The impact of typical school provision of physical education, physical activity and sports on adolescent physical activity behaviors. A systematic literature review.

Title: The Impact of Typical School Provision of Physical Education, Physical Activity and Sports on Adolescent Physical Activity Behaviors. A Systematic Literature Review.

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Abstract

Typical school provision of physical education, physical activity and sports, which reflects the response to national curriculum, resource base and ethos of schools, may impact adolescent physical activity behaviors. This impact has not been considered in systematic literature reviews to date. The Web of Science, SPORTDiscus, PsychINFO, ERIC and MEDLINE databases were searched for relevant literature (2000-2022) on adolescents aged 12-18 years in secondary schools. Thirteen studies met the inclusion criteria, including eight cross-sectional, three longitudinal and two cluster randomized control trials. Included studies contributed 84 reported effects. Physical activity behavior was the most frequently reported outcome (n=52), 48% of which were non-significant, 29% significantly positive, 10% significantly negative and 13% demonstrated a positive or negative trend but with no test of significance. Evidence was also found to support an impact on meeting physical activity guidelines (62.5% significantly positive effects) and in reducing sedentary behavior, particularly in girls. Notwithstanding considerable heterogeneity in the data paralleled with methodological limitations, presented evidence supports the positive impact of typical school provision of physical education, physical activity and sports on adolescent physical activity behaviors.

Keywords; Physical Education; Physical Activity; Sport; Adolescence; Youth; School.

Introduction

Regular engagement in physical activity is cited as a powerful predictor of future health among adolescents (Kwon et al., 2015; Piercy & Troiano, 2018; Rollo et al., 2020). International guidelines recommend at least an average of sixty-minutes of moderate to vigorous physical activity across the week for adolescents (World Health Organization, 2020). Despite this, just 20% of adolescents worldwide are meeting the recommended physical activity guidelines (Guthold et al., 2020; World Health Organization, 2018). Furthermore, physical activity habits developed in adolescence track into adulthood (Telama et al., 2005) emphasizing its importance for the promotion of public health in this phase of life. Physical inactivity cost $53.8 billion worldwide in 2013 (Ding et al., 2016) and is estimated to reach nearly $300 billion by 2030 (World Health Organization, 2022). International health experts have emphasized the requirement for physical activity promoting strategies to increase adolescent physical activity for health and reduce worldwide health costs (Bouchard et al., 2006; Morton et al., 2016). This study addresses this research gap by systematically reviewing the literature that examines typical school provision of physical education, physical activity and sports as a strategy to impact adolescent physical activity behaviors.

The unique position of schools as a primary vehicle to promote the importance of health and provide physical activity opportunities for adolescents (Morton et al., 2016; Pate et al., 2006) has been increasingly acknowledged by international policymakers (Hallal et al., 2012; Morton et al., 2016; World Health Organization, 2022). Approximately 80% of adolescents only source of physical activity is via the school setting (Ding et al., 2016). Additionally, adolescents are less likely to develop skills necessary to be physically active across a lifetime outside of school (Scruggs, 2007; World Health Organization, 2018). Family-based interventions have shown limited impact when compared with schools, which have been cited as "the most consistent, promising strategy" for engagement and education in physical activity (Kriemler et al., 2011 p923; Lounsbery et al., 2013).

Schools, as part of the education and wider curriculum, provide physical education as a subject and opportunities to participate in physical activity and sports to attending pupils. Physical education includes, "teaching students a structured curriculum to help them acquire the skills, knowledge and dispositions necessary to be “wise consumers” of physical activity” and sports (Johnson & Turner, 2016 p3; Fairclough & Stratton, 2004; Morton et al., 2016; Scruggs et al., 2007). Physical education endorses the theoretical underpinnings associated with adolescent physical activity for health and enhances student’s skills (e.g., muscular strength and flexibility) to effectively engage in physical activity and sports across a lifetime (Ennis, 2017; McKenzie & Lounsbery, 2009). Additionally, policy recognizing the provision of physical education as a school curriculum requirement is evident in 77% of countries globally with the highest proportion of those identified in Europe (92%), USA (90.2%) and Oceania (89%) (Hardman et al., 2014; Shape America, 2016). School physical activity involves “any bodily movement produced by skeletal muscle that results in energy expenditure” related to the school setting, e.g., active recess, active transport, extracurricular activities and active classroom breaks (Casperson et al., 1985 p126). School sports are considered “organized participation” that takes place in school settings, e.g., beyond the curriculum and involves preparing for or participating in school sport competitions, e.g., net games, invasion games and athletics (Bailey, 2005 p1). While physical education is the primary domain to promote physical activity among adolescents in schools, the International Society of Physical Activity for Health’s (ISPAH) ‘Eight investments that work for physical activity’ (2020) have identified that in order to maximize the impact of physical education, it’s imperative that whole school activity is considered, including school physical activity and sports.

The World Health Organization (WHO) has identified schools as a cost-effective investment to “impart physical and health literacy for lifelong health, active lifestyles, prevention of NCD’s and mental health disorders” (World Health Organization, 2018 p17). Thus, worldwide financial investment in typical school provision of physical education, physical activity and sports is vast. The European Union launched an Erasmus+ program for education, training and youth for the 2014-2020 period which saw approximately €265 million made available to boost skills, employability and educational institutions such as schools, for the provision of physical education, physical activity and sports (European Parliament, 2016). In the USA it has been identified that “funding from a variety of grant resources, including federal funding” has underpinned the transition of schools to high quality physical education, physical activity and sports programs (Kohl et al., 2013 para 51). Additionally, the Australian Department of Health launched a ‘Building the Education Revolution Initiative’, which saw $16.2 billion set aside “for world-class educational facilities, through new infrastructure and refurbishments" in schools; including the provision of typical school physical education, physical activity and sports (Australian Department of Health 2021, para 4; O'Brien 2018).

Despite the recognition of school as a primary vehicle to promote physical activity, the worldwide adoption of school physical education, physical activity and sports policies to promote physical activity and health, paralleled with significant investment, a paucity of evidence exists that synthesizes the impact of typical school provision of physical education, physical activity and sport on adolescent physical activity behaviors. Therefore, a review that evaluates its impact as a strategy to increase physical activity for health is required. Such research is essential to synthesize a deeper understanding on whether typical school provision of physical education, physical activity and sport is impactful and/or requiring modification to potentiate positive impact.

Current Study

Typical school provision of physical education, physical activity and sports, which reflects the response to national curriculum, resource base and ethos of schools, may have a considerable impact on adolescent physical activity behaviors. In the context of the current study, "typical" refers to what occurs in the majority of schools with no significant departure from the norm and "provision" refers to the underpinning structures and activities involved in providing the physical education curriculum and opportunities for physical activity and sports participation for adolescents in secondary schools. The extent and nature of the provision reflects the response to the national curriculum, resource base and ethos of a school. Some evidence regarding the specific nature of typical school provision exists however, no systematic literature review of this evidence has been completed to date. Therefore, the present study is underpinned by the following research questions: 1) How is typical school provision of physical education, physical activity and sports related to adolescent physical activity behaviors? 2) Is typical school provision of physical education, physical activity and sports impactful? 3) Are there robust examples of best practice in schools to potentiate positive impact on adolescent physical activity behaviors? 4) Does typical school provision of physical education, physical activity and sports have a greater impact on girls or boys physical activity behaviors? Accordingly, this systematic literature review will apply a narrative synthesis to the current body of evidence looking at typical school provision of physical education, physical activity and sports, summarizing the key characteristics that appear to be the most pertinent to impacting adolescent physical activity behaviors.

Method

Reporting in this review was underpinned by the Preferred Reporting Items for Systematic Reviews and Meta-analyses (Page et al. 2021) and was registered with the International Prospective Register of Systematic Reviews on March 25th, 2020 (ID number CRD42021200767) (Booth et al., 2012).

Study Eligibility Criteria

Eligible studies (1) examined male and/or female adolescents with a mean age of between 12-18 years, up to one standard deviation (SD) point, i.e., 66% of the population were required to be aged 12-18 years. If one SD was below 12 or above 18 years, a breakdown for the specific target population was required in the results section, (2) included “typical" school provision of physical education, physical activity and sports as an exposure (see earlier definition) (studies that only defined/measured school physical activity and/or sports but not physical education were excluded), (3) objective/device-based measures of physical activity behavior (i.e., accelerometer, heart-rate monitor, pedometer) and (4) comprised one or more of the following outcome variables: light physical activity, moderate physical activity, moderate to vigorous physical activity, physical activity guidelines, physical activity, physical inactivity and sedentary behavior. Articles were peer reviewed, published in English, between 2000-2022. Systematic literature reviews and meta-analysis were excluded. In intervention studies, control and/or intervention group pre and post baseline results were utilized (provided they had not received an intervention that caused significant or deliberate change to typical practice). Minor modifications to typical school provision of physical education, physical activity and sports were included e.g., additional time, emphasis on physical activity intensity or teacher support workshops. The setting for the physical education, physical activity and sports exposures was in secondary schools (i.e., post-primary, high school), within school time and extended before and after school physical activity and sports opportunities. The setting for the outcome measures was in and/or outside secondary schools. Outcomes measured within the physical education class only, were excluded.

Sources, Search Strategies and Selection Processes

A systematic search of five electronic databases was performed in March 2020: Web of Science, SPORTDiscus, PsychINFO, ERIC and MEDLINE. Search strategies were completed in collaboration with a university library technician from inception to December 2020. Keyword search terms included: "school", "provision", "physical education", "physical activity", "sports", "adolescents" and "physical activity behavior". A comprehensive copy of the search strategy is provided (Online Resource 1). Articles were imported to Rayyan Intelligent Systematic Review online platform where they were stored throughout the screening process (Ouzanni et al., 2016). Duplicates were removed. Screening of titles and abstracts were independently assessed for eligibility by two review authors (PR, LW). Subsequently, full text articles were assessed for eligibility by eight review authors (PR, LW, CMD et al). A 10% inter reviewer reliability check was incorporated into stage 1 and stage 2 of the screening process which established agreement among reviewers. Disagreements were resolved by consensus. A supplementary search was conducted in July 2022 via (1) updates across the five databases (2) screening reference lists of eligible articles (3) contacting leading experts in the field.

Quality Assessment and Data Extraction

The tool used to assess the quality of the included articles was a modified Downs and Black checklist (Downs & Black., 1998). This quality index has been validated as a tool for assessing experimental and non-experimental quantitative study designs in the physical activity and health field (Eime et al., 2013; Nugent et al., 2021). Articles were assessed independently by two review authors (PR, JW) via Covidence software and disagreements were resolved through consensus. The modified checklist included 22 items that were categorized in to 5 subscales: reporting (10), external validity (1), internal validity—bias (4), internal validity—confounding

(6) and power (1). Items were scored as 1 (compliance) or 0 (non-compliance). Study quality was assessed out of a total of 23 points (distribution of principal confounders were awarded 2 points). Aligning with the methodology outlined by Woods et al., we "calculated the total percentage of criteria met per study based on the criteria applicable to the type of study design" (2021 p4). Criteria that was not applicable were labelled NA.

