Evidence Portfolio – Youth Subcommittee, Question 2

In children and adolescents, is physical activity related to health outcomes?

a. What is the relationship between physical activity and cardiorespiratory and muscular fitness?
b. What is the relationship between physical activity and adiposity/weight status? Does physical activity prevent or reduce the risk of excessive increases in adiposity/weight?
c. What is the relationship between physical activity and cardiometabolic health?
d. What is the relationship between physical activity and bone health?
e. Are there dose-response relationships? If so, what are the shapes of those relationships?
f. Do the relationships vary by age, sex, race/ethnicity, weight status, or socio-economic status?

Sources of Evidence: Existing Systematic Reviews and Meta-Analyses

Conclusion Statements and Grades

Strong evidence demonstrates that, in children and adolescents, higher amounts of physical activity are associated with more favorable status for multiple health indicators, including cardiorespiratory and muscular fitness, bone health, and weight status or adiposity. **PAGAC Grade: Strong.**

Moderate evidence indicates that physical activity is positively associated with cardiometabolic health in children and adolescents. **PAGAC Grade: Moderate.**

Strong evidence demonstrates that increased moderate-to-vigorous physical activity increases cardiorespiratory fitness and that increased resistance exercise increases muscular fitness in children and adolescents. **PAGAC Grade: Strong.**

Strong evidence demonstrates that higher levels of physical activity are associated with smaller increases in weight and adiposity during childhood and adolescence. **PAGAC Grade: Strong.**

Moderate evidence indicates that physical activity is positively associated with cardiometabolic health in children and adolescents in general; the evidence is strong for plasma triglycerides and insulin. **PAGAC Grade: Moderate.**

Strong evidence demonstrates that children and youth who are more physically active than their peers have higher bone mass, improved bone structure, and greater bone strength. **PAGAC Grade: Strong**.

Available evidence is insufficient to determine the dose-response relationship between physical activity and health effects during childhood and adolescence. **PAGAC Grade: Not assignable.**

Available evidence is insufficient to determine whether the relationship between physical activity and health effects in youth is moderated by age, sex, race/ethnicity, weight status or socioeconomic status. **PAGAC Grade: Not assignable.**

Description of the Evidence

An initial search for systematic reviews, meta-analyses, pooled analyses, and reports identified sufficient literature to answer the research question as determined by the Youth Subcommittee. Additional searches for original research were not needed.

CARDIORESPIRATORY AND MUSCULAR FITNESS

Existing Systematic Reviews and Meta-Analyses

Overview

A total of 15 existing reviews that examined the association between physical activity and cardiorespiratory fitness were included: 6 meta-analyses[1-6] and 9 systematic reviews.[7-15]

The meta-analyses included a range of 9 to 32 studies and covered the following timeframes: from 1980 to 2008 and 2014[1, 2]; 1995 to 2005 and 2007[3, 4]; inception to 2012[5]; and inception to 2011.[6]

The systematic reviews included a range of 9 to 73 studies. The systematic reviews covered the following timeframes: 1985 to 2011 and 2013[7, 8]; 2008 to 2012[9]; inception to 2011[10]; 2000 to 2010[11]; 2000 to 2014[12]; inception to 2012[13]; no time limits[14]; and 2010 to 2016.[15]

Exposures

The meta-analyses examined various types of physical activity. Two meta-analyses focused on aerobic exercise,[3, 4] and two included aerobic and/or strength training.[5, 6] Beets et al[1] examined after-school interventions to promote moderate-to-vigorous physical activity (MVPA) and Clark[2] compared different combinations of endurance and resistance exercise alone or combined with dietary interventions.

The systematic reviews assessed different types of physical activity interventions including active video games or "exergames,"[8, 9, 15] structured exercise and/or sports,[11, 14] school-based interventions,[7, 13] and active transportation to school.[10]

Outcomes

All the existing reviews assessed cardiorespiratory fitness measured using a variety of maximum oxygen consumption (VO2max) tests.

ADIPOSITY/WEIGHT STATUS

Existing Systematic Reviews and Meta-Analyses

Overview

A total of 10 existing reviews that examined the association between physical activity and adiposity/weight status were included: 4 meta-analyses[4, 16-18] and 6 systematic reviews.[19-24]

The meta-analyses included a range of 6 to 37 studies and covered the following timeframes: from 1995 to 2007[4]; inception to 2010 and 2012[16, 17]; and 2000 to 2008.[18]

The systematic reviews included a range of 7 to 86 studies. The systematic reviews covered the following timeframes: 1950 to 2008[19]; 2000 to 2010[20]; 1990 to 2010, 2012, and 2014[21-23]; and inception to 2011.[24]

Exposures

The included reviews examined various types of physical activity including aerobic and/or resistance exercise[4, 19, 20] and school-based interventions.[16] Pate et al[21] and te Velde et al[23] assessed total physical activity and MVPA. Ramires et al[22] examined total, leisure, and transportation physical activity.

Outcomes

All the existing reviews assessed adiposity/weight status. The majority of reviews assessed adiposity measured with dual-energy X-ray absorptiometry and weight status using body mass index. Other measures included skin folds and bioelectrical impedance analysis.

CARDIOMETABOLIC HEALTH

Existing Systematic Reviews and Meta-Analyses

Overview

A total of 9 existing reviews that examined the association between physical activity and cardiometabolic health were included: 7 meta-analyses[2-5, 25-27] and 2 systematic reviews.[19, 28]

The meta-analyses included a range of 7 to 24 studies and covered the following timeframes: from 1980 to 2008 and 2014[2]; 1900 to 2012 and 2013[25, 27]; inception to 2013[26]; 1995 to 2005 and 2007[3, 4]; and inception to 2012.[5]

The systematic reviews included 86[19] and 27[28] studies, and covered the following timeframe: 1950 to 2008 and 2000 to 2010, respectively.

Exposures

The included existing reviews examined various types of physical activity. Three reviews focused on aerobic exercise[3, 4, 27] and 3 included aerobic and/or strength training.[5, 19, 28] Clark[2] compared different combinations of endurance and resistance exercise alone or combined with dietary interventions.

Outcomes

The included reviews examined cardiometabolic health outcomes including lipid profile, blood pressure, and glucose level.

BONE HEALTH

Existing Systematic Reviews and Meta-Analyses

Overview

A total of 10 existing reviews that examined the association between physical activity and bone health were included: 4 meta-analyses[16, 29-31] and 6 systematic reviews.[12, 19, 32-35]

The meta-analyses included a range of 12 to 22 studies and covered the following timeframes: from 1992 to 2010[29]; inception to 2012[16]; timeframe not reported[30]; and 2009 to 2015.[31]

The systematic reviews included a range of 14 to 86 studies. The systematic reviews covered the following timeframes: from 1964 to 2005[32]; 1950 to 2008[19]; 1887 to 2013[33]; 2000 to 2014[12, 35]; and 1921 to 2013.[34]

Exposures

The included existing reviews examined various types of physical activity, including weight bearing plyometric and non-plyometric exercise[29, 31] and high-impact weight-bearing exercise.[16, 30] Julián-Almárcegui et al[33] assessed non-weight bearing and weight bearing exercise. Mura et al[12] examined school-based interventions. Tan et al[34] and Weaver et al[35] examined weight-bearing physical activity including recreational and organized sports.

Outcomes

All the included reviews assessed bone health outcomes including bone mineral content, bone mineral density, and bone area.

Populations Analyzed

The table below lists the populations analyzed in each article.

Table 1. Populations Analyzed by All Sources of Evidence

	Sex	Age	Weight Status	Other
Beets, 2009		Children ≤18		
Clark, 2015		Children 6–18	Overweight	
Dobbins, 2013		Children 6–18		
Escalante, 2012		Children ≤14	Obese	
Fedewa, 2014		Children 6–19		
Gao, 2014		Children ≤18		
Garcia-Hermoso, 2013		Children ≤14	Obese	
Guinhouya, 2011		Children 6–18		
Hind, 2007		Children 8–17		Prepubertal, early pubertal, pubertal.
Ishikawa, 2013	Female	Youth		Prepubertal, early pubertal, pubertal.
Janssen, 2010		Children 5–17		
Julián-Almárcegui, 2015		Children 3–20		
Kelley, 2007		Children 5–19	Overweight and Obese	
Kelley, 2008		Children 5–19		
Kelley, 2014		Children 2–18	Overweight and Obese	
Laframboise, 2011		Children ≤18		
Lamboglia, 2013		Children 6–15		
Larouche, 2014		Children 5–17		
Millard-Stafford, 2013		Children 5–18	Overweight and Obese	
Mura, 2015		Children 3–18		
Nogueira, 2014		Children 5–17		
Pate, 2013		Children 5–18		

	Sex	Age	Weight Status	Other
Ramires, 2015		Children 8–14 baseline; 12–20 follow-up		
Saavedra, 2011		Children <18		
Specker, 2015	Male, Female	Children 3–18		Prepubertal, early pubertal, pubertal, postpubertal
Sun, 2013		Children 5–18		
Tan, 2014		Children 5–18		
te Velde, 2012		Children 4–6 baseline; <18 follow-up		
Timmons, 2012		Infants, toddlers, preschoolers		
Vasconcellos, 2014		Children 12–17	Overweight and Obese	
Waters, 2011		Children 0–5, 6–12, 13–18		
Weaver, 2016		≤21		
Wilks, 2011		Children 4–11		
Xu, 2016	Female	Children, adolescents		
Zeng, 2016		Children 8–19	Overweight and Obese	

Supporting Evidence

Existing Systematic Reviews and Meta-Analyses

Table 2. Existing Systematic Reviews and Meta-Analyses Individual Evidence Summary Tables

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Beets MW, Beighle A, Erwin HE, Huberty JL. After-school program impact on physical activity and fitness: a meta-analysis. Am J Prev Med. 2009;36(6):527–537. doi:10.1016/j.amepre.2009.01.033.</td></tr>
<tr><td>Purpose: To provide a systematic review of published research examining after-school programs targeting youth PA.</td><td rowspan="5">Abstract: CONTEXT: The majority of children do not participate in sufficient amounts of daily, health-enhancing physical activity. One strategy to increase activity is to promote it within the after-school setting. Although promising, the effectiveness of this strategy is unclear. A systematic review was performed summarizing the research conducted to date regarding the effectiveness of after-school programs in increasing physical activity. EVIDENCE ACQUISITION: Databases, journals, and review articles were searched for articles published between 1980 and February 2008. Meta-analysis was conducted during July of 2008. Included articles had the following characteristics: findings specific to an after-school intervention in the school setting; subjects aged <or=18 years; an intervention component designed to promote physical activity; outcome measures of physical activity, related constructs, and/or physical fitness. Study outcomes were distilled into six domains: physical activity, physical fitness, body composition, blood lipids, psychosocial constructs, and sedentary activities. Effect sizes (Hedge's g) were calculated within and across studies for each domain, separately. EVIDENCE SYNTHESIS: Of the 797 articles found, 13 unique articles describing findings from 11 after-school interventions were reviewed. Although physical activity was a primary component of all the tested interventions, only eight studies measured physical activity. From the six domains, positive effect sizes were demonstrated for physical activity (0.44 [95% CI=0.28-0.60]); physical fitness (0.16 [95% CI=0.01-0.30]); body composition (0.07 [95% CI=0.03-0.12]); and blood lipids (0.20 [95% CI=0.06-0.33]). CONCLUSIONS: The limited evidence suggests that after-school programs can improve physical activity levels and other health-related aspects. Additional studies are required that provide greater attention to theoretical rationale, levels of implementation, and measures of physical activity within and outside the intervention.</td></tr>
<tr><td>Timeframe: 1980–February 2008</td></tr>
<tr><td>Total # of Studies: 13 (only 8 measured PA)</td></tr>
<tr><td>Exposure Definition: After-school interventions to promote PA reported as bodily movement related to moderate physical activity (MPA); vigorous physical activity (VPA); total MVPA; total activity counts derived from accelerometers; daily step counts; or self-reported measures.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: PA: self report and objective measures, including accelerometers for steps or MVPA. Secondary outcomes: physical fitness, body composition, lipids, psychosocial activity, and sedentary activity.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Children ≤18</td><td>Author-Stated Funding Source: Not Reported</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness, Cardiometabolic Health</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Clark JE. Does the type of intervention method really matter for combating childhood obesity? A systematic review and meta-analysis. J Sports Med Phys Fitness. 2015;55(12):1524–1543.</td></tr>
<tr><td>Purpose: To explore the current understanding of changes elicited to body morphology in children and adolescents, with analysis for relative effectiveness on population-based studies related to diet, diet and exercise, or strictly exercise intervention used to induce body mass reduction (i.e. weight loss) and improvements in at least one other health measure.</td><td rowspan="5">Abstract: With the epidemic rise in obesity and related health issues in children and adolescents there have been numerous types of treatments established to slow or reverse this trend. In an effort to examine the effect of responses to the methods used for treatment, a systematic review of the current literature was performed. From 32 included studies, 120 distinct treatment groups were selected based on the treatment methods used to assess the effect for that treatment, with effect for each treatment based on the effect size (ES) for eliciting changes in body morphology, blood lipid profiles, and hormones (insulin, leptin, adiponectin) that have been linked to metabolic issues. Additionally, treatments were compared for effectiveness in eliciting changes in the aerobic capacity and for eliciting changes in caloric balance. In total three distinct ES patterns were observed, the first based on treatment and therapeutic ES the use of patterns of physical activity and exercise (endurance, ET, or resistance, RT) are more effective than dieting alone. The second, including organized exercise, showed to be a more effective treatment than a general physical activity program. The third including those treatments that were most effective in eliciting a caloric deficit which did not show the greatest impact on effectiveness of improving health status (e.g., hormone levels, blood lipids, and cardiorespiratory fitness). Thus, children and adolescent who are overweight should be encouraged to engage in organized bouts of physical activity that is meant to establish chronic stimulus for physiological response to the exercise stimulus and not rely solely on the establishment of an acute caloric deficit.</td></tr>
<tr><td>Timeframe: January 1980–January 2014</td></tr>
<tr><td>Total # of Studies: 32 (7 diet only)</td></tr>
<tr><td>Exposure Definition: Childhood obesity interventions that focused on PA in overweight children. Subgroups: diet only, diet with endurance exercise, diet with combined exercise, endurance exercise only, resistance exercise, and all exercise interventions.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Primary outcomes: Body mass, fat-free mass, fat mass, and body mass index. Secondary outcomes: lipid profile.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Children 6–18; Overweight</td><td>Author-Stated Funding Source: No funding source used</td></tr>
</table>

Cardiorespiratory and Muscular Fitness	
Systematic Review **Citation:** Dobbins M, Husson H, DeCorby K, LaRocca RL. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database Syst Rev.* 2013;(2):CD007651. doi:10.1002/14651858.CD007651.pub2.	
Purpose: To evaluate the effects of school-based interventions on promoting PA and fitness in children and adolescents. **Timeframe:** 1985–2011 **Total # of Studies:** 44 **Exposure Definition:** Interventions included changes to school curriculum and school routines to increase time spent on PA and time spent in vigorous PA during physical education; provision of equipment; training for teachers in incorporating PA into school; and educational materials for teachers, students, and parents. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Systolic and diastolic blood pressure (mmHg). Blood cholesterol (mg/dL). Maximal oxygen consumption (VO2max). **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Abstract:** Background: The World Health Organization (WHO) estimates that 1.9 million deaths worldwide are attributable to physical inactivity and at least 2.6 million deaths are a result of being overweight or obese. In addition, WHO estimates that physical inactivity causes 10% to 16% of cases each of breast cancer, colon, and rectal cancers as well as type 2 diabetes, and 22% of coronary heart disease and the burden of these and other chronic diseases has rapidly increased in recent decades.Objectives: The purpose of this systematic review was to summarize the evidence of the effectiveness of school-based interventions in promoting physical activity and fitness in children and adolescents. Search methods: The search strategy included searching several databases to October 2011. In addition, reference lists of included articles and background papers were reviewed for potentially relevant studies, as well as references from relevant Cochrane reviews. Primary authors of included studies were contacted as needed for additional information. Selection criteria: To be included, the intervention had to be relevant to public health practice (focused on health promotion activities), not conducted by physicians, implemented, facilitated, or promoted by staff in local public health units, implemented in a school setting and aimed at increasing physical activity, included all school-attending children, and be implemented for a minimum of 12 weeks. In addition, the review was limited to randomized controlled trials and those that reported on outcomes for children and adolescents (aged 6 to 18 years). Primary outcomes included: rates of moderate to vigorous physical activity during the school day, time engaged in moderate to vigorous physical activity during the school day, and time spent watching television. Secondary outcomes related to physical health status measures including: systolic and diastolic blood pressure, blood cholesterol, body mass index (BMI), maximal oxygen uptake (VO2max), and pulse rate. Data collection and analysis: Standardized tools were used by two independent reviewers to assess each study for relevance and for data extraction. In addition, each study was assessed for risk of bias as specified in the Cochrane Handbook for Systematic Reviews of Interventions. Where discrepancies existed, discussion occurred until consensus was reached. The results were summarized narratively due to wide variations in the populations, interventions evaluated, and outcomes measured. Main results: In the original review, 13,841 records were identified and screened, 302 studies were assessed for eligibility, and 26 studies were included in the review. There was some evidence that school-based physical activity interventions had a positive impact on four of the nine outcome measures. Specifically positive effects were observed for duration of physical activity, television viewing, VO2 max, and blood cholesterol. Generally, school-based interventions had little effect on physical activity rates, systolic and diastolic blood pressure, BMI, and pulse rate. At a minimum, a combination of

	printed educational materials and changes to the school curriculum that promote physical activity resulted in positive effects. In this update, given the addition of three new inclusion criteria (randomized design, all school-attending children invited to participate, minimum 12-week intervention) 12 of the original 26 studies were excluded. In addition, studies published between July 2007 and October 2011 evaluating the effectiveness of school-based physical interventions were identified and if relevant included. In total an additional 2378 titles were screened of which 285 unique studies were deemed potentially relevant. Of those 30 met all relevance criteria and have been included in this update. This update includes 44 studies and represents complete data for 36,593 study participants. Duration of interventions ranged from 12 weeks to six years.Generally, the majority of studies included in this update, despite being randomized controlled trials, are, at a mi imum, at moderate risk of bias. The results therefore must be interpreted with caution. Few changes in outcomes were observed in this update with the exception of blood cholesterol and physical activity rates. For example blood cholesterol was no longer positively impacted upon by school-based physical activity interventions. However, there was some evidence to suggest that school-based physical activity interventions led to an improvement in the proportion of children who engaged in moderate to vigorous physical activity during school hours (odds ratio (OR) 2.74, 95% confidence interval (CI), 2.01 to 3.75). Improvements in physical activity rates were not observed in the original review. Children and adolescents exposed to the intervention also spent more time engaged in moderate to vigorous physical activity (with results across studies ranging from five to 45 min more), spent less time watching television (results range from five to 60 min less per day), and had improved VO2max (results across studies ranged from 1.6 to 3.7 mL/kg per min). However, the overall conclusions of this update do not differ significantly from those reported in the original review. Authors' conclusions: The evidence suggests the ongoing implementation of school-based physical activity interventions at this time, given the positive effects on behavior and one physical health status measure. However, given these studies are at a minimum of moderate risk of bias, and the magnitude of effect is generally small, these results should be interpreted cautiously. Additional research on the long-term impact of these interventions is needed.
Populations Analyzed: Children 6–18	**Author-Stated Funding Source:** Cochrane Health Promotion and Public Health Field– Australia, City of Hamilton Public Health Services–Canada

