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Review

State laws governing school physical education in relation to attendance and physical activity among students in the USA: A systematic review and meta-analysis

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Abstract

Background: This study systematically synthesized and quantified the relationship linking state laws governing school physical education (PE) to PE attendance and physical activity (PA) in class and throughout the day and week among students in the USA.

Methods: A keyword search was performed in PubMed, Web of Science, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Academic Search Complete, and EconLit. Meta-analyses were performed to estimate the effects of state PE laws.

Results: A total of 17 studies were included in the review, and five contributed to the meta-analyses. A total of 8 studies used nationally representative school- or student-level data, three focused on multiple states, and the remaining six examined the PE laws of a single state. The presence and strength of state PE laws were positively associated with PE attendance and the frequency and duration of PA during PE classes and throughout the school day. Compared to those residing in states with weak or no PE laws, students in states with strong PE laws had an additional 0.2 days (95% confidence interval (95%CI): 0.1–0.4) of PE attendance per week and spent an additional 33.9 min (95%CI: 22.7–45.0) participating PE classes per week. State PE laws affected girls' PA more than boys'. Different aspects of state PE laws tended to affect students' PE attendance differently. Disparities in the implementation of state PE laws existed across schools.

Conclusion: Future studies should adopt objective measures on PE and PA participation and examine the roles schools and districts play in mediating the effect of state PE laws on students' PE attendance and PA.

Keywords: Meta-analysis; Physical activity; Physical education; Review; State law

1. Introduction

Physical activity (PA) among children and adolescents consistently links to lower risks for childhood obesity[1] and mental illnesses[2] and to higher academic performance.[3] In 2016, more than three-quarters (76%) of children and adolescents in the USA did not meet the guidelines-recommended daily PA level (i.e., at least 60 min of PA every day of the week).[4] In the meantime, nearly half (47%) of children and adolescents exceed 2 h per day of sedentary behavior.[5]

School is a central environment that the vast majority of children and adolescents interact with daily.[6] Schools can use a variety of evidence-based practices to promote PA before, during, and after school, such as improving physical education (PE); providing classroom PA breaks; offering programs, space, or equipment for PA; and building behavioral skills related to PA participation.[7] PE policies are essential for optimal PE implementation. Strategies that schools can use to promote PA during PE classes include employing a well-designed curriculum, changing instructional practices to incorporate more time for moderate-to-vigorous physical activity (MVPA), and providing teachers with appropriate training.[8,9] However, state laws mandating PE participation show a sharp decline when school grade level is considered—only 15%, 9%, and 6% of students in elementary, middle, and high schools, respectively, are required to take PE classes on 3 or

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more days a week during the entire academic year.[4] Surveillance data indicate that children in all grades, on average, may spend less than half (45%) of their PE time engaging in MVPA.[10]

State policy plays an essential role in promoting PA among school students.[11] By mandating PE and recess through legislation, students may have increased opportunities to engage in regular PA at school.[11] Currently, about three-quarters of US states have adopted basic requirements (e.g., PE curriculum, proficiency, frequency, duration, intensity, and the total amount of PA) for school PE classes.[12] Nevertheless, the 2016 Shape of the Nation report identified substantial disparities in state PE requirements and implementation approaches.[13] For instance, many states require PE teachers to meet professional credential requirements, but few require a minimum PE class time.[13] Moreover, state regulations may not be followed thoroughly, and implementation gaps are present and vary by school and district.[13]

This study aimed to synthesize and quantify systematically the relationship linking state PE laws to PE attendance, PA during PE classes, and PA throughout the day and week among students in the USA. It contributes to the literature in 3 ways. First, it is the first review that identifies and summarizes comprehensively the scientific evidence linking state PE laws to student outcomes related to PE and PA. Second, it goes beyond a narrative review by providing quantitative estimates of the magnitude of policy efficacy. Third, it identifies research gaps and limitations in the current literature that warrant future investigation. Study findings can be informative for state policy makers and school or district administrators in designing or revising PE-related legislation and implementation strategies to improve PE attendance and promote PA engagement among students.

