Review

Effectiveness of pre-school- and school-based interventions to impact weight-related behaviours in African American children and youth: a literature review

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Summary

This review assessed the effectiveness of pre-school- and school-based obesity prevention and/or treatment interventions targeting healthy eating, physical activity or obesity in African American children and adolescents. Systematic searches were conducted for English-printed research articles published between January 1980 and March 2013. Retained articles included experimental studies conducted in the United States that targeted ≥80% African American/black children and adolescents and/or studies whose results were stratified by race/ethnicity, and that were conducted in pre-schools/head start or schools (excluding after-school programmes). Of the 12,270 articles identified, 17 met the inclusion criteria (pre-school, $n = 2$; elementary school, $n = 7$; middle and secondary schools, $n = 8$). Thirteen studies found significant improvements in nutrition (pre-school, $n = 1$; elementary, $n = 7$; secondary, $n = 5$) and three found significant improvements in physical activity (pre-school, $n = 1$; elementary, $n = 2$) variables of interest. Two studies (pre-school, $n = 1$; secondary, $n = 1$) reported significant reductions in obesity in African American children. The evidence available suggests school-based interventions are effective in promoting healthy nutrition behaviours in African American children. Conclusions overall and, particularly, about effects on physical activity and obesity are limited due to the small number of studies, differences in assessment approaches and a lack of follow-up assessments.

Keywords: Body mass index, nutrition, physical activity, weight loss.

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Introduction

National health survey data from 2009–2010 indicate that 39.1% of non-Hispanic black children (2–11 years of age) and adolescents (12–19 years of age) are considered overweight/obese vs. 31.8% for all U.S. children (1). Overweight and obesity are strongly associated with higher risk of developing diabetes, cardiovascular diseases, certain cancers and other health problems (2). Like obesity, the prevalence of type 2 diabetes mellitus is estimated to be higher in African American (AA) children (3–10). Disparities at this early life stage have both immediate and longer term consequences.

Increased prevalence of obesity and obesity-related risk factors has been attributed to lifestyle factors such as decreased physical activity, increased sedentary behaviour (i.e. media usage) and poor dietary habits. Based on accelerometer data in U.S. children, approximately 42, 8 and 7.6% of 6- to 11-year-olds, 12- to 15-year-olds and 16- to 19-year-olds, respectively, met the physical activity recommendation of at least 60 min d^{-1} of moderate-to-vigorous physical activity (MVPA) (11). Studies of media use indicate that AA children, on average, use media approximately 6 h d^{-1} (e.g. TV, movies, video games and computer) compared to 3 h and 40 min d^{-1} for their white counterparts (12). Furthermore, consumption of more energy-dense food and high-calorie beverages has increased among children, and is more common among AA than white children (13). Interventions that focus on changing weight-related behaviours that can help prevent or treat childhood obesity in AA children are critically needed (14,15).

Schools and early child care settings have been identified as critical institutional settings for obesity prevention. For example, 'Accelerating Progress in Obesity Prevention' stated that 'schools need to be the national focal point for obesity prevention' (16). Outside of the home, school-based settings are the only institutions that have a 'continuous and intensive' connection with children and youth during the first two decades of life (17) and are a socializing agent that can favourably influence the health of children. Fifty-eight per cent of U.S. pre-school-age (2.9–5 years) children spend most of their weekdays (7:30 a.m.–4:30 p.m.) in early child care settings, and 95% of those greater than 5 years of age are in K–12 school settings for at least 6 h d^{-1} on weekdays (17,18). School-based settings can promote physical activity and proper nutrition through recess, physical and general health education, school policies, healthy school meals and school wellness programmes (19).

In the past few decades, several systematic reviews on paediatric obesity prevention programmes have been published (20–37). Interventions focused on altering physical activity and physical activity-related factors, diet, and nutrition knowledge, and varied in types, duration and outcome measures. Most studies were conducted with predominantly white children. Our review updates the evidence on this topic with a specific focus on AA children in school settings. We defined 'school-based' as including interventions conducted in pre-school, elementary and secondary schools during the school day, and included studies that targeted healthy eating, physical activity or obesity outcomes in AA children and youth in school settings.

Methods

Identification of studies

We conducted systematic database searches for research articles published in English between January 1980 and March 2013 using Academic Search Premier, CINAHL, PsycINFO, PubMed/Medline, ERIC, Cochrane and SPORTDiscus databases. To maximize the yield for research studies conducted on interventions focused on weight-related behaviours in pre-school- and school-age children, multiple keywords were used: *intervention, sedentary behaviors* (i.e. defined as recreational screen time and non-educational activities); *child/adolescent health behavior; school-based (preschool and school) programs/interventions; physical education; obesity; physical activity, inactivity/sedentary behavior; weight loss/maintenance; diet/nutrition; behavior change; body mass index (BMI); exercise and/or food consumption,* and *fitness*. Bibliographies of review articles and other relevant studies were examined manually to facilitate the identification of key research within the scope of this review. We identified a total of 12,270 articles; the titles and abstracts of these were examined for relevance.

Inclusion and exclusion criteria

The abstracts and methods sections of all the identified relevant studies were carefully examined to ensure that they met the inclusion and exclusion criteria. Our inclusion criteria were (i) obesity and/or obesity prevention interventions that targeted healthy eating, physical activity or both; (ii) randomized controlled trials, controlled clinical trials, comparative studies or quasi-experimental studies conducted in the United States; (iii) targeted towards AAs, or results were stratified by race/ethnicity and (vi) studies conducted in pre-school/head start or school settings. Because few studies met the race criterion, those whose populations consisted of ≥80% AA participants in the intervention group were also included. We excluded studies that were purely observational or cross-sectional; lacked inferential statistics to understand the effectiveness of the intervention; school-based programmes that included an after-school component; included <75 participants and had <20% of participants who were AA (to reduce the likelihood of including small studies with a few AA participants); did not stratify data; or did not describe the intervention components. If the intervention components were published in a separate manuscript, that paper was retrieved and reviewed.

Two independent reviewers (EKW and AM; see Acknowledgments) reviewed abstracts and retrieved full papers that appeared to meet the inclusion criteria. The methods section for each paper was further reviewed to evaluate eligibility. For studies that met inclusion criteria, the following data were extracted using a standardized form developed for this review process: (i) author(s) and article citation; (ii) description of study population (race/ethnicity, gender, age, sample size); (iii) study setting (pre-school, elementary, middle or high school); (iv) study design; (v) description of the intervention; (vi) duration of intervention and of follow-up period(s); (vii) outcomes assessed and (viii) summary of primary and secondary outcome(s). Two authors (SA and LER) resolved any differences between the reviewers.

Results

Figure 1 illustrates the search strategy; 17 studies met the inclusion criteria for this literature review. The description and outcomes for each study are summarized in Tables 1 and 2. Results are separated by school setting (pre-school, elementary and secondary). Results are reported for the entire study population and, when provided, specifically for the AA population. We also included the statistical significance of the race × intervention interaction term when provided. Two studies were conducted in a pre-school setting. The remaining 15 studies were conducted in elementary ($n = 7$; grades K–5) and secondary schools ($n = 8$; grades 6–12). Studies included in this review had between 48 and 6,956 participants; duration of interventions ranged from 1 month to 3 years and post-intervention follow-up ranged from immediately post-intervention to 2 years post-intervention.