<table>
<tr><th colspan="2">Cardiometabolic Health</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Escalante Y, Saavedra JM, García-Hermoso A, Domínguez AM. Improvement of the lipid profile with exercise in obese children: a systematic review. Prev Med. 2012;54(5):293–301. doi:10.1016/j.ypmed.2012.02.006.</td></tr>
<tr><td>Purpose: To examine the evidence for the effectiveness of diverse exercise interventions on the lipid profile of obese children.</td><td rowspan="5">Abstract: OBJECTIVE:
The objective of this systematic review was to assess the effectiveness of different physical exercise interventions on the lipid profile (high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), and triglycerides (TG)) of obese children.
METHOD:
A computerized search was made of seven databases using keywords. Effect sizes (ES) and 95% confidence intervals were calculated, and the heterogeneity (I(2)) of the studies was estimated using Cochran's Q-statistic applied to the effect size means. The studies were grouped according to the intervention program-aerobic alone or combined (aerobic fitness, strength, and flexibility).
RESULTS:
Seven studies were selected for review as satisfying the inclusion criteria. Six were randomized controlled trials (n=318) and one was a controlled clinical trial (groups not randomly assigned) (n=38). The main cumulative evidence indicates that the programs based on aerobic exercise alone have a moderate (ES=-0.49; I^2=87) and a large effect (ES=-0.55; I^2=77) on LDL-C and TG concentrations, respectively; and the programs based on combined exercise have a moderate effect (ES=0.50; I^2=0) on HDL-C concentration.
CONCLUSIONS:
The programs based on aerobic exercise (60 min, 3 times/week, ≤75% maximum heart rate) improve the LDL-C and TG concentrations. Moreover, the programs based on combined exercise (≥60 min, >75% maximum heart rate) also improve the HDL-C concentration.</td></tr>
<tr><td>Timeframe: 1900–January 2012</td></tr>
<tr><td>Total # of Studies: 7</td></tr>
<tr><td>Exposure Definition: Intervention: physical exercise of duration more than 8 weeks, excluding studies in which exercise was part of a multi component therapy involving a combination of aerobic and psychological therapies.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Lipid and lipoprotein parameters (HDL-C, LDL-C, TC, and TG).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children ≤14; Obese</td><td>Author-Stated Funding Source: European Regional Development Fund, the Autonomous Government of Extremadura</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiometabolic Health</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Fedewa MV, Gist NH, Evans EM, Dishman RK. Exercise and insulin resistance in youth: a meta-analysis. Pediatrics. 2014;133(1):e163–e174. doi:10.1542/peds.2013-2718.</td></tr>
<tr><td>Purpose: To provide quantitative effect size of exercise training on fasting insulin and insulin resistance among children and adolescents.</td><td rowspan="5">Abstract: BACKGROUND AND OBJECTIVES: The prevalence of obesity and diabetes is increasing among children, adolescents, and adults. Although estimates of the efficacy of exercise training on fasting insulin and insulin resistance have been provided, for adults similar estimates have not been provided for youth. This systematic review and meta-analysis provides a quantitative estimate of the effectiveness of exercise training on fasting insulin and insulin resistance in children and adolescents.
METHODS: Potential sources were limited to peer-reviewed articles published before June 25, 2013, and gathered from the PubMed, SPORTDiscus, Physical Education Index, and Web of Science online databases. Analysis was limited to randomized controlled trials by using combinations of the terms adolescent, child, pediatric, youth, exercise training, physical activity, diabetes, insulin, randomized trial, and randomized controlled trial. The authors assessed 546 sources, of which 4.4% (24 studies) were eligible for inclusion. Thirty-two effects were used to estimate the effect of exercise training on fasting insulin, with 15 effects measuring the effect on insulin resistance. Estimated effects were independently calculated by multiple authors, and conflicts were resolved before calculating the overall effect.
RESULTS: Based on the cumulative results from these studies, a small to moderate effect was found for exercise training on fasting insulin and improving insulin resistance in youth (Hedges' d effect size = 0.48 [95% confidence interval: 0.22–0.74], P < .001 and 0.31 [95% confidence interval: 0.06–0.56], P < .05, respectively).
CONCLUSIONS: These results support the use of exercise training in the prevention and treatment of type 2 diabetes.</td></tr>
<tr><td>Timeframe: Inception–June 2013</td></tr>
<tr><td>Total # of Studies: 24</td></tr>
<tr><td>Exposure Definition: Exercise training
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Fasting insulin or insulin resistance measures at baseline, during, and/or after exercise training.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 6–19</td><td>Author-Stated Funding Source: No funding source used</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Gao Z, Chen S. Are field-based exergames useful in preventing childhood obesity? A systematic review. Obes Rev. 2014;15(8):676–691. doi:10.1111/obr.12164.</td></tr>
<tr><td>Purpose: To synthesize the exergame-related research carried out in less controlled field-based settings including homes, schools, and communities, and discuss the effectiveness of exergames on children's obesity-related outcomes.</td><td rowspan="5">Abstract: Exergames have started to find their way into field-based settings, such as schools, communities and homes, as a possible solution to curbing physical inactivity and childhood obesity. However, a clear view of the effects of field-based exergaming on children's obesity-related outcomes is lacking. Hence, a systematic review on this topic is warranted. This review synthesizes the impact of field-based exergames on children's physical and psychosocial outcomes. A total of 34 articles conducted in field-based settings were identified from 104 peer-reviewed publications that investigated the effects of exergames. Upon screening, these articles met the inclusion criteria and a high inter-rater agreement for inclusion was reached between the authors. The effects of field-based exergames on children's habitual physical activity (PA) and obesity-related outcomes (e.g. weight loss, body composition) remain unclear due to design problems, measurement issues and other methodology concerns. In addition, exergame is appealing to children, although strategies are warranted to sustain their interests. In summary, exergames are desirable as a promising addition to promote PA and health. Professionals may integrate exergames at field settings to promote a physically active lifestyle among children with the goal of curbing childhood obesity.</td></tr>
<tr><td>Timeframe: 1985–2013</td></tr>
<tr><td>Total # of Studies: 34</td></tr>
<tr><td>Exposure Definition: Exergaming or active video games in a field-based setting.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Obesity-related outcome variables: maximal oxygen consumption (VO2), body composition, and cardiovascular fitness.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Children ≤18</td><td>Author-Stated Funding Source: Not Reported</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiometabolic Health</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: García-Hermoso A, Saavedra JM, Escalante Y. Effects of exercise on resting blood pressure in obese children: a meta-analysis of randomized controlled trials. Obes Rev. 2013;14(11):919–928. doi:10.1186/s13098-015-0034-3.</td></tr>
<tr><td>Purpose: To examine the evidence for the effectiveness of exercise interventions on the resting blood pressure of obese children.</td><td rowspan="4">Abstract: The purpose of this meta-analysis was to examine the evidence for the effectiveness of exercise interventions on the resting blood pressure (systolic and diastolic) of obese children. A computerized search was made of seven databases using keywords. Effect sizes (ES) and 95% confidence intervals were calculated, and the heterogeneity of the studies was estimated using Cochran's Q-statistic applied to the effect size means. Nine randomized controlled trial (RCT) studies were selected for review as satisfying the inclusion criteria (n = 205 exercise, 205 control). The main cumulative evidence indicates that the exercise programmes with a frequency of three sessions weekly lasting longer than 60 min had a moderate effect on systolic blood pressure (ES = -0.46, I(2) = 27%), and programmes of under 12 weeks with more than three sessions weekly were beneficial in terms of reduction of diastolic blood pressure (ES = -0.35, I(2) = 78%).</td></tr>
<tr><td>Timeframe: 1900–April 2013, depending on the database</td></tr>
<tr><td>Total # of Studies: 9</td></tr>
<tr><td>Exposure Definition: Mainly aerobic exercise and sports such as treadmills, cycle ergometers, aerobic sliders, running, walking, skipping rope, soccer, basketball, handball, swimming, and water games. Duration of the program: 8–24 weeks, frequency 2–6 days/week, 30–90 min, intensity: 55–75% to 65–85% maximum heart rate.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Resting blood pressure (systolic and diastolic): manual or electronic sphygmomanometer and appropriate size cuff, two or three readings. Interval between readings was 5–10 min (rest period), and final value taken as the mean of these values.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children ≤14; Obese</td><td>Author-Stated Funding Source: European Regional Development Fund, the Autonomous Government of Extremadura</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiometabolic Health</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Guinhouya BC, Samouda H, Zitouni D, Vilhelm C, Hubert H. Evidence of the influence of physical activity on the metabolic syndrome and/or on insulin resistance in pediatric populations: a systematic review. Int J Pediatr Obes. 2011;6(5–6):361–388. doi:10.3109/17477166.2011.605896.</td></tr>
<tr><td>Purpose: To systematically review and analyze data about the relationships between youth activity behavior and metabolic abnormalities as conceptualized by metabolic syndrome and/or insulin resistance.</td><td rowspan="4">Abstract: This study is aimed at updating the relationships between physical activity (PA) and the metabolic syndrome (MetS) and/or insulin resistance (IR) in youth. Cross-sectional, prospective cohort and intervention studies, which examined the effect of PA on MetS, its components and IR in children and adolescents (<18 yrs), were searched by applying a combination of criteria in the PubMed database. The electronic search of studies published from 2000-2010 yielded >150 references. Of these, 37 studies were included. Twenty-six studies (70%) were cross-sectional observation studies, and two studies (8%) were prospective cohort studies. The remaining eight studies (22%) were interventions, of which three (<10% of all included studies) were randomized controlled trials. Commonly, higher PA levels were consistently associated with an improved metabolic profile and a reduced risk for MetS and/or IR in these populations. The impact of PA on MetS and/or IR appeared to be either independent of other factors, or alternatively or simultaneously mediated by the physical fitness and adiposity of youth. However, more-robustly designed interventions (i.e., some mega-randomized controlled trials based on lifestyle interventions) and additional cohort studies are required to make definitive inference about the magnitude and role of PA as a single genuine preventive and treatment strategy for the metabolic and cardiovascular risk of youth in the current obesogenic context.</td></tr>
<tr><td>Timeframe: 2000–2010</td></tr>
<tr><td>Total # of Studies: 37</td></tr>
<tr><td>Exposure Definition: PA: a variety of PA types including aerobic, resistance, or mixed exercise; organized and non-organized sessions. Included studies assessed PA in various ways including accelerometer and self-reported.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Changes in metabolic syndrome factors, including glucose level, dylipidemia, blood pressure, and waist circumference. Metabolic syndrome: a continuous z-score or a score based on the number of criteria met.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 6–18</td><td>Author-Stated Funding Source: Not Reported</td></tr>
</table>

<table>
<tr><th colspan="2">Bone Health</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Hind K, Burrows M. Weight-bearing exercise and bone mineral accrual in children and adolescents: a review of controlled trials. Bone. 2007;40:14–27. doi:10.1016/j.bone.2006.07.006.</td></tr>
<tr><td>Purpose: To evaluate the effects of exercise on bone mineral accrual in children and adolescents.
Timeframe: 1964–2005
Total # of Studies: 22
Exposure Definition: Exercise interventions targeting bone mass in children. Interventions varied in type and duration (including jumping, circuit training, gymnastics, resistance exercise, etc.).
Measures Steps: No
Measures Bouts: No
Examines HIIT: No
Outcomes Addressed: Percentage increase in bone mass parameters (bone mineral content, areal bone mineral density, and volumetric bone mineral density).
Examine Cardiorespiratory Fitness as Outcome: No</td><td>Abstract: INTRODUCTION:
Osteoporosis is a serious skeletal disease and as there is currently no cure, there is a large emphasis on its prevention, including the optimisation of peak bone mass. There is increasing evidence that regular weight-bearing exercise is an effective strategy for enhancing bone status during growth. This systematic review evaluates randomised and non-randomised controlled trials to date, on the effects of exercise on bone mineral accrual in children and adolescents.
METHODS:
An online search of Medline and the Cochrane database enabled the identification of studies. Those that met the inclusion criteria were included in the review and graded according to risk for bias.
RESULTS:
Twenty-two trials were reviewed. Nine were conducted in prepubertal children (Tanner I), 8 in early pubertal (Tanner II-III) and 5 in pubertal (Tanner IV-V). Sample sizes ranged from n=10 to 65 per group. Exercise interventions included games, dance, resistance training and jumping exercises, ranging in duration from 3 to 48 months. Approximately half of the trials (n=10) included ground reaction force (GRF) data (2 to 9 times body weight). All trials in early pubertal children, 6 in pre pubertal and 2 in pubertal children, reported positive effects of exercise on bone (P<0.05). Mean increases in bone parameters over 6 months were 0.9-4.9% in prepubertal, 1.1-5.5% in early pubertal and 0.3-1.9% in pubertal exercisers compared to controls (P<0.05).
CONCLUSIONS:
Although weight-bearing exercise appears to enhance bone mineral accrual in children, particularly during early puberty; it remains unclear as to what constitutes the optimal exercise programme. Many studies to date have a high risk for bias and only a few have a low risk. Major limitations concerned selection procedures, compliance rates and control of variables. More well designed and controlled investigations are needed. Furthermore, the specific exercise intervention that will provide the optimal stimulus for peak bone mineral accretion is unclear. Future quantitative, dose-response studies using larger sample sizes and interventions that vary in GRF and frequency may characterise the most and least effective exercise programmes for bone mineral accrual in this population. In addition, the measurement of bone quality parameters and volumetric BMD would provide a greater insight into the mechanisms implicated in the adaptation of bone to exercise.</td></tr>
<tr><td>Populations Analyzed: Children 8–17; Pubertal status (prepubertal, early pubertal, and pubertal)</td><td>Author-Stated Funding Source: Not Reported</td></tr>
</table>

Bone Health	
Meta-Analysis **Citation:** Ishikawa S, Kim Y, Kang M, Morgan DW. Effects of weight-bearing exercise on bone health in girls: a meta-analysis. *Sports Med.* 2013;43(9):875–892. doi:10.1007/s40279-013-0060-y.	
Purpose: To evaluate the impact of weight-bearing exercise on the bone health of female children and adolescents and quantify the influence of key moderating variables on skeletal development in this cohort.	**Abstract:** BACKGROUND: Because growing bone possesses a greater capacity to adapt to mechanical loading than does mature bone, it is important for girls to engage in weight-bearing activities, especially since the prevalence of osteoporosis among older women is considerably higher than that of older men. In recent years, the osteogenic potential of weight-bearing activities performed by children and adolescents has received increasing attention and accumulating evidence suggests that this type of activity may improve bone health prior to adulthood and help prevent osteoporosis later in life. OBJECTIVE: Because previous interventions have varied with respect to the exercise parameters studied and sometimes produced conflicting findings, this meta-analysis was undertaken to evaluate the impact of weight-bearing exercise on the bone health of female children and adolescents and quantify the influence of key moderating variables (e.g. pubertal stage, exercise mode, intervention strategy, exercise duration, frequency of exercise, programme length and study design) on skeletal development in this cohort. METHODS: A comprehensive literature search was conducted using databases such as PubMed, MEDLINE, CINAHL, Web of Science, Physical Education Index, Science Direct and ProQuest. Search terms included 'bone mass', 'bone mineral', 'bone health', 'exercise' and 'physical activity'. Randomized- and non-randomized controlled trials featuring healthy prepubertal, early-pubertal and pubertal girls and measurement of areal bone mineral density (aBMD) or bone mineral content (BMC) using dual energy x-ray absorptiometry were examined. Comprehensive Meta-Analysis software was used to determine weighted mean effect sizes (ES) and conduct moderator analyses for three different regions of interest [i.e. total body, lumbar spine (LS), and femoral neck]. RESULTS: From 17 included studies, 72 ES values were retrieved. Our findings revealed a small, but significant influence of weight-bearing exercise on BMC and aBMD of the LS (overall ES 0.19; 95% confidence interval (CI) 0.05, 0.33 and overall ES 0.26, 95% CI 0.09, 0.43, respectively) and BMC of the femoral neck (ES 0.23; 95% CI 0.10, 0.36). For both aBMD and BMC, overall ES was not affected by any moderator variables except frequency of exercise, such that weight-bearing activity performed for more than 3 days per week resulted in a significantly greater ES value for LS aBMD compared with programmes lasting 3 or fewer days per week [Cochran's Q statistic (Qbetween) = 4.09; $p < 0.05$]. CONCLUSION: The impact of weight-bearing activities seems to be site specific, and a greater frequency of weight-bearing activities is related to greater aBMD of LS in growing girls. Future investigations are warranted to better understand the dose-response relationship between weight-bearing activity and bone health in girls and explore the mediating role of pubertal status in promoting skeletal development among female youth.
Timeframe: 1992–2010	
Total # of Studies: 17	
Exposure Definition: Weight-bearing exercise classified as plyometric (e.g., jumping, hopping) or non-plyometric. Intervention was either school or non-school based. Exercise duration ≤60 min or ≥60 min/week. Frequency ≤ or ≥ 3 days/week. 'Programme length' <12 months or >12 months. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No	
Outcomes Addressed: Changes in total bone mineral content and areal bone mineral density: dual-energy x ray absorptiometry or dual photon absorptiometry, examined in total body, lumbar spine, and femoral.	

Examine Cardiorespiratory Fitness as Outcome: No	
Populations Analyzed: Female; Youth; Prepubertal; early pubertal; pubertal.	**Author-Stated Funding Source:** No funding source used

<table>
<tr><th colspan="2">Adiposity/Weight Status, Cardiometabolic Health, Bone Health</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act. 2010;7:40. doi:10.1186/1479-5868-7-40.</td></tr>
<tr><td>Purpose: To perform a systematic review of the evidence informing the relation between PA and health in school-aged children and youth, defined here as those aged 5–17 years and make recommendations on the appropriate volume, intensity, and type of PA for minimal and optimal health benefits in school-aged children and youth.</td><td rowspan="5">Abstract: BACKGROUND: The purpose was to: 1) perform a systematic review of studies examining the relation between physical activity, fitness, and health in school-aged children and youth, and 2) make recommendations based on the findings. METHODS: The systematic review was limited to 7 health indicators: high blood cholesterol, high blood pressure, the metabolic syndrome, obesity, low bone density, depression, and injuries. Literature searches were conducted using predefined keywords in 6 key databases. A total of 11,088 potential papers were identified. The abstracts and full-text articles of potentially relevant papers were screened to determine eligibility. Data was abstracted for 113 outcomes from the 86 eligible papers. The evidence was graded for each health outcome using established criteria based on the quantity and quality of studies and strength of effect. The volume, intensity, and type of physical activity were considered. RESULTS: Physical activity was associated with numerous health benefits. The dose-response relations observed in observational studies indicate that the more physical activity, the greater the health benefit. Results from experimental studies indicate that even modest amounts of physical activity can have health benefits in high-risk youngsters (e.g., obese). To achieve substantive health benefits, the physical activity should be of at least a moderate intensity. Vigorous intensity activities may provide even greater benefit. Aerobic-based activities had the greatest health benefit, other than for bone health, in which case high-impact weight bearing activities were required. CONCLUSION: The following recommendations were made: 1) Children and youth 5-17 years of age should accumulate an average of at least 60 minutes per day and up to several hours of at least moderate intensity physical activity. Some of the health benefits can be achieved through an average of 30 minutes per day. [Level 2, Grade A]. 2) More vigorous intensity activities should be incorporated or added when possible, including activities that strengthen muscle and bone [Level 3, Grade B]. 3) Aerobic activities should make up the majority of the physical activity. Muscle and bone strengthening activities should be incorporated on at least 3 days of the week [Level 2, Grade A].</td></tr>
<tr><td>Timeframe: 1950–January 2008</td></tr>
<tr><td>Total # of Studies: 86</td></tr>
<tr><td>Exposure Definition: Exercise interventions included aerobic and/or resistance exercise. The studies ranged in length from 4 weeks to 2 years, with most being 4 to 6 months in duration. The duration of exercise prescribed typically ranged from 2 to 3.5 hours per week.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Cholesterol (mg/dL), hypertension (mmHg), obesity (BMI, z scores), and bone density (g/cm2). Specific devices were not described.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 5–17</td><td>Author-Stated Funding Source: Public Health Agency of Canada</td></tr>
</table>

<table>
<tr><th colspan="2">Bone Health</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Julián-Almárcegui C, Gómez-Cabello A, Huybrechts I, et al. Combined effects of interaction between physical activity and nutrition on bone health in children and adolescents: a systematic review. Nutr Rev. 2015;73(3):127–139. doi:10.1093/nutrit/nuu065.</td></tr>
<tr><td>Purpose: To update and summarize existing knowledge about the combined role of PA and diet in bone development during childhood and adolescence.</td><td rowspan="5">Abstract: CONTEXT: Osteoporosis is a major public health concern worldwide. Understanding the roles of diet and physical activity in ensuring adequate bone mass accrual during childhood and adolescence may help identify strategies to reduce the risk of osteoporotic fractures later in life. OBJECTIVE: The present systematic review was conducted to provide an overview of the current knowledge of the combined effects of physical activity and diet on bone mass accrual in children and adolescents. DATA SOURCES: Data were obtained via searches of the PubMed, EMBASE, SPORTDiscus, and ISI Web of Science databases. STUDY SELECTION: Studies published in English and Spanish between 1887 and August 2013 were eligible for inclusion. Two investigators evaluated the studies against the inclusion and exclusion criteria. A total of 14 studies (7 cross-sectional and 7 experimental) were included in the review. DATA EXTRACTION: The Pedro score and the Black and Down's checklist were used to evaluate the methodological quality of the experimental and the cross-sectional studies, respectively. Study characteristics were summarized in accordance with the review's PICO criteria. DATA SYNTHESIS: Significant exercise-by-calcium interaction was detected at several different bone sites. CONCLUSIONS: Although the results of cross-sectional studies were inconsistent, the results of randomized controlled trials showed that exercise has the potential to improve bone health under conditions of adequate calcium intake.</td></tr>
<tr><td>Timeframe: 1887–August 2013</td></tr>
<tr><td>Total # of Studies: 14</td></tr>
<tr><td>Exposure Definition: PA interventions alone or combined with dietary supplementation. Exercise interventions also varied including moderate impact exercise such as hopping, skipping, and jumping. Interventions ranged in duration from 12 weeks to 15 months and number and duration of sessions also varied widely.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Changes in bone mineral content, bone mineral density, or bone area: peripheral quantitative computed tomography or ultrasound parameters.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 3–20</td><td>Author-Stated Funding Source: Ministerio de Ciencia e Innovacion</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness, Adiposity/Weight Status, Cardiometabolic Health</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Kelley GA, Kelley KS. Effects of aerobic exercise on non-high-density lipoprotein cholesterol in children and adolescents: a meta-analysis of randomized controlled trials. Prog Cardiovasc Nurs. 2008;23(3):128–132.</td></tr>
<tr><td>Purpose: To examine the effects of aerobic exercise on non-high-density lipoprotein cholesterol in children and adolescents.</td><td rowspan="4">Abstract: The authors used the meta-analytic approach to examine the effects of aerobic exercise on non-high-density lipoprotein cholesterol (non-HDL-C) in children and adolescents. Thirteen non-HDL-C outcomes in 404 males and females (221 exercise, 183 control) were available for pooling. Random-effects modeling yielded a nonstatistically significant exercise minus control group reduction of 0.61% in non-HDL-C (X +/- SEM, -0.7 +/- 2.4 mg/dL, 95% confidence interval [CI], -5.4 to 5.0 mg/dL). A statistically significant decrease of 7% was found for percent body fat (X +/- SEM, -2.1 +/- 0.5%, 95% CI, -3.0 to -1.2%) as well as an 8% increase in aerobic capacity (X +/- SEM, 3.4 +/- 1.0 mL/kg/min, 95% CI, 1.4-5.3 mL/kg/min), both secondary outcomes of the study. It was concluded that aerobic exercise does not reduce non-HDL-C but does improve percent body fat and aerobic capacity in children and adolescents. However, a need exists for additional studies on this topic.</td></tr>
<tr><td>Timeframe: 1955–2007</td></tr>
<tr><td>Total # of Studies: 12</td></tr>
<tr><td>Exposure Definition: Supervised aerobic exercise included cycle ergometry, walking and jogging, or aerobic dance. Training program lasted between 5 and 16 weeks, 3–5 times/week, with a duration of 20 to 135 minutes/session, and intensity of 44–90 (%VOmax)..
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Changes in non-high-density lipoprotein cholesterol, total cholesterol, high-density lipoprotein cholesterol, body weight, percent body fat, and VO2max.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Children 5–19</td><td>Author-Stated Funding Source: National Institutes of Health—National Heart, Lung and Blood Institute</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness, Cardiometabolic Health</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Kelley GA, Kelley KS. Aerobic exercise and lipids and lipoproteins in children and adolescents: a meta-analysis of randomized controlled trials. Atherosclerosis. 2007;191(2):447-453. doi:10.1016/j.atherosclerosis.2006.04.019</td></tr>
<tr><td>Purpose: To use the meta-analytic approach to examine the effects of aerobic exercise on lipids and lipoproteins in children and adolescents.</td><td rowspan="5">Abstract: OBJECTIVE: Use the meta-analytic approach to examine the effects of aerobic exercise on total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglycerides (TG) in children and adolescents. STUDY DESIGN: Randomized controlled trials which were limited to aerobic exercise >or=4 weeks in children and adolescents 5-19 years of age. RESULTS: Twelve outcomes representing 389 subjects were available for pooling. Using random-effects modeling, a trend for statistically significant decreases of 12% was found for TG (X +/-S.E.M., -11.0+/-6.1mg/dl; 95% CI, -22.8-0.8 mg/dl) with no statistically significant changes for TC, HDL-C, and LDL-C. Decreases in LDL-C were associated with increased training intensity (r=-0.89; 99% CI, -0.99 to -0.04) and older age (r=-0.90; 99% CI, -0.99 to -0.25) while increases in HDL-C were associated with lower initial HDL-C (r=-0.75; 99% CI, -0.94 to -0.80). Statistically significant decreases in TG were observed in overweight/obese subjects with a trend for increases in HDL-C (TG, X +/-S.E.M., -23.9+/-7.0mg/dl; 95% CI, -37.6 to -10.1mg/dl; HDL-C, X +/-S.E.M., 4.0+/-2.3mg/dl; 95% CI, -0.5-8.5mg/dl). CONCLUSIONS: Aerobic exercise decreases TG in overweight/obese children and adolescents.</td></tr>
<tr><td>Timeframe: January 1955-January 2005</td></tr>
<tr><td>Total # of Studies: 12</td></tr>
<tr><td>Exposure Definition: Aerobic exercise training- length ranged from 5 -16 weeks, frequency ranged from 3-5 times per week, duration ranged from 20-60 minutes per session, and intensity ranged from 44-90% of VO2 max. The most common activities were walking, jogging, cycling, and various movements to music.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Blood lipid profile including total cholesterol, HDL, LDL, and triglycerides (mg/dL). Changes in body weight, percent body fat, and maximum oxygen consumpton.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Children 5-19; Overweight and Obese.</td><td>Author-Stated Funding Source: National Institutes of Health-National Heart, Lung and Blood Institute</td></tr>
</table>