2. Methods

2.1. Eligibility criteria

Studies that met the following criteria were eligible for the review: (1) study designs—experimental or quasi-experimental, longitudinal, cross-sectional, or modeling studies, (2) study subjects—children and adolescents enrolled in elementary and secondary schools, (3) exposure—state legislation, laws, regulations, and requirements governing PE and PA in schools, (4) outcomes—PE attendance and PA, (5) settings—schools or school districts in the USA, (6) article type—peer-reviewed original studies, (7) time window for publication—from the inception of the electronic bibliographic databases searched through March 8, 2020, and (8) language—studies written in English.

Exclusion criteria for the studies included the following: (1) studies that did not incorporate, as part of their outcomes, PE attendance and PA among school children and adolescents, (2) studies that did not investigate the impact of state legislation, laws, regulations, and requirements on PE attendance and PA at the county, city, school district, or school level, (3) non-USA-based studies, (4) studies that took the form of letters, editorials, study protocols, conference proceedings, books, or reviews, and (5) studies not written in English.

2.2. Search strategy

A keyword search was performed in 5 electronic bibliographic databases: PubMed, Web of Science, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Academic Search Complete, and EconLit. The search algorithm included keywords from the following 5 groups: (1) “state”; (2) “law”, “laws”, “policy”, “policies”, “requirement”, “requirements”, “legislation”, “legislations”, “bill”, “bills”, “regulation”, “regulations”, “guideline”, “guidelines”, “guide”, “rule”, “rules”, “statute”, “statutes”, “decree”, “decrees”, “standard”, “standards”, “order”, “orders”, “mandate”, or “mandates”; (3) “school” or “schools”; (4) “physical education” or “PE”; and (5) “physical activity”, “physical activities”, “exercise”, “exercises”, “sport”, “sports”, “attendance”, “attending”, “nonattendance”, “non-attendance”, “presence”, “present”, “absence”, “absent”, “absenteeism”, or “sick leave”. The 5 Medical Subject Headings (MeSH) terms “schools”, “physical education and training”, “exercise”, “sports”, and “sick leave” were included in the PubMed search. The database-specific search algorithms are provided in Supplementary Material 1. Along with the keyword search, a Google Scholar search was also conducted. Two of the coauthors (JL and RL) of the present review independently conducted the title and abstract screening against the eligibility criteria and identified potentially pertinent articles for a full-text review. Cohen κ was adopted for assessing inter-rater agreement ($\kappa = 0.91$). The 2 coauthors (JL and RL) resolved discrepancies via face-to-face discussion and jointly determined the final pool of articles included in the review.

A reference-list search and a cited reference search were conducted based on the full-text articles identified from the keyword search. Articles identified from the reference search were further screened using the same eligibility criteria.

2.3. Data extraction

A standardized form was constructed to collect methodological and outcome variables from each selected article, including authors, publication year, sample size, students’ grades, analytic approach, survey response rate, PE- and PA-related measures, and key results and findings.

2.4. Meta-analysis

The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[14]

Meta-analyses were performed to estimate the pooled effect size of state laws governing school PE among elementary and secondary school students in the USA. The 2 outcomes were days of PE attendance and time spent taking PE classes in a week. The reason we did not cover any other outcomes, such as PA duration in PE classes or throughout the day and week, was that no 2 (or more) studies included in the review reported the same quantitative outcomes, which precluded

meta-analysis. A total of 5 studies were included in the meta-analyses,[15–19] whereas the remaining 12 articles were excluded due to 3 reasons: (1) no studies reported the same outcome,[20–24] (2) neither standard error nor confidence interval (CI) of the estimated effect was reported,[25–27] or (3) no effect estimate was provided.[28–31] Study heterogeneity was evaluated by the I^2 index.[32] The level of heterogeneity represented by I^2 index was interpreted as modest ($I^2 \leq 25\%$), moderate ($25\% < I^2 \leq 50\%$), substantial ($50\% < I^2 \leq 75\%$), or considerable ($I^2 > 75\%$). A fixed-effect model was estimated when modest or moderate heterogeneity was present, and a random-effect model was estimated when substantial or considerable heterogeneity was present. Begg and Egger tests were conducted to assess publication bias. All statistical analyses were conducted using Stata 16.1 SE (Special Edition) version (Stata, College Station, TX, USA). All analyses used two-sided tests, and $p < 0.05$ was considered statistically significant.