Pre-school

Two studies (≥80% AA children) were conducted in a pre-school. One study was the efficacy trial (38) and the other was the effectiveness trial (39) for Hip Hop to Health Jr. Both studies are included in the current review because they were conducted at different times with different populations. Hip Hop to Health Jr. included a nutrition and physical activity programme that targeted both the pre-school and home setting (parents received newsletters and homework that mirrored the classroom curriculum). Classroom teachers implemented the intervention, and physical activity was objectively (39) and subjectively (parental report) (38) assessed. In both studies, children at control sites received a teacher-delivered general health intervention. In the 2005 efficacy trial, the treatment group (0.06 and 0.54 kg m^{-2}, respectively) had significantly smaller increases in body mass index (BMI) compared to the control (0.59 and 1.08 kg m^{-2}, respectively) group at the 1-year and 2-year follow-up visits (38). In addition, compared to the control group, the treatment group significantly reduced their per cent calories from saturated fats. In the 2011 effectiveness trial of Hip Hop to Health Jr., the intervention led to significant improvements in time spent in MVPA (intervention, 109.9 ± 2.0 min d^{-1}; control, 102.5 ± 2.0 min d^{-1}) and reductions in total screen time on an average day (intervention, 4.7 ± 0.1 min d^{-1}; control, 5.2 ± 0.2 min d^{-1}) (39). The interventions did not alter the main variable of interest, BMI or nutrition variables of interest.

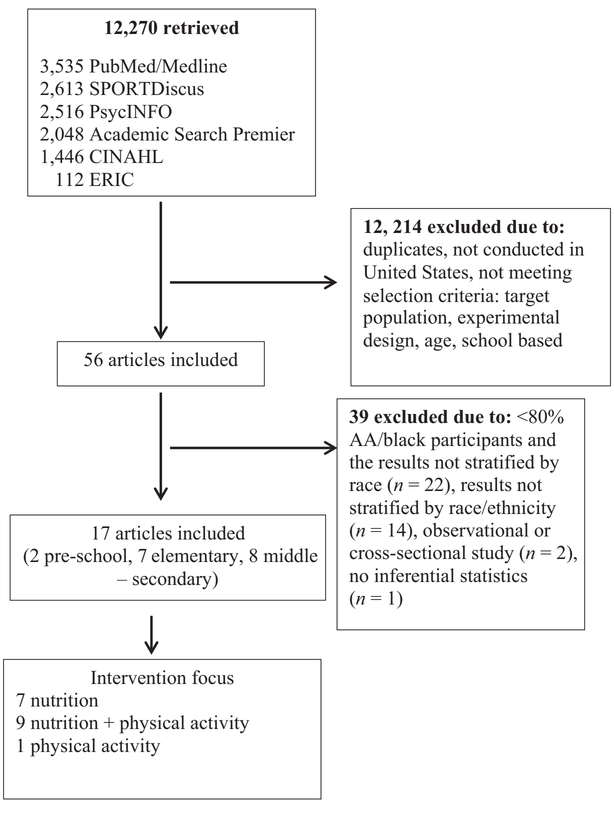

Figure 1 Search strategy for this review.

Elementary schools

Of the seven studies in elementary school settings, three included ≥80% AA participants (39–42). Overall, four studies targeted changes in nutrition (40,42–44), and three focused on a combination of nutrition and physical activity variables (41,45,46). No study solely focused on altering physical activity. Only four studies were longer than 12 weeks (41,43,45,46). All studies had multiple components (i.e. classroom curriculum, changes in school environment, lunchroom, physical education classes) (40–46). Two interventions were administered by teachers (i.e. classroom, health and/or physical education) (41,42) and five included a combination of teachers, administrators, school staff, graduate students and researchers (40,43–46). Only one study measured the primary outcome (per cent body fat) using objective measures (45); the remainder used self-reported measures to assess physical activity and dietary behaviour or nutrition knowledge) (40–44,46). All seven studies reported significant improvements in nutrition-related variables of interest that were higher in the treatment group compared with the control group (40–46). One study observed significant improvements in participants' per cent body fat (45). Only two studies reported any statistically significant improvements in physical activity variables of interest (45,46). Setting, method of delivery (e.g. in classroom, or by teacher vs. researcher) and behaviour targeted (e.g. nutrition alone vs. a combination) did not appear to impact study outcomes.

Table 1 Primary outcome(s) of studies included in review

Study authors, year	Population/sample	Study design/intervention	Outcome measure(s)	Results
Pre-school studies				
Fitzgibbon *et al.* 2005 (38)	$N = 409$ at baseline; INT $n = 197$ ($M = 48.6$ months; 99% AA) CON $n = 212$ ($M = 50.5$; 80.7% AA); 2-year follow-up INT $n = 126$, CON $n = 130$	Design: 'Weight control intervention' (WCI) RCT consisting of a teacher-delivered programme with 20-min nutrition and 20-min PA component in class three times per week. Parents received newsletters and homework. Time points included baseline, 1-year follow-up and 2-year follow-up. Control: General health intervention, 14 weeks (20 min/ 1 × week), parents received newsletters that reflected general health content (no diet or PA information) Setting: Classroom, home Duration of intervention: 14 weeks Duration of follow-up: 2 years	BMI and BMI Z scores Secondary: Dietary recall: (1) percent of total calorie intake from fat and (b) saturated fat, (c) grams per 1,000 kcal of fibre; PA (frequency/week and intensity), and TV viewing (hours/day)	Results for entire population (≥80% AA): Between groups: • No significant difference at post-test for BMI and BMI Z scores (BMI INT: 0.05 kg m^{-2}, CON: 0.14 kg m^{-2}, $P = .234$; BMI Z scores INT 0.06, CON 0.08, $P = 0.65$) • At year 1 follow-up, significant difference in increase in BMI, INT 0.02 kg m^{-2} vs. CON 0.64 kg m^{-2} ($P = .002$) • At year 2, increase in BMI was significant between groups, INT (0.48 kg m^{-2}) vs. CON (1.14 kg m^{-2}; $P = .008$) • Total fat intake, dietary fibre intake, exercise frequency and intensity, and hour of TV viewings were not significantly different between intervention and control as post-test, year 1, or year 2 follow-up • Saturated fat intake (% kcal) was significantly lower in intervention at year 1 (INT M: 11.6, SE: 0.2; CON M: 12.8, SE: 0.2; $P = .002$) but not at post-test (INT M: 11.4, SE: 0.3, CON: 12.1, SE: 0.2) or year 2 (INT M: 11.9, SE: 0.4, CON M: 11.6, SE: 0.4) Within group: Not reported
Fitzgibbon *et al.* 2011 (39)	$N = 618$ INT $n = 325$ CON $n = 293$ 94% AA Age range: 3–5 years	Design: RCT consisting of a teacher-delivered programme with a 20-min nutrition and 20-min PA component. Nutrition lessons used 'Pyramid Puppets' to represent food groups and incorporated two exercise routines consisting of a CD of songs. Parents were also given CD to play at home. Control: Teacher directed general health intervention Implemented by: Teachers, teachers' aides, parents Setting: Classroom, home Duration of intervention: 14 weeks Duration of follow-up: N/A	BMI and BMI Z score changes	Results for entire population (≥80% AA): Between groups: • No change in BMI (adjusted pre-post mean change – INT: 0.11, SE: 0.05; CON: 0.22, SE: 0.05), BMI Z scores (INT: 0.08, SE: 0.03; CON: 0.12, SE: 0.03, and dietary outcomes (post-intervention – adjusted for baseline) • Energy intake, INT: 1.63 kcal, SE: 57; CON: 1,55 kcal, SE: 61% • Dietary fat, INT: 33.3 kcal, SE: 0.7; INT: 32.2 kcal, SE: 0.7 • F consumption, INT: 1.0 servings/day, SE: 0.1; CON: 0.9 servings/day, SE: 0.1 • V consumption, INT: 1.2 servings/day, SE: 0.1; CON: 1.2 servings/day, SE: 0.1 • Significant change in MVPA (post-intervention – adjusted for baseline) – INT: 109.9 min d^{-1}, SE: 2.0; CON: 102.5 min d^{-1}, SE: 2.0 • Significantly less total screen time (post-intervention – adjusted for baseline) – INT: 4.7, SE: 0.1; CON: 5.2, SE: 0.2 • No difference in TV viewing time (post-intervention – adjusted for baseline) – INT: 2.4, SE: 0.1; CON: 2.6, SE: 0.1 Within group: Not reported