Cardiorespiratory and Muscular Fitness, Cardiometabolic Health	
Meta-Analysis **Citation:** Kelley GA, Kelley KS, Pate RR. Effects of exercise on BMI z-score in overweight and obese children and adolescents: a systematic review with meta-analysis. *BMC Pediatr*. 2014;14:225. doi:10.1186/1471-2431-14-225.	
Purpose: To examine the effects of exercise on BMI z-score in overweight and obese children and adolescents. **Timeframe:** Inception–2012 **Total # of Studies:** 10 **Exposure Definition:** Exercise interventions (aerobic, strenght training, or both) lasting >=4 weeks. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** BMI z-score. Body weight. BMI percentile. Body fat (absolute and percent). Fat-free mass. Waist circumference. Waist-to-hip ratio. Resting systolic and diastolic blood pressure. Lipid profile. Fasting glucose. Fasting insulin. Glycosylated hemoglobin. PA levels. Maximum oxygen consumption. Muscular strength. Energy intake. Energy expenditure. **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Abstract:** Background: Overweight and obesity are major public health problems in children and adolescents. The purpose of this study was to conduct a systematic review with meta-analysis to determine the effects of exercise (aerobic, strength or both) on body mass index (BMI) z-score in overweight and obese children and adolescents. Methods: Studies were included if they were randomized controlled exercise intervention trials ≥ 4 weeks in overweight and obese children and adolescents 2 to 18 years of age, published in any language between 1990–2012 and in which data were available for BMI z-score. Studies were retrieved by searching eleven electronic databases, cross-referencing and expert review. Two authors (GAK, KSK) selected and abstracted data. Bias was assessed using the Cochrane Risk of Bias Assessment Instrument. Exercise minus control group changes were calculated from each study and weighted by the inverse of the variance. All results were pooled using a random-effects model with non-overlapping 95% confidence intervals (CI) considered statistically significant. Heterogeneity was assessed using Q and I 2 while funnel plots and Egger's regression test were used to assess for small-study effects. Influence and cumulative meta-analysis were performed as well as moderator and meta-regression analyses. Results: Of the 4,999 citations reviewed, 835 children and adolescents (456 exercise, 379 control) from 10 studies representing 21 groups (11 exercise, 10 control) were included. On average, exercise took place 4 x week for 43 minutes per session over 16 weeks. Overall, a statistically significant reduction equivalent to 3% was found for BMI z-score (X^{---},−0.06,95%CI,−0.09to−0.03;Q=24.9,p=0.01;I2=59.8%). No small-study effects were observed and results remained statistically significant when each study was deleted from the model once. Based on cumulative meta-analysis, results have been statistically significant since 2009. None of the moderator or meta-regression analyses were statistically significant. The number-needed-to treat was 107 with an estimated 116,822 obese US children and adolescents and approximately 1 million overweight and obese children and adolescents worldwide potentially improving their BMI z-score by participating in exercise. Conclusions: Exercise improves BMI z-score in overweight and obese children and adolescents and should be recommended in this population group. However, a need exists for additional studies on this topic.
Populations Analyzed: Children 2–18; Overweight and Obese	**Author-Stated Funding Source:** The American Heart Association, Great Rivers Affiliate, Grant-in-Aid.

Adiposity/Weight status

<table>
<tr><td colspan="2">Systematic Review
Citation: Laframboise MA, Degraauw C. The effects of aerobic physical activity on adiposity in school-aged children and youth: a systematic review of randomized controlled trials. J Can Chiropr Assoc. 2011;55(4):256-268.</td></tr>
<tr><td>Purpose: To determine the quality of current evidence forming the relationship between aerobic PA and adiposity changes in school-aged children and youth.</td><td rowspan="4">Abstract: CONTEXT: The role of aerobic physical activity as a standalone treatment in decreasing adiposity in school-aged children and youth has not been well established. OBJECTIVE: To systematically search and assess the quality of the literature on the efficacy of aerobic physical activity to decrease adiposity in school-aged children and youth. METHODS: An electronic search strategy was conducted in EBSCO databases, including MEDLINE and CINAHL. Retrieved articles that met the eligibility criteria were rated for methodological quality by using the Downs and Black checklist. RESULTS: 10 articles met the inclusion criteria in the form of RCTs. Results indicate that five articles had positive results in decreasing adiposity compared to controls and five articles had no change in adiposity compared to controls. CONCLUSION: There is a paucity of evidence to support aerobic physical activity as a successful standalone treatment for decreasing adiposity. Despite the heterogeneity of the methods there is some evidence to support that school-aged children and youth benefit from aerobic physical activity to decrease adiposity and to limit weight gain.</td></tr>
<tr><td>Timeframe: January 2000–December 2010</td></tr>
<tr><td>Total # of Studies: 10</td></tr>
<tr><td>Exposure Definition: Aerobic exercise interventions ranging from 8 weeks to 8 months; frequency of activity ranging from 1 to 5 days per week; duration of sessions ranging from 30–90 minutes.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed:
Adiposity: variety of outcomes including weight, body mass index, skinfolds, percentage of body fat, waist circumference, trunk, and visceral fat composition.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 0–18</td><td>Author-Stated Funding Source: Not Reported</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Lamboglia CM, da Silva VT, de Vasconcelos Filho JE, et al. Exergaming as a strategic tool in the fight against childhood obesity: a systematic review. J Obes. 2013;2013:438364. doi:10.1155/2013/438364.</td></tr>
<tr><td>Purpose: To evaluate the use of exergaming as a strategic tool for the promotion of healthy behaviors in the fight against childhood obesity.</td><td rowspan="5">Abstract: Improper use of electronic media is considered a major contributing factor to childhood obesity. However, exergames, a new generation of active games, have made it possible to combine electronic entertainment with physical exercise. The purpose of this systematic review was to analyze the use of exergaming as a strategic tool in the fight against childhood obesity. Information was retrieved from the databases SciELO, LILACS, Pubmed, Ebsco, and Science Direct, using the search words “egames,” “exergames,” “exergaming,” “new generation of video games,” “active video games,” “energy expenditure,” “body composition,” and “physical activity” in English and Portuguese, covering the period January 2008 to April 2012. Nine articles met the inclusion criteria. Exergaming was found to increase physical activity levels, energy expenditure, maximal oxygen uptake, heart rate, and percentage of physical activity engaged in and to reduce waist circumference and sedentary screen time. Thus, exergaming may be considered a highly relevant strategic tool for the adoption of an active and healthy lifestyle and may be useful in the fight against childhood obesity.</td></tr>
<tr><td>Timeframe: January 2008–April 2012</td></tr>
<tr><td>Total # of Studies: 9</td></tr>
<tr><td>Exposure Definition: Exergames (combine electronic entertainment with physical exercise).
Measures Steps: Yes
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Energy expenditure. Level of physical activity. Waist circumference. Sedentary time. BMI. Blood pressure. VO2 max. Heart rate. Body fat. Fat mass.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Children 6–15</td><td>Author-Stated Funding Source: CAPES (Brazilian Government Program for Continuing Higher Education), FUNCAP (Ceara State Foundation for Research Support)</td></tr>
</table>

Cardiorespiratory and Muscular Fitness	
Systematic Review **Citation:** Larouche R, Saunders TJ, Faulkner G, Colley R, Tremblay M. Associations between active school transport and physical activity, body composition, and cardiovascular fitness: a systematic review of 68 studies. *J Phys Act Health*. 2014;11(1):206–227. doi:10.1123/jpah.2011-0345.	
Purpose: To examine the association between active school transport, cardiovascular fitness, and various indicators of body composition. **Timeframe:** Inception–April 2011 **Total # of Studies:** 73 **Exposure Definition:** Active school transport (cyclists and walkers). **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Body composition (BMI, waist circumference, skinfolds, etc.). Cardiovascular fitness (VO2 max). **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Abstract:** BACKGROUND: The impact of active school transport (AST) on daily physical activity (PA) levels, body composition and cardiovascular fitness remains unclear. METHODS: A systematic review was conducted to examine differences in PA, body composition and cardiovascular fitness between active and passive travelers. The Medline, PubMed, Embase, PsycInfo, and ProQuest databases were searched and 10 key informants were consulted. Quality of evidence was assessed with GRADE and with the Effective Public Health Practice Project tool for quantitative studies. RESULTS: Sixty-eight different studies met the inclusion criteria. The majority of studies found that active school travelers were more active or that AST interventions lead to increases in PA, and the quality of evidence is moderate. There is conflicting, and therefore very low quality evidence, regarding the associations between AST and body composition indicators, and between walking to/from school and cardiovascular fitness; however, all studies with relevant measures found a positive association between cycling to/from school and cardiovascular fitness; this evidence is of moderate quality. CONCLUSION: These findings suggest that AST should be promoted to increase PA levels in children and adolescents and that cycling to/ from school is associated with increased cardiovascular fitness. Intervention studies are needed to increase the quality of evidence.
Populations Analyzed: Children 5–17	**Author-Stated Funding Source:** Not Reported

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Millard-Stafford M, Becasen JS, Beets MW, Nihiser AJ, Lee SM, Fulton JE. Is physical fitness associated with health in overweight and obese youth? A systematic review. Kinesiol Rev (Champaign). 2013;2(4):233–247.</td></tr>
<tr><td>Purpose: To systematically examine and summarize a decade of peer-reviewed literature describing the association between selected components of physical fitness on health in school-aged youth who are overweight and obese and whether improvements in fitness are associated with beneficial changes in measures of chronic disease including adiposity, cardiovascular, or metabolic health risk factors.</td><td rowspan="5">Abstract: A systematic review of literature was conducted to examine the association between changes in health-related fitness (e.g. aerobic capacity and muscular strength /endurance) and chronic disease risk factors in overweight and/or obese youth. Studies published from 2000-2010 were included if the physical activity intervention was a randomized controlled trial and reported changes in fitness and health outcomes by direction and significance (p< 0.05) of the effect. Aerobic capacity improved in 91% and muscular fitness improved in 82% of measures reported. Nearly all studies (32 of 33) reported improvement in at least one fitness test. Changes in outcomes related to adiposity, cardiovascular, musculoskeletal, metabolic, and mental/emotional health improved in 60%, 32%, 53%, 41%, and 33% of comparisons studied, respectively. In conclusion, overweight and obese youth can improve physical fitness across a variety of test measures. When fitness improves, beneficial health effects are observed in some, but not all chronic disease risk factors.</td></tr>
<tr><td>Timeframe: January 2000–December 2010</td></tr>
<tr><td>Total # of Studies: 33</td></tr>
<tr><td>Exposure Definition: Exercise interventions included aerobic and resistance training, games, sports, dance, and others. Duration of interventions ranged from 6 weeks up to 36 weeks. Time spent in activity per week ranged from 80–420 minutes.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Aerobic capacity/cardio-respiratory endurance. Muscular strength and endurance. Changes in body composition.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Children 5–18; Overweight and Obese</td><td>Author-Stated Funding Source: President’s Council for Physical Fitness and Nutrition, National Center for Chronic Disease Prevention and Health Promotion</td></tr>
</table>

Cardiorespiratory and Muscular Fitness, Bone Health	
Systematic Review **Citation:** Mura G, Rocha NB, Helmich I, et al. Physical activity interventions in schools for improving lifestyle in European countries. *Clin Pract Epidemiol Ment Health*. 2015;11(suppl 1 M5):77–101. doi:10.2174/1745017901511010077.	
Purpose: To assess the effect of physical activity interventions in schools for improving lifestyles in European countries.	**Abstract:** BACKGROUND: In the last decades, children's and adolescents' obesity and overweight have increased in European Countries. Unhealthy eating habits and sedentary lifestyle have been recognized to determine such an epidemic. Schools represent an ideal setting to modify harmful behaviors, and physical activity could be regarded as a potential way to avoid the metabolic risks related to obesity. Methods : A systematic review of the literature was carried out to summarize the evidence of school-based interventions aimed to promote, enhance and implement physical activity in European schools. Only randomized controlled trials were included, carried out in Europe from January 2000 to April 2014, universally delivered and targeting pupils aged between 3 and 18 years old. Results : Forty-seven studies were retrieved based either on multicomponent interventions or solely physical activity programs. Most aimed to prevent obesity and cardiovascular risks among youths. While few studies showed a decrease in BMI, positive results were achieved on other outcomes, such as metabolic parameters and physical fitness. Conclusion : Physical activity in schools should be regarded as a simple, non-expensive and enjoyable way to reach all the children and adolescents with adequate doses of moderate to vigorous physical activity.
Timeframe: January 2000–April 2014	
Total # of Studies: 47	
Exposure Definition: School-based interventions with a mean duration of 12 months. Interventions varied widely and included iPlay, Fit'n'Dude, modified PE, daily activity breaks, and pedometer feedback. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No	
Outcomes Addressed: Change in BMI and body fat. Bone mineral content and density assessed by dual energy X-ray scan. Lipid profiles. Glucose, insulin. Blood systolic/diastolic pressure. Physical fitness. **Examine Cardiorespiratory Fitness as Outcome:** Yes	
Populations Analyzed: Children 3–18	**Author-Stated Funding Source:** Not Reported

<table>
<tr><th colspan="2">Adiposity/Weight Status, Bone Health</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Nogueira RC, Weeks BK, Beck BR. Exercise to improve pediatric bone and fat: a systematic review and meta-analysis. Med Sci Sports Exerc. 2014;46(3):610–621. doi:10.1249/MSS.0b013e3182a6ab0d.</td></tr>
<tr><td>Purpose: To systematically review the findings of school-based PA interventions that were designed to improve bone health, to determine whether improvements in muscle and reductions in fat were also observed.</td><td rowspan="5">Abstract: PURPOSE: This study aimed to determine the effects of school-based, bone-focused exercise interventions on bone, fat, and lean mass in children by systematically reviewing and meta-analyzing the literature. METHODS: Potentially relevant articles were identified by searching electronic databases. Abstracts were included if they described the effects of an in-school exercise intervention for children 5-17 yr old compared with controls and presented baseline and follow-up results for bone, fat, and lean measures. Identified studies were systematically reviewed for methodological quality. Meta-analyses were performed for whole body, lumbar spine, and femoral neck bone mineral content (BMC), fat, and lean mass. RESULTS: Sixteen eligible trials were identified including eight randomized controlled trials, three clinical controlled trials, and five nonrandomized, nonmatched studies. The quality analysis revealed two studies had low, nine had medium, and five had a high risk of bias. Meta-analyses revealed a small positive effect of bone-targeted exercise on whole body BMC (standardized mean difference [SMD] = 0.483, 95% CI = 0.132-0.833), femoral neck BMC (SMD = 0.292, 95% CI = -0.022 to 0.607), lumbar spine BMC (SMD = 0.384, 95% CI = 0.193-0.575), fat mass (SMD = -0.248, 95% CI = -0.406 to -0.089), and lean mass (SMD = 0.159, 95% CI = -0.076 to 0.394). CONCLUSIONS: Beneficial effects of school-based, bone-targeted exercise were observed for bone and fat, but not for lean mass. Excluding trials with high risk of bias strengthened that effect. Considerable study heterogeneity may have obscured effects on lean mass. The effects observed for bone and fat support the pursuit of brief, jumping-focused interventions to reduce fat as well as enhance musculoskeletal tissue in school age children.</td></tr>
<tr><td>Timeframe: Inception–August 2012</td></tr>
<tr><td>Total # of Studies: 16 (8–11 for meta analysis)</td></tr>
<tr><td>Exposure Definition: School-based physical activity interventions including high-impact weight-bearing exercise on bone. Some interventions combined different types of exercise, such as strength, aerobic, stretching, skills development, and high-impact maneuvers for 30–80 min, 2 to 5 times per week. Duration of interventions ranged from 10 weeks to 3 years.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Bone outcomes, including whole body, lumbar spine, and femoral neck bone mineral content. Lean mass, fat mass, body fat percentage, and BMI: dual energy x-ray absorptiometry.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 5–17</td><td>Author-Stated Funding Source: No funding</td></tr>
</table>

<table>
<tr><th colspan="2">Adiposity/Weight Status</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Pate RR, O'Neill JR, Liese AD, et al. Factors associated with development of excessive fatness in children and adolescents: a review of prospective studies. Obes Rev. 2013;14(8):645–658. doi:10.1111/obr.12035.</td></tr>
<tr><td>Purpose: To examine current scientific literature on the factors that predict the development of excessive fatness in children and adolescents.</td><td rowspan="5">Abstract: The purpose of this review was to examine the factors that predict the development of excessive fatness in children and adolescents. Medline, Web of Science and PubMed were searched to identify prospective cohort studies that evaluated the association between several variables (e.g. physical activity, sedentary behaviour, dietary intake and genetic, physiological, social cognitive, family and peer, school and community factors) and the development of excessive fatness in children and adolescents (5-18 years). Sixty-one studies met the eligibility criteria and were included. There is evidence to support the association between genetic factors and low physical activity with excessive fatness in children and adolescents. Current studies yielded mixed evidence for the contribution of sedentary behaviour, dietary intake, physiological biomarkers, family factors and the community physical activity environment. No conclusions could be drawn about social cognitive factors, peer factors, school nutrition and physical activity environments, and the community nutrition environment. There is a dearth of longitudinal evidence that examines specific factors contributing to the development of excessive fatness in childhood and adolescence. Given that childhood obesity is a worldwide public health concern, the field can benefit from large-scale, long-term prospective studies that use state-of-the-art measures in a diverse sample of children and adolescents.</td></tr>
<tr><td>Timeframe: January 1990–June 2012</td></tr>
<tr><td>Total # of Studies: 61 (7 PA)</td></tr>
<tr><td>Exposure Definition: Total and moderate-to-vigorous physical activity measured with accelerometer. Follow up ranged from 1 to 7 years.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Body Mass Index, Adiposity: dual x-ray absorptiometry, skin-fold thickness, bioelectrical impedance analysis.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 5–18</td><td>Author-Stated Funding Source: U.S. Department of Defense</td></tr>
</table>

<table>
<tr><th colspan="2">Adiposity/Weight Status</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Ramires VV, Dumith SC, Gonçalves H. Longitudinal association between physical activity and body fat during adolescence: a systematic review. J Phys Act Health. 2015;12(9):1344–1358. doi:10.1123/jpah.2014-0222.</td></tr>
<tr><td>Purpose: To compile and examine findings from observational longitudinal studies that have investigated the relationship between PA practice and its effect on body fat during adolescence.</td><td rowspan="4">Abstract: BACKGROUND: Physical activity (PA) practice has been inversely associated to body fat (BF) and recommended as a way to reduce and prevent obesity. The objective of this study was to conduct a systematic review on the association of PA and BF in adolescence. METHODS: The review includes 18 longitudinal studies found in the PubMed database, comprising papers published from January 1990 to July 2014. Studies assessing BF only through body mass index were excluded. RESULTS: Among the outcomes analyzed, waist circumference, skinfolds, and absolute and relative fat mass measurement were identified. Questionnaires were the more predominant way to evaluate PA. Most studies showed that PA promotes a protective effect against a higher BF gain. CONCLUSION: It was concluded that PA has a protective effect against BF with differences between the genders and according to the BF marker or measurement assessed; higher intensity PA leads to a greater effect against BF gain in both genders; and the maintenance or increase of PA level on BF observed through analysis of change in PA level yielded more consistent findings in the relation between PA and BF.</td></tr>
<tr><td>Timeframe: January 1990–July 2014</td></tr>
<tr><td>Total # of Studies: 18</td></tr>
<tr><td>Exposure Definition: Total PA, leisure PA, and active commuting over 1–10 years of follow up was measured primarily via questionnaires with some studies using accelerometers. Total activity was summarized as change in PA over the follow-up period or as a predictive baseline PA level.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Body fat: waist circumference, skinfold, dual energy x-ray absorptiometry (fat mass and lean mass components), isotope dilution, bioelectrical impedance, equation estimation.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 8–14 baseline, 12–20 follow up</td><td>Author-Stated Funding Source: Not Reported</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Saavedra JM, Escalante Y, Garcia-Hermoso A. Improvement of aerobic fitness in obese children: a meta-analysis. Int J Pediatr Obes. 2011;6(3-4):169–177. doi:10.3109/17477166.2011.579975.</td></tr>
<tr><td>Purpose: To estimate the effectiveness of diverse interventions on aerobic fitness adjusted for weight (peak VO 2 per kg) in obese children.</td><td rowspan="5">Abstract: The purpose of this meta-analysis was to assess the effectiveness of diverse interventions in aerobic fitness adjusted for weight in obese children. A computerized search of seven databases was carried out using keywords. Effect sizes and 95% confidence intervals were calculated, and the heterogeneity of the studies was assessed using Cochran's Q statistic applied to the effect size means. Nine studies were selected for review as satisfying the inclusion criteria (n patients = 311). The conclusions of the meta-analysis were: (i) the programs based on aerobic exercise have a moderate positive effect on aerobic fitness; (ii) the programs based on aerobic exercise lasting more than 12 weeks (3000 minutes total exercise time) in three sessions per week (more than 60 min per session) obtain better results; (iii) overall, combined programs fail to achieve improvements in aerobic fitness; and (iv) few randomized clinical trials have been conducted.</td></tr>
<tr><td>Timeframe: Inception–February 2011</td></tr>
<tr><td>Total # of Studies: 9</td></tr>
<tr><td>Exposure Definition: Six of the studies included aerobic programs based on equipment work with treadmills, rowers, stair-steppers, and bicycles; sports activities such as soccer, basketball, baseball, hockey, and badminton; aquatic activities such as swimming and water games; folk dancing; and running. The structure of the program varied greatly: total duration 8 to 36 weeks; frequency 3 to 5 per week; and duration 29 to 90 min. Four of the studies combined aerobic exercises with strength training.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Change in peak VO2: maximal or submaximal effort test on a treadmill or cycloergometer.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Children <18</td><td>Author-Stated Funding Source: European Social Funds (FEDER FUNDS), Autonomous Government of Extremadura (Junta de Extremadura)</td></tr>
</table>