2.5. Study quality assessment

Following Littell et al.,[33] a study-quality assessment tool rated each study based on the following 10 criteria: (1) Was the research question clearly stated? (2) Was the analytic approach documented in detail? (3) Did the data used in the analysis come from a validated, credible source? (4) Were the data used representative of the state or national student population? (5) Were potential confounders adequately adjusted for in the analysis? (6) Were outcomes assessed both before and after the changes in state PE laws? (7) Were different aspects of the state PE laws assessed separately? (8) Was a control group included? (9) Was a sample size justification provided? (10) Were the conclusions appropriately drawn from the study findings? For each assessment criterion, a score of 1 was given if "yes" was the response, whereas 0 was given otherwise. A study-specific overall score ranging from 0 to 10 was calculated by summing up scores across all criteria. The study quality assessment measured the strength of scientific evidence but was not used to determine the inclusion of studies.

3. Results

3.1. Study selection

Fig. 1 illustrates the study selection flow diagram. We identified a total of 630 articles through the keyword, hand, and reference search, including 183 articles from PubMed, 197 articles from Web of Science, 88 articles from CINAHL, 155 articles from Academic Search Complete, 4 articles from EconLit, 1 article from Google Scholar, and 2 articles from the reference search. After removing duplicates, 453 articles underwent title and abstract screening, in which 424 articles were excluded. The full texts of the remaining 29 articles were reviewed against the study's selection criteria. Of these, 12 articles were excluded: 10 articles did not assess the policy influence on PE attendance and PA,[34–43] and 2 studies focused on school or district PE policies rather than state PE laws.[44,45] The remaining 17 studies that examined the influence of state laws on PE attendance and PA among students in the USA were included in the review.[15–31]

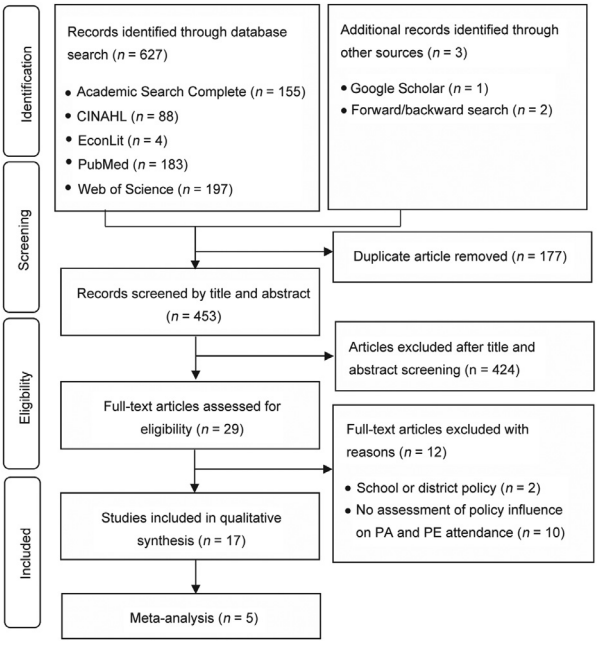

Fig. 1. Study-selection flow diagram (PRISMA). CINAHL = Cumulative Index to Nursing and Allied Health Literature; PA = physical activity; PE = physical education; PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