Table 1 *Continued*

Study authors, year	Population/sample	Study design/intervention	Outcome measure(s)	Results
Elementary school studies				
Blom-Hoffman *et al.* 2004 (40)	*N* = 91 3 intervention, 3 control classrooms K–1 grade students	Design: RCT Classroom/knowledge component: 10 detailed lesson plans addressing the 5-a-Day goal; 2 lessons/week × 5 weeks Home component: 10 newsletters and a cookbook Lunchtime/behaviour component: Identify F&V in lunches, verbal praise and rewards for consumption Control: No nutrition education (waitlist control) Implemented by: Classroom teachers, assistants, doctoral student Setting: Classroom, home, lunchroom Duration of intervention: 5 weeks Duration of follow-up: 1 month	Nutritional knowledge assessed using the Every Day, Lots of Ways tool Student vegetable consumption at lunch assessed visually	Results for entire population (≥80% AA): Between groups: • Significant increase in nutritional knowledge in intervention (pre: M = 72.3, SD = 16.29; post: M = 88.46, SD = 13.74) vs. CON group (pre: M = 65.13, SD = 17.86; post: M = 64.12, SD = 20.46). Intervention knowledge was maintained at the 1-month follow-up (INT: M = 88.94, SD = 13.33). • No change in students eating more V during school lunch (INT pre – M = 3.46, SD = 1.72; post – M = 3.21, SD = 1.88; CON pre – M = 2.98, SD = 1.77; post – M = 3.27, SD = 1.87). Within group: • Treated waitlist CON group showed improvements in vegetable consumption (pre-test: M = 2.98, SD = 1.77; post-test: M = 3.27, SD = 1.87) and nutrition knowledge (post-test: M = 84, SD = 13.82) scores • Intervention: no significant change in vegetable consumption (pre – M: 3.46, SD = 1.72; post : M = 3.21, SD = 1.88)
Edmundson *et al.* 1996 (46)	*N* = 6,956; Intervention group: CATCH only, *n* = 1989 CATCH plus family, *n* = 2087 CON *n* = 2880 13.9% AA; 3rd grade students	Design: RCT Group 1: School-based programme consisting of the CATCH health education curriculum (Grade 3, 15 sessions three times a week for 5 weeks): a PE programme, school food service intervention, and a school-wide non-smoking policy Group 2: Intervention group – family-based programme – the Hearty Heart Home Team Program, parent curriculum, and Family Fun Night Control group: Usual health curriculum Implemented by: Teachers and staff Setting: Classroom, PE, lunchroom, school environment Duration of intervention: 1 year Duration of follow-up: N/A	Psychosocial construct scales related to nutrition and PA assessed using the Health Behaviour Questionnaire	Results for entire population: Between groups: • Intervention groups scored significantly higher for each scale at post-intervention compared to CON except negative reinforcement for PA. Dietary intention – school INT: pre M = 2.074, SD = 6.13, post M = 6.034, SD = 6.351; School + Family INT: pre M = 1.591, SD = 5.859, post M = 6.526, SD = 6.290; CON: pre M = 1.355, SD = 5.791, post M = 2.117, SD = 6.266. Dietary knowledge – school INT: pre M = 5.213, SD = 5.451, post M = 9.437, SD = 4.861; School + Family INT: pre M = 4.660, SD = 5.266, post M = 9.619, SD = 4.553; CON: pre M = 4.031, SD = 5.625, post M = 5.654, SD = 5.539. PA support, positive reinforcement – school INT: pre M = 5.311, SD = 4.445, post M = 6.374, SD = 4.318; School + Family INT: pre M = 5.483, SD = 4.459, post M = 5.547, SD = 4.621; CON: pre M = 5.192, SD = 4.473, post M = 5.547, SD = 4.621. PA negative reinforcement – school INT: pre M = 3.458, SD = 3.193, post M = 6.374, SD = 4.318; School + Family INT: pre M = 3.609, SD = 2.995, post M = 4.365, SD = 2.842, CON: pre M = 3.178, SD = 3.255, post M = 3.983, SD = 3.085. Dietary self-efficacy – school INT: pre M = 6.081, SD = 6.233, post M = 7.844, SD = 6.379; School + Family INT: pre M = 5.719, SD = 6.208, post M = 7.708, SD = 6.619; CON: pre M = 5.626, SD = 6.346, post M = 6.203, SD = 6.639. PA self-efficacy – school INT: pre M = 2.172, SD = 2.403, post M = 2.915, SD = 2.228; School + Family INT: pre M = 2.256, SD = 2.402, post M = 3.045, SD = 2.207; CON: pre M = 2.108, SD = 2.472, post M = 2.572, SD = 2.327 • School + family INT showed greater improvements for dietary intention and usual food choices for lower fat and lower sodium foods Within group: Not reported Results for AA population: • No interaction between intervention effect and race

Table 1 *Continued*

Study authors, year	Population/sample	Study design/intervention	Outcome measure(s)	Results
Gortmaker *et al.* 1999 (41)	$N = 479$ INT $n = 190$ (92% AA) CON $n = 289$ (90% AA) 4th–5th grade students	Design: Quasi-experimental study design. Eat Well and Keep Moving Program taught in math, science, language arts and social studies (13 lessons for grades 4 and 5, five PE lessons integrated nutrition and used a 'Safe Workout' format). 18 Eat Well cards were introduced to students during lunch. Goals were to promote F&V consumption, limit television and increase walking. A coalition was developed to link the school initiative to parents and the community.Control: Usual health education materials Implemented by: Teachers Setting: Classroom Duration of intervention: 2 years Duration of follow-up: 2 years	Dietary intake (24-h recalls) and PA (24-h recalls), Food Activity Survey (self-report about PA and nutrition knowledge, TV viewing, socio-demographic information, behavioural components)	Results for entire population (≥80% AA): Between groups: • % of total energy from fat reduced in INT (pre M = 34.7, post M = 33.70) vs. CON (pre M = 34.6 post M = 35.20); $P = 0.04$ • F&V consumption (servings per 4,184 kJ INT: pre M = 1.5, post M = 1.78; CON: pre M = 1.5, post M = 1.41, $P = 0.01$ • Compared to CON, TV and video viewing reduced in intervention group, but not significantly (hours/day INT: pre M = 4.2, post M = 3.48; CON: pre M = 4.7, post M = 4.03), $P = 0.06$ Within group: Not reported
Greening *et al.* 2011 (45)	$N = 450$ INT $n = 204$ (58% AA) CON $n = 246$ (37% AA) Age range: 6–10 years	Design: RCT targeting healthy lifestyle behaviours through engagement in nutrition and PA; included monthly family events and incorporated elements from Pathways (family components) and CATCH projects (dietary habits). Control: Followed the state's standard health curriculum (included didactic nutrition education and health information incorporated into academic lessons, and weekly physical education classes) Implemented by: Teachers and researchers Setting: School (lunchroom), community Duration of intervention: 8 months Duration of follow-up: N/A	Know Your Body questionnaire (nutrition knowledge survey); President's Challenge PA and Fitness Awards Program (shuttle run, curl-ups and V-sit); PA (self-report); dietary habits (parental self-report); per cent body fat (bioelectrical impedance analysis)	Results for entire population: Between groups: • Body fat – INT demonstrated significant decrease from pre (26.17%) to post (25.61%) compared to CON group that remained stable (pre = 27.15%, post = 27.55%) • No change was found in waist circumference pre-post; however, there was a significant difference between the intervention and control groups at baseline • PA – INT reported more PA pre-post whereas CON demonstrated a decline ($F(1, 449) = 4.56$, $P < 0.04$) • Dietary fat intake – INT had improvement in fat intake compared to CON ($F(1, 449) = 12.30$, $P < .0005$). Caregivers in INT had a change in fat intake while caregivers in CON had an increase ($F(1, 449) = 4.32$, $P < .04$). • Fitness – INT demonstrated improvements in curl-ups ($F(1, 449) = 30.69$, $P < 0.0001$) and shuttle run ($F(1, 449) = 52.24$, $P < 0.0001$) Within group: Not reported Results for AA population: • No interaction between intervention effect and race ($ts = -0.06–1.28$, $P > .10$)