Bone Health	
Meta-Analysis **Citation:** Specker B, Thiex NW, Sudhagoni RG. Does exercise influence pediatric bone? A systematic review. *Clin Orthop Relat Res.* 2015;473(11):3658–3672. doi:10.1007/s11999-015-4467-7.	
Purpose: To determine whether data from pediatric trials could answer the following questions: Does exercise in childhood consistently increase bone mineral content, bone area, or aBMD? Do effects of exercise differ depending on pubertal status or sex of the children? Does calcium intake modify the bone response to exercise?	**Abstract:** BACKGROUND: Periods of growth are thought to be the best time to increase bone mineral content, bone area, and areal bone mineral density (aBMD) through increased loading owing to high rates of bone modeling and remodeling. However, questions remain regarding whether a benefit of exercise is seen at all bone sites, is dependent on pubertal status or sex of the child, or whether other factors such as diet modify the response to exercise. QUESTIONS/PURPOSES: We asked: (1) Does bone-loading exercise in childhood consistently increase bone mineral content, bone area, or aBMD? (2) Do effects of exercise differ depending on pubertal status or sex? (3) Does calcium intake modify the bone response to exercise? METHODS: A literature search identified 22 unique trials for inclusion in this meta-analysis of the effect of exercise on bone changes by bone site, pubertal status, and sex. Sample sizes ranged from 16 to 410 subjects 3 to 18 years old with length of intervention ranging from 3 to 36 months. Fifteen of 22 trials were randomized (child randomized in nine, classroom/school randomized in six) and seven were observational trials. Ten trials were Level 2 and 11 were Level 3 based on the Oxford Centre for Evidence-Based Medicine criteria. Random effects models tested the difference (intervention mean effect-control mean effect) in percent change in bone mineral content, bone area, and aBMD. Meta-regression was used to identify sources of heterogeneity and funnel plots were used to assess publication bias. RESULTS: Children assigned to exercise had greater mean percent changes in bone mineral content and aBMD than children assigned to the control groups. Mean differences (95% CI) in bone mineral content percent change between intervention and control groups at total body (0.8; 95% CI, 0.3-1.3; p = 0.003), femoral neck (1.5; 95% CI, 0.5-2.5; p = 0.003), and spine (1.7; 95% CI, 0.4-3.1; p = 0.01) were significant with no differences in bone area (all p > 0.05). There were greater percent changes in aBMD in intervention than control groups at the femoral neck (0.6; 95% CI, 0.2-1.1; p = 0.006) and spine (1.2; 95% CI, 0.6-1.8; p < 0.001). Benefit of exercise was limited to children who were prepubertal (bone mineral content: total body [0.9; 95% CI, 0.2-1.7; p = 0.01], femoral neck [1.8; 95% CI, 0.0-3.5; p = 0.047], spine [3.7; 95% CI, 0.8-6.6; p = 0.01], and aBMD: femoral neck [0.6; 95% CI, -0.1-1.2; p = 0.07], spine [1.5; 95% CI, 0.7-2.3; p < 0.001]), with no differences among children who were pubertal (all p > 0.05). Changes in aBMD did not differ by sex (all p > 0.05), although the number of studies providing male-specific results was small (six of 22 eligible studies included boys). There was significant heterogeneity in bone mineral content and bone area for which a source could not be identified. Heterogeneity in spine aBMD was reduced by including calcium intake and intervention length as covariates. Three trials designed to determine whether calcium intake modified the bone response to exercise all reported a greater effect of exercise on leg bone mineral content in children randomized to receive supplemental calcium than those
Timeframe: Not reported	
Total # of Studies: 22	
Exposure Definition: Exercise interventions included high-impact activities (jumps with weighted vests, step aerobics, strength training, box jumps). The length, types, and intensity of the interventions varied. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No	
Outcomes Addressed: Changes in bone mineral content, bone area, and aBMD: dual energy x-ray absorptometry. **Examine Cardiorespiratory Fitness as Outcome:** No	

Populations Analyzed: Children 3–18; Female, Male; Prepubertal, early pubertal, pubertal, postpubertal	receiving placebo. CONCLUSIONS: Exercise interventions during childhood led to 0.6% to 1.7% greater annual increase in bone accrual, with effects predominantly among children who were prepubertal. If this effect were to persist into adulthood, it would have substantial implications for osteoporosis prevention. It is important to identify sources of heterogeneity among studies to determine factors that might influence the bone response to increased exercise during growth. LEVEL OF EVIDENCE: Level II, therapeutic study.
	Author-Stated Funding Source: No funding source used

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Sun C, Pezic A, Tikellis G, et al. Effects of school-based interventions for direct delivery of physical activity on fitness and cardiometabolic markers in children and adolescents: a systematic review of randomized controlled trials. Obes Rev. 2013;14(10):818–838. doi:10.1111/obr.12047.</td></tr>
<tr><td>Purpose: To examine whether school-based PA interventions have an effect on the various measures of adiposity, fitness and cardiometabolic health among school-aged children and adolescence.</td><td rowspan="5">Abstract: To evaluate the effectiveness of school-based physical activity interventions on fitness, adiposity and cardiometabolic outcomes among schoolchildren. Medline, Embase, EBSCOhost CINAHL and ERIC databases were searched up to October 2012. INCLUSION CRITERIA: intervention delivered at school with controls having no intervention or usual physical education classes; participants aged 5-18 years; outcomes spanning some or all of the above. We assessed levels of evidence for identified trials based on methodological quality and sample size. Dose of the interventions (a total summary measure of intensity, frequency and duration) were considered. Eighteen randomized controlled trials (RCTs, total participants = 6,207) were included, of which six were large, higher quality trials with high dose of the intervention. The intervention was consistent in increasing fitness with large, higher quality studies and high dose of intervention providing strong evidence. Dose of school-based physical activity is an important determinant of trial efficiency. Some large, higher quality RCTs provided strong evidence for interventions to decrease skin-fold thickness, increase fitness and high-density lipoprotein cholesterol. Evidence for body mass index, body fat and waist circumference, blood pressure and triglycerides, low-density lipoprotein cholesterol and total cholesterol remain inconclusive and require additional higher quality studies with high dose of interventions to provide conclusive evidence.</td></tr>
<tr><td>Timeframe: Inception–October 2012</td></tr>
<tr><td>Total # of Studies: 18</td></tr>
<tr><td>Exposure Definition: School-based PA interventions. PA measured in metabolic equivalents of tasks (METs). METs were classified as low, average, moderate, or vigorous intensity. Estimates included: weekly summary measure (MET-min per week by frequency); and total summary measure-dose (weekly summary measure multiplied by duration in weeks).
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Body composition: BMI, skin-fold thickness, waist circumference, percent body fat, percent lean mass, fat mass and lean mass. Fitness: work capacity, VO2 max, Blood pressure, lipid profile.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Children 5–18</td><td>Author-Stated Funding Source: The Australian National Health and Medical Research Council (NHMRC), Victorian Government's Operational Infrastructure Support Program</td></tr>
</table>

<table>
<tr><th colspan="2">Bone Health</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Tan VP, Macdonald HM, Kim S, et al. Influence of physical activity on bone strength in children and adolescents: a systematic review and narrative synthesis. J Bone Miner Res. 2014;29(10):2161–2181. doi:10.1002/jbmr.2254.</td></tr>
<tr><td>Purpose: To determine the influence of PA and participation in organized sports on bone strength in children and adolescents.</td><td rowspan="5">Abstract: A preponderance of evidence from systematic reviews supports the effectiveness of weight-bearing exercises on bone mass accrual, especially during the growing years. However, only one systematic review (limited to randomized controlled trials) examined the role of physical activity (PA) on bone strength. Thus, our systematic review extended the scope of the previous review by including all PA intervention and observational studies, including organized sports participation studies, with child or adolescent bone strength as the main outcome. We also sought to discern the skeletal elements (eg, mass, structure, density) that accompanied significant bone strength changes. Our electronic-database, forward, and reference searches yielded 14 intervention and 23 observational studies that met our inclusion criteria. We used the Effective Public Health Practice Project (EPHPP) tool to assess the quality of studies. Due to heterogeneity across studies, we adopted a narrative synthesis for our analysis and found that bone strength adaptations to PA were related to maturity level, sex, and study quality. Three (of five) weight-bearing PA intervention studies with a strong rating reported significantly greater gains in bone strength for the intervention group (3% to 4%) compared with only three significant (of nine) moderate intervention studies. Changes in bone structure (eg, bone cross-sectional area, cortical thickness, alone or in combination) rather than bone mass most often accompanied significant bone strength outcomes. Prepuberty and peripuberty may be the most opportune time for boys and girls to enhance bone strength through PA, although this finding is tempered by the few available studies in more mature groups. Despite the central role that muscle plays in bones' response to loading, few studies discerned the specific contribution of muscle function (or surrogates) to bone strength. Although not the focus of the current review, this seems an important consideration for future studies.</td></tr>
<tr><td>Timeframe: 1921–2013</td></tr>
<tr><td>Total # of Studies: 37</td></tr>
<tr><td>Exposure Definition: Weight bearing PA interventions including recreational and organized sports (e.g., gymnastics). Assessment included self-report and accelerometers.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Bone strength: bone mineral (mass) and the distribution of bone mass from the neutral axis (structure). Bone mass: bone mineral content or bone mineral density).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 5–18</td><td>Author-Stated Funding Source: Not Reported</td></tr>
</table>

<table>
<tr><th colspan="2">Adiposity/Weight Status</th></tr>
<tr><td colspan="2">Systematic Review
Citation: te Velde SJ, van Nassau F, Uijtdewilligen L, et al; ToyBox-study group. Energy balance-related behaviours associated with overweight and obesity in preschool children: a systematic review of prospective studies. Obes Rev. 2012;13(suppl 1):56–74. doi:10.1111/j.1467-789X.2011.00960.x.</td></tr>
<tr><td>Purpose: To systematically review prospective studies addressing the relationship between energy balance-related behaviours and overweight among children.</td><td rowspan="5">Abstract: The current review aimed to systematically identify dietary, physical activity and sedentary behaviours in preschool children (4-6 years of age) that are prospectively related to overweight or obesity later in childhood. Prospective studies published between January 1990 and June 2010 were selected from searches in PubMed, EMBASE, PsycINFO, CINAHL and Cochrane Library. Studies examining the prospective association between at least one relevant behaviour measured during preschool period (children aged 4-6 years at baseline) in relation to at least one anthropometric measurement at follow-up (age <18 years) were included. Harvest plots were used to summarize the results and draw conclusions from the evidence. Of the 8,718 retrieved papers, 23 papers reporting on 15 different study samples were included in this review. Strong evidence was found for an inverse association between total physical activity and overweight. Moderate evidence was observed for a positive association between television viewing and overweight. Because of the heterogeneity in the assessed dietary behaviours, insufficient evidence was found for an association between dietary intake or specific dietary behaviours and overweight. These results suggest that interventions aiming to prevent overweight among preschool children should focus on promotion of total physical activity and limitation of screen time and that further research is needed to establish whether and which dietary behaviours are important for obesity prevention in this age group. However, despite the lack of evidence for dietary behaviours from the present review, future interventions may already target specific dietary behaviours that are highly prevalent and for which there a clear rationale as well as preliminary evidence that these behaviours are associated with overweight.</td></tr>
<tr><td>Timeframe: January 1990–June 2010</td></tr>
<tr><td>Total # of Studies: 23</td></tr>
<tr><td>Exposure Definition: Energy-balance related behaviours including PA assessed with accelerometers, heart rate monitors, or obeservation. Sub-group analysis by total PA, moderate to vigorous PA, and leisure activity.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Body composition: BMI or skinfold thickness.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 4–6 years at baseline, <18 follow up</td><td>Author-Stated Funding Source: The Seventh Framework Programme of the European Commission</td></tr>
</table>

<table>
<tr><th colspan="2">Adiposity/Weight Status</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Timmons BW, Leblanc AG, Carson V. Systematic review of physical activity and health in the early years (aged 0-4 years). Appl Physiol Nutr Metab. 2012;37(4):773–792. doi:10.1139/h2012-070.</td></tr>
<tr><td>Purpose: To identify, synthesize, and interpret the best available evidence for minimal and optimal amounts of PA needed to promote healthy growth and development in infants, toddlers, and preschoolers.

Timeframe: Inception–May 2011

Total # of Studies: 18

Exposure Definition: PA defined as any bodily movement generated by skeletal muscles that results in energy expenditure above resting levels. Parent report was most common indirect measure; other studies used direct observation or accelerometry.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed:
Adiposity: BMI, waist circumference skinfolds. Bone and skeletal health: bone mineral density, bone mineral content. Cardiometabolic indicators: blood pressure, plasma lipids, fasting glucose, insulin resistance, and inflammatory markers.
Examine Cardiorespiratory Fitness as Outcome: No</td><td>Abstract: The early years represent a critical period for promoting physical activity. However, the amount of physical activity needed for healthy growth and development is not clear. Using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework, we aimed to present the best available evidence to determine the relationship between physical activity and measures of adiposity, bone and skeletal health, motor skill development, psychosocial health, cognitive development, and cardiometabolic health indicators in infants (1 month - 1 year), toddlers (1.1-3.0 years), and preschoolers (3.1-4.9 years). Online databases, personal libraries, and government documents were searched for relevant studies. Twenty-two articles, representing 18 unique studies and 12 742 enrolled participants, met inclusion criteria. The health indicators of interest were adiposity (n = 11), bone and skeletal health (n = 2), motor development (n = 4), psychosocial health (n = 3), cognitive development (n = 1), and cardiometabolic health indicators (n = 3); these indicators were pre-specified by an expert panel. Five unique studies involved infants, 2 involved toddlers, and 11 involved preschoolers. In infants, there was low- to moderate-quality evidence to suggest that increased or higher physical activity was positively associated with improved measures of adiposity, motor skill development, and cognitive development. In toddlers, there was moderate-quality evidence to suggest that increased or higher physical activity was positively associated with bone and skeletal health. In preschoolers, there was low- to high-quality evidence on the relationship between increased or higher physical activity and improved measures of adiposity, motor skill development, psychosocial health, and cardiometabolic health indicators. There was no serious inconsistency in any of the studies reviewed. This evidence can help to inform public health guidelines. (PROSPERO registration: CRD42011001243). FAU - Timmons, Brian W</td></tr>
<tr><td>Populations Analyzed: Infants 1 month– 1; toddlers 1 and 1/2–3; preschoolers 3 and 1 month–4 and 9 months</td><td>Author-Stated Funding Source: Canadian Institutes of Health Research</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Vasconcellos F, Seabra A, Katzmarzyk PT, Kraemer-Aguiar LG, Bouskela E, Farinatti P. Physical activity in overweight and obese adolescents: systematic review of the effects on physical fitness components and cardiovascular risk factors. Sports Med. 2014;44(8):1139–1152. doi:10.1007/s40279-014-0193-7.</td></tr>
<tr><td>Purpose: To systematically review the effect of PA interventions on body composition, physical fitness components, hemodynamic variables, biochemical markers, endothelial function, and low-grade inflammation in overweight and obese adolescents (12–17 years).</td><td rowspan="5">Abstract: BACKGROUND:
The increasing prevalence of obesity in the pediatric age range has become a major concern. Studies have investigated the role of physical activity (PA) to prevent obesity in this population. However, previous reviews did not focus on the effects of PA in overweight/obese adolescents on physical fitness and risk factors for cardiovascular disease altogether.
OBJECTIVE:
The present systematic review analyzed trials investigating the effect of PA on aerobic capacity, muscle strength, body composition, hemodynamic variables, biochemical markers, and endothelial function in obese/overweight adolescents.
METHODS:
PubMed, LILACS, Web of Science, Scopus (including Embase), and SPORTDiscus databases were searched for relevant reports without time limits. Inclusion criteria included studies published in English, with overweight and obese adolescents aged 12-17 years. The review was registered (Number CRD42013004632) on PROSPERO, the International Prospective Register of Systematic Reviews.
RESULTS:
The results indicated that PA is associated with significant and beneficial changes in fat percentage, waist circumference, systolic blood pressure, insulin, low-density lipoprotein cholesterol, and total cholesterol, as well as with small non-significant changes in diastolic blood pressure, glucose, and high-density lipoprotein cholesterol.
CONCLUSION:
Although limited, results from controlled trials suggest that PA intervention may improve physical fitness and risk factors for cardiovascular disease in adolescents who are overweight or obese.</td></tr>
<tr><td>Timeframe: "Without time limits"</td></tr>
<tr><td>Total # of Studies: 24 (15 PA only, 9 PA plus lifestyle or dietary)</td></tr>
<tr><td>Exposure Definition: PA varied by study: 13 studies reported training sessions of less than 1 hour (9 studies with 1 to 1.5 hours), most with frequency of 3x/week, and a range of intensity (4 reported high and 6 low to moderate). Predominant type of PA was running, 9 studies used cycle ergometer, and 1 used dance.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed:
Primary outcomes: Body mass index and physical fitness.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed:
Children 12–17; Overweight and Obese</td><td>Author-Stated Funding Source: Carlos Chagas Filho Foundation for the Research Support in Rio de Janeiro (FAPERJ), the Brazilian Council for the Research Development (CNPq)</td></tr>
</table>

Adiposity/Weight Status	
Meta-Analysis **Citation:** Waters E, de Silva-Sanigorski A, Hall BJ, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev.* 2011;(12):CD001871. doi:10.1002/14651858.CD001871.pub3.	
Purpose: To determine the effectiveness of evaluated interventions intended to prevent obesity in children. **Timeframe:** Inception–March 2010 **Total # of Studies:** 55 (37 for meta-analysis) **Exposure Definition:** Childhood obesity prevention programs (diet, physical activity, lifestyle and social support) of at least 12 weeks; Subgroup performed for setting of and duration of intervention. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Standardized Mean Difference in body Mass index (BMI) or BMI z score:	**Abstract:** Background: Prevention of childhood obesity is an international public health priority given the significant impact of obesity on acute and chronic diseases, general health, development and well-being. The international evidence base for strategies that governments, communities and families can implement to prevent obesity, and promote health, has been accumulating but remains unclear. Objectives: This review primarily aims to update the previous Cochrane review of childhood obesity prevention research and determine the effectiveness of evaluated interventions intended to prevent obesity in children, assessed by change in Body Mass Index (BMI). Secondary aims were to examine the characteristics of the programs and strategies to answer the questions "What works for whom, why and for what cost?" Search methods: The searches were re-run in CENTRAL, MEDLINE, EMBASE, PsychINFO and CINAHL in March 2010 and searched relevant websites. Non-English language papers were included and experts were contacted.Selection criteria: The review includes data from childhood obesity prevention studies that used a controlled study design (with or without randomisation). Studies were included if they evaluated interventions, policies or programs in place for twelve weeks or more. If studies were randomised at a cluster level, 6 clusters were required. Data collection and analysis: Two review authors independently extracted data and assessed the risk of bias of included studies. Data was extracted on intervention implementation, cost, equity and outcomes. Outcome measures were grouped according to whether they measured adiposity, physical activity (PA)-related behaviours or diet-related behaviours. Adverse outcomes were recorded. A meta-analysis was conducted using available BMI or standardised BMI (zBMI) score data with subgroup analysis by age group (0-5, 6-12, 13-18 years, corresponding to stages of developmental and childhood settings). Main results: This review includes 55 studies (an additional 36 studies found for this update). The majority of studies targeted children aged 6-12 years. The meta-analysis included 37 studies of 27,946 children and demonstrated that programmes were effective at reducing adiposity, although not all individual interventions were effective, and there was a high level of observed heterogeneity (I2=82%). Overall, children in the intervention group had a standardised mean difference in adiposity (measured as BMI or zBMI) of -0.15kg/m2 (95% confidence interval (CI): -0.21 to -0.09). Intervention effects by age subgroups were -0.26kg/m2 (95% CI:-0.53 to 0.00) (0-5 years), -0.15kg/m2 (95% CI -0.23 to -0.08) (6-12 years), and -0.09kg/m2 (95% CI -0.20 to 0.03) (13-18 years). Heterogeneity was apparent in all three age groups and could not explained by randomisation status or the type, duration or setting of the intervention. Only eight studies reported on adverse effects and no evidence of adverse outcomes such as unhealthy dieting practices, increased prevalence of underweight or body image sensitivities was found. Interventions did not appear to increase health inequalities although this was examined in fewer studies. Authors' conclusions: We found strong evidence to support beneficial effects of child obesity prevention programmes on BMI, particularly for programmes targeted to children aged six to 12 years. However, given the

percent fat, skin-fold thickness and ponderal index. **Examine Cardiorespiratory Fitness as Outcome:** No	unexplained heterogeneity and the likelihood of small study bias, these findings must be interpreted cautiously. A broad range of programme components were used in these studies and whilst it is not possible to distinguish which of these components contributed most to the beneficial effects observed, our synthesis indicates the following to be promising policies and strategies: school curriculum that includes healthy eating, physical activity and body image; increased sessions for physical activity and the development of fundamental movement skills throughout the school week; improvements in nutritional quality of the food suppl in schools; environments and cultural practices that support children eating healthier foods and being active throughout each day; support for teachers and other staff to implement health promotion strategies and activities (e.g. professional development, capacity building activities); parent support and home activities that encourage children to be more active, eat more nutritious foods and spend less time in screen based activities. However, study and evaluation designs need to be strengthened, and reporting extended to capture process and implementation factors, outcomes in relation to measures of equity, longer term outcomes, potential harms and costs. Childhood obesity prevention research must now move towards identifying how effective intervention components can be embedded within health, education and care systems and achieve long term sustainable impacts.
Populations Analyzed: Children ≤18 (subgroups 0–5, 6–12, 13–18)	**Author-Stated Funding Source:** University of Teesside, University of Melbourne, Deakin University, Jack Brockhoff Child Health and Wellbeing Program, UK Department of Health, World Health Organisation, Victorian Health Promotion Foundation Australian Commonwealth Department of Health and Ageing, The Jack Brockhoff Foundation