3.2. Characteristics of the included studies

Table 1 reports the basic characteristics of the studies included in the review. All 17 studies were conducted in or after 2007,[15–31] and 11 were published in or after 2012.[15,17–19,21–24,27,30,31] A total of 8 studies used nationally representative school- or student-level data,[15–18,20,21,23,24] 3 studies focused on multiple states,[19,22,27] and the remaining 6 studies examined the PE laws of a single state (i.e., Alabama, California, North Carolina, Texas (covered by 2 studies), or Wyoming).[25,26,28–31] A total of 8 studies analyzed and reported student-level outcomes,[15–17,19–21,23,31] whereas the remaining 9 studies reported outcomes at the school or school district level.[18,22,24–30] Among the studies reporting student-level outcomes,[15–17,19–21,23,31] the mean and median number of students was 105,065 and 36,833, respectively. Among the studies reporting school-level outcomes,[18,22,24–30] the mean and median number of schools was 449 and 169, respectively. Of the 17 studies, four focused exclusively on elementary school students (Grades 1–5),[22,23,29,31] seven focused exclusively on middle or high school students (Grades 6–12),[15–17,19–21,26] and the remaining six included both elementary and middle or high school students.[18,24,25,27,28,30] A total of 7 studies used data from repeated cross-sectional surveys or interviews of school children or staff,[15–17,20,21,25,29] five employed a 1-time cross-sectional survey,[24,26–28,31] four utilized longitudinal surveys or administration data at either the student or school level,[18,19,22,30] and the remaining study

Table 1
Basic characteristics of the studies included in the review.

Study	State	Sample size	Grade	Data source	Datasets and years/ waves	Analytic approach	Response rate (%)	PE-class measures	PA-related measures
Benham-Deal et al. (2007)[25]	Wyoming	165 schools	ES, MS, and HS	Repeated cross-sectional survey	Self-collected	Descriptive statistics	43	Frequency and duration of PE class	—
Cawley et al. (2007)[20]	50 states and DC	36,884 students	9th−12th grades	Repeated cross-sectional survey	Youth Risk Behavior Surveillance System 1999, 2001, and 2003	Regression (instrumental variable)	67	Duration of PE class	Frequency of VPA, LPA, and strength-building activity
Cawley et al. (2007)[16]	50 states and DC	36,833 students	9th−12th grades	Repeated cross-sectional survey	Youth Risk Behavior Surveillance System 1999, 2001, and 2003	Regression	84	Duration of PE time	Frequency of VPA, LPA, and strength-building activity
Barroso et al. (2009)[26]	Texas	112 schools	6th−8th grades	Cross-sectional survey	School Physical Activity and Nutrition Questionnaire 2006−2007 and 2007−2008	Descriptive statistics	85	Frequency and quality of structured PA in PE classes	—
Evenson et al. (2009)[28]	North Carolina	106 school districts	ES and MS	Cross-sectional survey	Self-collected	Descriptive statistics	96	Frequency and duration of PE class	Recess and classroom Energizers
Kelder et al. (2009)[29]	Texas	169 schools	4th grade	Repeated cross-sectional survey	Self-collected	Descriptive statistics	79	Duration of PE class	—
Kim et al. (2012)[21]	50 states and DC	Cycle 1: 25,251 students Cycle 2: 23,728 students	MS and HS	Repeated cross-sectional survey	National Survey of Children's Health 2003 and 2007	Regression	68	—	Frequency of VPA
Perna et al. (2012)[18]	50 states and DC	410 schools	ES, MS, and HS	Longitudinal school-level data	School Health Policies and Programs Survey 2006	Regression	62	Duration of PE class	—
Slater et al. (2012)[22]	47 states	1761 schools	K−5th grade	Longitudinal school-level data	Self-collected	Regression	62	Duration of PE class	Recess
Chriqui et al. (2013)[27]	42 states	195 public school districts	ES and MS	Cross-sectional survey	Self-collected	Regression	44	Frequency and duration of PE class and percent time spent in MVPA during PE time	—
Lafleur et al. (2013)[30]	California	34 schools	ES, MS, and HS	Longitudinal school-level data	Self-collected	Descriptive statistics	94	Duration of PE class	—
Taber et al. (2013)[19]	40 states	5510 students	8th grade	Longitudinal student survey	Early Childhood Longitudinal Study-Kindergarten Class 2007	Regression	59	PE attendance	Frequency of PA
Robinson et al. (2014)[31]	Alabama	683 students	5th grade	Cross-sectional survey	Self-collected	Descriptive statistics	92	Duration of PE class	School-day PA

(*continued on next page*)

Table 1 (Continued)