Table 1 *Continued*

Study authors, year	Population/sample	Study design/intervention	Outcome measure(s)	Results
Lytle *et al.* 1996 (43)	*N* = 1,182 INT *n* = 709 students in 56 schools CON *n* = 473 students in 40 schools 10% AA; 3rd–5th grade students	Design: RCT using CATCH curriculum (3rd grade – 15 classroom sessions over 5 weeks; 4th–5th grade – 24 classroom sessions over 12 weeks per grade level) targeting nutrient levels for total energy, dietary cholesterol and dietary fibre; and changes in proportion of energy from fat, protein, carbohydrates and fatty acids. Menu changes in lunchroom and increase in MVPA in PE. Control: Not reported Implemented by: Teacher, staff, family Setting: Classroom, PE, school environment Duration of intervention: 3 years Duration of follow-up: N/A	Changes in nutrient intake assessed using 24-h dietary recall	Results for entire population: Between groups: • INT demonstrated significant reductions in % energy from fat (INT: pre M = 32.7, SD = 7.4, post M = 30.3, SD = 6.8; CON: pre M = 32.6, SD = 6.6, post M = 32.2, SD = 7.1) and % energy from saturated fat (INT: pre M = 12.8, SD = 3.6, post M = 11.4, SD = 3.5; CON: pre M = 12.5, SD = 3.3, post M = 12.1, SD = 3.5) Within group: • Total energy intake increase in intervention and control groups, but increase was smaller in intervention group (total energy, kcal, INT: pre M = 2,043, SD = 666, post M = 2,074, SD = 736; CON: pre M = 2,030, SD = 688, post M = 2,169, SD = 772) Results for AA population: • No significant interaction between race in intervention group. Treatment did not have a differential effect by ethnic group for nutrient intake.
Perry *et al.* 1998 (44)	*N* = 1,750; INT *n* = 10 schools CON *n* = 10 schools 19.1% AA; 4th–5th grade students	Design: School-based RCT using 5-a-Day Power Plus programme. Sixteen classroom sessions, 40–45 min (2 times a week, 8 weeks), skill building, problem solving, snack preparation and taste testing activities. Team competition to eat F&V during lunch. Food service intervention: Encouraged selection and consumption of F&V at school lunch via specific strategies. Control: Not reported (delayed programme condition/waitlist) Implemented by: Teachers, staff Setting: School environment, lunchroom Duration of intervention: 8 weeks Duration of follow-up: 1 year	Self-report 24-h recall, direct observation of selected students; lunchroom behaviour	Results for entire population: Between groups: • Total dietary intake – significant increased consumption of F&V servings per 1,000 kcal (INT: M = 2.82, CON: M = 2.41) – no report of interaction effect with race • Significant increased serving of F (INT: M = 2.75, CON: M = 2.13), but no change in V (INT: M = 2.50, CON: M = 2.52) • Significant decrease in total fat, % of kcal (INT: M = 30.02, CON: M = 31.82) Within group: Not reported Results for AA secondary outcomes: • Favourable trends for changes in % of calories as fat (AA INT: M = 31.25, CON: M = 33.50) and saturated fat (AA INT: M = 11.56, CON: M = 13.31) observed in AA compared to unfavourable trends observed for Hispanic and no change observed for whites

Table 1 *Continued*

Study authors, year	Population/sample	Study design/intervention	Outcome measure(s)	Results
Tuuri *et al.* 2009 (42)	*N* = 560 across 14 schools INT *n* = 32 classrooms CON *n* = 37 classrooms 82% AA; 4th–5th grade students, 14 schools	Design: School-based RCT using the 'Smart Bodies Programme' Three components: The Louisiana BodyWalk™, OrganWise Guys™ and the National School Lunch Program. The health message is to consume F&V. Engage in daily bouts of PA within the classroom integrated with academic lessons with activities that promoted the health benefits of eating F&V. Control: Not reported Implemented by: Teachers Setting: Classroom, school environment Duration of intervention: 12 weeks Duration of follow-up: N/A	F&V preferences, self-efficacy, outcome expectations (positive/negative), social norms	Results for entire population (≥80% AA): Between groups: • Significant increase in nutrition knowledge (INT: pre M = 6.65, post M = 7.31; CON: pre M = 6.77, post M = 6.98), self-efficacy to consume F&V (INT: pre M = –0.05, post M = 0.40; CON: pre M = 0.14, post M = 0.18) and food preference for V Within group: • Mixed results for preference of F&V • 4th graders preference for V decrease while 5th graders preference stayed the same
Middle and high school studies				
Covelli 2008 (53)	*N* = 48; 100% AA; *M* age = 15 years; INT *n* = 31; CON *n* = 17	Design: Quasi-experimental study design (9 week, 1×/week lecture and 1 d week^{-1} of exercise; each session consisted of 90 min). Targeted cognitive-behavioural components of health knowledge, health promotion concepts, nutrition and exercise. Control: Life Management class Implemented by: Researcher Setting: Classroom Duration of intervention: 9 weeks Duration of follow-up: N/A	Health knowledge questionnaire, exercise (7-d recall questionnaire), nutrition (2-d dietary recall) and BP	Results for entire population (≥80% AA): Between groups: • Health knowledge – INT group significantly increased health knowledge and was significantly higher than CON (INT: pre M = 3.5 (2), post M = 18.6 (1.6); CON: pre M = 5.7 (3.7), post M = 6.7 (3.5)) • F&V intake per week – INT group increased their F&V consumption compared to CON (INT: pre M = 2.6 (0.8), post M = 4.9 (1.2); CON: pre M = 2.7 (1.4), post M = 2.5 (0.1)) • Exercise per week – INT group increased their exercise per week compared to CON (INT: pre M = 2.6 (0.9), post M = 4.5 (1.4); CON: pre M = 2.1 (0.8), post M = 2.2 (0.1)), greatest difference seen in females Within group: • No change in blood pressure for both groups