Data were extracted through the use of a customized data extraction table via Covidence, by two review authors (PR, JW). A 10% inter reviewer reliability was incorporated which established agreement among reviewers. Disagreements were resolved through consensus. The data extraction table included study descriptives, population demographics and data that reported the relationship between the exposure and outcome content. Authors of articles were contacted to obtain omitted details where necessary.

Data Analysis

Outcome data was tabulated to determine the impact of typical school provision of physical education, physical activity and sports on three key outcomes: physical activity, physical activity guidelines and sedentary behavior. Detailed description of each outcome is provided in Table 1. The potential effects of typical school provision of physical education, physical activity and sports on each outcome investigated was established by two independent reviewers (PR, CMD) using the method described by Panter et al (2019). The main reported effects were assessed and extracted for all specified outcomes within each article, based on four levels of effects; significantly positive; significantly negative; inconclusive/no effect or no significant test. Many articles tested multiple outcomes, therefore, the overall evidence of impact was expressed as a percentage of the four effects within each article (i.e., significantly positive; significantly negative; inconclusive/no effect or no significant test). An article was deemed significantly positive when 50% or more of the reported effects were significant and in positive direction, significantly negative when 50% or more of the reported effects were significant and in a negative direction and inconclusive/no effect when 50% of more of the reported effects were non-significant or when results were mixed (both positive and negative). An article was deemed to have no significant test when the reported effects were not supported with a test of significance. Where no test of significance was applied the direction of the effect was required i.e., positive/negative direction.

Table 1. Descriptions of the Outcomes Synthesized in this Review

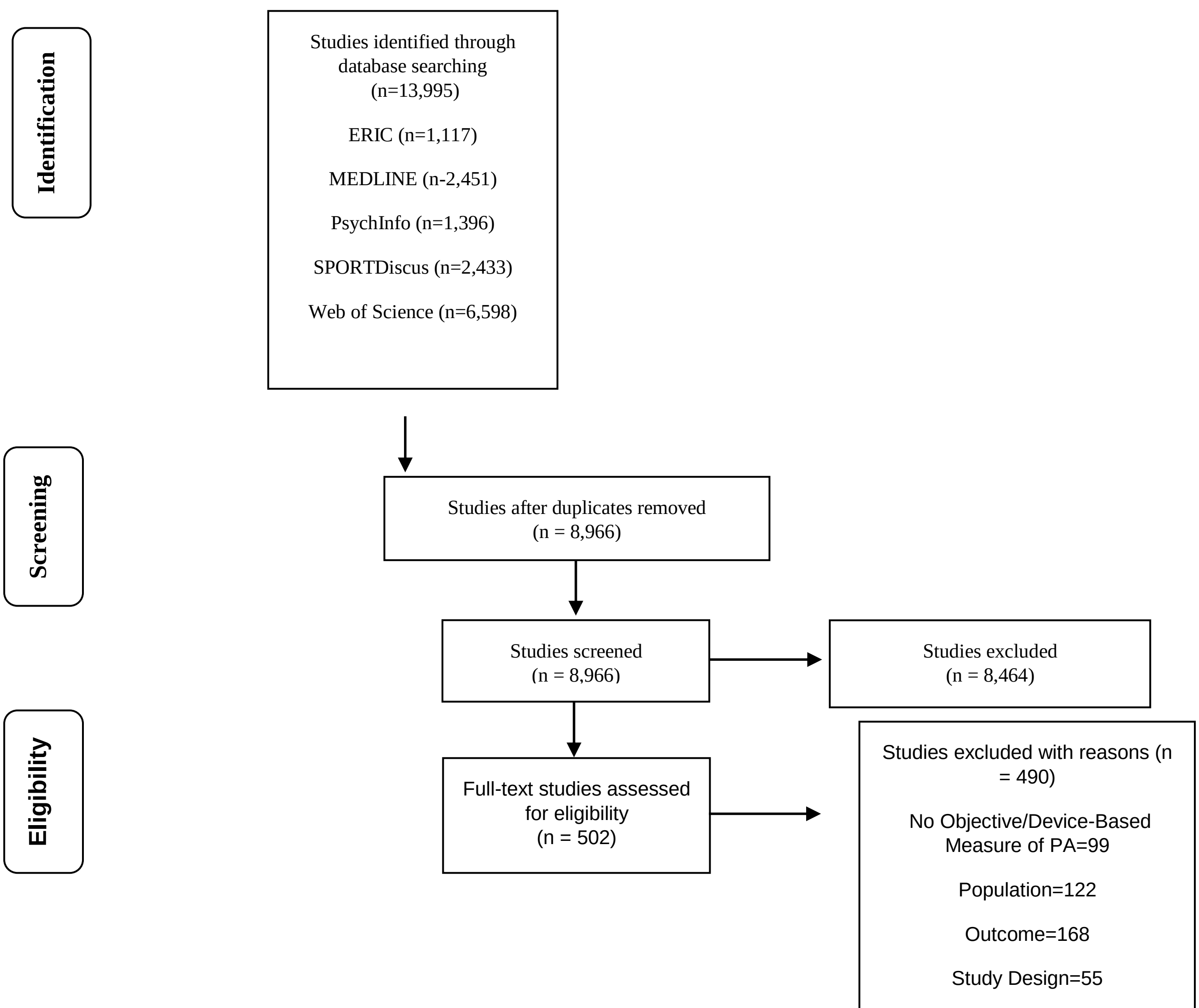
Outcomes	Description
Physical Activity	"Any bodily movement produced by skeletal muscle that results in energy expenditure", such as moderate to vigorous physical activity, moderate physical activity, light physical activity and steps (Casperson et al., 1985 p126).
Moderate to Vigorous Physical Activity	Any waking behavior that requires energy expenditure of between 3-6 metabolic equivalents.
Moderate Physical Activity	Any waking behavior that requires energy expenditure of 3 metabolic equivalents.
Light Physical Activity	Any waking behavior that requires energy expenditure of below 3 metabolic equivalents.
Steps	Any waking behavior that requires energy expenditure of any intensity whereby one whereby one lifts one's foot and sets it back down in a new position.
Active Transport	Any walking, jogging or pedal biking for purposes other than enjoyment (Adams, 2010).

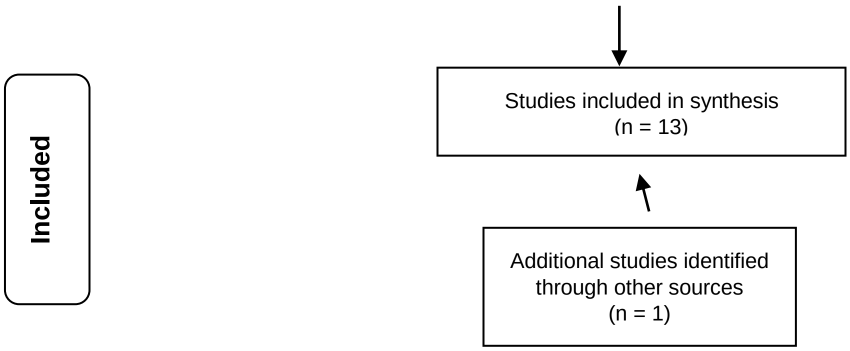
Results

Article Identification

The search strategy yielded 13,995 peer reviewed articles (Web of Science=6,598; SPORTDiscus=2,433; PsychINFO=1,396; ERIC=1,117; MEDLINE=2,451). A total of 8,966 articles remained after removing duplicates. Upon completing stage 1 screening of title and abstracts, 502 articles remained for full text review. Upon completion of stage 2 screening of full text articles, 12 articles were included for analysis. The most common reasons for excluding articles at stage 2 screening was the incorrect outcome (n=168), wrong population (n=122), no objective/device-based measures of physical activity (n=99) and wrong study design (n=55). A supplementary search of the literature yielded one additional article. See Figure 1 for the study flowchart.

Fig. 1 PRISMA Flowchart of the Study Selection Process





Study Design and Location

Of the 13 articles included in this review, eight were cross sectional (Aljuhani & Sandercock, 2019; Comte et al., 2015; Dias et al., 2017; Ewald et al., 2014; Fromel et al., 2016; Mayorga-Vega et al., 2018; Slingerland et al., 2012; Sprengeler et al., 2019), three were longitudinal (Hobin et al., 2014; Hobin et al., 2017; Zuo et al., 2016) and two were cluster randomized control trials (Ha et al., 2020; Kolle et al., 2020). Six studies were conducted in Europe (Dias et al., 2017; Fromel et al., 2016; Kolle et al., 2020; Mayorga-Vega et al., 2018; Sprengeler et al., 2019; Slingerland et al., 2012) four in Canada (Comte et al., 2015; Hobin et al., 2014; Hobin et al., 2017; Zuo et al., 2016) and one in the USA (Kolle et al., 2020), Australia (Ha et al., 2020) and Saudi Arabia (Aljuhani & Sandercock, 2019). All 13 articles were published in 2012 or later and seven were published in 2017 or later.

Population

The number of schools sampled in each article ranged from 1-31, with a combined total of 208 schools and a mean of 16 schools per article. Sample sizes ranged from 111-757 participants, with a combined total of 5,111 and a mean of 393 participants per article. Mean age of the included participants ranged from 14-16.5 years. Twelve articles had a mixed gender sample.

Exposure

Articles typically reported on the physical education curriculum with eight of the 13 articles reporting this as a primary exposure (Aljuhani & Sandercock 2019; Ewald et al., 2014; Fromel et al., 2016; Ha et al., 2020; Kolle et al., 2020; Mayorga-Vega et al., 2018; Slingerland et al., 2012;

Sprengeler et al., 2019). For the purpose of this study, physical education curriculum is described as a standard physical education class in accordance with the National physical education curriculum of the specified country or state. Additional typical school provision of physical education, physical activity and sports exposures included state physical education policy (Comte et al., 2015; Hobin et al., 2014; Hobin et al., 2017; Zuo et al., 2016), physical education facilities (Slingerland et al., 2012), school recess (Fromel et al., 2016), active transport to school (Slingerland et al., 2012) and a Self-Fit physical education intervention study (Ha et al., 2020). The same physical education policy was investigated in four articles with alternative outcome variables, in the same location (Comte et al., 2015; Hobin et al., 2014; Hobin et al., 2017; Zuo et al., 2016).

