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Review Article

The effectiveness of school-based physical activity interventions for adolescent girls: A systematic review and meta-analysis

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ABSTRACT

Physical activity (PA) decreases during the transition from childhood to adolescence, with larger declines observed in girls. School-based interventions are considered the most promising approach for increasing adolescents' PA levels although, it is unclear which types of school-based interventions have the greatest impact. The objective of this systematic review is to assess the impact and design of school-based PA interventions targeting adolescent girls. A systematic search was conducted using four electronic databases (PubMed, Web of Science, SPORTDiscus and PsychInfo). This systematic review was registered with PROSPERO (Registration number: CRD42016037428) and PRISMA guidelines (2009) were followed throughout. Twenty studies were identified as meeting the inclusion criteria and were included in a narrative synthesis. Seventeen studies were eligible for inclusion in a meta-analysis. There was a significant small positive treatment effect for school-based PA interventions for adolescent girls ($k = 17$, $g = 0.37$, $p < 0.05$). After an outlier was removed (residual $z = 7.61$) the average treatment effect was significantly reduced, indicating a very small positive effect ($k = 16$, $g = 0.07$, $p = 0.05$). Subgroup analysis revealed very small significant effects for multi-component interventions ($k = 7$, $g = 0.09$, $p < 0.05$), interventions underpinned by theory ($k = 12$, $g = 0.07$, $p < 0.05$), and studies with a higher risk of bias ($k = 13$, $g = 0.09$, $p < 0.05$). Intervention effects were very small which indicates that changing PA behaviors in adolescent girls through school-based interventions is challenging. Multi-component interventions and interventions underpinned by theory may be the most effective approaches to positively change adolescent girls' PA.

1. Introduction

The World Health Organisation (2014) has classified physical inactivity as the fourth leading risk factor for global mortality from non-communicable diseases. Insufficient physical activity (PA) contributes towards 3.2 million deaths (5.5%) worldwide per year (World Health Organisation, 2014). A strong body of evidence indicates that regular moderate-to-vigorous physical activity (MVPA) is associated with numerous health benefits for children and young people (Chief Medical Officers, 2011). These include reduced body fat and the promotion of healthy weight, enhanced cardio-metabolic and bone health, and enhanced psychological well-being (Biddle and Asare, 2011; Janssen and Leblanc, 2010).

Though the benefits and protective effects of regular PA are well understood, insufficient PA during adolescence is a major concern (Heitzler et al., 2011; Khunti et al., 2007; Sisson et al., 2010). Inactive adolescents are more at risk of being overweight or obese and have a greater chance of developing type 2 diabetes (World Health Organisation, 2015). Additionally, physical inactivity is a major risk factor for not only poor physical health but is also associated with poor mental wellbeing (Ar-yuwat et al., 2013). More frequent engagement in PA contributes towards greater well-being and lower levels of anxiety and depressive symptoms in both sexes (McMahon et al., 2017).

According to global estimates of self-reported PA, 80% of 13–15-year-olds do not engage in 60 min of MVPA per day, with girls being less active than boys (Hallal et al., 2012). A combination of biological and psychosocial factors put adolescent girls at risk of inactivity and uptake of sedentary lifestyles (Young et al., 2014). A review of 26 longitudinal studies concluded that there was a 7% decrease in total PA per year during adolescence (Dumith et al., 2011), with the most recent studies indicating that girls' PA levels declined at a greater rate than boys'. Research assessing objectively measured PA from the

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International Children's Accelerometry Database (ICAD) suggests that boys were more active than girls but, both boys' and girls' MVPA levels declined steadily through adolescence (Cooper et al., 2015). There is no widely accepted explanation for this decrease in adolescent girls. However, it is suggested that alongside biological changes, lack of enjoyment, negative experiences in, and perceptions of school-based PA may be important factors (Barr-Anderson et al., 2008).

Previous systematic reviews (Camacho-Minano et al., 2011; Voskuil et al., 2017) and a meta-analysis (Pearson et al., 2015) have assessed interventions to promote PA in adolescent girls across school and community settings. Voskuil et al. (2017) reported highly variable effect sizes, inferring that PA interventions only had a small effect on objectively measured PA in girls aged 6–18 years (Voskuil et al., 2017). Camacho-Minano et al. (2011) found overall mixed results regarding the effectiveness of PA interventions for adolescent girls but, suggested that multicomponent school-based interventions, which included PE that addressed the unique needs of girls were the most effective. Pearson et al. (2015) reported small but significant effects ($g = 0.35$, $p < 0.001$) for the effectiveness of PA interventions on girls aged 12 to 18 years. Larger effects were found for interventions which were underpinned by theory, school-based, girls only, targeted younger adolescents (ages 12 to 15), multicomponent in design, and that targeted both PA and sedentary behaviour.