<table>
<tr><th colspan="2">Bone Health</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Weaver CM, Gordon CM, Janz KF, et al. The National Osteoporosis Foundation’s position statement on peak bone mass development and lifestyle factors: a systematic review and implementation recommendations. Osteoporos Int. 2016;27:1281–1386. doi:10.1007/s00198-015-3440-3.</td></tr>
<tr><td>Purpose: To provide evidence-based guidance and a national implementation strategy for the purpose of helping individuals achieve maximal peak bone mass early in life.</td><td rowspan="5">Abstract: Lifestyle choices influence 20-40 % of adult peak bone mass. Therefore, optimization of lifestyle factors known to influence peak bone mass and strength is an important strategy aimed at reducing risk of osteoporosis or low bone mass later in life. The National Osteoporosis Foundation has issued this scientific statement to provide evidence-based guidance and a national implementation strategy for the purpose of helping individuals achieve maximal peak bone mass early in life. In this scientific statement, we (1) report the results of an evidence-based review of the literature since 2000 on factors that influence achieving the full genetic potential for skeletal mass; (2) recommend lifestyle choices that promote maximal bone health throughout the lifespan; (3) outline a research agenda to address current gaps; and (4) identify implementation strategies. We conducted a systematic review of the role of individual nutrients, food patterns, special issues, contraceptives, and physical activity on bone mass and strength development in youth. An evidence grading system was applied to describe the strength of available evidence on these individual modifiable lifestyle factors that may (or may not) influence the development of peak bone mass (Table 1). A summary of the grades for each of these factors is given below. We describe the underpinning biology of these relationships as well as other factors for which a systematic review approach was not possible. Articles published since 2000, all of which followed the report by Heaney et al. [1] published in that year, were considered for this scientific statement. This current review is a systematic update of the previous review conducted by the National Osteoporosis Foundation [1]. [Table: see text] Considering the evidence-based literature review, we recommend lifestyle choices that promote maximal bone health from childhood through young to late adolescence and outline a research agenda to address current gaps in knowledge. The best evidence (grade A) is available for positive effects of calcium intake and physical activity, especially during the late childhood and peripubertal years-a critical period for bone accretion. Good evidence is also available for a role of vitamin D and dairy consumption and a detriment of DMPA injections. However, more rigorous trial data on many other lifestyle choices are needed and this need is outlined in our research agenda. Implementation strategies for lifestyle modifications to promote development of peak bone mass and strength within one's genetic potential require a multisectored (i.e., family, schools, healthcare systems) approach.</td></tr>
<tr><td>Timeframe: January 2000–December 2014</td></tr>
<tr><td>Total # of Studies: 53</td></tr>
<tr><td>Exposure Definition: PA interventions using various modalities including sports, games, dance, or high-impact exercises (jumping, hopping), typically ranged from 7 to 24 months in duration, 2–5 sessions per week, 10–60 min per session.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Bone mass and density: dual-energy X-ray absorptiometry (DXA). Bone structural outcomes.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: ≤21</td><td>Author-Stated Funding Source: Alliance for Potato Research and the Dairy Research Institute</td></tr>
</table>

<table>
<tr><th colspan="2">Adiposity/Weight Status</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Wilks DC, Sharp SJ, Ekelund U, et al. Objectively measured physical activity and fat mass in children: a bias-adjusted meta-analysis of prospective studies. PLoS One. 2011;6(2):e17205. doi:10.1371/journal.pone.0017205.</td></tr>
<tr><td>Purpose: To quantitatively synthesize the evidence on the prospective association between measured PA energy expenditure and change in percent body fat in children in order to better inform evidence based policy making with respect to PA strategies.</td><td rowspan="5">Abstract: BACKGROUND: Studies investigating the prevention of weight gain differ considerably in design and quality, which impedes pooling them in conventional meta-analyses, the basis for evidence-based policy making. This study is aimed at quantifying the prospective association between measured physical activity and fat mass in children, using a meta-analysis method that allows inclusion of heterogeneous studies by adjusting for differences through eliciting and incorporating expert opinion. METHODS: Studies on prevention of weight gain using objectively measured exposure and outcome were eligible; they were adopted from a recently published systematic review. Differences in study quality and design were considered as internal and external biases and captured in checklists. Study results were converted to correlation coefficients and biases were considered either additive or proportional on this scale. The extent and uncertainty of biases in each study were elicited in a formal process by six quantitatively-trained assessors and five subject-matter specialists. Biases for each study were combined across assessors using median pooling. Results were combined across studies by random-effects meta-analysis. RESULTS: The combined correlation of the unadjusted results from the six studies was -0.04 (95%CI: -0.22, 0.14) with considerable heterogeneity (I(2) = 78%), which makes it difficult to interpret the result. After bias-adjustment the pooled correlation was -0.01 (95%CI: -0.18, 0.16) with apparent study compatibility (I(2) = 0%). CONCLUSION: By using this method the prospective association between physical activity and fat mass could be quantitatively synthesized; the result suggests no association. Objectively measured physical activity may not be the key determinant of unhealthy weight gain in children.</td></tr>
<tr><td>Timeframe: January 2000–September 2008</td></tr>
<tr><td>Total # of Studies: 6</td></tr>
<tr><td>Exposure Definition: PA energy expenditure was assessed by doubly-labeled water, indirect calorimetry, heart rate monitors, or accelerometry.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Body fat: dual-energy X-ray absorptiometry (DXA) or skinfold calipers.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Children 4–11</td><td>Author-Stated Funding Source: UK Medical Research Council Population, Health Sciences Research Network</td></tr>
</table>

<table>
<tr><th colspan="2">Bone Health</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Xu J, Lombardi G, Jiao W, Banfi G. Effects of exercise on bone status in female subjects, from young girls to postmenopausal women: an overview of systematic reviews and meta-analyses. Sports Med. 2016;46(8):1165–1182. doi:10.1007/s40279-016-0494-0.</td></tr>
<tr><td>Purpose: To summarize current evidence for the effects of exercise and PA interventions on bone status in girls and women, and to explore whether specific exercise programs exist for improving or maintaining bone mass or bone strength in females.</td><td rowspan="4">Abstract: BACKGROUND: Osteoporosis and postmenopausal bone loss pose a huge social and economic burden worldwide. Regular exercise and physical activity are effective interventions for maximizing or maintaining peak bone mass and preventing bone loss in the elderly; however, most recommendations are addressed to the general public and lack specific indications for girls and women, the segment of the population most at risk for developing osteoporosis. OBJECTIVE: The aim of this overview of systematic reviews and meta-analyses was to summarize current evidence for the effects of exercise and physical activity interventions on bone status in girls and women, and to explore whether specific exercise programs exist for improving or maintaining bone mass or bone strength in females. METHODS: The PubMed, EMBASE, PEDro, and Cochrane Library databases were searched from January 2009, updated to 22 June 2015, using the following groups of search terms: (i) 'physical activity' and 'exercise'; and (ii) 'bone', 'bone health', 'bone strength', 'bone structure', 'bone metabolism', 'bone turnover', and 'bone biomarkers'. Searches and screening were limited to systematic reviews or meta-analyses of studies in females and published in English. Our final analysis included 12 articles that met the inclusion criteria. RESULTS: Combined-impact exercise protocols (impact exercise with resistance training) are the best choice to preserve/improve bone mineral density in pre- and postmenopausal women. Peak bone mass in young girls can be improved with short bouts of school-based high-impact plyometric exercise programs. Whole-body vibration exercises have no beneficial effects on bone in postmenopausal or elderly women. CONCLUSIONS AND IMPLICATIONS: Lifelong exercise, specific for age, is an effective way to sustain bone health in girls and women.</td></tr>
<tr><td>Timeframe: January 2009–June 2015</td></tr>
<tr><td>Total # of Studies: 12</td></tr>
<tr><td>Exposure Definition: Exercise programs included (1) plyometric (e.g., jumping, hopping), or (2) non-plyometric weight-bearing exercises (muscle strengthening) lasting from 26 weeks to 24 months. Exercise frequency ranged from 1–5 days/week in school-based or non-school-based settings. Exercise duration was from 10–20 minutes for most plyometric exercises and 30–45 minutes for non plyometric weight-bearing exercises.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Changes in bone density: dual energy x-ray absorptiometry (DXA) or peripheral quantitative computed tomography (pQCT).
Examine Cardiorespiratory Fitness as Outcome: No</td><td></td></tr>
<tr><td>Populations Analyzed: Female; Children, adolescents.</td><td>Author-Stated Funding Source: China Scholarship Council, Italian Ministry of Health</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiorespiratory and Muscular Fitness</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Zeng N, Gao Z. Exergaming and obesity in youth: current perspectives. Int J Gen Med. 2016;9:275–284. doi:10.2147/IJGM.S99025.</td></tr>
<tr><td>Purpose: To systematically review and synthesize the exergame-based research that targets overweight or/and obese individuals as well as to discuss the effectiveness of exergaming on health-related outcomes.</td><td rowspan="4">Abstract: Although exergaming has been used as a physical activity modality among various populations, the evidence regarding its effectiveness on health-related outcomes in overweight/obese individuals remains unclear. The current study systematically reviewed literature and summarized findings of exergame-based interventions in overweight/obese populations with the goal of clarifying the current perspectives on exergaming and obesity. The initial search yielded 202 articles from six databases; 12 studies were included after evaluating for inclusion criteria and removing duplicates. Among these studies, seven were randomized controlled trials, two were control trials, and three were comparison studies. Overall, exergaming has the potential to attenuate weight gain and shows promise when used for physical activity and physical fitness promotion. Further, exergame play is positively associated with psychological well-being, but its effects on physiological outcomes are inconclusive. Finally, effects of exergaming on energy intake are not clear. Existing evidence supports that exergaming may elicit some health benefits in people who are overweight or/and obese. The limited number of available randomized controlled trials, however, restrict the ability to draw a conclusion that exergaming can trigger a change in all health-related outcomes. More research is warranted to make definitive conclusions regarding the effects of exergaming on health-related outcomes in such populations.</td></tr>
<tr><td>Timeframe: January 2010–May 2016</td></tr>
<tr><td>Total # of Studies: 12</td></tr>
<tr><td>Exposure Definition: Intervention employed commercially available exergames including, but not limited to, Nintendo Wii, Xbox Kinect, and Dance Dance Revolution. Intervention length ranged from 6 to 24 weeks.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Adiposity oucomes: BMI, percentage body fat, skin fold thickness, waist circumference and waist-to-hip ratio. Physical outcomes: skill-related fitness or changed habitual physical activity. Physiological outcomes: energy expenditure, cardiorespiratory fitness, blood pressure, cholesterol, triglycerides, glucose, and insulin.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Children 8–19; Overweight and Obese</td><td>Author-Stated Funding Source: Not Reported</td></tr>
</table>

Table 3. Existing Systematic Reviews and Meta-Analyses Quality Assessment Chart

AMSTARExBP: SR/MA					
	Beets, 2009	Clark, 2015	Dobbins, 2013	Escalante, 2012	Fedewa, 2014
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	Yes	No	Yes
Was a comprehensive literature search performed?	Yes	Yes	Yes	Partially Yes	Yes
Duplicate study selection and data extraction performed.	No	No	Yes	No	No
Search strategy clearly described.	No	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	No	No	No	Yes	No
List of studies (included and excluded) provided.	No	No	Yes	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	No	No	N/A	No	No
Scientific quality (risk of bias) of included studies assessed and documented.	Partially Yes	No	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	N/A	Yes	Yes	Yes
Scientific quality used appropriately in formulating conclusions.	No	N/A	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	No	N/A	Yes	Yes
Effect size index chosen justified, statistically.	Yes	Yes	N/A	Yes	Yes
Individual-level meta-analysis used.	No	No	N/A	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	No	Yes	No	Yes
Conflict of interest disclosed.	No	Yes	Yes	Yes	Yes

AMSTARExBP: SR/MA	Gao, 2014	Garcia-Hermoso, 2013	Guinhouya, 2011	Hind, 2007	Ishikawa, 2013
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	No	Yes	No
Was a comprehensive literature search performed?	Yes	Yes	Partially Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	No	No	No	No
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	No	No	No	Yes	Yes
List of studies (included and excluded) provided.	No	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	N/A	No	N/A	N/A	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	No	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	Yes	N/A	Yes	No
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	N/A	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	N/A	Yes	N/A	N/A	Yes
Effect size index chosen justified, statistically.	N/A	Yes	N/A	N/A	Yes
Individual-level meta-analysis used.	N/A	No	N/A	N/A	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	Yes	No	No	No
Conflict of interest disclosed.	Yes	Yes	No	No	Yes

AMSTARExBP: SR/MA	Janssen, 2010	Julián-Almárcegui, 2015	Kelley, 2007	Kelley, 2008	Kelley, 2014
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	Yes	No	No	No	Yes
Was a comprehensive literature search performed?	Yes	Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	No	Yes	No	Yes
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	No	No	Yes	Yes	Yes
List of studies (included and excluded) provided.	No	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	No	No	Yes
FITT defined and examined in relation to outcome effect sizes.	Yes	N/A	Yes	No	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	No	Yes	Yes	Yes
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	No	N/A	Partially Yes	Yes	Yes
Effect size index chosen justified, statistically.	Yes	N/A	Yes	Yes	Yes
Individual-level meta-analysis used.	No	N/A	No	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	No	Yes	Yes	Yes
Conflict of interest disclosed.	Yes	Yes	No	No	Yes

AMSTARExBP: SR/MA	Laframboise, 2011	Lambogliia, 2013	Larouche, 2014	Millard-Stafford, 2013	Mura, 2015
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	Yes	No	No	Yes	No
Was a comprehensive literature search performed?	Yes	Partially Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	No	No	Yes	No
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	No	No	Yes	No	No
List of studies (included and excluded) provided.	No	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	N/A	N/A	N/A	N/A	N/A
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Partially Yes	Yes	No	No
Results depended on study quality, either overall, or in interaction with moderators.	Yes	No	Yes	N/A	N/A
Scientific quality used appropriately in formulating conclusions.	Yes	No	Yes	N/A	N/A
Data appropriately synthesized and if applicable, heterogeneity assessed.	N/A	N/A	N/A	N/A	N/A
Effect size index chosen justified, statistically.	N/A	N/A	N/A	N/A	N/A
Individual-level meta-analysis used.	N/A	N/A	N/A	N/A	N/A
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	No	No	No	No
Conflict of interest disclosed.	No	No	No	No	No

AMSTARExBP: SR/MA					
	Nogueira, 2014	Pate, 2013	Ramires, 2015	Saavedra, 2011	Specker, 2015
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	No	No	Yes
Was a comprehensive literature search performed?	Yes	Partially Yes	No	Yes	Yes
Duplicate study selection and data extraction performed.	No	Yes	No	Yes	No
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	No	No	No	No	No
List of studies (included and excluded) provided.	No	No	No	No	No
Characteristics of included studies provided.	Yes	No	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	No	N/A	N/A	No	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	No	No	Yes	No
Results depended on study quality, either overall, or in interaction with moderators.	Yes	N/A	N/A	Yes	N/A
Scientific quality used appropriately in formulating conclusions.	Yes	N/A	N/A	Yes	N/A
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	N/A	N/A	Yes	Yes
Effect size index chosen justified, statistically.	Yes	N/A	N/A	Yes	Yes
Individual-level meta-analysis used.	No	N/A	N/A	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	No	Yes
Likelihood of publication bias assessed.	Yes	No	No	No	Yes
Conflict of interest disclosed.	Yes	Yes	No	Yes	Yes

AMSTARExBP: SR/MA	Sun, 2013	Tan, 2014	te Velde 2012	Timmons, 2012	Vasconcellos, 2014
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	Yes	No	Yes	No
Was a comprehensive literature search performed?	Yes	Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	Yes	Yes	Yes	No
Search strategy clearly described.	Yes	Yes	Yes	No	Yes
Relevant grey literature included in review.	Yes	No	No	No	No
List of studies (included and excluded) provided.	Yes	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	N/A	N/A	N/A	N/A	N/A
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	Yes	Yes	Yes	Yes
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	N/A	N/A	N/A	N/A	N/A
Effect size index chosen justified, statistically.	N/A	N/A	N/A	N/A	N/A
Individual-level meta-analysis used.	N/A	N/A	N/A	N/A	N/A
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	No	No	No	No
Conflict of interest disclosed.	Yes	No	Yes	Yes	Yes

AMSTARExBP: SR/MA	Waters, 2011	Weaver, 2016	Wilks, 2011	Xu, 2016	Zeng, 2016
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	Yes	Yes	Yes	No	No
Was a comprehensive literature search performed?	Yes	Partially Yes	No	Yes	Yes
Duplicate study selection and data extraction performed.	No	No	No	Yes	Yes
Search strategy clearly described.	Yes	Yes	No	Yes	Yes
Relevant grey literature included in review.	Yes	No	No	No	No
List of studies (included and excluded) provided.	Yes	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	No	N/A	No	No	N/A
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Yes	Yes	No
Results depended on study quality, either overall, or in interaction with moderators.	No	Yes	Yes	Yes	N/A
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	Yes	Yes	N/A
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	N/A	Yes	No	N/A
Effect size index chosen justified, statistically.	Yes	N/A	Yes	Yes	N/A
Individual-level meta-analysis used.	No	N/A	No	No	N/A
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	Yes	No	No	No	No
Conflict of interest disclosed.	Yes	Yes	Yes	Yes	No

Appendices

Appendix A: Analytical Framework

Topic Area
Youth

Systematic Review Question
In children and adolescents, is physical activity related to health outcomes?

a. What is the relationship between physical activity and cardiorespiratory and muscular fitness?
b. What is the relationship between physical activity and adiposity/weight status? Does physical activity prevent or reduce the risk of excessive increases in adiposity/weight?
c. What is the relationship between physical activity and cardiometabolic health?
d. What is the relationship between physical activity and bone health?
e. Are there dose-response relationships? If so, what are the shapes of those relationships?
f. Do the relationships vary by age, sex, race/ethnicity or socio-economic status?

Population
Children, ages 0–18

Exposure
All types and intensities of physical activity, including any kind of play (structured or free), sports, and other activities

Comparison
Least active subgroup

Endpoint Health Outcomes

- Bone density
- Bone strength
- Cardiorespiratory fitness
- Cardiometabolic risk factors
  - Blood pressure
  - Dyslipidemia
  - Glucose
  - Insulin resistance
  - Waist circumference
- Musculoskeletal health
- Obesity
- Overweight
- Weight gain

Appendix B: Final Search Strategy

Search Strategy: PubMed (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: PubMed; Date of Search: 12/6/2016; 222 results

Set	Search Strategy
Limit: Language	(English[lang])
Limit: Exclude animal only	NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh]))
Limit: Exclude adult only	NOT (("adult"[Mesh]) NOT (("adult"[Mesh]) AND ("infant"[Mesh] OR child[Mesh])))
Limit: Exclude subheadings	NOT (ad[sh] OR aa[sh] OR ci[sh] OR cn[sh] OR dh[sh] OR de[sh] OR dt[sh] OR em[sh] OR en[sh] OR es[sh] OR eh[sh] OR ge[sh] OR hi[sh] OR is[sh] OR ip[sh] OR lj[sh] OR ma[sh] OR mi[sh] OR og[sh] OR ps[sh] OR py[sh] OR pk[sh] OR pd[sh] OR po[sh] OR re[sh] OR rt[sh] OR rh[sh] OR st[sh] OR sd[sh] OR tu[sh] OR th[sh] OR tm[sh] OR tr[sh] OR us[sh] OR ut[sh] OR ve[sh] OR vi[sh])
Limit: Publication Date	AND ("2006/01/01"[PDAT] : "3000/12/31"[PDAT])
Limit: Publication Type Include	AND (systematic[sb] OR meta-analysis[pt] OR “systematic review”[tiab] OR “systematic literature review”[tiab] OR metaanalysis[tiab] OR "meta analysis"[tiab] OR metanalyses[tiab] OR "meta analyses"[tiab] OR "pooled analysis"[tiab] OR “pooled analyses”[tiab] OR "pooled data"[tiab])
Limit: Publication Type Exclude	NOT (“comment”[Publication Type] OR “editorial”[Publication Type])
Physical Activity	AND (("Active games"[tiab] OR "Active recreation"[tiab] OR "Exercise"[mh] OR "Exercise"[tiab] OR "High intensity activities"[tiab] OR "High intensity activity"[tiab] OR "Low intensity activities"[tiab] OR "Low intensity activity"[tiab] OR "Moderate to Vigorous Activities”[tiab] OR "Moderate to Vigorous Activity”[tiab] OR "Muscle-strengthening"[tiab] OR "Physical activity"[tiab] OR ("Recess"[tiab] AND ("Child"[tiab] OR "Youth"[tiab] OR Child[mh])) OR "Screen time"[tiab] OR "Sedentary lifestyle"[mh] OR "Television viewing"[tiab] OR "Television watching"[tiab] OR "Tummy time"[tiab] OR "TV viewing"[tiab] OR "TV watching"[tiab] OR "Video game"[tiab] OR "Video gaming"[tiab] OR "Vigorous Activities"[tiab] OR "Vigorous Activity"[tiab] OR "Play and Playthings"[mh]) OR (("Active play"[tiab] OR "Aerobic activities"[tiab] OR "Aerobic activity"[tiab] OR "Cardiovascular activities"[tiab] OR "Cardiovascular activity"[tiab] OR "Free Play"[tiab] OR "Outdoor Play"[tiab] OR "Physical activities"[tiab] OR "Recreational activities"[tiab] OR "Recreational activity"[tiab] OR

Set	Search Strategy
	"Sedentary"[tiab] OR "Walk"[tiab] OR "Walking"[tiab] OR "Youth sports"[tiab]) NOT medline[sb]))
Outcomes	AND (("Adiposity"[mh] OR "Asthma"[mh] OR "Blood glucose"[mh] OR "Blood lipids"[tiab] OR "Blood pressure"[mh] OR "Body composition"[mh] OR "Body Mass Index"[mh] OR "Bone density"[mh] OR "Cardiometabolic risk factors"[tiab] OR "Cardiometabolic risk factor"[tiab] OR "Dyslipidemias"[mh] OR "Fatness"[tiab] OR "Muscle mass"[tiab] OR "Musculoskeletal development"[mh] OR "Musculoskeletal fitness"[tiab] OR "Hyperglycemia"[mh] OR "Hypertension"[mh] OR "Insulin resistance"[mh] OR "Metabolic syndrome X"[mh] OR "Obesity"[mh] OR Diabetes Mellitus, Type 2[mh]) OR (("Adiposity"[tiab] OR "Asthma"[tiab] OR "Blood glucose"[tiab] OR "Blood pressure"[tiab] OR "Body composition"[tiab] OR "Body Mass Index"[tiab] OR BMI[tiab] OR "Dyslipidemia"[tiab] OR "Dyslipidemias"[tiab] OR "Musculoskeletal development"[tiab] OR "Hyperglycemia"[tiab] OR "Hypertension"[tiab] OR "Insulin resistance"[tiab] OR "Metabolic syndrome"[tiab] OR "Obese"[tiab] OR "Obesity"[tiab] OR "Type 2 Diabetes"[tiab] OR "Bone mineral content"[tiab] OR "Bone mineral density"[tiab] OR "Bone geometry"[tiab]) NOT medline[sb]))
Age	AND ((Child[mh] OR infant[mh]) OR (("Baby"[tiab] OR "Babies"[tiab] OR "Boy"[tiab] OR "Boys"[tiab] OR "Child"[tiab] OR "Children"[tiab] OR "Girl"[tiab] OR "Girls"[tiab] OR "Infant"[tiab] OR "Infants"[tiab] OR "Nursery school"[tiab] OR "Preschool"[tiab] OR "Pre school"[tiab] OR "Preschooler"[tiab] OR "Pre schooler"[tiab] OR "Pre-K"[tiab] OR "Toddler"[tiab] OR "Toddlers"[tiab]) NOT medline[sb]))

