervention: a 21-lesson (21 weeks) teacher-guided, peer-led initiative focused on healthy eating, physical activity and body image. Grade 4–7 students received a 45-min lesson from a teacher and then taught their K to grade 3 peers in a 30-min lesson. Control: no intervention | Mean BMI z-score: decreased in intervention and increased in control school ($P = 0.028$) Mean blood pressure z-score increased less in the intervention schools ($P < 0.05$) Self-esteem score increased, but decreased in control school ($P = 0.005$) Nutrition food knowledge, nutritious food consumption and healthy body image increased in intervention, but were not significantly different from those in the control No changes in diet |
| Lift + Program Wilson <i>et al.</i> (2012) | 1119 grade 7 students from 10 middle schools in rural Central Virginia, United States Five intervention and five control schools | Intervention: eight workshops (1 h each over 8 weeks) on the harms of tobacco and benefits of vegetables and fruit based on social cognitive theory and the theory of reasoned action. Program delivered to grade seven students by high school peer leaders. The following year, grade 8 students who had received the program served as peer leaders for grade 6 students. Control: no intervention (delayed) | Greater vegetable and fruit intake post-program ($P = 0.039$) and after 1 year ($P = 0.040$) compared with control Higher fruit consumption post-program ($P = 0.018$) but not maintained over 1 year ($P = 0.060$) Higher vegetable consumption post-program ($P = 0.010$) but maintained over 1 year for White students only ($P = 0.036$) Greater proportion of intervention students correctly identified vegetable and fruit intake recommendation compared with control students ($P = 0.002$) but not maintained over 1 year Those with ≥ 4 positive role models more likely to be confident they could consume ≥ 5 servings of fruits and vegetables compared with controls ($P = 0.022$). Program was well received by students, teachers and parents |
| Peer Power Program Thomas and Ward (2006) | 805 students from three middle schools in a primarily rural north-eastern region in North Carolina, United States | A school program that trained high school students as health educators and mentors for middle school students. The program included 2–3 weekly lessons promoting physical activity, nutrition and avoiding tobacco. Outcomes were measured by the North Carolina Institute for Public Health through interviews and focus groups, and by the Kate B. Reynolds Charitable Trust's SELF Improvement Program through surveys pre- and post-semester. | Parents reported increased self-esteem, responsibility, confidence and skills for youth Improvement in nutrition and physical activity related choices BMI decreased by 4% for 66% of students |

(continued)