Outcomes

Please see Table 1 for description of outcomes. Physical activity outcomes were present in 11 articles (Aljuhani & Sandercock, 2019; Comte et al., 2015; Dias et al., 2017; Ewald et al., 2014; Fromel et al., 2016; Hobin et al., 2014; Hobin et al., 2017; Ha et al., 2020; Kolle et al., 2020; Mayorga-Vega et al., 2018; Slingerland et al., 2012). Physical activity guidelines in seven articles (Aljuhani & Sandercock, 2019; Comte et al., 2015; Fromel et al., 2016; Hobin et al., 2014; Hobin et al., 2017; Mayorga-Vega et al., 2018; Sprenegeler et al., 2019) and sedentary behavior in five articles (Comte et al., 2015; Fromel et al., 2016; Kolle et al., 2020; Mayorga-Vega et al., 2018; Zuo et al., 2016). Of the 13 articles, objective/device-based measures used an accelerometer in 10 articles (Aljuhani & Sandercock, 2019; Comte et al., 2015; Ewald et al., 2014; Ha et al., 2020; Hobin et al., 2014; Hobin et al., 2017; Kolle et al., 2020; Mayorga-Vega et al., 2018; Sprengeler et al., 2019; Zuo et al., 2016), a pedometer in one article, (Dias et al., 2017) while one article combined accelerometer and heart rate (HR) data (Slingerland et al., 2012) and another combined accelerometer and pedometer data (Fromel et al., 2016). In articles using accelerometers, moderate to vigorous physical activity and sedentary behavior were the most commonly reported outcomes and were primarily measured in minutes and percent of time spent in moderate to vigorous physical activity and sedentary behavior. Most often, accelerometer data was translated into adherence with physical activity guidelines. Pedometer data was expressed as steps per minute and per class/recess, while HR data was expressed as energy expenditure.

Quality Assessment

All 13 articles were assessed for quality using a modified Downs and Black checklist by two reviewers (PR, JW) (Nugent et al., 2021). A kappa coefficient was obtained to identify the percent agreement between the reviewers. A kappa value of 0.8 was recorded initially, but upon consensus, a value of 1.0 was achieved, indicating perfect agreement between the reviewers. Eight articles had a rating of 'fair' (55-69%), four articles had a rating of 'good' (70-84%) and one article had a rating of 'poor' (<55%). The mean quality assessment score was 67% (fair). None of the articles achieved a rating of 'excellent' (85-100%). One study demonstrated external validity by ensuring the sample was representative of the entire population from which they were recruited. Two studies provided a power calculation to demonstrate an adequate sample size (see Table 2).

Table 2. Summary of Downs and Black Checklist Quality Assessment Score

Study	Reporting (10 items)	External Validity (1 item)	Internal Validity (Bias) (4 items)	Internal Validity (Confounding) (6 items)	Power (1 item)	Total Score	Quality Rating
Aljunhani & Sandercock, 2019	9	0	2	1	0	12/15 (80%)	Good
Comte et al., 2015	9	0	2	1	0	12/15 (80%)	Good
Hobin et al., 2014	10	0	3	1	0	14/21 (67%)	Fair
Zuo et al., 2016	9	0	3	2	0	12/21 (57%)	Fair
Hobin et al., 2017	9	0	3	1	0	14/21 (67%)	Fair
Fromel et al., 2016	7	0	2	0	0	9/15 (60%)	Fair
Ha et al., 2019	8	1	4	3	1	17/23 (74%)	Good
Mayorga-Vega et al., 2018	9	0	2	1	0	12/15 (80%)	Good
Sprengeler et al., 2019	6	0	3	1	0	10/20 (50%)	Poor

Dias, A et al., 2017	7	0	2	0	1	10/15 (66%)	Fair
Slingerland et al., 2012	7	0	2	0	0	9/15 (60%)	Fair
Ewald et al., 2014	6	0	2	1	0	9/15 (60%)	Fair
Kolle et al., 2020	9	0	3	3	0	15/23 (65%)	Fair

Note: Quality rating of 'excellent' (85-100%), 'good' (70-84%), 'fair' (55-69%) or 'poor' (<55%) (Woods et al., 2021).

Summary of Findings

This section provides an overview of the main findings presented in Table 3. Included studies (n=13) contributed a total of 84 reported effects between typical school provision of physical education, physical activity and sports and adolescent physical activity behaviors. The bulk of the evidence indicated 39% of the reported effects were significantly positive (n=33), 42% were non-significant (n=35), 8% were significantly negative (n=7), and 11% had no significant test applied (n=9) (some numbers add to 99/101% due to rounding). Of the reported effects that indicated no significant test, one demonstrated a positive direction while eight demonstrated a negative direction. The impact summary of the reported effects within each article indicated that 38% were significantly positive (n=5 articles) (Aljuhani & Sandercock, 2019; Fromel et al., 2016; Mayorga-Vega et al., 2018; Slingerland et al., 2012; Sprengeler et al., 2019), 46% were inconclusive/no effect (n=6 articles) (Comte et al., 2015; Dias et al., 2017; Ewald et al., 2014; Ha et al., 2020; Hobin et al., 2014; Zuo et al., 2016), 8% were significantly negative (n=1 article) (Hobin et al., 2017) and 8% demonstrated a negative direction but with no significant test (n=1 article) (Kolle et al., 2020). When analyzed by study design, the overall frequency of reported effects showed that 67% (n=59, n=8 articles) occurred in cross-sectional studies (Aljuhani & Sandercock, 2019; Comte et al., 2015; Dias et al., 2017; Ewald et al., 2014; Fromel et al., 2016; Mayorga-Vega et al., 2018; Slingerland et al., 2012; Sprengeler et al., 2019), 18% (n=14, n=3 articles) in longitudinal studies (Hobin et al. 2014; Zuo et al. 2016; Hobin et al. 2017) and 15% (n=11, n=2 articles) in cluster randomized controlled trials (Ha et al., 2019; Kolle et al., 2020).

The bulk of significantly positive effects (88% n=29) and non-significant effects (74% n=26) were reported most frequently in cross-sectional studies, while longitudinal studies had the highest percentage (although infrequent) of significantly negative effects (57% n=4). Of the eight cross-sectional studies included, the impact summary indicated that 62% (n=5 articles) were significantly positive (Aljuhani & Sandercock, 2019; Fromel et al., 2016; Mayorga-Vega et al., 2018; Slingerland et al., 2012; Sprengeler et al., 2019) and 38% (n=3 articles) were inconclusive/no effect (Comte et al., 2015; Dias et al., 2017; Slingerland et al., 2012). Of the three longitudinal studies, 33% (n=1 article) were significantly negative (Hobin et al., 2017) while 67% (n=2 articles) were inconclusive/no effect (Hobin et al., 2014; Zuo et al., 2016). Of the cluster randomized control trials, 50% (n=1 article) demonstrated a negative direction but with no significant test (Kolle et al., 2020) and 50% (n=1 article) was inconclusive/no effect (Ha et al., 2020). Table 3 provides an in-depth analysis of each outcome.

Table 3. Summary Findings of Included Studies

Reference, Country, Study Design, QR	School Level, Pupils Age, School Number, Total Students, Aim	PE, PA, Sports Exposure	Outcome Measure, Instrument	Summary Results	Main Reported Effects, Impact Summary	Conclusion/Nuance
Aljunhani, & Sandercock (2019) **Saudi Arabia** **Cross Sectional** **QR: 70.58%**	Secondary School 13.6 (±0.8) 4 Schools 111 Pupils/Boys Aim: To examine the contribution of PE to the daily PA of adolescents.	**1. PE Curriculum** *Day No PE versus PE Day- v PE Day+* *Days without PE classes (Day no-PE), Days with PE classes (PE day+), PE days excluding PE time (PE day-).*	1. Daily MVPA minutes 2. PE MVPA minutes 3. % of PE duration in MVPA (%) 4. % PE MVPA that meets PA guidelines. Accelerometer (7 days)	**MVPA on Days with and without PE:** Sig more time in MVPA on PE day than on Day no PE (p<0.05)* After excluding the duration of PE class from PE days no sig difference emerged in time spent in MVPA on PE day compared to Day no PE (p>0.05)* **Contribution of PE to overall MVPA:** PE contributes 21% variance to overall daily MVPA.* 40% met PA guidelines on the PE day; percentages were lower for day no PE (24%, p=0.005) and after excluding the duration of PE class from PE days (28%, p=0.001).**	 Significantly Positive Non-Significant Positive Direction/No Significant Test Significantly Positive ____ **Significantly Positive Effects**	PE classes increase daily engagement in MVPA.
Comte et al., (2015) **Canada** **Cross Sectional** **QR: 77.7%**	Secondary School 16.09 (±0.8) 30 Schools 508 Pupils/259 (Boys), 249 (Girls) Aim: To determine if participation in PE was associated with increased MVPA levels in adolescents.	**1.PE Policy** *Enrolled versus Not Enrolled in PE* *The new PE policy extended secondary school graduation requirements from 2 to 4 PE credits, mandating PE for grades 11 and 12 for the first time in Canada and includes three components: (1) core, (2) flexible delivery, and (3) PA practicum. The core component is a minimum 25 (- 30 hours) of the 110 credit hours spent in class studying health and personal planning, building competence for personal decisions around PA. The 55-hour time frame for the PA practicum was established based on the expectation that students need to accumulate a minimum of 30 minutes of moderate to vigorous PA (MVPA) per day on at least 5*	1. Sedentary minutes 2. Light PA minutes 3. Moderate PA minutes 4. Vigorous PA minutes 5. MVPA minutes 6.> 60 mins/ day 7. > 60 mins/ weekday 8. >60 mins/ weekend day 9. School Sports Accelerometer (7 Days)	**Enrolled versus Not Enrolled in PE** Students enrolled in PE were sig more likely to participate in school sports than students not enrolled in PE (P= .03).* School sports is a sig predictor of daily MVPA (p=0.003).* No Sig differences between enrolled PE versus not enrolled in PE for 2,3,4,5 (p>.05).* No Sig differences between enrolled PE versus Not enrolled PE for sedentary minutes (p>.05).*** The differences in MVPA in adolescents enrolled in PE versus not enrolled in PE were larger for boys (53.9 ± 28.3 mins/day vs 48.6 ± 24.7 mins/day, P = .14) than girls (39.8 ± 21 mins/day vs 39.3 ± 24.7 mins/day, P = .87)* No Sig differences between enrolled PE versus not enrolled PE to achieve > 60 mins MVPA/weekend day (p>.05).** Students enrolled in PE were sig more likely to achieve >60 mins MVPA daily/weekday than students not enrolled in PE (p<.05)**	 Significantly Positive Significantly Positive Non-Significant Non-Significant Non-Significant Non-Significant Significantly Positive _______ **Inconclusive/No**	Enrolment in PE is associated with higher levels of MVPA and an increased likelihood of meeting PA guidelines particularly among boys. Greater effect in boys (AOR, 2.4) than girls (AOR,1.17)