Table 1 *Continued*

Study authors, year	Population/sample	Study design/intervention	Outcome measure(s)	Results
Fahlman *et al.* 2008 (47)	*N* = 783; 11 schools; INT *n* = 613 (pre-test), *n* = 407 (post-test; *M* age = 12.5 ± 0.5 years; 87% AA); CON *n* = 245 (pre-test), *n* = 169 (post-test; *M* age = 11.9 ± 0.8 years; 25% AA)	Design: Quasi-experimental study design (1 month; 8 lessons/month; totalling 8–10 h). Health education teacher professional development programme to improve youth nutrition knowledge, behaviours and self-efficacy. Control: Not reported Implemented by: Certified health teachers Setting: Health class Duration of intervention: 1 month Duration of follow-up: N/A	Nutrition knowledge questionnaire, eating behaviour, and efficacy expectations regarding healthy eating	Results for entire population (≥80% AA): Between groups: • F&V consumption – INT group demonstrated significant improvements (increase consumption) pre to post compared to CON (mean servings – fruits – INT: pre M = 2.48, SD = 1.8, post M = 3.25, SD = 0.7; CON: pre M = 2.52, SD = 1.5, post M = 2.41, SD = 1.0) (vegetables – INT: pre M = 1.11, SD = 1.1, post M = 2.03, SD = 1.2; CON: pre M = 1.38, SD = 1.4, post M = 1.22, SD = 2.0) • Nutrition knowledge – INT group demonstrated improvements pre to post and significantly higher than CON (% correct, total nutritional knowledge score – INT: pre 32, post 49; CON: pre 39, post 39) Within group: • Efficacy expectation regarding health eating – INT group demonstrated improvements pre to post, no pre to post differences were seen in CON ◦ *Eat more F&V*, INT: pre M = 4.2, SD = 1.9, post M = 6.3, SD = 1.9; CON: pre M = 4.3, SD = 1.9, post M = 4.2, SD = 1.9 ◦ *Eat less fat*, INT: pre M = 4.7, SD = 1.9; CON: pre M = 4.8, SD = 1.9, post M = 4.9, SD = 1.9 ◦ *Drink less pop*, INT: pre M = 4.6, SD = 2.0, post M = 4.5, SD = 2.2; CON: pre M = 4.5, SD = 2.2, post M = 4.6, SD = 1.8 ◦ *Eat healthy at a fast-food restaurant*, INT: pre M = 4.0, SD = 2.0, post M = 5.9, SD = 2.0; CON: pre M = 4.4, SD = 2.1, post M = 3.3, SD = 2.0)

Table 1 *Continued*

Study authors, year	Population/sample	Study design/intervention	Outcome measure(s)	Results
Forneris *et al.* 2010 (48)	*N* = 2,120; *n* = 999 (2-year follow-up); 6th grade students; INT *n* = 12 schools (46.5% AA); CON *n* = 11 schools (53.5% AA)	Design: RCT, high school students were trained to teach middle school students about positive eating habits (12 sessions over 12 weeks). Measures were assessed over four time periods: T1: baseline, T2: post-intervention, T3: 1-year follow-up, T4: 2-year follow-up Control: Not reported (waitlist control) Implemented by: Peer leader (high school student) Setting: School Duration of intervention: 12 weeks Duration of follow-up: 2 years	Survey to test six healthy eating outcomes: (1) self-efficacy to eat healthy food, (2) perceived taste of low-fat foods, (3) fat and fibre knowledge, (4) fat intake, (5) fibre intake and (6) F&V intake	Results for the entire population: Between groups: • Fat and fibre knowledge – knowledge scores for fat and fibre significantly increased and was significantly higher in intervention schools at T2 and maintained at T3 (INT: T2 M = 8.81, SE = 0.12, T3 M = 9.67, SE = 0.13; CON: T2 M = 8.57, SE = 0.13, T3 M = 9.35, SE = 0.14) • Differences between conditions were not present at T4. Within group: • Self-efficacy to eat healthy – increased in the intervention from T1 to T2 (INT: T1 M = 6.64, SE = 0.06, T2 M = 7.06, SE = 0.06), but decreased to the levels of CON at T4 (INT: T4 M = 6.85, SE = 0.07; CON: T4 M = 6.75, SE = 0.09.13, T3 M = 9.35, SE = 0.14). (INT T1–T2 ES = 0.05) • Fat food frequency score – INT was not effective (remained the same from T1 to T2, reduced from T2 to T3, and reminded the same at T4; $P = .89$) • F&V food frequency score – F&V scores decreased for both conditions over time ($P = .76$) Results for AA population: • Self-efficacy to eat healthy – AA reported less confidence in their ability to eat healthier (M = 6.65, SE = 0.06) • Perceived taste of low-fat foods – AA perceived that low-fat foods tasted worse (M = 6.81, SE = 0.05) • Fat food frequency score – AA had higher fat intake (M = 4.06, SE = 0.02) • Fibre food frequency – AA consumed less fibre (M = 2.4, SE = 0.02) • F&V food frequency score – there was a significant effect of time by ethnic group. AA had lower F&V consumption.

Table 1 *Continued*

Study authors, year	Population/sample	Study design/intervention	Outcome measure(s)	Results
Frenn *et al.* 2003 (49)	$N = 130$ INT $n = 67$ CON $n = 63$ 44.6% AA; age range = 12–15 years	Design: Quasi-experimental study design, with online information and videos targeting nutrition and PA (6, 50-min sessions). Targeted stage of exercise readiness for PA and aimed to decrease per cent of dietary fat intake (4 Internet sessions plus a healthy snack session and a gym class) Control: Not reported Implemented by: Peer models (nursing students), Internet, peer-led PE Setting: Classroom, PE Duration of intervention: Not provided Duration of follow-up: N/A	Food Habits Questionnaire (consumption of high- and low-fat foods); PA participation (7-d recall)	Results for the entire population: Between groups: • No difference in % of dietary fat between INT and CON (INT: pre M = 31%, post M = 31%; CON: pre M = 32%, post M = 32%) • Both CON and INT groups decreased their amount of MVPA (pre-post decrease; INT: –8.58 min; CON: 37.61 min, $P = .024$) Within group: • The level of decrease in MVPA was less among INT group • Peer-led gym class increased MVPA in INT ($P = .002$) Results for AA population: • AA girls in INT group decreased dietary fat compared to CON group ($P = .018$) • CON – boys in each racial group decreased fat; for INT group no change was associated with less access to low-fat foods (except AA) • The INT group increased PA among those with the lowest income for all races except NA ($P = .04$)
Frenn *et al.* 2005 (50)	$N = 103$; INT diet $n = 43$ (50% AA) and activity (33% AA); CON diet $n = 60$ (34.7% AA) and activity (26.7% AA)	Design: Quasi-experimental study design, with online information and videos; targeted stage of exercise readiness for PA and aimed to decrease per cent of dietary fat intake (8 online, 40-min sessions) Control: Science classes with usual assignments Implemented by: Internet Setting: Classroom Duration of intervention: 1 month Duration of follow-up: N/A	Food Habits Questionnaire (Consumption of high- and low-fat foods); PA participation (7-d recall)	Results for the entire population: Between groups: • Not reported Within group: • Increase in PA in INT group (but not significant, $t(13) = 1.53$, $P = .15$). INT students who completed more than half of the sessions increased MVPA by an average of 22 min, compared with a decrease in the CON group of 46 min, $t(103) = -1.99$, $P = .05$. • Decrease in percentage of dietary fat for those participating in more than half of the INT (INT: pre M = 30.7, post M = 29.9; $t(87) = 2.73$, $P = .008$. CON: pre M = 31.5%, post M = 31.6%) Results for AA population: • Increase in MVPA for those that participated in more than half of the INT • For those who participated in more than half of the sessions, dietary fat increased in AA more than W