Study	State	Sample size	Grade	Data source	Datasets and years/ waves	Analytic approach	Response rate (%)	PE-class measures	PA-related measures
Barrett et al. (2015)[23]	50 states and DC	Simulated USA student population	ES	Computer simulated data	Self-collected	Microsimulation	Not applicable	MVPA during PE	School-day MVPA
An et al. (2019)[15]	50 states and DC	533,468 students	HS	Repeated cross-sectional survey	Youth Risk Behavior Surveillance System 2003−2017	Regression	87	PE attendance	—
Lin et al. (2020)[17]	50 states and DC	97,590 students	9th−11th grade	Repeated cross-sectional survey	Youth Risk Behavior Surveillance System for 2005−2017	Regression	98	PE attendance	PA
Piekarz-Porter et al. (2021)[24]	50 states and DC	1090 schools	ES, MS, and HS	Cross-sectional survey	School Nutrition and Meal Cost Study Principal Survey 2014−2015	Regression	87	Duration of PE class	—

Abbreviations: DC = district of Columbia; ES = elementary school; HS = high school; K= kindergarten; LPA = light physical activity; MS = middle school; MVPA = moderate-to-vigorous physical activity; PA = physical activity; PE = physical education; VPA = vigorous physical activity.

used computer-simulated student-level data.[23] A total of 6 studies reported descriptive statistics and conducted statistical testing between schools subjected or not subjected to state PE laws or between the 2 periods before and after state PE laws took place,[25,26,28−31] 10 studies performed multiple regressions to estimate the independent effect of state PE laws, adjusting for potential confounders,[15−22,24,27] and the remaining study built a computer microsimulation model to project the influence of state PE laws.[23] Among the 16 studies that reported a survey/interview response rate,[15−22,24−31] the mean and median percentage was 75% and 82%, respectively. A variety of PE- and PA-related measures were assessed in the included studies—PE attendance,[15,17,19] frequency and duration of PE class,[25,27] frequency of PA,[16,20,26,28] vigorous PA,[16,20,26,28] light PA,[20] strength-building activity,[20] quality of structured PA,[26] and percentage of time spent in MVPA during PE.[26] PA-related measures were based on self-report and/or administrative data. State PE laws were not uniformly evaluated across the studies included in the review. Among the studies that assessed state PE laws nationwide, a quantitative scoring system based on legal documents was commonly applied to classify state PE laws into various categories, such as absent, weak, or strong PE laws.[15−18,20−24]

3.3. Main findings of the included studies

Table 2 reports the estimated effects and main findings of state laws governing PE.

First, the presence and strength of state PE laws were positively associated with PE attendance among middle and high school students. In comparison to no or weak state PE laws, strong state PE laws were found to be associated with a reduction in the risk of being absent from PE class by 19.3%.[17] In comparison to an absence of such requirements, state requirements on PE unit and curriculum were found to be positively correlated with students' participation in PE classes.[16]

Second, the presence and strength of state PE laws were positively associated with the frequency and duration of PA during PE classes and throughout the school day among elementary, middle, and high school students.[16,18,20,22,24−27,29,30] In comparison to no or weak state PE laws, high-school students under strong PE laws reported an additional 31 min per week of PA during PE classes.[20] In elementary and middle schools, strong state PE laws were found to be associated with an additional 0.63 days and 0.73 days of PE per week, respectively.[27] In comparison to no or weak state PE laws, strong state PE laws were estimated to increase MVPA duration per PE class by 1.87 min.[23]

Third, girls' PE attendance and PA were more likely to be positively influenced by state PE laws than boys' attendance among middle and high school students. In comparison to no or weak state PE laws, strong state PE laws were found to be associated with an increased number of days per week that girls reported having exercised vigorously or having engaged in strength-building activities, but such an association was not present in boys.[20] Girls, but not boys, were found to be more

Table 2
Estimated effects and main findings of state laws governing PE.