Table 1. Continued

| Program name ^b Reference | Population | Program design | Main outcomes |
|--|---|---|---|
| Students for Nutrition and eXercise Bogart <i>et al.</i> (2011) | 399 grade 7 students from a middle school in Los Angeles, California, United States | A school program where 140 grade 7 peers learned to distribute healthy samples of cafeteria food and bookmarks with educational messages to other students during lunchtime over 5 weeks. New leaders were recruited each week. Sliced fruit and signage with nutrition information were added to the cafeteria. Outcomes included students' attitudes towards cafeteria food and the intake of soda, sports and fruits drinks, and healthy entrees. Measurements were taken using surveys administered at 1-month post-intervention. | Improved cafeteria attitudes for peer advocates ($P=0.003$) but not for non-peer advocates Reduced intake of sports/fruit drinks for peer advocates ($P=0.03$) and non-significantly for non-peer advocates ($P=0.06$) Fruit consumption increased in intervention and decreased in control at 1-month post-intervention ($P<0.001$ for both) Proportion of students served a healthy entrée increased in intervention ($P<0.001$) and decreased in control at 1-month post-intervention |
| Teen Mentoring Program Smith (2011) | 72 grade 3 and 4 students from three schools in a rural Appalachian school district, United States 13 teen mentors from 2 nearby high schools Three intervention schools (controls were non-participants from same schools) | Intervention: a curriculum with eight sessions (1h each over 8 weeks) adapted from 'Just for Kids!' that taught healthy diet and physical activity. Teen mentors delivered the curriculum after school to 1–2 'mentees', supervised by adult After School Network Leaders. Control: no mentorship. Outcomes included BMI percentile, nutritional knowledge, attitudes and self-efficacy towards healthy behaviors and perceived support for healthy behaviors. | Teen-mentoring group: significant reduction in BMI percentile (-0.38 percentile, $P=0.03$) and increase in behavioral intention to eat healthy ($P=0.02$, but not in control) Increase in all theoretical concepts hypothesized to influence behavioral intention, including nutritional knowledge ($P=0.05$) and attitudes toward eating healthy ($P=0.025$), while these all decreased in control group (with exception to self-efficacy toward healthy eating which remained unchanged) |
| TEENS Story <i>et al.</i> (2002) | 677 grade 7 students and 226 peer leaders from eight schools in the Minneapolis/St Paul, Minnesota area, United States Eight intervention and eight control schools | Outcomes were measured using questionnaires and height and weight measurements pre- and post-intervention. Intervention: a 2-year program based on social cognitive theory. Peer leaders helped teachers to deliver the grade 7 curriculum (10 sessions, 40–45 min each) which included group discussion, hands-on activities, food preparation, facilitated group decision-making and problem solving. Control: no intervention. Measurements included perceptions of the TEENS program on various domains. | Peer Leaders: 89% enjoyed being a leader, 92% thought they did a good job, 81% would be a leader again, 85% thought they learned more about healthy eating by being a leader, 75% thought they learned more from the program by being a leader, 64% thought they ate healthier Students: 58% thought that the peer leaders were helpful Teachers: 93% thought that the peer leaders were useful or very useful, 75% thought peer leaders led station activities very well, 88% thought that peer leaders led all activities OK or very well |

(continued)

Table 1. *Continued*

| Program name ^b Reference | Population | Program design | Main outcomes |
|--|---|---|---|
| TEENS Bimbaum <i>et al.</i> (2002) | 3503 grade 7 students from 16 schools in Minneapolis/St Paul, Minnesota, United States | Four intervention doses: control (no intervention), school environment only, classroom curriculum and school environment, peer leaders and curriculum and school environment ($n = 226$) The curriculum included 10 sessions informed by social cognitive theory; peer leaders helped teachers to deliver lessons. Control: no intervention. | Highest dose group: increase in daily fruit ($P = 0.014$) and vegetable consumption ($P = 0.059$), with an average increase of 0.92 servings of vegetables and fruit to choose lower fat foods ($P = 0.002$) Curriculum and school environment group: 0.64-point increase in food choice score (tendency) The highest dose of intervention (with peer leaders) had greatest impact on food choices (fruit, vegetables, lower fat foods). No significant difference between treatment and control groups except for food choice score; schools in the treatment group had higher scores (made lower fat choices) When compared with the control group and those with 'low dose' (environmental intervention only without curriculum) of the intervention, those with a 'high dose' (participated in curriculum) had higher food choice score (difference of -0.05 , $P = 0.01$), and those participating in the peer-led seventh grade curriculum had the highest scores. |
| TEENS Lytle <i>et al.</i> (2004) | 455 (24-h recall), and 2883 (survey) grade 7 and 8 students from 16 schools in the Twin Cities, Minnesota area, United States | Intervention: three delivery channels informed by social cognitive theory: classroom, family and school-wide components. Multiple doses of the intervention: control (no intervention), environment only, environment and curriculum, and environment, curriculum and peer leaders Peer leaders were involved in delivering segments of the grade 7 lessons in the intervention schools. Control: no intervention. | Fruit and vegetable consumption and food choice scores were measured using questionnaires pre- and post-intervention. Intervention: three delivery channels informed by social cognitive theory: classroom, family and school-wide components. Multiple doses of the intervention: control (no intervention), environment only, environment and curriculum, and environment, curriculum and peer leaders Peer leaders were involved in delivering segments of the grade 7 lessons in the intervention schools. Control: no intervention. |
| TACOS French <i>et al.</i> (2004) | Students from 20 secondary schools in the Minneapolis-St Paul area, Minnesota, United States 10 control schools, with enrollment ranging | Intervention: a 2-year multicomponent environmental intervention to increase the availability of lower-fat foods in the cafeteria, and peer-based promotions of these foods. TACOS staff trained student groups to implement promotion activities including taste tests, food choice assessments and media campaigns. Control: no intervention. | Intervention group was more likely to agree that the cafeteria offered enough low-fat foods ($P = 0.001$), that it was easy to tell which foods were low-fat ($P = 0.03$), that it was easy to buy low-fat foods ($P = 0.05$), that their friends usually buy low-fat foods ($P = 0.01$), adults encourage them to buy low-fat foods ($P = 0.007$). |