Search Strategy: CINAHL (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: CINAHL; Date of Search: 12/8/16; 6 results
Terms searched in title or abstract

Set	Search Terms
Physical Activity	("Active games" OR "Active play" OR "Active recreation" OR "Aerobic activities" OR "Aerobic activity" OR "Cardiovascular activities" OR "Cardiovascular activity" OR "Exercise" OR "Exercise" OR "Free Play" OR "High intensity activities" OR "High intensity activity" OR "Low intensity activities" OR "Low intensity activity" OR "Moderate to Vigorous Activities" OR "Moderate to Vigorous Activity" OR "Muscle-strengthening" OR "Outdoor Play" OR "Physical activity" OR "Physical activities" OR ("Recess" AND ("Child" OR "Youth")) OR "Recreational activities" OR "Recreational activity" OR "Screen time" OR "Sedentary" OR "Sedentary lifestyle" OR "Television viewing" OR "Television watching" OR "Tummy time" OR "TV viewing" OR "TV watching" OR "Video game" OR "Video gaming" OR "Vigorous Activities" OR "Vigorous Activity" OR "Walk" OR "Walking" OR "Play and Playthings" OR "Youth sports")
Outcomes	AND ("Adiposity" OR "Adiposity" OR "Asthma" OR "Asthma" OR "Blood glucose" OR "Blood glucose" OR "Blood lipids" OR "Blood pressure" OR "Blood pressure" OR "Body composition" OR "Body composition" OR "Body Mass Index" OR "Body Mass Index" OR BMI OR "Bone density" OR "Cardiometabolic risk factors" OR "Cardiometabolic risk factor" OR "Dyslipidemia" OR "Dyslipidemias" OR "Dyslipidemias" OR "Fatness" OR "Muscle mass" OR "Musculoskeletal development" OR "Musculoskeletal development" OR "Musculoskeletal fitness" OR "Hyperglycemia" OR "Hyperglycemia" OR "Hypertension" OR "Hypertension" OR "Insulin resistance" OR "Insulin resistance" OR "Metabolic syndrome" OR "Metabolic syndrome X" OR "Obese" OR "Obesity" OR "Obesity" OR "Type 2 Diabetes" OR Diabetes Mellitus, Type 2 OR "Bone mineral content" OR "Bone mineral density" OR "Bone geometry")
Age	AND ("Baby" OR "Babies" OR "Boy" OR "Boys" OR "Child" OR "Children" OR "Girl" OR "Girls" OR "Infant" OR "Infants" OR "Nursery school" OR "Preschool" OR "Pre school" OR "Preschooler" OR "Pre schooler" OR "Pre-K" OR "Toddler" OR "Toddlers" OR "Child" OR "infant")
Systematic Reviews and Meta-Analyses	AND ("systematic review" OR "systematic literature review" OR metaanalysis OR "meta analysis" OR metanalyses OR "meta analyses" OR "pooled analysis" OR "pooled analyses" OR "pooled data")
Limits	2006–present English language Peer reviewed Exclude Medline records Human

Search Strategy: Cochrane (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: Cochrane; Date of Search: 12/15/16; 112 results
Terms searched in title, abstract, or keywords

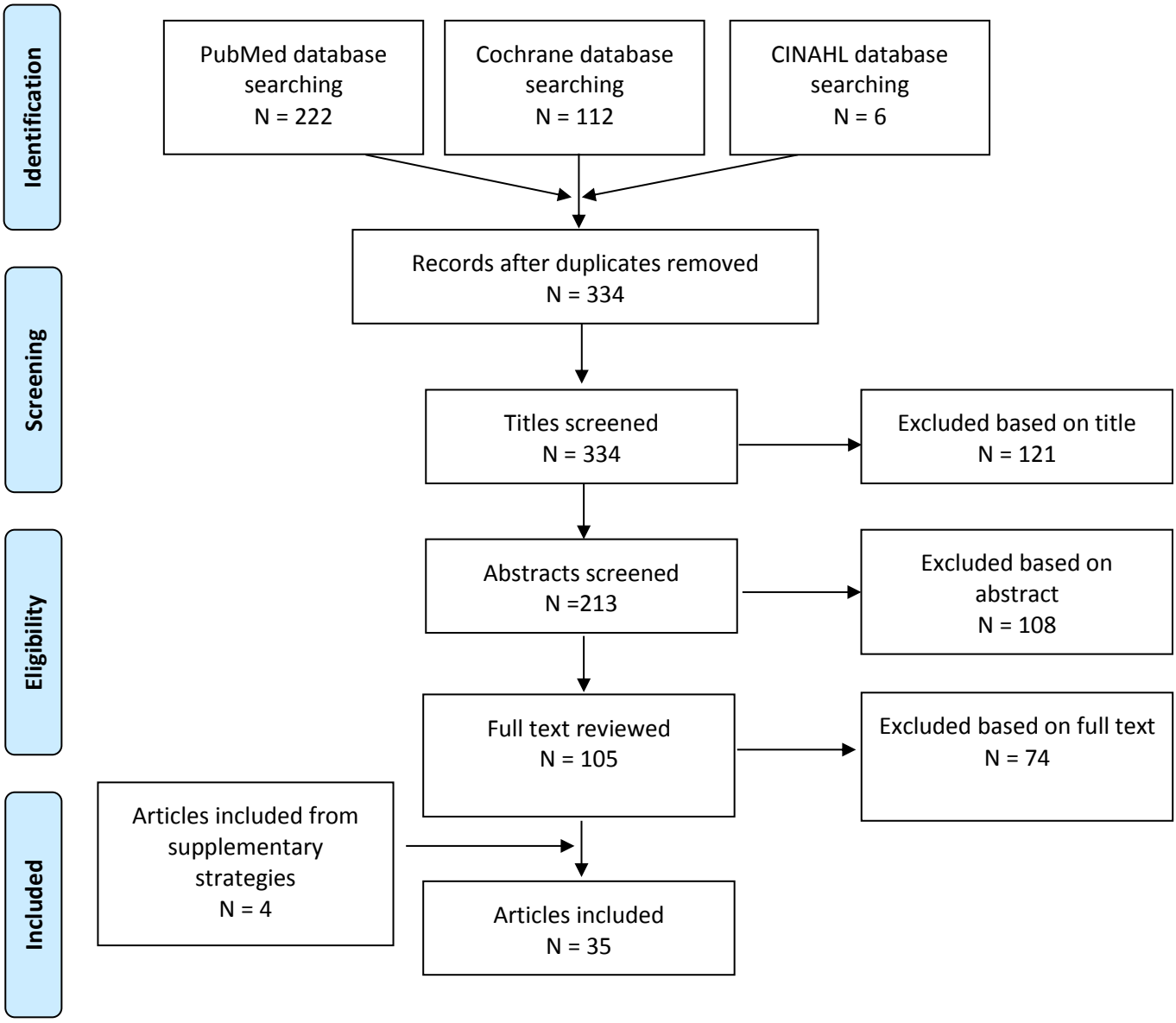
Set	Search Terms
Physical Activity	("Active games" OR "Active play" OR "Active recreation" OR "Aerobic activities" OR "Aerobic activity" OR "Cardiovascular activities" OR "Cardiovascular activity" OR "Exercise" OR "Exercise" OR "Free Play" OR "High intensity activities" OR "High intensity activity" OR "Low intensity activities" OR "Low intensity activity" OR "Moderate to Vigorous Activities" OR "Moderate to Vigorous Activity" OR "Muscle-strengthening" OR "Outdoor Play" OR "Physical activity" OR "Physical activities" OR ("Recess" AND ("Child" OR "Youth")) OR "Recreational activities" OR "Recreational activity" OR "Screen time" OR "Sedentary" OR "Sedentary lifestyle" OR "Television viewing" OR "Television watching" OR "Tummy time" OR "TV viewing" OR "TV watching" OR "Video game" OR "Video gaming" OR "Vigorous Activities" OR "Vigorous Activity" OR "Walk" OR "Walking" OR "Play and Playthings" OR "Youth sports")
Outcomes	AND ("Adiposity" OR "Adiposity" OR "Asthma" OR "Asthma" OR "Blood glucose" OR "Blood glucose" OR "Blood lipids" OR "Blood pressure" OR "Blood pressure" OR "Body composition" OR "Body composition" OR "Body Mass Index" OR "Body Mass Index" OR BMI OR "Bone density" OR "Cardiometabolic risk factors" OR "Cardiometabolic risk factor" OR "Dyslipidemia" OR "Dyslipidemias" OR "Dyslipidemias" OR "Fatness" OR "Muscle mass" OR "Musculoskeletal development" OR "Musculoskeletal development" OR "Musculoskeletal fitness" OR "Hyperglycemia" OR "Hyperglycemia" OR "Hypertension" OR "Hypertension" OR "Insulin resistance" OR "Insulin resistance" OR "Metabolic syndrome" OR "Metabolic syndrome X" OR "Obese" OR "Obesity" OR "Obesity" OR "Type 2 Diabetes" OR Diabetes Mellitus, Type 2 OR "Bone mineral content" OR "Bone mineral density" OR "Bone geometry")
Age	AND ("Baby" OR "Babies" OR "Boy" OR "Boys" OR "Child" OR "Children" OR "Girl" OR "Girls" OR "Infant" OR "Infants" OR "Nursery school" OR "Preschool" OR "Pre school" OR "Preschooler" OR "Pre schooler" OR "Pre-K" OR "Toddler" OR "Toddlers" OR "Child" OR "infant")
Limits	2006–present Word variations not searched Cochrane Reviews and Other Reviews

Supplementary Strategies:

The Physical Activity Guidelines Youth Subcommittee also used a supplementary search strategy—expert consultation. Members suggested relevant reviews that were not captured by the search strategies. Four relevant articles were identified: Pate et al[21]; Ramires et al[22]; Timmons et al[24]; and Weaver et al.[35]

Appendix C: Literature Tree

Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports Literature Tree



Appendix D: Inclusion/Exclusion Criteria

Youth Subcommittee
Q2. In children and adolescents, is physical activity related to health outcomes?

a. What is the relationship between physical activity and cardiorespiratory and muscular fitness?
b. What is the relationship between physical activity and adiposity/weight status? Does physical activity prevent or reduce the risk of excessive increases in adiposity/weight?
c. What is the relationship between physical activity and cardiometabolic health?
d. What is the relationship between physical activity and bone health?
e. Are there dose-response relationships? If so, what are the shapes of those relationships?
f. Do the relationships vary by age, sex, race/ethnicity, weight status, or socio-economic status?

Category	Inclusion/Exclusion Criteria	Notes/Rationale
Publication Language	**Include:** • Studies published with full text in English	
Publication Status	**Include:** • Studies published in peer-reviewed journals • Reports determined to have appropriate suitability and quality by PAGAC **Exclude:** • Grey literature, including unpublished data, manuscripts, abstracts, conference proceedings	
Research Type	**Include:** • Original research • Meta-analyses • Systematic reviews • Pooled analyses • Reports determined to have appropriate suitability and quality by PAGAC	
Study Subjects	**Include:** • Human subjects	
Age of Study Subjects	**Include:** • Children ages 0–18 **Exclude:** • Adults	
Health Status of Study Subjects	**Include:** • Healthy children • Overweight or obese children **Exclude:** • Children with disabilities • Children with chronic conditions	
Date of Publication	**Include:** • Systematic reviews and meta-analyses published 2006–present • Original research published whenever	

Study Design	**Include:** • Randomized trials • Non-randomized trials • Prospective cohort studies • Retrospective cohort studies • Case-control studies • Before-after studies • Time series • Systematic reviews • Meta-analyses • Reports **Exclude:** • Narrative reviews • Commentaries • Editorials • Cross-sectional studies • Study protocol	
Intervention/ Exposure	**Include studies in which the exposure or intervention is:** • All types and intensities of physical activity **Exclude:** • Studies that do not include physical activity (or the lack thereof) as the primary exposure variable or used solely as a confounding variable • Studies of a specific therapeutic exercise delivered by a medical professional (e.g., physical therapist)	

Outcome	**Include studies in which the outcome is:**
	• Bone density
	• Bone strength
	• Cardiorespiratory fitness
	• Cardiometabolic risk factors
	  ○ Blood pressure
	  ○ Dyslipidemia
	  ○ Glucose
	  ○ Insulin resistance
	  ○ Waist circumference
	• Musculoskeletal health
	• Obesity
	• Overweight
	• Weight gain	

Appendix E: Rationale for Exclusion at Abstract or Full-Text Triage for Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports

The table below lists the excluded articles with at least one reason for exclusion, but may not reflect all possible reasons.

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Adachi-Mejia AM, Longacre MR, Gibson JJ, Beach ML, Titus-Ernstoff LT, Dalton MA. Children with a TV in their bedroom at higher risk for being overweight. *Int J Obes (Lond).* 2007;31(4):644-651. doi:10.1038/sj.ijo.0803455.				X		
Adatia I, Haworth SG, Wegner M, et al. Clinical trials in neonates and children: report of the pulmonary hypertension academic research consortium pediatric advisory committee. *Pulm Circ.* 2013;3(1):252-266. doi:10.4103/2045-8932.109931.				X		
Aftosmes-Tobio A, Ganter C, Gicevic S, et al. A systematic review of media parenting in the context of childhood obesity research. *BMC Public Health.* 2016;16:320. doi:10.1186/s12889-016-2981-5.				X		
Aguilar Cordero MJ, Ortegón Piñero A, Mur Vilar N, et al. Physical activity programmes to reduce overweight and obesity in children and adolescents; a systematic review. *Nutr Hosp.* 2014;30(4):727-740. doi:10.3305/nh.2014.30.4.7680.						X
Alberdi G, McNamara AE, Lindsay KL, et al. The association between childcare and risk of childhood overweight and obesity in children aged 5 years and under: a systematic review. *Eur J Pediatr.* 2016;175(10):1277-1294. doi:10.1007/s00431-016-2768-9.				X		
Alexander D, Rigby MJ, Di Mattia P, Zscheppang A. Challenges in finding and measuring behavioural determinants of childhood obesity in Europe. *J Public Health.* 2015;23(2):87-94. doi:10.1007/s10389-015-0657-8.	X					
Antwi F, Fazylova N, Garcon MC, Lopez L, Rubiano R, Slyer JT. The effectiveness of web-based programs on the reduction of childhood obesity in school-aged children: a systematic review. *JBI Libr Syst Rev.* 2012;10(suppl 42):1-14. doi:10.11124/jbisrir-2012-248.			X			
Arterburn DE. Obesity in children. *BMJ Clin Evid*. 2007;pii:0325:110-111.				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Atkin AJ, Ekelund U, Moller NC, et al. Sedentary time in children: influence of accelerometer processing on health relations. *Med Sci Sports Exerc.* 2013;45(6):1097-1104. doi:10.1249/MSS.0b013e318282190e.	X					
Atlantis E, Barnes EH, Singh MA. Efficacy of exercise for treating overweight in children and adolescents: a systematic review. *Int J Obes (Lond).* 2006;30(7):1027-1040. doi:10.1038/sj.ijo.0803286.					X	
Azevedo LB, Ling J, Soos I, Robalino S, Ells L. The effectiveness of sedentary behaviour interventions for reducing body mass index in children and adolescents: systematic review and meta-analysis. *Obes Rev*. 2016;17(7):623-635. doi:10.1111/obr.12414.				X		
Bäcklund C, Sundelin G, Larsson C. Effect of a 1-year lifestyle intervention on physical activity in overweight and obese children. *Adv Physiother.* 2011;13(3):87-96. doi:10.3109/14038196.2011.566353.			X			
Bäcklund C, Sundelin G, Larsson C. Effects of a 2-year lifestyle intervention on physical activity in overweight and obese children. *Adv Physiother.* 2011;13(3):97-109. doi:10.3109/14038196.2011.562540.			X			
Barr-Anderson DJ, Adams-Wynn AW, DiSantis KI, Kumanyika S. Family-focused physical activity, diet and obesity interventions in African-American girls: a systematic review. *Obes Rev.* 2013;14(1):29-51. doi:10.1111/j.1467-789X.2012.01043.x.				X		
Berge JM. A review of familial correlates of child and adolescent obesity: what has the 21st century taught us so far? *Int J Adolesc Med Health.* 2009;21(4):457-483.	X					
Berge JM, Everts JC. Family-based interventions targeting childhood obesity: a meta-analysis. *Child Obes.* 2011;7(2):110-121. doi:10.1089/chi.2011.07.02.1004.berge.				X		
Birch L, Perry R, Penfold C, Beynon R, Hamilton-Shield J. What change in body mass index is needed to improve metabolic health status in childhood obesity: protocol for a systematic review. *Syst Rev.* 2016;5(1):120. doi:10.1186/s13643-016-0299-0.			X			

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Bleich SN, Ku R, Wang YC. Relative contribution of energy intake and energy expenditure to childhood obesity: a review of the literature and directions for future research. *Int J Obes (Lond).* 2011;35(1):1-15. doi:10.1038/ijo.2010.252.				X		
Blohm D, Ploch T, Apelt S. Efficacy of exercise therapy to reduce cardiometabolic risk factors in overweight and obese children and adolescents: a systematic review. *Dtsch Med Wochenschr.* 2012;137(50):2631-2636. doi:10.1055/s-0032-1327333.					X	
Bochner RE, Sorensen KM, Belamarich PF. The impact of active video gaming on weight in youth: a meta-analysis. *Clin Pediatr (Phila).* 2015;54(7):620-628. doi:10.1177/0009922814545165.				X		
Brown EC, Buchan DS, Baker JS, Wyatt FB, Bocalini DS, Kilgore L. A systematised review of primary school whole class child obesity interventions: effectiveness, characteristics, and strategies. *Biomed Res Int.* 2016;2016:4902714. doi:10.1155/2016/4902714.				X		
Brown T, Summerbell C. Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence. *Obes Rev.* 2009;10(1):110-141. doi:10.1111/j.1467-789X.2008.00515.x.				X		
Bryant MJ, Lucove JC, Evenson KR, Marshall S. Measurement of television viewing in children and adolescents: a systematic review. *Obes Rev.* 2007;8(3):197-209. doi:10.1111/j.1467-789X.2006.00295.x.			X	X		
Bustamante EE, Williams CF, Davis CL. Physical activity interventions for neurocognitive and academic performance in overweight and obese youth: a systematic review. *Pediatr Clin North Am.* 2016;63(3):459-480. doi:10.1016/j.pcl.2016.02.004.	X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Caleyachetty R, Echouffo-Tcheugui JB, Tait CA, Schilsky S, Forrester T, Kengne AP. Prevalence of behavioural risk factors for cardiovascular disease in adolescents in low-income and middle-income countries: an individual participant data meta-analysis. *Lancet Diabetes Endocrinol.* 2015;3(7):535-544. doi:10.1016/S2213-8587(15)00076-5.				X		
Canoy D, Bundred P. Obesity in children. *BMJ Clin Evid.* 2011;2011:pii:0325.				X		
Carlin A, Murphy MH, Gallagher AM. Do interventions to increase walking work? A systematic review of interventions in children and adolescents. *Sports Med.* 2016;46(4):515-530. doi:10.1007/s40279-015-0432-6.	X					
Carson V, Hunter S, Kuzik N, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth: an update. *Appl Physiol Nutr Metab*. 2016;41(6 suppl 3):S240-S65. doi:10.1139/apnm-2015-0630.				X		
Cattuzzo MT, Dos Santos Henrique R, Ré AH, et al. Motor competence and health related physical fitness in youth: a systematic review. *J Sci Med Sport.* 2016;19(2):123-129. doi:10.1016/j.jsams.2014.12.004.				X		
Chai LK, Burrows T, May C, Brain K, Wong See D, Collins C. Effectiveness of family-based weight management interventions in childhood obesity: an umbrella review protocol. *JBI Database System Rev Implement Rep.* 2016;14(9):32-39. doi:10.11124/JBISRIR-2016-003082.			X			
Chaplais E, Naughton G, Thivel D, Courteix D, Greene D. Smartphone interventions for weight treatment and behavioral change in pediatric obesity: a systematic review. *Telemed J E Health.* 2015;21(10):822-830. doi:10.1089/tmj.2014.0197.			X			X
Chen SR, Chiu HW, Lee YJ, Sheen TC, Jeng C. Impact of pubertal development and physical activity on heart rate variability in overweight and obese children in Taiwan. *J Sch Nurs.* 2012;28(4):284-290. doi:10.1177/1059840511435248.			X			