Camacho-Minano et al. (2011) and Pearson et al. (2015) suggested that school-based PA interventions are the most promising setting to impact adolescent girls' PA levels. Thus, this review aims to address this gap in the literature and assess the effectiveness of girl-specific and mixed-sex school-based interventions on adolescent girls' PA. The inclusion of mixed-sex studies is novel because often reviews (Camacho-Minano et al., 2011; Voskuil et al., 2017) focus only on interventions exclusively designed for girls, when mixed-sex interventions could be equally as effective for girls. The purpose of this study was to systematically review school-based PA interventions involving adolescent girls and quantify their effect through meta-analysis.

2. Methods

This systematic review was registered with PROSPERO (Registration number: CRD42016037428). This review adhered to the PRISMA reporting guidelines for systematic reviews (Moher et al., 2009).

2.1. Search procedure

A systematic search was conducted using four electronic databases (PubMed, Web of Science, SPORTDiscus and PsychInfo). Journal articles published in English post 31/12/2004 until the date of the last search (01/12/16) were considered for review. The key words included; physical activity, physical education, sedentary behaviour, sedentary time, walking, sport, fitness, energy expenditure, school, teacher, classroom, gymnasium, sports hall, recess, playtime, break time, playground, before-school and after-school. The search strategies are detailed in the supplementary information (Supplementary Table 1). Reference lists of retrieved articles were examined for additional articles.

2.2. Inclusion and exclusion criteria

Studies were eligible if they reported the effects of school-based PA interventions on PA outcomes among adolescent girls (mean age 11–18 years), with the primary outcome being objectively measured or self-reported PA levels. Feasibility and pilot studies were included. Mixed sexed studies were included if girls' data were presented separately to boys' or if girls' data were received upon request. A school-based intervention was defined as one that occurred in the school environment. The extended school day (8 am–6 pm) was used to operationally define the school day, so as to capture school-based interventions that took place before and after formal hours (e.g., breakfast clubs, boot camps, and after-school activities). Studies could be randomised or non-randomised and only published peer-reviewed studies were reviewed. Only journal articles published post 31/12/2004 were considered after preliminary searches ('physical activity' AND 'girls' AND 'intervention') indicated that most interventions had been conducted in the last 10 years with the earliest published in 2004.

All search results were exported into a reference manager (Endnote × 7.4, Thomson Reuters) and duplicates were removed. Initially, the first author (MO) screened all titles and abstracts for obvious irrelevance, and a random sample (20%) were also checked by another author (WC). The full-text of eligible studies were then retrieved and reviewed by two authors (MO and WC). Where full texts were not readily available, the lead author was contacted and asked to provide the full text for further assessment on eligibility. If no response was received after a follow-up reminder, these studies were excluded as they could not be fully assessed for eligibility. Any disagreements were resolved in a meeting involving three authors (MO, WC, and SF).

2.3. Data extraction and synthesis

Relevant data from the selected studies were extracted by the first author (MO) and checked by the second author (WC) (see Table 1). If studies reported multiple PA outcomes, data for the primary outcome stated in the studies' aims and objectives were used. Any disagreements were resolved through a consensus discussion between MO and WC. A narrative synthesis was completed to provide a summary of school-based PA interventions for adolescent girls (11–18).

2.4. Risk of bias assessment

Included studies were assessed for risk of bias using a modified tool (Morton et al., 2016; Pluye et al., 2009) appropriate for PA reviews which include measures for quantitative experimental and quantitative observational studies. This adapted risk of bias assessment tool (Supplementary Table 2) used a 1–4 scoring system (i.e., 1 = weak, 2 = moderate, 3 = strong and 4 = very strong) at study level as a combined risk of bias score. A higher risk of bias score indicates better methodological quality with a lower risk of bias score indicating poorer methodological quality. Risk of bias was scored on the presence or absence of each criteria respectively (sequence generation and/or randomisation, concealment and/or blinding, complete outcome data and/or low withdrawal/drop-out (< 20%), appropriate outcome measure). Studies were scored on what was reported in the current article or if they cited a previously published protocol paper which was examined for further information.

2.5. Meta-analysis

Meta-analytic procedures were conducted in R (https://cran.r-

Table 1
Data extraction procedure.

Study characteristics	(a) Author, year of publication, country (b) Aims and objectives of study (c) Participant characteristics (d) Study design (e) Intervention content
Theory underpinning intervention	(f) Any theory or model that the authors suggest underpins the intervention, including non-behaviour change theories
PA measurement tool	(g) Any measurement tool used to collect PA data, including outcome measure of PA
Primary PA findings	(h) Key findings of each study in relation to PA change due to the intervention