		days per week to achieve the course credit.			**Effect**	
Hobin et al., (2014) **Canada Longitudinal QR: 66.66%**	Secondary School 15.2 (± 0.81) 31 Schools 447 Pupils/ 204 (Boys), 239 (Girls) Aim: To examine the longitudinal changes in and the factors associated with the PA trajectories of adolescents in Manitoba during their tenure as secondary school students in the context of the described school-based PE policy.	**1.PE Policy** *The new PE policy extended secondary school graduation requirements from 2 to 4 PE credits, mandating PE for grades 11 and 12 for the first time in Canada and includes three components: (1) core, (2) flexible delivery, and (3) PA practicum. The core component is a minimum 25 (- 30 hours) of the 110 credit hours spent in class studying health and personal planning, building competence for personal decisions around PA. The 55-hour time frame for the PA practicum was established based on the expectation that students need to accumulate a minimum of 30 minutes of moderate to vigorous PA (MVPA) per day on at least 5 days per week to achieve the course credit.*	1. MVPA minutes 2. % accumulating >30 min MVPA/day 3. % accumulating >60 MVPA/day Accelerometer (7 Days)	**MVPA Trajectories:** Total achieving >30 MVPA min/day fell 20.7% from baseline to follow up.** Total achieving >60 MVPA min/day fell 23.6% from baseline to follow up.** Average rate of decline in MVPA among students was 3.2 minutes per semester (p < 0.0001), corresponding to an average MVPA decline of 11.3% over a school year. * Students with low or moderate baseline PA had slower average rates of MVPA decline than students with high baseline PA (P <0.0001).* Students MVPA trajectories over time did not sig differ by gender (P=0.32).*	Negative Direction/No Significant Test Negative Direction/No Significant Test Significantly Negative Significantly Positive Non-Significant ___________ **Inconclusive/No Effect**	Despite the PE policy, there was a grade-related decline in the PA trajectories of the total sample of adolescents. However, it also be noted that the PE policy slowed the decline of PA in adolescents with low/moderate PA levels.
Zuo, et al., (2016) **Canada Longitudinal QR: 57.14%**	Secondary School 15.2 (± 0.81) 31 Schools 447 Pupils/ 204 (Boys), 239 (Girls) Aim: Describe the longitudinal changes in ST among a sample of adolescents in Manitoba between 2008 and 2011 in the context of a province-wide PE policy, and to identify student and school-	**1.PE Policy** *The new PE policy extended secondary school graduation requirements from 2 to 4 PE credits, mandating PE for grades 11 and 12 for the first time in Canada and includes three components: (1) core, (2) flexible delivery, and (3) PA practicum. The core component is a minimum 25 (- 30 hours) of the 110 credit hours spent in class studying*	1.Sedentary minutes Accelerometer (7 Days)	**Sedentary Trajectories (ST):** Students ST increased by 1.0 minute/day/semester from baseline to follow-up (p=0.433).*** Girls ST showed an average decline of 5.5 minutes/day/semester compared to boys (p=0.029) (adjusting for semester and gender).*** Students ST trajectories did not differ by baseline PA levels (I.e., low, moderate, high) (p=0.216).*** When adjusted for socio-demographic variables girls ST trajectories declined by 5.7 minutes/day/semester when compared to boys (p=0.035).***	Non-Significant Significantly Positive (G) Non-Significant Significantly Positive (G)	Total ST per day may remain high throughout secondary school. However, overall girls reported a decline in SD in comparison to boys.

	neighborhood factors associated with ST trajectories.	*health and personal planning, building competence for personal decisions around PA. The 55-hour time frame for the PA practicum was established based on the expectation that students need to accumulate a minimum of 30 minutes of moderate to vigorous PA (MVPA) per day on at least 5 days per week to achieve the course credit.*			______ **Inconclusive / No Effect**	
Hobin et al., (2017) **Canada Longitudinal QR: 61.90%**	Secondary School Comparison: 13.5 (± 0.71) Intervention: 15.2 (± 0.82) Comparison: n=6 Schools Intervention: n=31 Schools Comparison: n=224/ 91 (Boys), 133 (Girls) Intervention: n=447/ 208 (Boys), 239 (Girls) Aim: To examine the impact of a province-wide PE policy on secondary school students MVPA.	**1.PE Policy** *"The new PE policy extended secondary school graduation requirements from 2 to 4 PE credits, mandating PE for grades 11 and 12 for the first time in Canada and includes three components: (1) core, (2) flexible delivery, and (3) PA practicum. The core component is a minimum 25% (-30 hours) of the 110 credit hours spent in class studying health and personal planning, building competence for personal decisions around PA. The 55-hour time frame for the PA practicum was established based on the expectation that students need to accumulate a minimum of 30 minutes of moderate to vigorous PA (MVPA) per day on at least 5 days per week to achieve the course credit.*	1. MVPA minutes 2. % accumulating >30 min MVPA/day 3. % accumulating >60 MVPA/day Accelerometer (7 Days)	**MVPA Trajectories:** Decrease of 3.7 ± 25.3 min/day of MVPA from baseline to last follow-up in the comparison condition and 13.4 ± 26.2 min/day of MVPA in the intervention condition (p<.0001).* >30 MVPA min/day fell to 79.4% and 67.9% in comparison and intervention conditions from baseline to last follow up (p= 0.007).** >60 MVPA min/day fell to 29.1% and 20.9% in comparison and intervention conditions from baseline to last follow up (p=0.04).** There were no significant differences in students' MVPA trajectories between intervention and comparison conditions (p=0.12). * The difference in the adjusted MVPA trajectories across baseline sex was not significant (p>0.05).*	Significantly Negative There is sign diff between baseline and follow up Significantly Negative Significantly Negative Non-Significant Non-Significant ______ **Significantly Negative**	A province-wide school-based PE policy mandating a PE credit had no effect on student MVPA overall.
Fromel et al., (2016)	Secondary School Boys 16.55 (± 1.27), Girls 16.59 (± 1.15)	**1. PE Curriculum** *With PEL versus Without*	1.kcal/kg/hour 2. Steps/hour 3.Physical Inactivity	**With PEL versus Without PEL:** Student participation in PE contributed sig to 1,2,	Significantly Positive	Both boys and girls participating in a PEL reported significantly

	24 Schools	*PEL*	minutes	5,6,7,8,9,10 compared to non-PE participants (p<.05).*		better results compared with nonparticipating individuals regarding all indicators of volume and intensity of School PA.
Czech Republic **Cross Sectional** **QR: 64.70%**	641 Pupils/ 208 (Boys), 433 (Girls)	**2. School Recess**	4. < 3 MET minutes 5. 3-5.9 MET minutes 6. ≥6 MET minutes 7. <50% minutes	Student participation in PE contributed sig to physical inactivity compared to non-PE participants (p<.05).***	Significantly Positive	
	Aim: To investigate school lifestyle among adolescents in terms PA structure: (1) adolescents participating in a PE lesson (PEL) versus (2) aggregate recess time exceeding 60 minutes.	*>60 min recess versus <60 min recess*	8.50-59.9% minutes 9.60-84.9% minutes 10. 85-100% minutes	Student participation in PE had non-sig effects for < 3 MET (min/hour) compared to non-PE participants (p>.05).*	Non-Significant	In most SPA indicators, longer aggregate recess time (>60 minutes) had a statistically significant effect, particularly on the volume of School PA.
			Accelerometer (3 Days) Pedometer (Up to 7 Days)	For boys, 83% of PE participants and 32% of non-PE participants and for girls 69% of PE participants and 31% of non-PE participants met the recommended 500 steps/hour during school PA (P<.05).**	Significantly Positive	
				Foy boys, 74% of PE participants and 23% of non-PE participants and for girls 50% of PE participants and 31% of non-PE participants met the recommendation of 20 minutes MVPA during SPA (p<.05).**	Significantly Positive	Increased School PA are significantly supported more by PELs than by longer recess time.
				>60 min recess versus <60 min recess:		For the purpose of this study physical inactivity is described as a stable body position, sitting or lying which indicates sedentary behavior.
				Students' participation in >60 min recess contributed significantly to 1,2,5 compared to <60 min recess (p<.05).*	Significantly Positive	
				Students' participation in >60 min recess had non-sig effects for 4,6,7,8,9,10 when compared to <60 min recess time. (p>.05) *	Non-Significant.	
				Boys' participation in >60 min recess contributed significantly to reducing physical inactivity levels compared to girls (p<.05).***	Significantly Positive (B)/Non-Significant (G)	
				41% of boys and 42% of girls for >60 min recess time compared to 26% and 11% for <60 min recess time met the recommended 500 steps/hour (p=.012, p=.000).**	Significantly Positive	
				41% of boys and 32% of girls for >60 min recess time compared to 11% and 8% for <60 min recess time met the recommendation of 20 minutes of MVPA (p<.05).**	Significantly Positive	
				Overall: The daily recommendation of 60 minutes of MVPA/day was achieved by 62.70% of boys and 59.81% of girls who had more than 20 minutes of MVPA during school time (p<.05).**	Significantly Positive _______ **Significantly Positive**	

Ha et al., (2019) **Australia** **Cluster RCT** **QR: 82.61%**	Secondary School 14.4 (± 0.78) 26 Schools 667 Pupils/ 261 (Boys), 463 (Girls) Aim: To examine the effects of the SELF-FIT intervention on students MVPA and motivation in PE.	**1. PE Curriculum (Control)** **2. Self-Fit (Intervention)** *- PE needs support workshop for teachers.* *- Fitness Dice* *- Upbeat Music*	1.Weekday MVPA minutes 2.Weekend MVPA minutes 3. 7 Day MVPA minutes Accelerometer (7 days)	No sig difference between the control and experimental groups for weekday MVPA min (p=.78), weekend MVPA min (p=.12) and 7-day MVPA min (p=.71) at follow-up.* No sig difference between baseline and follow up for weekend MVPA min (p=0.35) and 7-day MVPA min (p=0.69). * There was a sig difference between baseline and follow up for weekday MVPA min (p>.01).* No sig group x time interaction effect for weekday (p=.79), weekend (p=.34) and 7-day MVPA min (p=.02).* No sig sex x group x time interaction effect for weekday (p=.68), weekend (p=.53) and 7-day MVPA min (p=.53).*	Non-Significant Non-Significant Significantly Positive Non-Significant Non-Significant __________ **Inconclusive/No Effect**	A Self-Fit intervention had no effect on MVPA overall.
Mayorga-Vega et al., (2018) **Spain** **Cross Sectional** **QR: 80%**	Secondary School 14.58 (± 1.18) 1 School 158 Pupils/ 83 (Boys), 75 (Girls) Aim: To compare the accelerometer-measured PA and SB between PE, non-PE and weekend days in adolescents. Secondarily, the purposes of the present study were: (a) to compare the percentage of adolescents achieving the daily recommendation of PA between PE, non-PE and weekend days, and (b) to examine the contribution of PE to the adolescents daily PA.	**1.PE Curriculum** *PE Days versus Non-PE Days versus Weekend Days*	1.% time in MVPA 2.% time in LPA 3.Vertical Axis counts/ min 4.Vector Magnitude counts/min 5. Steps/min 6. % Sedentary time 7. Sedentary bouts/ hour 8. Total time in sedentary bouts 9. Average time in sedentary bouts Accelerometer (2 Days)	Sig higher values for 1-5 on PE days versus non-PE and 1,3,4,5 on PE days versus weekend days for the whole sample (p< 0.001).* No sig difference for the % time in LPA on PE Days versus weekend days for the whole sample (p>0.05). * Sig higher values for 1-5 on PE days versus non-PE and 1,3,4,5 on PE days versus weekend days for boys and for girls (p< 0.05). * No sig difference for % time in LPA on PE days versus weekend days for boys and for girls (p>0.05).* Sig higher percentage of students achieved the daily recommendation of 60 min of MVPA and 10,000 steps on PE days than on non-PE and weekend days (p< 0.01). ** Sig lower values for 6-8 on PE days versus non-PE days and 6, 9 on PE days versus weekend days for the whole sample (p< 0.01).*** No sig difference for average time in sedentary bouts	Significantly Positive Non-Significant Significantly Positive Non-Significant Significantly Positive Significantly Positive	PE contributes significantly to reducing adolescents daily physical inactivity and SB. Adolescents had greater daily PA levels, higher compliance of the PA recommendations and lower SB on PE days than on non-PE and weekend days. Although both boys and girls showed the same trend, girls seem to benefit more from the contribution of PE. Associations between non-PE days and weekend days were excluded as they did not pertain to the overall research question.