Study	Key results	Main findings
Benham-Deal et al. (2007)[25]	Since the adoption of state PE regulations, the overall duration of elementary PE per week remained largely unchanged, and frequency and number of class sessions declined while the duration of each session increased.	Elementary children failed to meet recommended amounts of weekly PE, but as grade level increased students came closer to meeting the recommended levels.
Cawley et al. (2007)[20]	High school students with a binding PE requirement reported an average of additional 31 min per week spent physically active in PE class. Additional PE time increased the number of days per week that girls reported having exercised vigorously or having engaged in strength-building activities.	Increasing PE credit requirements may make girls more physically active overall.
Cawley et al. (2007)[16]	Two policies are positively correlated with participation in PE class for both boys and girls—a binding PE unit requirement and a state PE curriculum.	A binding PE unit requirement and a state PE curriculum were positively correlated with student participation in PE class.
Barroso et al. (2009)[26]	In 2005, the Texas state legislature passed Senate Bill 42 (SB42), which required public middle-school students (Grades 6−8) to participate in 30 min of daily structured PA. Post-implementation of SB42 reported a minimum of 4 days per week of PE instruction and more than 58 min per PE class, exceeding the 30-min minimum of structured PA per day or 135 min per week as required. An increase in the number of days of PE class was observed between 2004−2005 and 2006−2008, with the 8th grade students reporting an average of 2.0 days and 3.7 days of PE per week, respectively ($p < 0.001$).	Implementation of SB42 positively affected the frequency of school PE in Texas and the prevalence of child self-reported PA.
Evenson et al. (2009)[28]	Positive policy effects on PA participation in elementary and middle schools were observed.	School districts reported that implementation of the policy produced positive PA results for students and staff.
Kelder et al. (2009)[29]	In 2001, the Texas state legislature passed Senate Bill 19 (SB19), requiring public elementary school children (K-6) to participate in 30 min of daily PA or 135 min per week. Following implementation, school principals reported an average of 179 min of PE per week, higher than the 135-min mandate.	SB19 is not being adhered to equally across Texas, and some regions may require further support to increase implementation.
Kim et al. (2012)[21]	In Cycle 1, overall, a 10% increase in the percentage of schools requiring PE was associated with a 28% increase in the number of days having VPA per week. In Cycle 2, the association was statistically nonsignificant. However, significant variation in the association by gender in Cycle 2 suggests an influence of schools' PE requirement on girls' PA only.	Gaps exist between state PE-related policies and implementation in schools. However, schools' PE requirement seems to improve children's PA, with some gender differences.
Perna et al. (2012)[18]	Schools in states with specific PE requirements averaged over 27 and 60 more min of PE per week at the elementary and middle school levels, respectively, compared to schools in states without such requirements. The difference was nonsignificant for high schools.	Strong codified laws with specific time requirements for PE may be an important tool contributing to adequate PE time and daily PA recommendations.
Slater et al. (2012)[22]	The odds of schools' having 150 min of PE per week increased if they were located in states (OR = 2.8, 95%CI: 1.3−5.7) or school districts (OR = 2.4, 95%CI: 1.3−4.3) having PE requirements.	By mandating PE, policy makers can effectively increase school-based PA for youth.
Chriqui et al. (2013)[27]	At elementary schools, state laws were associated with 0.63 more days of PE, and districts in states with PE time laws reported 18 more min of PE per week. At middle schools, state laws were associated with 0.73 more days of PE per week.	State PE laws have the potential to increase PE time at the elementary and middle schools.
Lafleur et al. (2013)[30]	PE class duration increased in high-income elementary schools following the implementation of state PE laws.	State PE laws may have contributed to some modest improvements of PE in some schools.
Taber et al. (2013)[19]	Girls were more likely than boys to attend PE ≥ 3 days/week (74.1% *vs.* 52.1%, respectively) if they resided in states with strong PE laws compared to no PE laws. Girls reported 0.31 more days of activity if they resided in states with strong PE laws compared to no PE laws.	Strong PE laws with specific time requirements may increase PE attendance and PA in girls.
Robinson et al. (2014)[31]	All schools reflected the state PE requirements (i.e., 30 min of daily PE) in their written school policies and had a certified PE teacher or staff. All students had daily PE taught by a certified PE teacher for a minimum of 30 min, 5 days per week. However, during the course of the study, PE was often cancelled or shortened because of teachers' taking the students to the gym late and/or picking up the students early.	State PE requirements may not be fully implemented by schools, and there are variations in implementation across schools.
Barrett et al. (2015)[23]	State "active PE" policy would increase MVPA duration per 30-min PE class by 1.87 min, representing a 16% increase over existing MVPA levels during PE.	State "active PE" policy at the elementary school level could have a small influence on PA levels.