Table 1 *Continued*

Study authors, year	Population/sample	Study design/intervention	Outcome measure(s)	Results
Gortmaker *et al.* 1999 (51)	*N* = 1,295 INT *n* = 641 (11% AA) CON *n* = 654 (15% AA) *M* age = 11.7 ± 0.7 years	Design: RCT to change the following: decrease TV viewing to <2 h d^{-1}, decrease consumption of high-fat foods, increase MVPA, and increase consumption of F&V to 5 servings/day. Teachers implemented 4 lessons/year (45 min each); PE implemented 30 'microunits' each year focusing on PA and inactivity (5 min each) Control: Normal health curricula and PE class Implemented by: Teacher Setting: Classroom, PE Duration of intervention: 2 years Duration of follow-up: N/A	BMI, television viewing (Food & Activity Survey), PA, dietary intake (Youth Activity Questionnaire)	Results for entire population: Between groups: • Obesity prevalence significantly decreased in girls in INT (pre 23.6%, post 20.3%) vs. CON group (pre 21.5%, post 23.7%) • Significant decrease in hours/day TV viewing in both girls and boys in INT vs. CON group (girls – INT: pre 2.98, post 2.28; CON: pre 3.10, post 2.99/boys – INT: pre 3.73, post 3.03; CON: pre 3.78, post 3.43) • Girls – significant increase in F&V consumption (servings/day – INT: pre 3.4, post 3.6; CON: pre 4.1, post 3.9) Within group: Not reported Results for AA population: • AA girls decreased in obesity prevalence in INT vs. CON (OR, 0.14; 95% CI, 0.04–0.48; *P* = .007)
McCaughtry *et al.* 2011 (52)	*N* = 2,132 students and 32 teachers; INT *n* = 1476 students (*M* age = 12.63 ± 0.87 years; 92% AA); CON *n* = 656 students (*M* age = 12.82 ± 0.76 years; 18% AA)	Design: Quasi-experimental study design, health education teacher professional development programme to improve youth's nutrition knowledge, behaviours and self-efficacy (six one-hour lessons over 6 weeks) Control: No nutrition education instruction Implemented by: Health education teacher Setting: Health class Duration of intervention: 6 weeks Duration of follow-up: N/A	Dietary knowledge, dietary self-efficacy and dietary behaviours	Results for entire population (≥80% AA): Between groups: • Significant increase in nutrition knowledge (INT: pre M = 6, SD = 2, post M = 11.4, SD = 4; CON: pre M = 6, SD = 3, post M = 6, SD = 4), dietary self-efficacy (INT: pre M = 17, SD = 3, post M = 28, SD = 3; CON: pre M = 18, SD = 3, post M = 18, SD = 5) • Dietary behaviour – improvements related to consuming F (INT: pre M = 2.48, SD = 1.8, post M = 3.25, SD = 0.7; CON: pre M = 2.52, SD = 1.5, post M = 2.41, SD = 1.0), V (INT: pre M = 1.31, SD = 1.1, post M = 2.83, SD = 1.2; CON: pre M = 1.38, SD = 1.4, post M = 1.32, SD = 2.4) and meats (INT: pre M = 2.08, SD = 1.7, post M = 1.12, SD = 1.7; CON: pre M = 2.11, SD = 1.9, post M = 3.16, SD = 1.9), but none for dairy (INT: pre M = 2.71, SD = 1.6, post M = 2.95, SD = 1.7; CON: pre M = 2.99, SD = 1.6, post M = 2.92, SD = 1.7) and grain (INT: pre M = 2.86, SD = 2.1, post M = 3.65, SD = 2.0; CON: pre M = 2.89, SD = 1.7; post M = 2.52, SD = 1.9) Within group: Not reported

Table 1 *Continued*

Study authors, year	Population/sample	Study design/intervention	Outcome measure(s)	Results
Young *et al.* 2006 (54)	N = 221 (pre-test) female students; n = 210 (post-test); 83% AA; M = 13.8 ± 0.5 years; INT n = 111; CON n = 99	Design: Three-year RCT school-based study, focused on life skills to maximize PA in PE for two semesters. PE class held 5 d/week and lasted approximately 45 min. Control: Standard physical education Implemented by: Teacher hired by research team Setting: PE Duration of intervention: 8 months Duration of follow-up: N/A	Daily energy expenditure (7-d recall), sedentary activity (questionnaire); cardiorespiratory fitness assessed by a submaximal three-stage step test; selected cardiovascular risk factors assessed by height, weight, waist-to-hip ratio, resting BP, plasma total cholesterol, high-density lipoprotein cholesterol and low-density lipoprotein cholesterol.	Results for entire population (≥80% AA): Between groups: • No significant difference in mean daily or MVPA energy expenditure (INT: pre M = 34.6 kcal kg^{-1}, SD = 3.2, post M = 34.2 kcal kg^{-1}, SD = 2.9; CON: pre M = 34.2 kcal kg^{-1}, SD = 2.7, post M = 34.2 kcal kg^{-1}, SD = 2.1) • Decrease in TV viewing time of more than 3 h d^{-1} (school day – INT: pre M = 22.3, post M = 17; CON: pre M = 26.7, post M = 26.7; weekend INT: pre M = 34.2, post M = 27; CON: pre M = 35.6, post M = 35.6) Within group: • INT increased fitness level (changes in submaximal heart rate, within group change INT: M = 7.1, SD = 1.8; CON: M = -7.4, SD = 2.0)

Note: For all significant findings, $P \leq 0.05$.

For duration follow-up, N/A indicates that there was no follow-up period and post-measurement was assessed immediately following the intervention.

Unless otherwise stated, reported results for AA population are for AA participants in the intervention and control groups.

AA, African American; BP, blood pressure; CATCH, Child and Adolescent Trial for Cardiovascular Health; CON, control; F, fruits; H, Hispanic; INT, intervention; M, mean; MVPA, moderate-to-vigorous physical activity; PA, physical activity; PE, physical education; RCT, randomized controlled trial; SD, standard deviation; SE, standard error; V, vegetable; W, white.

Table 2 Quality assessment and successes and challenges

Study	Randomized, intervention defined	Eligibility criteria	≥80% AA population	Present results by race	Present analysis by race	Successes/strengths	Challenges
Pre-school studies							
Fitzgibbon *et al.* 2005 (38)	+, +	NR	Yes	N/A	N/A	• Effective in reducing weight gain (as determined by BMI) in both genders and among low-income pre-school students • Intervention designed to meet developmental, cultural and financial needs of this Head Start minority pre-schoolers	• Single dietary recall and non-validated PA measure may not have adequately captured participants' behaviours • Trained specialists (not classroom teachers) delivered intervention, decreasing generalizability • Dose-response effect (three times a week vs. once a week) may have influenced results between conditions
Fitzgibbon *et al.* 2011 (39)	+, +	NR	Yes	N/A	N/A	• Teachers incorporated intervention into daily schedule; all teachers completed at least 21/28 nutrition and 21/28 exercise lessons • Used accelerometers to assess PA	• Teachers expressed difficulty in implementing PA because (1) many children were resistant and became tired; (2) teachers had limitations in participating in PA • No dietary difference seen between groups at post-intervention, possibly due to a lack of parental intervention component
Elementary school studies							
Blom-Hoffman *et al.* 2004 (40)	+, +	NR	Yes	N/A	N/A	• Study had high levels of acceptability among teachers, paraprofessional aides, students • Study highlighted the importance of implementing a nutrition programme with both an educational and behavioural component	• Challenges promoting and maintaining intervention integrity • All classrooms from one school • Changes in child eating patterns outside of school lunch were not evaluated • Lack of change in consumption of vegetables during school could be due to short study duration
Edmundson *et al.* 1996 (46)	+, +	NR	No	No	Yes	• Intervention led to changes in what children expect to do, confidence, perceived support and reinforcement; components consistent with the social cognitive theory	• PE intervention was only implemented for one semester in the 3rd grade • Results for PA determinants were weak
Gortmaker *et al.* 1999 (41)	–, +	+	Yes	N/A	N/A	• Interdisciplinary classroom-based programme with potential for sustainability by teachers • 95% of respondents said lessons were 'effective'; 97% said they would use the moving cards again	• Both intervention and control schools had minimal PE programmes; therefore, making PE more active to increase student PA was not included in intervention • Dietary intake and PA based on student self-reports