				on PE days versus non-PE days and 7-8 on PE days versus weekend days for the whole sample (p>0.05). *** Sig lower values for % sedentary time on PE Days versus non-PE days and 6-9 on PE days versus weekend days for boys (p<0.01).*** No sig difference for 7-9 in PE days versus non-PE days and 7-8 on PE days versus weekend days for boys (p>0.05).*** Sig lower values for 6-8 on PE Days versus non-PE days and 6, 9 on PE days versus weekend days for girls (p<0.01).*** No sig difference for 9 in PE days versus non-PE days and 7-8 on PE days versus weekend days for girls (p>0.05).***	Non-Significant Significantly Positive Non-Significant Significantly Positive Non-Significant ______ **Significantly Positive**	
Sprengeler et al., (2019) **Cross Sectional** **Germany** **QR: 50%**	Secondary School 13.6 (± 1.3) (Adolescent data only) 2 Schools 187 Pupils/ 99 (Boys), 88 (Girls) Aim: To investigate the distribution of objectively measured PA intensities achieved by schoolchildren during PE and the contribution of PE to the achievement of the PA recommendations.	**1. PE Curriculum**	1.PA guidelines. 2.Sedentary minutes 3.Light PA minutes 4.MVPA minutes Accelerometer (7 Days)	Adolescents were sig more likely to meet PA guidelines if they had PE at least 1 (AOR, 2.57) or 2 times per week (AOR, 5.52).** Adolescents were sig more likely to meet PA guidelines if they had PE for at least >90 min/week (AOR, 9.69). ** Adolescents were not sig more likely to meet PA guidelines if they had PE for at least 45-90 min/week (AOR, 1.71) or <45 min/week (AOR, 1.00).**	Significantly Positive Significantly Positive Non-Significant _________ **Significantly Positive**	PE was found to support adolescents to engage sufficiently in MVPA and the associated PA recommendations. Conclusions pertaining to outcome 2,3,4 were excluded as these only measured PA intensities during PE class and not the impact of the class on daily/weekly PA outside of class.
Dias, A et al., (2017) **Cross Sectional** **Spain** **QR: 70.59%**	Secondary School 14-18 years (No SD) 10 Schools 176 Pupils/ 71 (Boys), 105 (Girls). Aim: To verify the association between the characteristics of the school	**1.PE Facilities** *Quality / Quantity (Measured via a school audit tool)* *Quantity: The sum of structures categorized as; 1) one structure; 2) three to four structures; and 3) five and six structures.*	1.Steps in PE class 2. Steps in Recess Pedometer (3 days)	**Steps in PE Class:** There was no sig association between 1 structure and the number of steps in PE class for boys (p=0.13) and girls (p =0.17).* There was no sig association between 3 and 4 structures and the number of steps in PE class for boys (p=0.20) and girls (p =0.43).*	Non-Significant Non-Significant	There were no significant associations found between facilities (quality/quantity) with number of PE/recess steps for boys or girls. Public schools with larger and/or better structures do

	structure and the PA of students in the PE class and school recess.	*Quality: (1) regular quality: the structure does not have some feature to be used, or it has some wear, damage or lack of maintenance, but the use is not impossible; (2) good quality: the structure has all or almost all the resources to be used, or is preserved and presents good conditions; and (3) excellent quality: the structure has all the features to be used, or it does not present wear or visible damage.*		There was no sig association between quality of structure with number of steps in the PE class for boys (p=0.07) and girls (p=0.45).* **Steps in School Recess:** A sig inverse association was found between quality of structures with number of steps in the school recess for boys (p =0.03). * There was no sig association between quality of structure with number of steps in the school recess for girls (p=0.15).* There was no sig association between 1 structure and the number of steps in school recess for boys (p=0.85) and girls p =0.99).* There was no sig association between 3 and 4 structures and the number of steps in school recess for boys (p=0.54) and girls (p =0.81).*	Non-Significant Significantly Negative Non-Significant Non-Significant Non-Significant _____ **Inconclusive / No Effect**	not necessarily influence adolescents in the practice of PA during school recess and PE classes.
Slingerland et al., (2012) **Cross Sectional Netherlands QR: 60%**	Secondary School 15.7 (No SD) 3 Schools 73 Pupils/ 37 (Boys), 36 (Girls). Aim: This study investigated the contribution of PE and active transport to and from school to total Physical Activity Energy Expenditure (PAEE) during a average school week in adolescents	**1. PE Curriculum** **2. Active Transport to School**	1.% of PAEE on weekdays without PE 2.% of PAEE on weekday with PE 3.% of PAEE during school hours ACTi heart monitor (Combined HR + Accelerometer, 8 Days)	**PE:** PE was not a sig contributor to total PAEE (p>.001) PE was a sig contributor to PAEE during school hours (p<.001) % of PAEE on weekday with PE was sig greater for boys than girls (P<.05).* There was no sig difference for % of PAEE in PE on weekdays, and % of PAEE during school hours between boys and girls (p>.05).* **Active Transport to School:** Active transport was a sig contributor to school hours PAEE (p<.001) Active transport was a sig contributor to total PAEE (p<.001)	 Non-Significant Significantly Positive Significantly Positive (B)/Non-Significant (G) Non-Significant Significantly Positive Significantly Positive	During school hours, PE and active transport had large contributions to PAEE.

				There was no sig difference for % of PAEE in active transport to school on weekdays, and during school hours for boys and for girls (p>.05).* **Overall:** During school hours, 73% of the variance in total PAEE could be explained by PE and active transport to school (p<001).*	Non-Significant Significantly Positive ____ **Significantly Positive**	
Ewald et al., (2014) **Cross Sectional** **USA** **QR: 60%**	Secondary School 14-16 (No SD) Schools Not reported 268 Pupils / 112 (Boys), 102 (Girls) Aim: To determine whether adolescents engage in activity compensation throughout the school day, and whether this compensation is dependent upon the amount of non-exercise activity thermogenesis (NEAT) and MVPA adolescents engage in during PE class.	**1. PE Curriculum**	1) NEAT minutes 2) MVPA minutes Accelerometer (7 Days)	**Odds of ≥10% non-PE Time Spent in NEAT:** Gender (p=0.0063), PE class length (p=0.0168), and PE class NEAT (p<.0001) minutes are all sig associated with the likelihood of spending >10% of non-PE class time in NEAT.* PE class MVPA was not sig associated with the likelihood of spending >10% of non-PE class time in NEAT (p=0.3492).* A sig negative relationship exists between individuals who had 10% or more of their non-PE class time spent in NEAT and the length of their PE class (p<.05).* **Odds of ≥0% non-PE Time Spent in NEAT:** PE class NEAT (P<.0001) minutes and PE class length (p=0.0398) are sig associated with the likelihood of spending >0% of non-PE class time in NEAT.* Gender (p=0.1824) and PE class MVPA (p=0.2766) were not sig associated with the likelihood of spending >0% of non-PE class time in NEAT.* Sig negative relationship between PE class length and the percent of non-PE class time spent in NEAT (p= -0.0004).*	Significantly Positive Non-Significant Significantly Negative Significantly Positive Non-Significant Significantly Negative __ **Inconclusive / No Effect**	Findings from this preliminary study suggest that adolescents who engage in high levels of light (NEAT) PA do so regardless of class environment (i.e., PE or non-PE classes)
Kolle et al., (2020) **Cluster RCT** **Norway** **QR: 69.5%**	Secondary School 14 (±0.3) 9 Schools 757 Pupils/ 386 (Boys), 371 (Girls) Aim: To analyze the effect of two school-based PA	**1.PE Curriculum (Control)**	1. Average PA CPM 2. Sedentary min/day 3. MVPA min/day Accelerometer (7 Days)	**<u>PAL Full Day:</u>** Average PA CPM decreased by 48 CPM from baseline to follow up.* Time spent in MVPA decreased by 6 min/day from baseline to follow up.* Sedentary time increased by 17 min/day from baseline	Negative Direction/No Significant Test Negative Direction/No Significant Test Negative	Significant values pertain to between group differences in the intervention and control groups only (not baseline versus follow-up). Intervention groups are not considered ‘typical’

interventions on daily PA levels among adolescents.	to follow up.***	Direction/No Significant Test	PE in this study; therefore, they are excluded.
	<u>PAL School hours</u>		
	Average PA CPM decreased by 22 CPM from baseline to follow up.*	Negative Direction/No Significant Test	
	Time spent in MVPA decreased by 5 min/day from baseline to follow up.*	Negative Direction/No Significant Test	
	Sedentary time increased 7 min/day from baseline to follow up.***	Negative Direction/No Significant Test	
		Negative Direction/No Significant Test	

Notes: * Physical activity outcome, ** PA guidelines outcome, *** Sedentary behavior outcome. Abbreviations: Quality Rating (QR), Physical Education (PE), Physical Activity (PA), Moderate to Vigorous Physical Activity (MVPA), Light Physical Activity (LPA), Girls (G), Boys (B). Significantly Positive = when 50% or more of the reported effects are significant and in positive direction, Significantly Negative = when 50% or more of the reported effects are significant and in a negative direction, Inconclusive/No Effect = when 50% of more of the reported effects were non-significant or when results were mixed (both positive and negative), No significant Test = when the reported effects were not supported with a test of significance the direction of the effect whether positive or negative is indicated.