(continued)

Table 1. Continued

| Program name ^a Reference | Population | Program design | Main outcomes |
|--|--|---|--|
| TACOS Fulkerson <i>et al.</i> (2003) | from 812 to 3157 students. | Outcomes included attitudes towards cafeteria food, cafeteria food sales based on fat content and food choice scores. | Students were more likely to report seeing advertisements about foods in the cafeteria or participating in taste tests or contests in the cafeteria compared with the control group ($P < 0.001$). Significantly higher change in means sales of lower fat foods in year 1 as a percentage of food sales (10 versus -2.8%, $P = 0.002$) and higher mean total percentage of sales of lower fat foods in year 2 (33.6 versus 22.1%, $P = 0.042$) |
| TACOS Hamdan <i>et al.</i> (2005) | Students from 20 secondary schools in Minneapolis-St Paul, Minnesota, United States 10 intervention and 10 control schools, with enrollment ranging from 812 to 3157 students. 397 students from 10 schools in Minnesota, United States 10 intervention and 10 control schools. | Intervention: a 2-year multicomponent intervention to increase the sales and choices of lower-fat foods in cafeterias via education, food service and school environment changes. Students groups planned, organized, and implemented promotional activities under the supervision of at least one trained staff member. Control: no intervention. Outcomes included cafeteria food sales and promotional activity data collected by TACOS staff. A 2-year initiative to increase the number of lower-fat food items and increase the sales of lower-fat foods in high schools. The intervention schools incorporated student-led promotional activities with the support of TACOS staff and school faculty advisors. Highly involved ($n = 54$): voluntarily participated and were involved in planning, implementing, and evaluation activities. Less involved ($n = 343$): participated because teachers implemented the activities and were involved in assisting in the implementation of the program (≤ 5 h). Measurements included students' perceptions of TACOS, cafeteria food sales, and attitudes towards healthy eating. | Number of promotions conducted was significantly associated with change in percentage of total food sales as lower-fat foods in year 1 ($P = 0.033$), but not in year 2 Duration of promotions was significantly associated with an increase in change in percentage of lower-fat food sales in year 2 ($P = 0.029$) but not in year 1 Significant differences between highly involved and less involved students across all domains of eating behaviors, attitudes, social norms, student involvement and experiences gained ($P < 0.001$). Highly involved students more likely to perceive that TACOS changed the way they chose foods, gave them the opportunity to try lower fat foods and vegetables and fruit, influenced them to eat more fruits and vegetables, improved their attitudes towards lower-fat foods, and had an impact on the number of students eating lower-fat foods in the cafeteria ($P < 0.001$). |

(continued)

Table 1. *Continued*

| Program name ^b Reference | Population | Program design | Main outcomes |
|--|---|--|--|
| Youth Can! Jones <i>et al.</i> (2011) | 98 grade 4 and 5 students (same students across 2 years) from five schools in a rural county of East Tennessee, United States Two intervention and three control schools | Intervention: grade 4 youth leaders received youth development training (19, 45-min sessions). The following year, these now fifth grade leaders identified priorities for nutrition interventions and implemented their plans. They co-taught (with an adult) 12 nutrition and physical activity lessons from the CATCH curriculum to their peers. Control: CATCH nutrition education Measurements included food intake by % energy from fat, low fat milk servings, fruit and vegetable servings, and healthy eating behaviors taken pre- and post-intervention. | Increase in fruit consumption in both intervention schools ($P < 0.001$ and $P = 0.03$) and increase in vegetable consumption in one intervention school ($P = 0.02$) were significantly higher than in the controls. Marginal decrease in energy intake ($P = 0.06$) and % energy from fat ($P = 0.05$) for one of the intervention schools compared with the controls. Actual measurements for the controls were not reported. |