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Chen YC, Tu YK, Huang KC, Chen PC, Chu DC, Lee YL. Pathway from central obesity to childhood asthma. Physical fitness and sedentary time are leading factors. *Am J Respir Crit Care Med.* 2014;189(10):1194-1203. doi:10.1164/rccm.201401-0097OC.			X			
Chinapaw MJ, Proper KI, Brug J, van Mechelen W, Singh AS. Relationship between young peoples' sedentary behaviour and biomedical health indicators: a systematic review of prospective studies. *Obes Rev.* 2011;12(7):e621-e632. doi:10.1111/j.1467-789X.2011.00865.x.				X		
Ciampa PJ, Kumar D, Barkin SL, et al. Interventions aimed at decreasing obesity in children younger than 2 years: a systematic review. *Arch Pediatr Adolesc Med.* 2010;164(12):1098-1104. doi:10.1001/archpediatrics.2010.232.				X		
Cliff DP, Hesketh KD, Vella SA, et al. Objectively measured sedentary behaviour and health and development in children and adolescents: systematic review and meta-analysis. *Obes Rev.* 2016;17(4):330-344. doi:10.1111/obr.12371.				X		
Colquitt JL, Loveman E, O'Malley C, et al. Diet, physical activity, and behavioural interventions for the treatment of overweight or obesity in preschool children up to the age of 6 years. 2016;(3):CD012105. doi:10.1002/14651858.CD012105.				X		
Cote AT, Devlin AM, Panagiotopoulos C. Initial screening of children treated with second-generation antipsychotics points to an association between physical activity and insulin resistance. *Pediatr Exerc Sci*. 2014;26(4):455-462. doi:10.1123/pes.2014-0076.				X		
Cradock AL, Barrett JL, Kenney EL, et al. Using cost-effectiveness analysis to prioritize policy and programmatic approaches to physical activity promotion and obesity prevention in childhood. *Prev Med.* 2017;95(suppl):S17-S27. doi:10.1016/j.ypmed.2016.10.017.	X					
Craigie AM, Lake AA, Kelly SA, Adamson AJ, Mathers JC. Tracking of obesity-related behaviours from childhood to adulthood: a systematic review.	X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Maturitas. 2011;70(3):266-284. doi:10.1016/j.maturitas.2011.08.005.						
De Bourdeaudhuij I, Van Cauwenberghe E, Spittaels H, et al. School-based interventions promoting both physical activity and healthy eating in Europe: a systematic review within the HOPE project. *Obes Rev.* 2011;12(3):205-216. doi:10.1111/j.1467-789X.2009.00711.x.					X	
Dellert JC, Johnson P. Interventions with children and parents to improve physical activity and body mass index: a meta-analysis. *Am J Health Promot*. 2014;28(4):259-267. doi:10.4278/ajhp.120628-LIT-313.					X	
DeMattia L, Lemont L, Meurer L. Do interventions to limit sedentary behaviours change behaviour and reduce childhood obesity? A critical review of the literature. *Obes Rev.* 2007;8(1):69-81. doi:10.1111/j.1467-789X.2006.00259.x.					X	
Demetriou Y, Höner O. Physical activity interventions in the school setting: a systematic review. *Psychol Sport Exerc.* 2012;13(2):186-196. doi:10.1016/j.psychsport.2011.11.006.					X	
Dennison ME, Sisson SB, Lora K, Stephens LD, Copeland KC, Caudillo C. Assessment of body mass index, sugar sweetened beverage intake and time spent in physical activity of American Indian children in Oklahoma. *J Community Health.* 2015;40(4):808-814. doi:10.1007/s10900-015-0004-6.			X			
Duch H, Fisher EM, Ensari I, Harrington A. Screen time use in children under 3 years old: a systematic review of correlates. *Int J Behav Nutr Phys Act.* 2013;10:102. doi:10.1186/1479-5868-10-102.				X		
Dunton GF, Kaplan J, Wolch J, Jerrett M, Reynolds KD. Physical environmental correlates of childhood obesity: a systematic review. *Obes Rev.* 2009;10(4):393-402. doi:10.1111/j.1467-789X.2009.00572.x.	X					
Ekelund U, Luan J, Sherar LB, Esliger DW, Griew P, Cooper A; International Children's Accelerometry Database (ICAD) Collaborators. Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. *JAMA*.				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
2012;307(7):704-712. doi:10.1001/jama.2012.156.						
Ferreira I, van der Horst K, Wendel-Vos W, Kremers S, van Lenthe FJ, Brug J. Environmental correlates of physical activity in youth—a review and update. *Obes Rev.* 2007;8(2):129-154. doi:10.1111/j.1467-789X.2006.00264.x.	X	X		X		
Fisberg M, Maximino P, Kain J, Kovalskys I. Obesogenic environment—intervention opportunities. *J Pediatr (Rio J).* 2016;92(3 suppl 1):S30-S39. doi:10.1016/j.jped.2016.02.007.	X	X		X		
Fleischhacker S, Roberts E, Camplain R, Evenson KR, Gittelsohn J. Promoting physical activity among Native American youth: a systematic review of the methodology and current evidence of physical activity interventions and community-wide initiatives. *J Racial Ethn Health Disparities.* 2016;3(4):608-624. doi:10.1007/s40615-015-0180-1.						X
Flodmark CE, Marcus C, Britton M. Interventions to prevent obesity in children and adolescents: a systematic literature review. *Int J Obes (Lond).* 2006;30(4):579-589. doi:10.1038/sj.ijo.0803290.				X		
Foulds HJ, Rodgers CD, Duncan V, Ferguson LJ. A systematic review and meta-analysis of screen time behaviour among North American indigenous populations. *Obes Rev.* 2016;17(5):455-466. doi:10.1111/obr.12389.	X			X		
Frerichs L, Ataga O, Corbie-Smith G, Tessler Lindau S. Child and youth participatory interventions for addressing lifestyle-related childhood obesity: a systematic review. *Obes Rev*. 2016;17(12):1276-1286. doi:10.1111/obr.12468.				X		
Galantino ML, Galbavy R, Quinn L. Therapeutic effects of yoga for children: a systematic review of the literature. *Pediatr Phys Ther.* 2008;20(1):66-80. doi:10.1097/PEP.0b013e31815f1208.						X
García-Hermoso A, Carmona-López MI, Saavedra JM, Escalante Y. Physical exercise, detraining and lipid profile in obese children: a systematic review. *Arch Argent Pediatr.* 2014;112(6):519-525. doi:10.1590/S0325-00752014000600007.				X	X	

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
García-Hermoso A, Sánchez-López M, Escalante Y, Saavedra JM, Martínez-Vizcaíno V. Exercise-based interventions and C-reactive protein in overweight and obese youths: a meta-analysis of randomized controlled trials. *Pediatr Res.* 2016;79(4):522-527. doi:10.1038/pr.2015.274.		X				
Golley RK, Hendrie GA, Slater A, Corsini N. Interventions that involve parents to improve children's weight-related nutrition intake and activity patterns—what nutrition and activity targets and behaviour change techniques are associated with intervention effectiveness? 2011;12(2):114-130. doi:10.1111/j.1467-789X.2010.00745.x.	X	X		X		
Gomes TN, Katzmarzyk PT, dos Santos FK, Souza M, Pereira S, Maia JA. Overweight and obesity in Portuguese children: prevalence and correlates. *Int J Environ Res Public Health.* 2014;11(11):11398-11417. doi:10.3390/ijerph111111398.			X			
Gorga E, Regazzoni V, Bansilal S, et al. School and family-based interventions for promoting a healthy lifestyle among children and adolescents in Italy: a systematic review. *J Cardiovasc Med (Hagerstown).* 2016;17(8):547-555. doi:10.2459/JCM.0000000000000404.	X					
Gray C, Gibbons R, Larouche R, et al. What is the relationship between outdoor time and physical activity, sedentary behaviour, and physical fitness in children? A systematic review. *Int J Environ Res Public Health.* 2015;12(6):6455-6474. doi:10.3390/ijerph120606455.	X					
Guerra PH, Nobre MR, da Silveira JA, Taddei JA. School-based physical activity and nutritional education interventions on body mass index: a meta-analysis of randomised community trials—project PANE. *Prev Med.* 2014;61:81-89. doi:10.1016/j.ypmed.2014.01.005.				X		
Guy S, Ratzi-Leewing A, Gwadry-Sridhar F. Moving beyond the stigma: systematic review of video games and their potential to combat obesity. *Int J Hypertens*. 2011;2011:179124. doi:10.4061/2011/179124.	X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Habibzadeh S, Rahmani-Nia F, Daneshmandi H. The Effect of Walking Exercise on the Amount of Fat Mass and Serum Insulin in Obese Girls. zumsj. 2010; 18 (73) :18-25.		X				
Haines MS, Kim DH. A study of the effects of physical activity on asthmatic symptoms and obesity risk in elementary school-aged children. *Am J Health Educ*. 2013;44(3):156-161. doi:10.1080/19325037.2013.779905.		X				
Hammad SS, Berry DC. The child obesity epidemic in Saudi Arabia: a review of the literature. *J Transcult Nurs.* Sept 2016;pii:1043659616668398. doi:10.1177/1043659616668398.	X	X				
Hammersley ML, Jones RA, Okely AD. Parent-focused childhood and adolescent overweight and obesity ehealth interventions: a systematic review and meta-analysis. *J Med Internet Res*. 2016;18(7):e203. doi:10.2196/jmir.5893.				X		
Haney EM, Huffman LH, Bougatsos C, et al. *Screening for lipid disorders in children and adolescents [Internet]*. U.S. Preventive Services Task Force Evidence Syntheses, formerly Systematic Evidence Reviews. Report No.: 07-0598-EF-1. Rockville, MD: Agency for Healthcare Research and Quality; 2007.	X			X		
Hansen D, Marinus N, Remans M, et al. Exercise tolerance in obese vs. lean adolescents: a systematic review and meta-analysis. *Obes Rev.* 2014;15(11):894-904. doi:10.1111/obr.12202.	X					
Harris KC, Kuramoto LK, Schulzer M, Retallack JE. Effect of school-based physical activity interventions on body mass index in children: a meta-analysis. *CMAJ*. 2009;180(7):719-726. doi:10.1503/cmaj.080966.					X	
Hendrie GA, Brindal E, Corsini N, Gardner C, Baird D, Golley RK. Combined home and school obesity prevention interventions for children: what behavior change strategies and intervention characteristics are associated with effectiveness? *Health Educ Behav.* 2012;39(2):159-171. doi:10.1177/1090198111420286.	X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Hildebrand M, Oglund GP, Wells JC, Ekelund U. Prenatal, birth and early life predictors of sedentary behavior in young people: a systematic review. *Int J Behav Nutr Phys Act.* 2016;13:63. doi:10.1186/s12966-016-0389-3.	X			X		
Hinkley T, Salmon J, Okely AD, Trost SG. Correlates of sedentary behaviours in preschool children: a review. *Int J Behav Nutr Phys Act*. 2010;7:66. doi:10.1186/1479-5868-7-66.	X			X		
Ho M, Garnett SP, Baur L, et al. Effectiveness of lifestyle interventions in child obesity: systematic review with meta-analysis. *Pediatrics.* 2012;130(6):e1647-e1671. doi:10.1542/peds.2012-1176.				X		
Ho M, Garnett SP, Baur LA, et al. Impact of dietary and exercise interventions on weight change and metabolic outcomes in obese children and adolescents: a systematic review and meta-analysis of randomized trials. *JAMA Pediatr.* 2013;167(8):759-768. doi:10.1001/jamapediatrics.2013.1453.				X		
Hodges EA, Smith C, Tidwell S, Berry D. Promoting physical activity in preschoolers to prevent obesity: a review of the literature. *J Pediatr Nurs.* 2013;(4):3-19. doi:10.1016/j.pedn.2012.01.002.			X			
Innella N, Breitenstein S, Hamilton R, Reed M, McNaughton DB. Determinants of obesity in the Hispanic preschool population: an integrative review. *Public Health Nurs.* 2016;33(3):189-199. doi:10.1111/phn.12215.		X				
Kanekar A, Sharma M. Meta-analysis of school-based childhood obesity interventions in the UK and US. *Int Q Community Health Educ.* 2008;29(3):241-256. doi:10.2190/IQ.29.3.d.				X		
Katz DL, O'Connell M, Njike VY, Yeh MC, Nawaz H. Strategies for the prevention and control of obesity in the school setting: systematic review and meta-analysis. *Int J Obes (Lond).* 2008;32(12):1780-1789. doi:10.1038/ijo.2008.158.				X		
Kelishadi R, Azizi-Soleiman F. Controlling childhood obesity: a systematic review on strategies and challenges. *J Res Med Sci.* 2014;19(10):993-1008.				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Kelley GA, Kelley KS, Pate RR. Exercise and BMI z-score in overweight and obese children and adolescents: a systematic review and network meta-analysis of randomized trials. *J Evid Based Med*. 2017;10(2):108-128. doi:10.1111/jebm.12228.		X				
Kellou N, Sandalinas F, Copin N, Simon C. Prevention of unhealthy weight in children by promoting physical activity using a socio-ecological approach: what can we learn from intervention studies? *Diabetes Metab*. 2014;40(4):258-271. doi:10.1016/j.diabet.2014.01.002.					X	
Kemp C, Pienaar AE. Physical activity levels and energy expenditure of 9-year-old—12-year-old overweight and obese children. *Health SA Gesondheid.* 2011;16(1):1-6. doi:10.4102/hsag.v16i1.557.			X			
Kesten JM, Griffiths PL, Cameron N. A systematic review to determine the effectiveness of interventions designed to prevent overweight and obesity in pre-adolescent girls. *Obes Rev.* 2011;12(12):997-1021. doi:10.1111/j.1467-789X.2011.00919.x.				X		
Kim K, Ok G, Jeon S, Kang M, Lee S. Sport-based physical activity intervention on body weight in children and adolescents: a meta-analysis. *J Sports Sci*. 2017;35(4):369-376. doi:10.1080/02640414.2016.1166389.					X	
Kitzman-Ulrich H, Wilson DK, St George SM, Lawman H, Segal M, Fairchild A. The integration of a family systems approach for understanding youth obesity, physical activity, and dietary programs. *Clin Child Fam Psychol Rev.* 2010;13(3):231-253. doi:10.1007/s10567-010-0073-0.				X		
Langford R, Bonell CP, Jones HE, et al. The WHO Health Promoting School framework for improving the health and well-being of students and their academic achievement. *Cochrane Database Syst Rev.* 2014;(4):CD008958. doi:10.1002/14651858.CD008958.pub2.				X		
Laws R, Campbell KJ, van der Pligt P, et al. The impact of interventions to prevent obesity or improve obesity related behaviours in children (0-5 years) from socioeconomically disadvantaged and/or indigenous families: a systematic				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
review. *BMC Public Health.* 2014;14:779. doi:10.1186/1471-2458-14-779.						
Leech RM, McNaughton SA, Timperio A. The clustering of diet, physical activity and sedentary behavior in children and adolescents: a review. *Int J Behav Nutr Phys Act.* 2014;11:4. doi:10.1186/1479-5868-11-4.			X			
Lee JE, Pope Z, Gao Z. The role of youth sports in promoting children's physical activity and preventing pediatric obesity: a systematic review. *Behav Med*. June 2016;1-15. doi:10.1080/08964289.2016.1193462.	X					
Lee SS, Kang S. Effects of regular exercise on obesity and type 2 diabete mellitus in Korean children: improvements glycemic control and serum adipokines level. *J Phys Ther Sci.* 2015;27(6):1903-1907. doi:10.1589/jpts.27.1903.			X			
Leinaar E, Alamian A, Wang L. A systematic review of the relationship between asthma, overweight, and the effects of physical activity in youth. *Ann Epidemiol.* 2016;26(7):504-510.e6. doi:10.1016/j.annepidem.2016.06.002.		X		X		
Leung MM, Agaronov A, Grytsenko K, Yeh MC. Intervening to reduce sedentary behaviors and childhood obesity among school-age youth: a systematic review of randomized trials. *J Obes*. 2012:685430. doi:10.1155/2012/685430.				X		
Lien AS, Cho YH, Tsai JL. Effectiveness evaluation of healthy lifestyle interventions in childhood obesity prevention: a systematic review. *Hu Li Za Zhi.* 2013;60(4):33-42. doi:10.6224/JN.60.3.33.					X	
Lim CS, Mayer-Brown SJ, Clifford LM, Janicke DM. Pain is associated with physical activity and health-related quality of life in overweight and obese children. *Child Health Care.* 2014;43(3):186-202. doi:10.1080/02739615.2013.837825.		X				
Lissau I. Prevention of overweight in the school arena. *Acta Paediatr.* 2007;96(454):12-18. doi:10.1111/j.1651-2227.2007.00164.x.					X	
Lovasi GS, Hutson MA, Guerra M, Neckerman KM. Built environments and obesity in disadvantaged populations. *Epidemiol Rev*. 2009;31:7-20. doi:10.1093/epirev/mxp005.				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Loveman E, Al-Khudairy L, Johnson RE, et al. Parent-only interventions for childhood overweight or obesity in children aged 5 to 11 years. 2015;(12):CD012008. doi:10.1002/14651858.CD012008.		X				
Lubans DR, Boreham CA, Kelly P, Foster CE. The relationship between active travel to school and health-related fitness in children and adolescents: a systematic review. *Int J Behav Nutr Phys Act.* 2011;8:5. doi:10.1186/1479-5868-8-5.					X	
Lv N, Xiao L, Ma J. Weight management interventions in adult and pediatric asthma populations: a systematic review. *J Pulm Respir Med.* 2015;5(232):pii:1000232. doi:10.4172/2161-105X.1000232.		X				
Mahgoub MS, Aly S. The effects of continuous vs intermittent exercise on lipid profile in obese children. *Int J Ther Rehabil.* 2015;22(6):272-276. doi:10.12968/ijtr.2015.22.6.272.			X			
Marty K, Wolff C, Morgan I. Overweight, diet, physical activity, and hypertension in low-income school-aged children. *Calif J Health Promot.* 2006;4(2):47-58.			X			
Marson EC, Delevatti RS, Prado AK, Netto N, Kruel LF. Effects of aerobic, resistance, and combined exercise training on insulin resistance markers in overweight or obese children and adolescents: a systematic review and meta-analysis. *Prev Med.* 2016;93:211-218. doi:10.1016/j.ypmed.2016.10.020.		X				
Mears R, Jago R. Effectiveness of after-school interventions at increasing moderate-to-vigorous physical activity levels in 5- to 18-year olds: a systematic review and meta-analysis. *Br J Sports Med.* May 2016. doi:10.1136/bjsports-2015-094976.	X	X		X		
McCormack LA, Meendering J. Diet and physical activity in rural vs urban children and adolescents in the United States: a narrative review. *J Acad Nutr Diet.* 2016;116(3):467-480. doi:10.1016/j.jand.2015.10.024.	X		X			
McNeill G, Osei-Assibey G, Dick S, et al. P32 Using evidence to prioritise areas for public health actions for tackling childhood overweight. *J Epidemiol Community Health.* 2010;64:A46.	X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Mei H, Xiong Y, Xie S, et al. The impact of long-term school-based physical activity interventions on body mass index of primary school children—a meta-analysis of randomized controlled trials. *BMC Public Health*. 2016;16:205. doi:10.1186/s12889-016-2829-z.					X	
Metcalf B, Henley W, Wilkin T. Effectiveness of intervention on physical activity of children: systematic review and meta-analysis of controlled trials with objectively measured outcomes (EarlyBird 54). *BMJ.* 2012;345:e5888(2). doi:10.1136/bmj.e5888.	X					
Mistry SK, Puthussery S. Risk factors of overweight and obesity in childhood and adolescence in South Asian countries: a systematic review of the evidence. *Public Health*. 2015;129(3):200-209. doi:10.1016/j.puhe.2014.12.004.		X		X		
Nixon CA, Moore HJ, Douthwaite W, et al. Identifying effective behavioural models and behaviour change strategies underpinning preschool- and school-based obesity prevention interventions aimed at 4-6-year-olds: a systematic review. *Obes Rev.* 2012;13(suppl 1):106-117. doi:10.1111/j.1467-789X.2011.00962.x.				X		
Nyberg G, Ekelund U, Yucel-Lindberg TL, Mode RT, Marcus C. Differences in metabolic risk factors between normal weight and overweight children. *Int J Pediatr Obes*. 2011;6(3-4):244-252. doi:10.3109/17477166.2011.575226.			X			
Oude Luttikhuis H, Baur L, Jansen H, et al. Interventions for treating obesity in children. *Cochrane Database Syst Rev.* 2009;(1):CD001872. doi:10.1002/14651858.CD001872.pub2.	X					
Paes ST, Goncalves CF, Terra MM, et al. Childhood obesity: a (re) programming disease? *J Dev Orig Health Dis.* Oct 2015;1-6. doi:10.1017/S2040174415007837.				X		
Pakhale S, Luks V, Burkett A, Turner L. Effect of physical training on airway inflammation in bronchial asthma: a systematic review. *BMC Pulm Med.* 2013;13:38. doi:10.1186/1471-2466-13-38.		X				

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Parkhad SB, Palve SB. Association of physical activity and physical fitness with blood pressure profile in Maharashtrian adolescent boys and girls. *Internet Journal of Medical Update*. 2014;9(1):4-9.			X			
Papandreou C, Mourad TA, Jildeh C, Abdeen Z, Philalithis A, Tzanakis N. Obesity in Mediterranean region (1997-2007): a systematic review. *Obes Rev*. 2008;9(5):389-399. doi:10.1111/j.1467-789X.2007.00466.x.				X		
Peirson L, Fitzpatrick-Lewis D, Morrison K, et al. Prevention of overweight and obesity in children and youth: a systematic review and meta-analysis. *CMAJ Open*. 2015;3(1):E23-E33. doi:10.9778/cmajo.20140053.				X		
Peirson L, Fitzpatrick-Lewis D, Morrison K, Warren R, Usman Ali M, Raina P. Treatment of overweight and obesity in children and youth: a systematic review and meta-analysis. *CMAJ Open*. 2015;3(1):E35-E46. doi:10.9778/cmajo.20140047.				X		
Pigford AA, Sanou D, Ball GD, Fehderau DD, Willows ND. Abdominal adiposity and physical activity in Cree First Nations children living on-reserve in an Alberta community. *Can J Diabetes*. 2011;35(4):328-333. doi:10.1016/S1499-2671(11)54008-0.			X			
Pinard CA, Yaroch AL, Hart MH, Serrano EL, McFerren MM, Estabrooks PA. Measures of the home environment related to childhood obesity: a systematic review. *Public Health Nutr*. 2012;15(1):97-109. doi:10.1017/S1368980011002059.				X		
Poitras VJ, Gray CE, Borghese MM, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Appl Physiol Nutr Metab.* 2016;41(6 suppl 3):S197-S239. doi:10.1139/apnm-2015-0663.				X		
Prentice-Dunn H, Prentice-Dunn S. Physical activity, sedentary behavior, and childhood obesity: a review of cross-sectional studies. *Psychol Health Med.* 2012;17(3):255-273. doi:10.1080/13548506.2011.608806.						X