Table 2 *Continued*

Study	Randomized, intervention defined	Eligibility criteria	≥80% AA population	Present results by race	Present analysis by race	Successes/strengths	Challenges
Greening *et al.* 2011 (45)	+, +	+	No	No	Yes	• Mean BMI percentile and parental dietary intake at intervention school was stable at post-intervention compared to the control school • Objective adiposity and fitness measures used	• Intervention was short, limiting interpretations of treatment effects on other measures of adiposity • Future research on role of culturally sensitive variables in treatment outcome for minority vs. nonminority students
Lytle *et al.* 1996 (43)	+, +	NR	No	Yes	Yes	• School-based intervention improved children's intake of total fat and saturated fat relative to energy intake • Intervention effective in all regions, race/ethnic groups and genders	• Used student self-reported data, no parent survey conducted • Need further studies to determine durability of intervention effects • Lack of change in school physical activity levels could be due to short study duration
Perry *et al.* 1998 (44)	+, +	NR	No	For secondary outcome only	Yes	• Programme provided evidence that multi-component school-based behavioural programmes can improve health behaviours of children • Increase in lunchtime vegetable consumption among girls • Fat consumption was lower among intervention students in the 24-h food recalls	• Only included a school intervention (not home) • Difficult to explain how intervention, which focused on F&V consumption, could have contributed to lower fat consumption only among Asian–American and AA students
Tuuri *et al.* 2009 (42)	+, +	NR	Yes	N/A	N/A	• Designed to use existing resources of local schools	• Limited study duration might not have been sufficient for changes in food preference and related psychosocial variables to occur • Results based on student self-report questionnaires
Middle and high school studies							
Covelli 2008 (53)	–, +	+	Yes	N/A	N/A	• Intervention targeted only low-income, AA youth and successfully improved healthy behaviours and actions • Girls significantly increased the amount of time spent being physically active	• Knowledge alone does not necessarily lead to behavioural changes • Small sample size and high attrition rate, particularly in the control group
Fahlman *et al.* 2008 (47)	–, +	NR	Yes	N/A	N/A	• Middle school students in intervention increased their nutrition knowledge and were more likely to report making positive changes in eating habits	• Short-term pilot study • Self-report measures run the risk of encountering the Hawthorne effect

Table 2 *Continued*

Study	Randomized, intervention defined	Eligibility criteria	≥80% AA population	Present results by race	Present analysis by race	Successes/strengths	Challenges
Forneris *et al.* 2010 (48)	+, +	+	No	No	Yes	• Results demonstrated positive changes in self-efficacy and knowledge (fat and fibre content) due to the Goals for Health intervention.	• All gains in self-efficacy and fat and fibre content knowledge was not maintained at the 2-year post-intervention assessment. • Short study duration and high attrition, especially in rural areas
Frenn *et al.* 2003 (49)	–, +	NR	No	No	Yes	• Dose-response effect between intervention exposure and changes in dietary fat • Intervention effects varied among races and sexes	• Six-session intervention was not successful in improving moderate-to-vigorous physical activity participation or reducing dietary fat intake • Small sample size
Frenn *et al.* 2005 (50)	–, +	+	No	No	Yes	• Students who completed over half of the computer-tailored Internet/video sessions improved MVPA participation and decreased dietary fat intake • Eight-session intervention was effective across racial groups and for those with the lowest income	• Self-report measures were used and could lead to inaccurate results • No measures of acculturation • Did not measure a full dietary recall (e.g. F&V intake)
Gortmaker *et al.* 1999 (51)	+, +	+	No	No	Yes	• Intervention reduced obesity prevalence and obesity-related behaviours in girls	• Randomization of students was limited to randomization by schools • Limited validity of measures of dietary intake and PA based on self-reports
McCaughtry *et al.* 2011 (52)	–, +	NR	Yes	N/A	N/A	• Professional development training for teachers conducting nutrition education programme	• Experiment fidelity could have been inaccurate due to self-report measures • No comparison to other theory-based programmes (just a true control group)
Young *et al.* 2006 (54)	+, +	+	Yes	N/A	N/A	• Alternative PE increased participation in PA during PE	• Although successful in increasing PA during PE, intervention did not change total daily PA • Self-report measures were used.

–, not included; +, present; F&V, fruits and vegetables; MVPA, moderate-to-vigorous physical activity; N/A, not applicable if study population was ≥80%; NR, not reported; PA, physical activity; PE, physical education.

Secondary schools

Six studies were conducted in middle schools (47–52) and two in high schools (53,54). Overall, half were conducted in a sample with ≥80% AA participants (47,52–54). Three studies targeted changes in nutrition behaviour (47,48,52), one targeted physical activity behaviour (54), and four focused on both behaviours (49–51,53). Only two interventions lasted longer than 12 weeks (51,54). Five studies had multiple components (i.e. classroom curriculum, changes in school environment, lunchroom, physical education classes) (49–51,53,54) and three focused solely on either classroom or physical education curricula (47,48,52). Three interventions were implemented solely by teachers (i.e. classroom, health and/or physical education) (47,51,52); two by researchers (53,54); and three by a combination of teachers, administrators, school staff, graduate students, peer leaders and researchers (48–50). Most studies ($n = 7$) used self-report measures to assess primary outcomes (47–50,52–54). Only one study assessed the primary outcome (change in BMI) using objective measures (51); however, both dietary and physical activity variables were assessed using self-reported measures (51). Five studies found significant positive changes in nutrition (47,48,51–53), but no studies reported significant changes in physical activity variables between treatment and control groups. The one study that examined changes in BMI found improvements in obesity prevalence (i.e. weight loss) among AA girls (51).

Discussion

Several reviews have assessed the effectiveness of school-based interventions in promoting healthy nutrition, physical activity, healthy weight/BMI and/or other health-related outcomes (20–36). The objective of the current review was to assess the evidence for school-based interventions that promote healthy eating and physical activity in AA children and adolescents. We believe this is the first review to focus on studies targeting weight-related behaviours in school settings among AA children and youth. Overall, the findings provide limited evidence for school-based approaches that might be effective for improving weight-related behaviours for AA children, but leave major gaps in understanding what should be done to address the major disparities in obesity that affect children in this population.