^aBMI, body mass index; CATCH, coordinated approach to child health; TACOS, Trying Alternative Cafeteria Options in Schools; TEENS, Teens Eating for Energy and Nutrition at School.

^bListed alphabetically.

used, including program satisfaction, behavior change constructs, self-esteem and body image, self-reported diet and health behavior changes, anthropometric measures (e.g. body mass index [BMI], waist circumference), and cafeteria sales and promotions.

The four studies that reported on satisfaction collectively showed that these types of programs were well received by students, staff and parents [15, 47–48]. All 13 studies that evaluated self-efficacy, knowledge, intentions and attitudes related to health behaviors showed improvement at program completion [11, 21, 23, 24, 27–29, 32, 37, 45–47, 50]. Two studies also reported improvements in self-esteem [37, 49], and while one study reported an improvement in body image over time, this improvement did not differ from that in the control group [37]. Of the studies that used diet or health behavior change as an outcome measure ($n = 13$), 11 (85%) found improvement in these variables immediately post-program. Changes included increases in fruit and vegetable intake [24, 30, 42], reductions in sugar-sweetened beverage intake [22, 31], reductions in fat intake [11, 38] and improvements in self-reported habit and behavior scores [21, 23, 27, 46]. These changes tended not to be maintained when longer-term impacts (i.e. 3 months to 2 years) were assessed [11, 22, 24, 26].

Results were promising in the four studies that investigated anthropometric measures as a program outcome, revealing either decreases in BMI z-scores or percentiles, expected changes in BMI related to normal growth, or increases that were less than in the control group [21, 23, 37, 47]. A significant difference in blood pressure was reported in one study where increases were less among participants compared with controls [37]. The study also noted a decrease in waist circumference among program participants [37]. Three studies investigated the dose-response relationship for varying levels of involvement in the Teens Eating for Energy and Nutrition at School (TEENS) and Trying Alternative Cafeteria Options in School (TACOS) programs [24, 26, 28], unanimously finding that the highest dose had the greatest impact on food choices and health behaviors.

Discussion

Knowledge, self-efficacy and attitudes

The current review found that peer-led school nutrition education programs have the potential to improve knowledge, self-efficacy and attitudes towards healthy eating, but more research is needed to determine the impact of these changes on diet quality. Social cognitive theory suggests that outcome expectations and self-efficacy are key determinants of change in health behaviors [32]. Thus, improvements in knowledge, along with the enhancement of self-efficacy to change one's health habits, may address important barriers to making healthier choices.

Despite the promising findings, it is recognized that the diets of youth are affected at multiple levels of influence. These include individual factors, as well as social, physical and macro-level environments; improvements in knowledge and attitudes are not necessarily sufficient to provoke improved dietary habits [10, 33]. Future research aimed at determining the extent to which such improvements may influence diet in the context of peer-based school nutrition programs would be of interest, as the only study investigating knowledge, self-efficacy or attitudes towards healthy eating in addition to dietary intake did not explore the relationship between these variables [11]. Further, the use of validated tools to strengthen results must be stressed given that six [11, 27, 29, 42, 45, 47] out of 12 studies reporting self-efficacy or attitudes did not indicate the use of validated tools to measure outcomes.