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Quelly SB, Norris AE, DiPietro JL. Impact of mobile apps to combat obesity in children and adolescents: a systematic literature review. *J Spec Pediatr Nurs.* 2016;21(1):5-17. doi:10.1111/jspn.12134.				X		
Rahman T, Cushing RA, Jackson RJ. Contributions of built environment to childhood obesity. *Mt Sinai J Med.* 2011;78(1):49-57. doi:10.1002/msj.20235.				X		
Ramsey Buchanan L, Rooks-Peck CR, Finnie RK, et al; Community Preventive Services Task Force. Reducing recreational sedentary screen time: a community guide systematic review. *Am J Prev Med*. 2016;50(3):402-415. doi:10.1016/j.amepre.2015.09.030.				X		
Rauner A, Mess F, Woll A. The relationship between physical activity, physical fitness and overweight in adolescents: a systematic review of studies published in or after 2000. *BMC Pediatr.* 2013;13:19. doi:10.1186/1471-2431-13-19.						X
Reed M, Wilbur J, Schoeny M. Parent and African American daughter obesity prevention interventions: an integrative review. *J Health Care Poor Underserved.* 2015;26(3):737-760. doi:10.1353/hpu.2015.0103.				X		
Reichert FF, Baptista Menezes AM, Wells JC, Carvalho Dumith S, Hallal PC. Physical activity as a predictor of adolescent body fatness: a systematic review. *Sports Med.* 2009;39(4):279-294. doi:10.2165/00007256-200939040-00002.					X	
Robinson LE, Webster EK, Whitt-Glover MC, Ceaser TG, Alhassan S. Effectiveness of pre-school- and school-based interventions to impact weight-related behaviours in African American children and youth: a literature review. *Obes Rev.* 2014;(2):5-25. doi:10.1111/obr.12208.				X		
Ross SE, Flynn JI, Pate RR. What is really causing the obesity epidemic? A review of reviews in children and adults. *J Sports Sci.* 2016;34(12):1148-1153. doi:10.1080/02640414.2015.1093650.				X		
Salmon J, Arundell L, Hume C, et al. A cluster-randomized controlled trial to reduce sedentary behavior and promote physical activity and health of 8-9 year olds: the Transform-Us! study. *BMC*	X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Public Health. 2011;11:759. doi:10.1186/1471-2458-11-759.						
Salmon J, Booth ML, Phongsavan P, Murphy N, Timperio A. Promoting physical activity participation among children and adolescents. *Epidemiol Rev.* 2007;29(1):144-159. doi:10.1093/epirev/mxm010.	X					
Santaliestra-Pasias AM, Mouratidou T, Verbestel V, et al.; Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-sectional Study Group. Food consumption and screen-based sedentary behaviors in European adolescents: the HELENA study. *Arch Pediatr Adolesc Med*. 2012;166(11):1010-1020. doi:10.1001/archpediatrics.2012.646.	X					
Saunders TJ, Gray CE, Poitras VJ, et al. Combinations of physical activity, sedentary behaviour and sleep: relationships with health indicators in school-aged children and youth. *Appl Physiol Nutr Metab.* 2016;41(6 suppl 3):S283-S293. doi:10.1139/apnm-2015-0626.					X	
Schranz N, Tomkinson G, Olds T. What is the effect of resistance training on the strength, body composition and psychosocial status of overweight and obese children and adolescents? A Systematic review and meta-analysis. *Sports Med*. 2013;43(9):893-907. doi:10.1007/s40279-013-0062-9.		X				
Schulzke SM, Trachsel D, Patole SK. Physical activity programs for promoting bone mineralization and growth in preterm infants. *Cochrane Database Syst Rev*. 2007;(2):Cd005387. doi:10.1002/14651858.CD005387.pub2.		X				
Schulzke SM, Kaempfen S, Trachsel D, Patole SK. Physical activity programs for promoting bone mineralization and growth in preterm infants. *Cochrane Database Syst Rev*. 2014;(4):CD005387. doi:10.1002/14651858.CD005387.pub3.		X				
Schwartz C, King NA, Perreira B, Blundell JE, Thivel D. A systematic review and meta-analysis of energy and macronutrient intake responses to physical activity interventions in children and adolescents with obesity. *Pediatr Obes.* 2016;12:179-194. doi:10.1111/ijpo.12124.	X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Sims J, Scarborough P, Foster C. The effectiveness of interventions on sustained childhood physical activity: a systematic review and meta-analysis of controlled studies. *PLoS One.* 2015;10(7):e0132935. doi:10.1371/journal.pone.0132935.	X			X		
Sisson SB, Krampe M, Anundson K, Castle S. Obesity prevention and obesogenic behavior interventions in child care: a systematic review. *Prev Med.* 2016;87:57-69. doi:10.1016/j.ypmed.2016.02.016.	X					
Smith SA, Ansa B. A systematic review of lifestyle interventions for chronic diseases in rural communities. *J Ga Public Health Assoc*. 2016;5(4):304-313. doi:10.21663/jgpha.5.404.	X	X		X		
Snethen JA, Broome ME, Cashin SE. Effective weight loss for overweight children: a meta-analysis of intervention studies. *J Pediatr Nurs*. 2006;21(1):45-56. doi:10.1016/j.pedn.2005.06.006.	X					
Snethen JA, Broome ME, Treisman P, Castro E, Kelber ST. Effective weight loss for children: a meta-analysis of intervention studies 2002-2015. *Worldviews Evid Based Nurs.* 2016;13(4):294-302. doi:10.1111/wvn.12156.				X		
Stanhope KK, Kay C, Stevenson B, Gazmararian JA. Measurement of obesity prevention in childcare settings: a systematic review of current instruments. *Obes Res Clin Pract*. 2017;11(5S1):52-89. doi:10.1016/j.orcp.2016.06.002.	X					
Staniford LJ, Breckon JD, Copeland RJ. Treatment of childhood obesity: a systematic review. *J Child Fam Stud*. 2012;21(4):545-564. doi:https://doi.org/10.1007/s10826-011-9507-7.	X					
Steeves JA, Thompson DL, Bassett DR, Fitzhugh EC, Raynor HA. A review of different behavior modification strategies designed to reduce sedentary screen behaviors in children. *J Obes.* 2012;2012:379215. doi:10.1155/2012/379215.	X					
Steinberger J, Daniels SR, Eckel RH, et al.; American Heart Association Atherosclerosis, Hypertension, and Obesity in the Young Committee of the Council on Cardiovascular Disease in the			X			

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Young; Council on Cardiovascular Nursing; and Council on Nutrition, Physical Activity, and Metabolism. Progress and challenges in metabolic syndrome in children and adolescents: a scientific statement from the American Heart Association Atherosclerosis, Hypertension, and Obesity in the Young Committee of the Council on Cardiovascular Disease in the Young; Council on Cardiovascular Nursing; and Council on Nutrition, Physical Activity, and Metabolism. *Circulation*. 2009;119(4):628-647. doi:10.1161/CIRCULATIONAHA.108.191394.						
Stice E, Shaw H, Marti CN. A meta-analytic review of obesity prevention programs for children and adolescents: the skinny on interventions that work. *Psychol Bull.* 2006;132(5):667-691. doi:10.1037/0033-2909.132.5.667.		X				
Straker L, Abbott R, Collins R, Campbell A. Evidence-based guidelines for wise use of electronic games by children. *Ergonomics*. 2014;57(4):471-489. doi:10.1080/00140139.2014.895856.	X			X		
Stoner L, Rowlands D, Morrison A, et al. Efficacy of exercise intervention for weight loss in overweight and obese adolescents: meta-analysis and implications. *Sports Med.* 2016;46(11):1737-1751. doi:10.1007/s40279-016-0537-6.		X				
Summerbell CD, Douthwaite W, Whittaker V, et al. The association between diet and physical activity and subsequent excess weight gain and obesity assessed at 5 years of age or older: a systematic review of the epidemiological evidence. *Int J Obes (Lond).* 2009;33(suppl 3):S1-S92. doi:10.1038/ijo.2009.80.						X
Sung-Chan P, Sung YW, Zhao X, Brownson RC. Family-based models for childhood-obesity intervention: a systematic review of randomized controlled trials. *Obes Rev*. 2013;14(4):265-278. doi:10.1111/obr.12000.	X					
Swyden K, Sisson SB, Lora K, Castle S, Copeland KA. Association of child-care arrangement with overweight and obesity in preschool-aged children: a narrative review of literature. *Int J Obes*				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
(Lond). 2017;41(1):1-12. doi:10.1038/ijo.2016.198.						
Tajik E, Zulkefli NA, Baharom A, Minhat HS, Latiff LA. Contributing factors of obesity among stressed adolescents. *Electron Physician*. 2014;6(1):771-778. doi:10.14661/2014.771-778.				X		
Telama R. Tracking of physical activity from childhood to adulthood: a review. *Obes Facts*. 2009;2(3):187-195. doi:10.1159/000222244.	X					
Thivel D, Rumbold PL, King NA, Pereira B, Blundell JE, Mathieu ME. Acute post-exercise energy and macronutrient intake in lean and obese youth: a systematic review and meta-analysis. *Int J Obes (Lond).* 2016;40(10):1469-1479. doi:10.1038/ijo.2016.122.	X					
Thompson M, Dana T, Bougatsos C, Blazina I, Norris S. Screening for Hypertension in Children and Adolescents to Prevent Cardiovascular Disease: Systematic Review for the U.S. Preventive Services Task Force [Internet]. *U.S. Preventive Services Task Force Evidence Syntheses, formerly Systematic Evidence Reviews.* Report No. 13-05181-EF-1.2013. Rockville, MD: Agency for Healthcare Research and Quality (US); 2013.	X					
Thompson S, Ekelund U, Jebb S, et al. A proposed method of bias adjustment for meta-analyses of published observational studies. *Int J Epidemiol*. 2011;40(3):765-777. doi:10.1093/ije/dyq248.					X	
Tremblay MS, LeBlanc AG, Kho ME, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act.* 2011;8:98. doi:10.1186/1479-5868-8-98.				X		
Uijtdewilligen L, Waters CN, Müller-Riemenschneider F, Lim YW. Preventing childhood obesity in Asia: an overview of intervention programmes. *Obes Rev.* 2016;17(11):1103-1115. doi:10.1111/obr.12435.						X
van Ekris E, Altenburg TM, Singh AS, Proper KI, Heymans MW, Chinapaw MJ. An evidence-update on the prospective relationship between childhood sedentary behaviour and biomedical health indicators: a systematic review and meta-analysis. *Obes Rev.*		X		X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
2016;17(9):833-849. doi:10.1111/obr.12426.						
van Hoek E, Bouwman LI, Koelen MA, Lutt MAJ, Feskens EJM, Janse AJ. Development of a Dutch intervention for obese young children. *Health Promot Int.* 2017;32(4):624-635. doi:10.1093/heapro/dav115.	X		X			
van Lippevelde W, Verloigne M, De Bourdeaudhuij I, et al. Does parental involvement make a difference in school-based nutrition and physical activity interventions? A systematic review of randomized controlled trials. *Int J Public Health*. 2012;57(4):673-678. doi:10.1007/s00038-012-0335-3.				X		
Vasques C, Magalhães P, Cortinhas A, Mota P, Leitão J, Lopes VP. Effects of intervention programs on child and adolescent BMI: a meta-analysis study. *J Phys Act Health.* 2014;11(2):426-444. doi:10.1123/jpah.2012-0035.				X		
Vissers D, Hens W, Hansen D, Taeymans J. The effect of diet or exercise on visceral adipose tissue in overweight youth. *Med Sci Sports Exerc.* 2016;48(7):1415-1424. doi:10.1249/MSS.0000000000000888.		X				
Voskuil VR, Frambes DA, Robbins LB. Effect of physical activity interventions for girls on objectively measured outcomes: a systematic review of randomized controlled trials. *J Pediatr Health Care.* 2017;31(1):75-87. doi:10.1016/j.pedhc.2016.03.003.					X	
Wahi G, Parkin PC, Beyene J, Uleryk EM, Birken CS. Effectiveness of interventions aimed at reducing screen time in children: a systematic review and meta-analysis of randomized controlled trials. *Arch Pediatr Adolesc Med.* 2011;165(11):979-986. doi:10.1001/archpediatrics.2011.122.				X		
Walker SE, Smolkin ME, O'Leary ML, et al. Predictors of retention and BMI loss or stabilization in obese youth enrolled in a weight loss intervention. *Obes Res Clin Pract*. 2012;6(4):e330-e339. doi:10.1016/j.orcp.2011.08.157.	X		X			
Wang Y, Wu Y, Wilson RF, et al. Childhood obesity prevention programs: comparative effectiveness review and meta-analysis. *AHRQ Comparative Effectiveness Review No. 115*. AHRQ Publication No. 13-EHC081-EF. Rockville,				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
MD: Agency for Healthcare Research and Quality; 2013.						
Ward DS, Welker E, Choate A, et al. Strength of obesity prevention interventions in early care and education settings: a systematic review. *Prev Med*. 2017;95(suppl):S37-S52. doi:10.1016/j.ypmed.2016.09.033.				X		
Williams AJ, Henley WE, Williams CA, Hurst AJ, Logan S, Wyatt KM. Systematic review and meta-analysis of the association between childhood overweight and obesity and primary school diet and physical activity policies. *Int J Behav Nutr Phys Act.* 2013;10:101. doi:10.1186/1479-5868-10-101.		X		X		
Williams AJ, Wyatt KM, Hurst AJ, Williams CA. A systematic review of associations between the primary school built environment and childhood overweight and obesity. *Health Place*. 2012;18(3):504-514. doi:10.1016/j.healthplace.2012.02.004.		X		X		
Wolfenden L, Jones J, Williams CM, et al. Strategies to improve the implementation of healthy eating, physical activity and obesity prevention policies, practices or programmes within childcare services. *Cochrane Database Syst Rev*. 2016;(10):CD011779. doi:10.1002/14651858.CD011779.pub2.						
Workman M, McDade TW, Adair LS, Kuzawa CW. Slow early growers have more muscle in relation to adult activity: evidence from Cebu, Philippines. *Eur J Clin Nutr*. 2015;69(12):1350-1355. doi:10.1038/ejcn.2015.18.	X	X				
Wright J, Fairley L, McEachan R, et al. *Development and evaluation of an intervention for the prevention of childhood obesity in a multiethnic population: the Born in Bradford applied research programme*. Southampton, UK: NIHR Journals Library. Programme Grants for Applied Research; 2016.		X	X			
Wu L, Sun S, He Y, Jiang B. The effect of interventions targeting screen time reduction: a systematic review and meta-analysis. *Medicine (Baltimore).* 2016;95(27):e4029. doi:10.1097/MD.0000000000004029.				X		
Wu Y, Lau BD, Bleich S, et al. *Future research needs for childhood obesity prevention programs: identification of future research needs from comparative*			X			

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
effectiveness. AHRQ Future Research Needs Papers, No. 31. Rockville, MD: Agency for Healthcare Research and Quality; 2013.						
Yildirim M, van Stralen MM, Chinapaw MJ, et al; Energy Consortium. For whom and under what circumstances do school-based energy balance behavior interventions work? Systematic review on moderators. *Int J Pediatr Obes.* 2011;6(2-2):e46-e57. doi:10.3109/17477166.2011.566440.				X		
Zhang G, Wu L, Zhou L, Lu W, Mao C. Television watching and risk of childhood obesity: a meta-analysis. *Eur J Public Health.* 2016;26(1):13-18. doi:10.1093/eurpub/ckv213.				X		

References

1. Beets MW, Beighle A, Erwin HE, Huberty JL. After-school program impact on physical activity and fitness: a meta-analysis. *Am J Prev Med*. 2009;36(6):527–537. doi:10.1016/j.amepre.2009.01.033.

2. Clark JE. Does the type of intervention method really matter for combating childhood obesity? A systematic review and meta-analysis. *J Sports Med Phys Fitness*. 2015;55(12):1524–1543.

3. Kelley GA, Kelley KS. Aerobic exercise and lipids and lipoproteins in children and adolescents: a meta-analysis of randomized controlled trials. *Atherosclerosis*. 2007;191(2):447–453. doi:10.1016/j.atherosclerosis.2006.04.019.

4. Kelley GA, Kelley KS. Effects of aerobic exercise on non-high-density lipoprotein cholesterol in children and adolescents: a meta-analysis of randomized controlled trials. *Prog Cardiovasc Nurs*. 2008;23(3):128–132.

5. Kelley GA, Kelley KS, Pate RR. Effects of exercise on BMI z-score in overweight and obese children and adolescents: a systematic review with meta-analysis. *BMC Pediatr*. 2014;14:225. doi:10.1186/1471-2431-14-225.

6. Saavedra JM, Escalante Y, Garcia-Hermoso A. Improvement of aerobic fitness in obese children: a meta-analysis. *Int J Pediatr Obes*. 2011;6(3-4):169–177. doi:10.3109/17477166.2011.579975.

7. Dobbins M, Husson H, DeCorby K, LaRocca RL. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database Syst Rev*. 2013;(2):CD007651. doi:10.1002/14651858.CD007651.pub2.

8. Gao Z, Chen S. Are field-based exergames useful in preventing childhood obesity? A systematic review. *Obes Rev*. 2014;15(8):676–691. doi:10.1111/obr.12164.

9. Lamboglia CM, da Silva VT, de Vasconcelos Filho JE, et al. Exergaming as a strategic tool in the fight against childhood obesity: a systematic review. *J Obes*. 2013;2013:438364. doi:10.1155/2013/438364.

10. Larouche R, Saunders TJ, Faulkner G, Colley R, Tremblay M. Associations between active school transport and physical activity, body composition, and cardiovascular fitness: a systematic review of 68 studies. *J Phys Act Health*. 2014;11(1):206–227. doi:10.

11. Millard-Stafford M, Becasen JS, Beets MW, Nihiser AJ, Lee SM, Fulton JE. Is physical fitness associated with health in overweight and obese youth? A systematic review. *Kinesiol Rev (Champaign)*. 2013;2(4):233–247.

12. Mura G, Rocha NB, Helmich I, et al. Physical activity interventions in schools for improving lifestyle in European countries. *Clin Pract Epidemiol Ment Health*. 2015;11(suppl 1 M5):77–101. doi:10.2174/1745017901511010077.

13. Sun C, Pezic A, Tikellis G, et al. Effects of school-based interventions for direct delivery of physical activity on fitness and cardiometabolic markers in children and adolescents: a systematic review of randomized controlled trials. *Obes Rev*. 2013;14(1.

14. Vasconcellos F, Seabra A, Katzmarzyk PT, Kraemer-Aguiar LG, Bouskela E, Farinatti P. Physical activity in overweight and obese adolescents: systematic review of the effects on physical fitness components and cardiovascular risk factors. *Sports Med*. 2014;.

15. Zeng N, Gao Z. Exergaming and obesity in youth: current perspectives. *Int J Gen Med*. 2016;9:275–284. doi:10.2147/IJGM.S99025.

16. Nogueira RC, Weeks BK, Beck BR. Exercise to improve pediatric bone and fat: a systematic review and meta-analysis. *Med Sci Sports Exerc*. 2014;46(3):610–621. doi:10.1249/MSS.0b013e3182a6ab0d.

17. Waters E, de Silva-Sanigorski A, Hall BJ, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev*. 2011;(12):CD001871. doi:10.1002/14651858.CD001871.pub3.

18. Wilks DC, Sharp SJ, Ekelund U, et al. Objectively measured physical activity and fat mass in children: a bias-adjusted meta-analysis of prospective studies. *PLoS One*. 2011;6(2):e17205. doi:10.1371/journal.pone.0017205.

19. Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Act*. 2010;7:40. doi:10.1186/1479-5868-7-40.

20. Laframboise MA, Degraauw C. The effects of aerobic physical activity on adiposity in school-aged children and youth: a systematic review of randomized controlled trials. *J Can Chiropr Assoc*. 2011;55(4):256–268.

21. Pate RR, O'Neill JR, Liese AD, et al. Factors associated with development of excessive fatness in children and adolescents: a review of prospective studies. *Obes Rev*. 2013;14(8):645–658. doi:10.1111/obr.12035.

22. Ramires VV, Dumith SC, Gonçalves H. Longitudinal association between physical activity and body fat during adolescence: a systematic review. *J Phys Act Health*. 2015;12(9):1344–1358. doi:10.1123/jpah.2014-0222.

23. te Velde SJ, van Nassau F, Uijtdewilligen L, et al; ToyBox-study group. Energy balance-related behaviours associated with overweight and obesity in preschool children: a systematic review of prospective studies. *Obes Rev*. 2012;13(suppl 1):56–74. doi:10.1.

24. Timmons BW, Leblanc AG, Carson V. Systematic review of physical activity and health in the early years (aged 0-4 years). *Appl Physiol Nutr Metab*. 2012;37(4):773–792. doi:10.1139/h2012-070.

25. Escalante Y, Saavedra JM, García-Hermoso A, Domínguez AM. Improvement of the lipid profile with exercise in obese children: a systematic review. *Prev Med*. 2012;54(5):293–301. doi:10.1016/j.ypmed.2012.02.006.

26. Fedewa MV, Gist NH, Evans EM, Dishman RK. Exercise and insulin resistance in youth: a meta-analysis. *Pediatrics*. 2014;133(1):e163–e174. doi:10.1542/peds.2013-2718.

27. García-Hermoso A, Saavedra JM, Escalante Y. Effects of exercise on resting blood pressure in obese children: a meta-analysis of randomized controlled trials. *Obes Rev*. 2013;14(11):919–928. doi:10.1186/s13098-015-0034-3.

28. Guinhouya BC, Samouda H, Zitouni D, Vilhelm C, Hubert H. Evidence of the influence of physical activity on the metabolic syndrome and/or on insulin resistance in pediatric populations: a systematic review. *Int J Pediatr Obes*. 2011;6(5-6):361–388. doi:10.

29. Ishikawa S, Kim Y, Kang M, Morgan DW. Effects of weight-bearing exercise on bone health in girls: a meta-analysis. *Sports Med*. 2013;43(9):875–892. doi:10.1007/s40279-013-0060-y.

30. Specker B, Thiex NW, Sudhagoni RG. Does exercise influence pediatric bone? A systematic review. *Clin Orthop Relat Res*. 2015;473(11):3658–3672. doi:10.1007/s11999-015-4467-7.

31. Xu J, Lombardi G, Jiao W, Banfi G. Effects of exercise on bone status in female subjects, from young girls to postmenopausal women: an overview of systematic reviews and meta-analyses. *Sports Med*. 2016;46(8):1165–1182. doi:10.1007/s40279-016-0494-0.

32. Hind K, Burrows M. Weight-bearing exercise and bone mineral accrual in children and adolescents: a review of controlled trials. *Bone*. 2007;40:14–27. doi:10.1016/j.bone.2006.07.006.

33. Julián-Almárcegui C, Gómez-Cabello A, Huybrechts I, et al. Combined effects of interaction between physical activity and nutrition on bone health in children and adolescents: a systematic review. *Nutr Rev*. 2015;73(3):127–139. doi:10.1093/nutrit/nuu065.

34. Tan VP, Macdonald HM, Kim S, et al. Influence of physical activity on bone strength in children and adolescents: a systematic review and narrative synthesis. *J Bone Miner Res*. 2014;29(10):2161–2181. doi:10.1002/jbmr.2254.

35. Weaver CM, Gordon CM, Janz KF, et al. The National Osteoporosis Foundation's position statement on peak bone mass development and lifestyle factors: a systematic review and implementation recommendations. *Osteoporos Int*. 2016 Apr;27(4):1281–1386. doi: 10.