Best practices in child-focused interventions on obesity and related behaviours call for comprehensive, multilevel approaches (16,21,25,55). A 2013 IOM report on physical activity in schools (56) calls for a 'whole-of-school' approach that includes teachers, principals, school administrators, superintendents, students, and parents, and involves active use of the resources within the school environment (i.e. school buildings, outdoor grounds and playgrounds, indoor/outdoor equipment and streets/pathways in the surrounding neighbourhood). Although none of the interventions included in the current review focused on physical activity environment changes within the intervention approach, we found that six of the interventions identified took a multi-component approach that included various aspects of the school's environment (40–45). Generally, studies that incorporated the lunchroom setting and school nutrition (in the classroom or in the lunchroom) reported positive outcomes in altering dietary behaviours while those that did not include this environment demonstrated smaller but positive changes (43,49,51,54).

As it relates to implementation, the person delivering the intervention did not appear to impact study outcomes. The lack of differences in findings regarding who implemented the programme could mean that, as long as a programme is well written, the intervention can be successfully delivered by a variety of trained and qualified individuals. Given the limited budgets and continued reductions in staff and resources in schools, having interventions that can be delivered by a variety of individuals could increase the likelihood of implementation.

Most of the interventions incorporated separate health-based lesson plans that were not integrated within academic coursework (38–45,47,49,50) while two incorporated the intervention lesson plans within the academic classroom and physical education classes (46,54). Given limited budgets for schools, interventions might be more feasible and acceptable if they can be incorporated into ongoing classroom activities. A recent review suggests that incorporating physical activity into academic lessons could enhance teacher participation and adherence (57).

Incorporating parental involvement and various community initiatives to support behaviour change in children outside of the school setting may enhance the potential for effectiveness, but additional evidence regarding this approach is needed. Edmundson's (46) study was the only one included in the current review to compare the effects of a nutrition and physical activity intervention that took place in the school or in both the school and home environment. The family-based programme included a parent curriculum, family fun night and health teams. Both intervention groups reported positive outcomes in students' psychosocial constructs for physical activity and nutrition, but the family-based participants demonstrated greater benefits from the intervention. A 2013 review of family-focused interventions targeting physical activity, diet and obesity in AA girls concluded that additional studies are needed to understand how to effectively involve family members in intervention (58).

Our ability to draw strong conclusions was limited by the nature of and variation in assessment approaches (i.e. range of outcomes assessed and instrumentation) and the lack of follow-up assessments. Psychosocial or behavioural self-report measures included nutrition knowledge, nutrition or physical activity self-efficacy, recalls of physical activity and dietary intake, food preferences, and direct observations of dietary behaviours during lunch (see Table 1). Only one study objectively measured physical activity with accelerometers (39). Although such measures provide valuable information on physical activity and dietary behaviours, they may not be the most accurate tool for children under 10 years old (59). Using valid and reliable measures and having consistency across studies would be particularly important for studies of specific populations where the evidence base is likely to be smaller and would facilitate better understanding of the effectiveness of school-based intervention on obesity and other health-related outcomes in AA children.

The current review focused on interventions targeting weight-related behaviours, which is critical given the prevalence of childhood obesity among children and adolescents. Change in BMI was the focus of only three studies included in this review (38,39,51); positive outcomes for AA children were seen in two (38,51). Both studies incorporated a nutrition and physical activity component (38,51) and Gortmaker *et al*. also incorporated decreasing TV time. It is important to note that seven studies included in the current review focused only on nutrition, 10 focused on nutrition and physical activity, and only one focused solely on physical activity. While most studies showed improvements in nutrition-related behaviours, only two studies (45,49) showed improvements in self-report physical activity. Given the importance of energy balance as it relates to obesity, effective intervention strategies should target and positively impact both sides of the energy equation to effectively influence weight.

Intervention duration did not appear to impact study findings; however, only eight studies incorporated an intervention length longer than 12 weeks (38,39,41,43,45,46,51,54). There is no clear evidence about the intervention length that is required to achieve change in weight-related behaviours in children. Given the importance of teachers for school-based intervention implementation and sustainability, it would be important to incorporate their input on feasible intervention length and timing (57).

A majority of the programmes included in the current review conducted pre- and immediately post-intervention follow-up and five studies included a follow-up assessment that ranged from 1 month to 2 years (38,40,41,44,48). In general, few studies with children and adolescents have examined the maintenance of physical activity or nutrition behaviour beyond 6 months after adoption of the behaviour (60). Evidence from the adult literature clearly states that maintenance is critically important for ongoing participation in the behaviour and sustaining health benefits (60). Future interventions should incorporate the assessment of long-term maintenance of behaviour change (e.g. ≥6 months post-intervention) to understand intervention effectiveness.

We acknowledge that there are some limitations to this current review. Our inclusion and exclusion criteria could have eliminated some potentially relevant studies. It is also possible that relevant papers were published after our final search date (beginning of March 2013) or are currently in press and not yet published. This review only included studies that took place during school hours, excluding after-school programmes that targeted AA participants or presented results for AA participants. Findings from after-school programmes might provide additional insights on strategies for intervening with AA children. A separate review in this supplement of *Obesity Reviews* focuses on after-school and community-based programmes targeting obesity in AA children (61). School-based interventions are also considered in Kumanyika *et al*.'s review of studies of environmental and policy changes (62). Finally, our review did not include studies that used a single group design or studies from the grey literature (e.g. theses, dissertations), and we are unable to garner any insights that such studies might offer. Such studies might have identified potentially successful intervention strategies for AAs. In terms of study design, most studies in this review used a pre-test and post-test design or were pilot studies specifically designed to address questions related to intervention programmes in AA children and youth. Most of what is known about obesity and/or obesity prevention interventions in AA children is from non-experimental studies (41,47,49,50,52,53). Additionally, many interventions were designed primarily for white children and youth; those results were extrapolated to AA children and youth (43–46,48–51). Future intervention studies should be designed to address the societal and environmental needs of the intended population.

This review also possesses several strengths including our systematic approach to identifying and reviewing studies to be included in this review. We carefully selected inclusion/exclusion criteria based on previous reviews of the literature and used trained individuals to review abstracts to be sure we obtained all relevant publications. The focus on AA children in the current review adds additional insight to the literature on potentially effective strategies for intervening in high-risk populations.

Future intervention approaches should consider strategies that incorporate weight-related behaviours into the academic curriculum (e.g. short 10–12 min intermittent bouts of physical activity incorporated into the academic classroom to alleviate long periods of sedentary behaviours (60,63–65)), which could increase feasibility and acceptability among classroom teachers. Additional research is needed to understand how best to change the school environment to support positive weight-related behaviours. Previous and emerging literature stresses the importance of culturally relevant programming in health behaviour interventions. Culturally relevant programmes and interventions that include the adaptation of programmes, materials and messages to racial/ethnic subpopulations have been effective in adult populations (66–68). None of the school-based interventions in the current review identified cultural adaptations to meet the unique needs of children and youth. There might be a need for interventions that incorporate the current 'pop culture' and technology to make behaviour change interventions more appealing to children and youth. For AA children and youth, these interventions need to translate back to the students' homes and communities to empower them to make the necessary lifestyle changes.

Conclusion

Although the findings from this review are limited due to the small number of studies, the heterogeneity of primary outcome variables, and the dearth of studies that incorporated follow-up assessments, the evidence reviewed supports the applicability of well-designed school-based interventions for promoting health-positive nutrition behaviours in AA children. However, the types of interventions that are effective on physical activity and BMI outcomes in children and adolescents are less clear. Given the recognized importance of interventions in school settings as part of obesity prevention strategies and the higher than average risks of obesity in AA children, these findings suggest that high priority should be given to studies that could potentially serve as a foundation for scalable interventions in AA communities. Approaches tested should include evaluations of strategies that address the culture of the target population.

Conflict of interest statement

No conflict of interest was declared.

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