Dietary intake

Of the studies investigating self-reported dietary intake, findings were overwhelmingly positive; all but one of the studies [28] that examined vegetable and fruit consumption reported at least some improvement among those exposed to the program. The importance of increasing vegetable and fruit intake is underscored by the fact that in Canada, only about 50% of girls and <40% of boys aged 12 years or older consume five or more servings of

vegetables and fruit daily [34]. Five servings already falls below the recommendations set by Canada's Food Guide, a Health Canada publication that outlines a pattern of eating associated with reducing the risk of chronic disease and optimizing overall health [35]. A similar trend has been seen in the United States, where only about a third of adults, and even fewer secondary school students, meet daily recommendations for vegetable and fruit intake [36].

One program was associated with an increase in the mean consumption of 'nutritious foods' [37] and another with a decrease in mean sugary beverage consumption [22]. This is promising because sugary beverages, particularly in the form of soft drinks, have been associated with a number of adverse health outcomes including weight gain [38], dental caries, and an inadequate intake of vitamins and minerals [39]. Moreover, an increase in soft drink intake is associated with a decrease in milk intake in adolescence [40], suggesting that instances of soft drink consumption could represent lost opportunities for milk, calcium and vitamin D intake, nutrients associated with achievement of peak bone mass [41]. Although the TACOS studies found the program to be associated with significant increases in the sales of lower-fat food items in school cafeterias, it would be of interest in future studies to investigate the impact of the program on dietary intake. Future research should also ensure that validated tools are used to assess diet. Although many studies reporting dietary intake as an outcome indicated the use of measurement tools that were either validated [23, 24, 28, 37, 46] or tested and revised [22], this was not the case in three of the studies [11, 29, 31].

Anthropometric measures

The only consistent anthropometric result was that participants in the intervention group saw either a significant reduction or a lesser increase in some measure of BMI (including z-scores and percentiles) compared with controls. Notably, all studies that described the process of obtaining BMI measures reported using measured (rather than self-reported)

values of height and weight [21, 23, 37]. The BMI outcomes were surprising, considering the short time frame of most of the studies (<1 year) and the fact that the school is only one of the many environments that influence choices (e.g. diet, physical activity) that may lead to changes in BMI. Although the results show promise, longer-term follow-up is needed to determine if the BMI changes seen would be sustained over time, or if attenuation effects would occur. It remains likely that peer-led programs, while valuable, would be more effective in achieving clinically significant BMI changes among the population if accompanied by policies and programs aimed at multiple levels of influence (e.g. family, public policy) beyond the school environment.

Dose-response effects

Of particular interest for the current review was the significance of peers in the positive effects resulting from the reported initiatives. Three studies of two distinct programs (TEENS and TACOS) explicitly distinguished between various participation levels. In both cases, the addition of the peer-led component to other program activities resulted in a greater impact (more improvement) in outcome measures compared with lower-dose versions that excluded peers. Similarly, the ‘Youth Can’ program was compared with a control group that received all other program components except for peer involvement [42]. Only the peer intervention group saw improvements in vegetable and fruit intake, suggesting that the peer influence provided additional benefits. This is consistent with evidence on preventing and reducing tobacco and other forms of drug use, where peers tend to have a greater impact than adults [17, 43], perhaps because peer influence and acceptance is a particularly powerful force of social influence during adolescence [16].

The use of peers in health education is beneficial not just to program recipients, but also to the peer leaders themselves, who have reported improvements in healthy eating knowledge, consumption of healthier foods and confidence in leadership skills [24]. However, there remains limited insight

into the impact of same-age versus older peers on program recipients. With consideration for positive impacts being found across studies using peers of all ages and the heterogeneity in outcome measures, the impact of same-age peers versus older peers could not be teased apart. Even in the one study that included two intervention groups (older versus same-aged peers), differences could not be assessed because the same-aged peer group also included older peers [22]. Future studies aimed at addressing this knowledge gap would be of interest.