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Table 2 (Continued)

Study	Key results	Main findings
An et al. (2019)[15]	A 1-score increase in state laws governing PE class time, staffing for PE, joint-use agreement for PA, assessment of health-related fitness, and PE curriculum was associated with an increase in weekly PE attendance by 0.30 days, 0.28 days, 0.22 days, 0.20 days, and 0.13 days ($p < 0.001$), respectively. In contrast, a 1-score increase in state laws governing MVPA time in PE, PE proficiency, and recess time was associated with a reduction in weekly PE attendance by 0.25 days, 0.15 days, and 0.09 days ($p < 0.001$), respectively. The effects of most state PE policies on PE class attendance were larger among girls than boys.	State PE policies differentially affected high school students' PE class attendance, with larger effects on female students.
Lin et al. (2020)[17]	State PE laws were associated with 19.3% lower probability of not attending PE class. State PE laws were associated with 3.1% lower probability of no days of PA ≥ 60 min, 3.7% lower probability of no days of moderate exercise ≥ 30 mins, and 4.2% lower probability of no days of vigorous exercise ≥ 20 min. The laws were associated with a 2.4% higher probability of daily moderate exercise ≥ 30 min in male students and a 3.4% higher probability in female students ($p < 0.01$).	PE state requirements can increase PE attendance. PE state requirements can enhance adolescents' ability to meet recommended amounts of daily PA.
Piekarz-Porter et al. (2021)[24]	Schools located in states that required at least 90 min of PE per week at the elementary or 150 min of PE per week at the middle or high school levels had almost 7 times higher odds of requiring structured PE. Schools located in states that required daily participation of PE had almost 5 times higher odds of at least some students' taking PE daily.	State laws with longer PE time required were associated with higher odds of schools in those states providing structured PE classes on a daily basis.

Abbreviations: 95%CI = 95% confidence interval; K = kindergarten; MVPA = moderate-to-vigorous physical activity; OR = odds ratio; PA = physical activity; PE = physical education; VPA = vigorous physical activity.

likely to attend PE ≥ 3 days/week if they resided in states with strong PE laws compared to weak or no PE laws (74.1% *vs.* 52.1%, respectively).[19] Girls reported 0.31 more days of PA if they resided in states with strong PE laws compared to weak or no PE laws.[19] In comparison to no or weak state PE laws, strong state PE laws were found to be associated with a 2.4% higher probability of daily moderate PA ≥ 30 min among male students but a 3.4% higher probability among female students ($p < 0.01$).[17]

Fourth, differing aspects of state PE laws tended to influence students' PE attendance differently. In comparison to an absence of such laws, state laws governing PE class time, staffing for PE, joint-use agreement for PA, assessment of health-related fitness, and PE curriculum were associated with increased weekly PE attendance.[15] In contrast, state laws governing MVPA time in PE, PE proficiency, and recess time were associated with reduced PE attendance.[15]

Finally, disparities and gaps in the implementation of state PE laws were present among local schools and school districts. Although all schools reflected the state PE requirements in their written school policies and had a certified PE teacher or staff, PE classes were often canceled or shortened because teachers took the students to the gym late or picked them up early.[31]

3.4. Meta-analysis

Table 3 reports modeling results from the meta-analyses. Compared to students residing in states with weak or no PE laws, students residing in states with strong PE laws had an additional 0.2 days (95% confidence interval (95%CI): 0.1−0.4; I^2 index = 86%; random-effect) of PE attendance per week and spent an additional 33.9 min (95%CI: 22.7−45.0; I^2 index < 0.1%; fixed-effect) in participating PE classes per week. No publication bias was identified by Egger or Begg tests ($p > 0.05$).

3.5. Study quality assessment

Table 4 reports criterion-specific and overall ratings from the study quality assessment. The included studies, on average, scored 7.2 out of 10, with a range from 4 to 9. All 17 studies included in the review clearly stated the research question; documented the analytic approach in detail; analyzed data from

Table 3
Results from meta-analysis and publication bias tests.