Physical Activity

Physical activity outcomes were identified in 85% of articles (n=11), representing 62% (n=52) of the total reported effects. Of this, 29% (n=15) were significantly positive, 48% (n=25) were non-significant, 10% (n=5) were significantly negative and 13% (n=7) had no significant test, one reported a positive direction while six reported a negative direction. The bulk of the evidence was most prevalent in cross-sectional studies (64%, n=7 articles) (Aljuhani & Sandercock, 2019; Comte et al., 2015; Dias et al., 2017; Ewald et al., 2014; Fromel et al., 2016; Mayorga-Vega et al., 2018; Slingerland et al., 2012), then longitudinal studies (18%, n=2 articles) (Hobin et al., 2014; Hobin et al., 2017) and randomized control trials (18%, n=2 articles) (Kolle et al., 2020; Mayorga-Vega et al., 2018). When analyzed by study design, the frequency of reported effects indicated that 71% (n=37) occurred in cross sectional studies, 11% (n=6) in longitudinal studies and 17% (n=9) in cluster randomized controlled trials. Of the cross-sectional studies, the reported effects indicated that 38% (n=14) were significantly positive, 51% (n=19) were non-significant, 8% (n=3) were significantly negative and 3% (n=1) indicated a positive direction but with no significant test. Of the longitudinal studies, the reported effects indicated that 17% (n=1) were significantly positive, 50% (n=3) were non-significant and 33% (n=2) were significantly negative. Of the cluster randomized control trials, the reported effects indicated that 11% (n=1) were significantly positive, 44% (n=4) were non-significant and 44% (n=4) indicated a negative direction but with no significant test. There were zero significantly negative effects in the cluster randomized control trials for physical activity outcomes

Physical Activity Guidelines

Physical activity guideline outcomes were identified in 54% of articles (n=7), representing 19% (n=16) of the total reported effects. Of this, 62.5% (n=10) were significantly positive, 12.5% (n=2) were non-significant, 12.5% (n=2) were significantly negative and 12.5% (n=2) indicated a negative direction but with no significant test. The bulk of the evidence was most prevalent in cross-sectional studies (75%, n=5 articles) (Aljuhani & Sandercock, 2019; Comte et al., 2015; Fromel et al., 2016; Mayorga-Vega et al., 2018; Sprengeler et al., 2019), then longitudinal studies (25%, n=2 articles) (Hobin et al., 2014; Hobin et al., 2017). There were no cluster randomized control trial study designs for this outcome. When analyzed by study design, the frequency of reported effects indicated that 75% (n=12) occurred in cross-sectional studies and 25% (n=4) occurred in longitudinal studies. Of the cross-sectional studies, the reported effects indicated that 83% (n=10) were significantly positive, and 17% (n=2) were non-significant. There were zero significantly negative and no significant tests associated with physical activity guidelines in the cross-sectional studies. Of the longitudinal studies, the reported effects indicated that 50% (n=2) were significantly negative and 50% (n=2) indicated a negative direction but with no significant test. There were zero significantly positive and non-significant effects for physical activity guidelines in the longitudinal studies.

Sedentary Behavior

Sedentary behavior outcomes were identified in 38% of articles (n=5), representing 19% (n=16) of the total reported effects. Of this, 44% (n=7) were significantly positive, 44% (n=7) were non-significant and 12.5% (n=2) indicated a negative direction but with no significant test. There were zero significantly negative effects for sedentary behavior. The bulk of the evidence was most prevalent in cross-sectional studies (60%, n=3 articles) (Comte et al., 2015; Fromel et al., 2016; Mayorga-Vega et al., 2018), then longitudinal studies (20%, n=1 article) (Zuo et al., 2016) and randomized control trials (20%, n=1 article) (Kolle et al., 2020). When analyzed by study design, the frequency of reported effects indicated that 62.5% (n=10) occurred in cross-sectional studies, 25% (n=4) in longitudinal studies and 12.5% (n=2) in cluster randomized controlled trials. Of the cross-sectional studies, the reported effects indicated that 60% (n=6) were significantly positive and 40% (n=4) were non-significant. In the longitudinal study, the reported effects indicated that 50% (n=2) were significantly positive and 50% (n=2) were non-significant. There were zero significantly negative and no significant test for sedentary behavior in cross-sectional and longitudinal studies. In the cluster randomized control trial, the reported effects indicated that 100% (n=2) had a negative direction but with no statistical test. There were zero significantly negative/positive and non-significant effects for the sedentary behavior in cluster randomized control trial studies. Figure 2 and 3 illustrates the frequency of reported effects by outcome and study design.

Fig. 2 Frequency of Reported Effects by Outcome

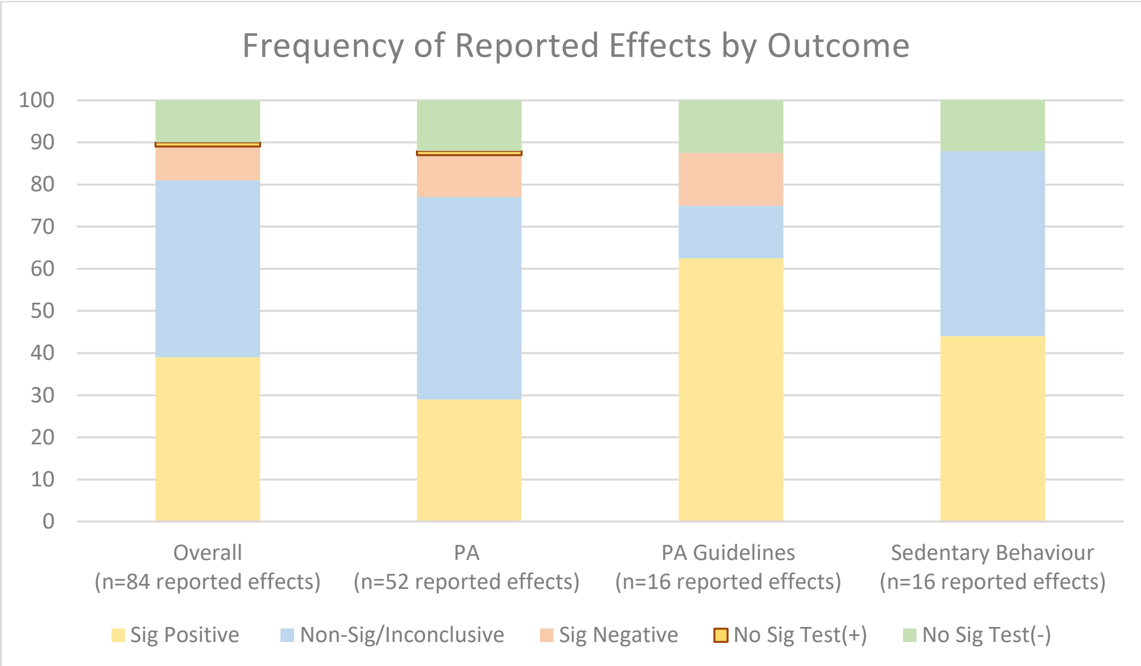
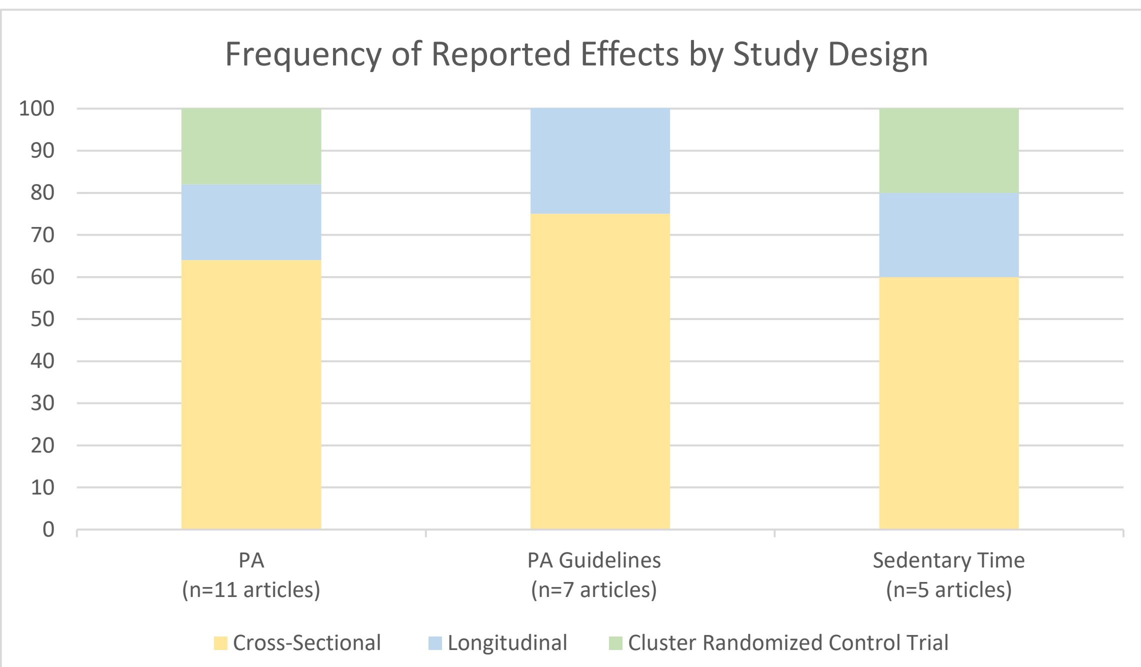


Fig. 3 Frequency of Reported Effects by Study Design



Discussion

Identifying strategies to increase adolescent physical activity for health that is understood to track from adolescence into adulthood is a public health priority to reduce worldwide health costs (Morton et al., 2016). The study expands upon previous research that examines physical activity behaviors inside the physical education class (Laurson et al., 2008), by targeting articles that emphasize the impact of provision on physical activity behaviors outside of the physical education class i.e., physical activity behavior within or outside of the school. Therefore, this study systematically organized and evaluated the current body of evidence on the impact of typical school provision of physical education, physical activity and sports on adolescent physical activity behaviors, namely, physical activity, meeting physical activity guidelines and time spent sedentary. Thirteen articles of fair to good quality were rigorously assessed and included, all of which were published in 2012 or later, highlighting the recency of inquiry into this research area. While the presented evidence supports the positive impact of typical school provision of physical education, physical activity and sports adolescent physical activity behaviors, future research should consider examining the additive impact of all three exposures as the included studies examined individual components of provision only.