Methodological considerations

To draw conclusions about program impacts, most articles ($n = 12$, 71%) reported a control group that received either no intervention or a lower dose of the intervention without the inclusion of peers. Control groups were often comparable youth of the same age from nearby schools, allowing for the inference of cause-and-effect. However, only 10 of 17 articles (59%) reported random assignment of intervention and control conditions [11, 15, 21, 24–29, 46]. There were cases where some members of the control group attended the same school as the intervention group, meaning some diffusion of the intervention to non-participating controls may have occurred. In such cases, it is possible that the magnitude of the effect of an intervention was underestimated. Future studies should aim to minimize these methodological weaknesses, though the evaluation of programs that may be of benefit to students should not be discouraged should this not be possible. Furthermore, the importance of using validated measures to strengthen findings even in a well-designed study must be noted, as there were several cases where outcomes were not measured using validated tools.

Though the review was limited to programs in Canada or the United States, the populations studied varied with respect to age, heterogeneity and ethnicity. As such, peer-led programs can likely be successfully adapted to a variety of target audiences, though programs must ideally be tailored to the population of interest to maximize the possibility of a positive impact. Notably, two of the programs

reviewed included students in the planning and design of the program, although the advantages of this involvement were not assessed. Assessments of such advantages would be of interest in the future, as involving students in program development could help ensure the program meets their needs and desires for change, while also identifying potential problems from the perspectives of students [44].

Feasibility, sustainability and maintenance of program impact

Even a program that has been demonstrated to be effective in changing dietary behavior may not have utility for health promotion if it is not feasible or practical to implement and maintain. Fortunately, in the studies that evaluated perceptions of parents, students and staff, peer-led nutrition education programs were positively received and well accepted [15, 45–47]. This is important because overweight and obesity are complex problems requiring long-term solutions, so programs need to be sustainable in order to make a lasting impact on behavior. Of the studies that conducted follow-up assessment ($n = 3$), all reported a disappearance of at least one significant positive outcome over time. This is consistent with the literature on school-based obesity interventions where short-term positive results tended not to persist over longer time periods [48]. When resources allow, longer-term follow-ups assessing the maintenance of improvements attributed to peer-led school nutrition initiatives would be of interest.

With the numerous opportunities to improve health behaviors in youth in the school environment, there are also a number of potential hindrances to the long-term success of school-based health promotion programs, including budget constraints and environmental barriers [48, 49]. Budget constraints are a concern because they may not allow a program to be adequately implemented as intended [49], meaning that even a well-designed program will not be utilized to their fullest potential. Budget constraints may also act as catalysts for environmental barriers, as limited funding may prevent schools from building a supportive environment through changes such as improvements in the availability of healthier food

options [48]. With respect to peer-led nutrition education programs, further investigation into the barriers, challenges, opportunities and supports to the sustainability of the initiatives from the perspectives of students, teachers, staff and administrators would allow for the development of program designs that can be feasibly maintained and continuously evaluated, updated and improved.

Limitations

Because few studies investigated dietary intake and many focused solely on constructs such as self-efficacy or knowledge, the effect of peer-led school nutrition education programs on diet quality cannot be established with certainty. Further, as only Canadian and American studies were included, the findings cannot be generalized beyond these countries. Although the studies reviewed included a variety of different populations (e.g. rural, urban, Indigenous), needs assessments and formative evaluations should help guide the development of initiatives for unique populations. Finally, although it is possible that relevant studies may have been overlooked, the fact that the search was replicated by two independent researchers has reduced this possibility.

Conclusion

Based on the evidence reviewed, peer-led nutrition education programs in schools have the potential to improve knowledge, self-efficacy and attitudes towards healthy eating, at least in the short-term. Though few dose-response studies exist, those available demonstrate that the peer influence is a contributor to improved program outcomes compared with programs that did not include peer guidance. More studies are needed to investigate the impact of improvements in behavior change constructs attributable to the programs on dietary behavior. Further, care should be taken to ensure program sustainability, feasibility and practicality in order to promote long-term impact. Continuous program evaluation and the use of qualitative methodology to understand the perspectives of program staff, teachers, parents and students are recommended.

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Conflict of interest statement

None declared.

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