The Impact of Typical School Provision of Physical Education, Physical Activity and Sports on Physical Activity Behaviors

A large proportion of the scientific evidence indicated a mix of inconclusive/no effect and significantly positive findings when examining the impact of typical school provision of physical education, physical activity and sports on physical activity outcomes outside of the physical education class, including moderate to vigorous physical activity, light physical activity, moderate physical activity and steps. The relationship between typical school provision of physical education, physical activity and sports and physical activity was examined in only 11 articles which confirms the limited body of evidence in this research area. Of the significantly positive effects, the current study reported that moderate to vigorous physical activity levels in adolescents, which is the target physical activity intensity to promote health, is significantly higher on **physical education days versus non- physical education days** (Aljuhani & Sandercock, 2019; Fromel et al., 2016; Mayorga-Vega et al., 2018; Slingerland et al., 2012). These finding are consistent with the postulation that physical education is a significant contributor to adolescent daily moderate to vigorous physical activity, with one study citing a 16-minute increase in moderate to vigorous physical activity on physical education days (Meyer et al., 2012). The present review confirmed that adolescents who were **enrolled in physical education** are more likely to engage in daily moderate to vigorous physical activity compared to adolescents who were not enrolled in physical education (Comte et al., 2015). This supports existing research that controlled for organized sports, reporting as little as one minute of moderate to vigorous physical activity in physical education is "associated with an additional 1.4 minutes of total daily moderate to vigorous physical activity", indicating that even small proportions of moderate to vigorous physical activity in physical education can impact moderate to vigorous physical activity outside of the physical education class (Mooses et al., 2017 p606).

Our findings indicated that adolescent participation in **>60 minutes recess** contributed significantly to steps per hour and moderate physical activity minutes but was not an adequate substitute for physical education (Fromel et al., 2016). Physical activity in recess time encompassed 17.9% and 15.5% of daily moderate to vigorous physical activity for **boys and girls** respectively, which is inconsistent with findings from a recent longitudinal study that found just 10.7% and 6.6% of moderate to vigorous physical activity for boys and girls was as a result of school recess time (Ridgers et al., 2012). This inconsistency may be due to the use of a longitudinal study design that is better positioned to measure cause and effect over time. It is noteworthy that of the longitudinal studies presented in this review on physical activity outcomes, just one reported effect was significantly positive (Hobin et al., 2014), with the rest indicating non-significant or significantly negative effects (Hobin et al., 2017). These findings align with an 11-year prospective controlled study that identified non-significant effects for physical education on physical activity behavior (Lahti et al., 2018). However, a comparison group from the same study with an additional 140 minutes of physical education weekly demonstrated elevated levels of physical activity that tracked into adulthood and remained four years post intervention. Thus, additional physical education time seems a viable strategy to enhance adolescent physical activity behaviors.

Active transport was found to be a significant contributor to daily physical activity (Slingerland et al., 2012). This data aligns with a recent systematic literature review that found significantly positive associations between active transport and physical activity, with walking to school identified as the most significant contributor (Jones et al., 2019). However, further research is required to strengthen these findings.

Interestingly, adolescents enrolled in **physical education were significantly more likely to participate in school sports and more importantly**, school sports were found to be a significant predictor of daily moderate to vigorous physical activity (Comte et al., 2015). These findings are consistent with a recent longitudinal study that monitored participants for over 50 years and found school sports to be a significant determinant of physical activity. Furthermore, physical activity levels remained high as the participants transitioned into their senior years and served as an important predictor for health status in old age (Dohle et al., 2013). This illuminates the unique impact of school physical education and the resulting additive impact of school physical activity and sports.

Contrastingly, the current study indicated **that policy mandating** physical education for grade 11 and 12 (16-18 years), requiring 30 minutes of moderate to vigorous physical activity to be delivered during physical education class, had non-significant effects on adolescent physical activity behaviors (Hobin et al., 2014; Hobin et al., 2017). Additionally, of the significantly negative effects there was an average moderate to vigorous physical activity decline of 11.3% over a school year when exposed to the same physical education policy. These findings are consistent with a systematic literature review of 52 articles that reported non-significant effects for school physical activity policies on physical activity behavior in youth (Stylianou et al., 2022). This illuminates the need to further investigate the gap between policy implementation and practice in which a systematic literature review by Nathan et al., suggests is often due to lack of teacher support and teacher training (2018).

Non-Significant differences were found in the cluster randomized control trial for 7-day moderate to vigorous physical activity minutes between a physical education control group and a Self-Fit intervention that included a physical education needs support workshop for personnel, fitness dice and upbeat music during the class (Ha et al., 2019). However, this is inconsistent with an umbrella review of 20 reviews that found up to 65% of school-based interventions to be effective (Laurson et al., 2008). It must be noted that while the cluster randomized control trial for 7-day moderate to vigorous physical activity minutes demonstrated non-significant effects, the intervention group slowed the **decline of moderate to vigorous physical activity** from baseline to follow up on weekdays in comparison to the physical education control group. Slowing the moderate to vigorous physical activity decline is a relatively recent phenomenon in this research area and warrants further investigation to analyze and compare physical activity behavior in typical physical education interventions with minor modification to existing practice versus control groups in longitudinal study designs. The current study also found non-significant effects for the quality and quantity of physical education facilities on physical activity steps in physical education and recess (Dias et al., 2017). This is inconsistent with a study that found that adolescents enrolled in schools with a higher number of physical education facilities (e.g., volleyball court, soccer field, dance room) were three times more likely to engage in physical activity (Haug et al., 2008) and suggests that future research should consider longitudinal studies that examine cause and effect rather than a cross sectional study design such as in this review.

It is noteworthy that just 38% of articles (n=4) associated with the impact of typical school provision of physical education provision on physical activity outcomes specified the nature of the exposure beyond the standard physical education class in accordance with the National Curriculum (Comte et al., 2015; Dias et al., 2017; Hobin et al., 2014; Hobin et al., 2017). Of the articles that did specify the nature of the exposure, there were non-significant or significantly negative effects associated with all of them. These findings indicate the paucity of evidence on exposure type and the need for future research to identify the impact of specific aspects of physical education provision such as class type, facilities, or equipment on adolescent physical activity behaviors. **Overall, typical school provision of physical education, physical activity and sports had a significantly greater impact on boys in comparison to their female counterparts which aligns strongly with the literature and suggests renewed strategies to promote physical activity in girls should be of paramount importance in schools (Currie, 2012; Woods et al., 2018).**

The Impact of Typical School Provision of Physical Education, Physical Activity and Sports on Meeting the Physical Activity Guidelines

Of all the outcomes reported in this review, typical school provision of physical education, physical activity and sports had the greatest impact on meeting physical activity guidelines with the bulk of evidence reporting 62.5% significantly positive effects. One such study found that adolescents who had **>90 minutes of physical education weekly, were almost 10 times more likely to meet** physical activity guidelines. Contrastingly, there were non-significant findings for adolescents meeting physical activity guidelines with <90 minutes of physical education weekly (Sprengeler et al., 2019). These findings are consistent with a plethora of studies including the findings from the Global School-Based Student Health Survey longitudinal study, conducted on a representative sample of 206,417 adolescents in 65 countries, over a nine-year period, that identified that a higher frequency of physical education had “significantly higher odds of meeting the WHO’s physical activity recommendations” (Materova et al., 2022; Silva et al., 2018; Uddin et al., 2020 p4). Previous studies hypothesis that the aforementioned effects are due to the fact that physical education enhances student preparedness to engage in multidisciplinary physical activity both in and outside of school (Silva et al., 2018; Palmer et al., 2018). Unsurprisingly, the present study illuminated the percentage of adolescents meeting the physical activity guidelines decreases as much as **16% on non- physical education days (**Aljuhani & Sandercock, 2019; Mayorga-Vega et al., 2018). Interestingly, our findings also reported a total of **41% of boys and 32% of girls who participated in >60 minutes recess time compared to 11% of boys a**nd 8% of girls who participated in <60 minutes recess time achieved the specific school physical activity recommendations of 20 minutes moderate to vigorous physical activity (Cradock et al. 2014; Fromel et al., 2016). This is consistent with research that recognizes "physical activity-oriented recess periods is a health-enhancing and cost-effective way to increase school physical activity" and calls to attention the potential contribution of a multifaceted approach to achieving adolescent physical activity guidelines, via increasing both physical education and recess time simultaneously (Fromel et al., 2020 p4).

Contrastingly, the current review reported non-significant differences between adolescents enrolled in physical education versus not enrolled **in physical education to achieving the physical activity guidelines on weekend days** (Comte et al., 2015). This suggests that while school physical education may impact achieving physical activity recommendations on weekdays, this does not pertain to weekend days. These findings are consistent with the postulation that overall adolescent achieve higher values of physical activity on physical education days compared to non- physical education and weekend days and highlight the need for supplementary physical activity opportunities such as engagement in sports clubs to achieve physical activity guidelines on the weekends (Brusseau et al., 2011; Gao et al., 2015). When examining the impact of physical education policy on meeting physical activity guidelines, a longitudinal study that mandated 30 minutes of school moderate to vigorous physical activity daily, reported **significantly negative** effects with 44.5% of adolescents achieving >60 minutes moderate to vigorous physical activity daily at baseline, pre implementation of the physical education policy, compared to 20.9% at follow three years post implementation of the physical education policy (Hobin et al., 2014; Hobin et al. 2017). In fact, a comparator school in the same study, that did not implement the physical education policy recorded a lesser decline in meeting physical activity guidelines from baseline (33.9%) to follow up (29.1%). This discrepancy may be due to an insufficient level of moderate to vigorous physical activity under the physical education policy and suggests a need to assess the policy fidelity with a renewed moderate to vigorous physical activity level to better support meeting physical activity guidelines. Similarly, to the physical activity outcomes, just 43% of articles (n=3) on physical activity guidelines specified the nature of the exposure beyond the physical education curriculum (Comte et al., 2015; Hobin et al., 2014; Hobin et al., 2017).

Overall typical school provision of physical education, physical activity and sports had a significantly greater impact on **boys in comparison to their female counterparts with the**

current study revealing as much as a 14% difference in boys who participated in physical education achieving the school physical activity guidelines compared to girls (Fromel et al., 2016). However, it is noteworthy that this gender difference is reduced to as little as 3% for achieving daily physical activity guidelines (**62.70% for boys and 59.81% for girls) should they attain more than 20 minutes moderate to vigorous physical** activity during school time. This suggests that physical activity recommendations for segments of school days targeted at achieving greater than 20 minutes moderate to vigorous physical activity could prove highly beneficial in achieving daily physical activity guidelines and bridging the physical activity gender gap (Gao et al. 2015).

The Impact of Typical Provision of School Physical Education, Physical Activity and Sports on Sedentary Behavior

There are zero significantly negative effects associated with typical school provision of physical education, physical activity and sports on adolescent sedentary behavior in this review. The evidence reported a mix of significantly positive and non-significant effects. Of the significantly positive effects, sedentary behavior was found to be significantly lower on physical education days versus non- physical education days when exposed to the physical education curriculum (Comte et al., 2015). Although adolescents spend a considerable amount of time seated during school days, "physical education seems to contribute significantly to inverting this trend" (Mayorga-Vega et al., 2018 p8). These findings are consistent with the hypothesis that physical education is a significant contributor to reducing sedentary behavior. A recent study reported as much as 9.7-minute decrease in sedentary time on physical education days, thus, increasing the frequency of physical education classes is strongly recommended (Mooses et al., 2017). Similarly to physical activity and physical activity guidelines, this study found >60 minute of recess to be a positive contributor to reducing sedentary behavior, particularly in boys (Fromel et al., 2016).

Contrastingly, policy mandating physical education in grade 11/12 that compared students enrolled in physical education versus not enrolled in physical education, found no significant difference in sedentary minutes (Comte et al., 2015). Additionally, a sister study using the same physical education policy found an increase of 1 minute/day/semester of adolescent sedentary time from inception to a three year follow up (Zuo et al., 2016). This illuminates the need for further investigation into exposure type, which is reported in just 40% of articles (n=2) on sedentary behavior (Comte et al., 2015; Zuo et al., 2016). Similarly to moderate to vigorous physical activity, research suggests that sedentary time in physical education class is associated with daily sedentary time. Thus, while physical education is a significant contributor to reducing sedentary behavior, these findings should be interpreted with caution, with one study revealing that as little as one minute spent sedentary in physical education class ensued a 5.3-minute increase in daily sedentary behavior (Chen et al., 2014). This finding suggests that if pupils spend more time sedentary in physical education class, this may impact daily sedentary behavior and warrants further research to examine this relationship further. In addition, this finding highlights to teaching personnel to not only stress the promotion of moderate to vigorous physical activity during physical education class but to simultaneously limit sedentary time as even the smallest proportions could have a significant impact on adolescent's daily sedentary patterns. The current review confirmed that adolescents who participate in physical education are more likely to reduce daily sedentary behavior compared to their non-participating counterparts (Fromel et al., 2016). This supports existing evidence that suggests attendance in as little as one physical education class weekly is associated with lower frequency of sedentary behavior, indicating that even small proportions of physical education can impact daily sedentary time in adolescents (De Jesus et al., 2022). It is well documented that physical activity habits in youth track into adulthood, thus, strategies to decrease sedentary time during physical education class and increase moderate to vigorous physical activity may prove pertinent to enhancing overall physical activity behavior that track into adulthood. It must be noted that the present review found non-significant differences for sedentary bouts/hour and total time in sedentary bouts on physical education days versus weekend days (Mayorga-Vega et al., 2018). This is inconsistent with a study that found young people to be less sedentary on physical education days versus weekend days (Stone et al., 2009). These divergent findings may be due to the use of a cross sectional study design with a small sample size of just one school, which limits the study's power. Future research may consider a longitudinal study design with a larger, representative sample to allow for more generalizability of the results.

Although similar trends for sedentary behavior exist for both boys and girls in this study, the contribution of physical education policy on sedentary behavior seemed to have greater impact on girls with one article reporting as much as a 5.5 minute/day/semester decline in sedentary time in comparison to their male counterparts across a three-year period (Zuo et al., 2016). Contrastingly, the European Youth Heart Cohort Study found there to be no significant differences between male and female trajectories for sedentary behavior (Ortega et al., 2013). This discrepancy may be as a result of regional differences (i.e., European countries versus Canada) or differences in follow-up periods (Ortega et al., 2013) and calls to attention the need for gender specific study designs in this research area.

Strengths and Limitations

A key strength of this systematic literature review is that it is the first to examine the impact of typical school provision of physical education, physical activity and sports on adolescent physical activity behaviors. In addition, a comprehensive search strategy enabled an extensive review of the literature that included all study designs except systematic literature reviews and meta-analysis. The use of multiple researchers throughout each phase allowed for a thorough examination of the literature and minimized bias. The concurrent examination of physical activity, physical activity guidelines and sedentary behavior, which often receives less focus enabled a comprehensive investigation of the most up to date research. Lastly, the inclusion of objective/device-based measures of physical activity strengthened the reviews methodological quality while the use of a suitably recognized quality assessment tool enhanced the overall integrity and rigor of this systematic literature review.

However, there were some limitations. Heterogeneity associated with the article's methodological designs, analysis protocols and reported outcomes, presented challenges in synthesizing the data in a coherent, logical fashion. The bulk of the evidence employed cross-sectional study designs and a large proportion of the evidence was conducted in high income countries (Hamadeh et al., 2022). Most of the evidence was deemed 'fair' quality indicating the need for studies with higher methodological study designs. The nature of the exposure type was rarely reported. Grey literature were excluded. Although recent literature advocate for a whole school approach to promoting physical activity behavior (ISPAH, 2020), few studies investigated the additive impact of physical education and another exposure, such as school physical activity and sports. Lastly, in terms of data analysis, some articles had a higher frequency of reported effects than others which was not accounted for in this review.

Conclusion

Identifying strategies that increase adolescent physical activity for health is a public health priority. Therefore, this systematic literature review synthesized the evidence base on typical school provision of physical education, physical activity and sports as a strategy to impact adolescent physical activity behaviors. The present review found the relationship between typical school provision of physical education, physical activity and sports on adolescent physical activity behaviors to be multifaceted. In the context of typical school provision of physical education, this study illuminated that the provision of regular physical education class, extension of minutes dedicated to physical education (>90 minutes), maximizing opportunities for moderate to vigorous physical activity and minimizing opportunities for sedentary behavior should be considered when strategizing to impact adolescent physical activity behaviors. Typical school provision of physical activity and sports were considered to have a positive impact on adolescent physical activity behaviors via active transport, extension of recess time (>60 minutes) which in turn impacted the opportunities for active recess paralleled with the participation in school sports via provision of a wide variety of school sports. While typical school provision of physical education, physical activity and sports had the greatest impact on meeting adolescent physical activity guidelines, future research should consider examining the additive impact of all three exposures as the included studies currently underpin individual components of provision only.

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Contributions

PR conceived of the study, participated in its design and coordination, performed the analysis and drafted the manuscript; BOK conceived of the study, participated in its design and coordination and interpretation of the data; LW participated in the design and interpretation of the data; MS participated in the design and interpretation of the data; JW participated in the design and interpretation of the data and performed the analysis; LGG participated in the design and interpretation of the data; WOB participated in the design and interpretation of the data; TC participated in the design and interpretation of the data; IS conceived of the study, participated in its design and coordination, performed the analysis and drafted the manuscript; PMM conceived of the study and participated in its design and coordination; CMD conceived of the study, participated in its design and coordination, performed the analysis and drafted the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

The authors report no conflict of interest.

Preregistration

A structured protocol for this systematic literature review was registered on the International Prospective register of Systematic Reviews (ID number CRD42021200767).

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Search Strategy

S1 (School)

School* OR “junior high” OR “secondary education” OR “secondary college” OR “secondary school” OR “second level school” (TI)

OR

School* OR “junior high” OR “secondary education” OR “secondary college” OR “secondary school” OR “second level school” (AB)

S2 (Level of Provision)

“Natural experiment” OR Impact* OR Effect OR Influence OR Outcome OR Contribution OR Provision OR Polic* OR Association* OR Environment (TI)

OR

“Natural experiment” OR Impact* OR Effect OR Influence OR Outcome OR Contribution OR Provision OR Polic* OR Association* OR Environment (AB)

S3 (Physical Education, Physical Activity, Sport)

“physical education” OR pe OR “adapted physical education” OR “movement education” OR “quality physical education” OR “health-related physical education” OR “active play” OR “active recreation” OR “active transport” OR “active commuting” OR “after school exercise” OR “school recess” OR lunchtime OR walk* OR “youth sport*” OR “extra-curricular physical activit*” OR “extra-curricular sport*” OR “after-school physical activit*” OR “school physical activit* OR “school sport*” OR “after school sport*” (TI)

OR

“physical education” OR pe OR “adapted physical education” OR “movement education” OR “quality physical education” OR “health-related physical education” OR “active play” OR “active recreation” OR “active transport” OR “active commuting” OR “after school exercise” OR “school recess” OR lunchtime OR walk* OR “youth sport*” OR “extra-curricular physical activit*” OR “extra-curricular sport*” OR “after-school physical activit*” OR “school physical activit* OR “school sport*” OR “after school sport*” (AB)

S4 (Population)

adolescen* OR teenagers OR young OR youth OR teens OR student OR

child* (TI)OR

adolescen* OR teenagers OR young OR youth OR teens OR student OR child* (AB)

S5 (Outcome Variables: PA Behaviours)

Exercise or **“light intensity activity”** OR “low intensity activit*” OR “light intensity physical activity” OR “light intensity lifestyle” OR Light physical activity OR “activities of daily living” OR “domestic physical activity” OR housework activity OR Household physical activity OR “non- exercise activity thermogenesis” OR “incidental physical activity” OR “Lifestyle Activity” OR “lifestyle physical activity” OR **“moderate intensity physical activity”** OR “moderate intensity PA” OR “moderate intensity exercise” OR **“Moderate to vigorous physical activity”** OR MVPA OR “moderate-to-vigorous-physical activity” OR **“Physical Activity Guidelines”** OR “PA Guidelines” OR “Physical Activity Recommendations” OR “Physical Activity Level*” OR “Total **Physical Activity”** OR “Active games” OR “Active play” OR “Active recreation” OR “Aerobic activit*” OR “Cardiovascular activit*” OR “Free Play” OR “unstructured play” OR “spontaneousplay” OR “High intensity activit*” OR “Moderate to Vigorous Activit*” OR “Outdoor Play” ORPhysical activit* OR “Recess Activity” OR “Break time Activity” OR “Recreational activit*” OR “Screen time” OR “Screen Viewing” OR Sedentary OR “Sedentary lifestyle” OR “Television Viewing” OR “Television Watching” OR Video gam* OR Vigorous Activit* OR Walk* OR Play*OR “Youth sports” OR “extra-curricular physical activities” OR “after school physical activit*” OR “school physical activit*” OR leisure time physical activit* OR “transport physical activit*” OR “active transport” OR “active commuting” OR **“Physical inactivity”** OR “physically inactive”OR inactivity OR “Computer time” OR “Computer use” OR Sitting OR Sedentarism OR “sedentary person” OR **“sedentary behaviour*”** OR Sport (TI)

OR

Exercise or **“light intensity activity”** OR “low intensity activit*” OR “light intensity physical activity” OR “light intensity lifestyle” OR Light physical activity OR “activities of daily living” OR “domestic physical activity” OR housework activity OR Household physical activity OR “non- exercise activity thermogenesis” OR “incidental physical activity” OR “Lifestyle Activity” OR “lifestyle physical activity” OR **“moderate intensity physical activity”** OR “moderate intensity PA” OR “moderate intensity exercise” OR **“Moderate to vigorous physical activity”** OR MVPA OR “moderate-to-vigorous-physical activity” OR **“Physical Activity Guidelines”** OR “PA Guidelines” OR “Physical Activity Recommendations” OR “Physical Activity Level*” OR “Total **Physical Activity”** OR “Active games” OR “Active play” OR “Active recreation” OR “Aerobic activit*” OR “Cardiovascular activit*” OR “Free Play” OR “unstructured play” OR “spontaneousplay” OR “High intensity activit*” OR “Moderate to Vigorous Activit*” OR “Outdoor Play” OR