Outcome	Outcome unit	Contrasts	Studies included in meta-analysis	Pooled effect size (95%CI)	I^2 index (%)	Model	Publication bias test	
							p Egger test	*p* Begg test
Weekly PE attendance	day/week	Strong state PE law *vs.* weak or no law	Taber et al. (2013)[19] An et al. (2019)[15] Lin et al. (2020)[17]	0.21 (0.07−0.35)	86.4	RE	0.28	0.60
PE duration per week	min/week	Strong state PE law *vs.* weak or no law	Cawley et al. (2007)[16] Perna et al. (2012)[18]	33.85 (22.66−45.03)	0.0	FE	0.99	0.32

Abbreviations: 95%CI = 95% confidence interval; FE = fixed-effect model; PE = physical education; RE = random-effect model.

Table 4
Study quality assessment.

Criteria	Benham-Deal et al. (2007)[25]	Cawley et al. (2007)[20]	Cawley et al. (2007)[16]	Barroso et al. (2009)[26]	Evenson et al. (2009)[28]	Kelder et al. (2009)[29]	Kim et al. (2012)[21]	Perna et al. (2012)[18]	Slater et al. (2012)[22]	Chriqui et al. (2013)[27]	Lafleur et al. (2013)[30]	Taber et al. (2013)[19]	Robinso et al. (2014)[31]	Barrett et al. (2015)[23]	An et al. (2019)[15]	Lin et al. (2020)[17]	Piekarz-Porter et al. (2021)[24]
Was the research question clearly stated?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Was the analytic approach documented in detail?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Did the data used in the analysis come from a validated, credible source?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Were the data used representative of the state or national student population?	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Were potential confounders adequately adjusted for in the analysis?	0	1	1	0	0	0	1	1	1	1	0	1	0	1	1	1	1
Were outcomes assessed both before and after the changes in state physical education laws?	1	1	1	0	0	1	1	1	1	0	1	1	0	1	1	1	0
Were different aspects of the state physical education laws assessed separately?	0	0	1	1	0	0	0	0	1	1	0	0	0	0	1	0	1
Was a control group included?	0	1	1	0	0	0	1	1	1	1	0	1	0	1	1	1	1
Was a sample size justification provided?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Were the conclusions appropriately drawn from the study findings?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total scores	5	8	9	6	5	6	8	8	9	8	6	8	4	8	9	8	8

Notes: 1 denotes yes; 0 denotes no.

a validated, credible source; and drew conclusions appropriately from the study findings. A total of 15 studies used data representative of the state or national student population.[15−24,26−30] A total of 12 studies assessed the PE- or PA-related outcomes both before and after the changes in state PE laws.[15−23,25,29,30] A total of 11 studies adjusted adequately for potential confounders in the statistical analysis or included a control group.[15−24,27] In contrast, only 6 studies assessed different aspects of the state PE laws (e.g., PE class time, staffing for PE, PE curriculum, MVPA time in PE, PE proficiency, and recess time).[15,16,22,24,26,27] No study provided a sample size justification.

4. Discussion

This study systematically reviewed scientific evidence regarding state laws governing school PE on PE attendance and PA among students in the USA. The presence and strength of state PE laws were positively associated with PE attendance and the frequency and duration of PA during PE classes and throughout the school day. Compared to boys' PA levels, girls' PA levels were more positively associated with state PE laws. Differing aspects of state PE laws might affect students' PE attendance differently. Disparities and gaps in the implementation of state PE laws existed across schools.

The 2018 Physical Activity Guidelines for Americans recommends at least 60 min of MVPA daily among children.[46] PE plays an essential role in children's daily accumulation of PA and is of particular importance for those who are obese or lack access to PA opportunities outside of school.[47] Based on our meta-analyses, students residing in states with strong PE laws had an additional 0.2 days of PE attendance per week and spent an additional 33.9 min in participating PE classes per week in comparison to their counterparts residing in states with weak or no PE laws. The findings indicate that in the absence of a state mandate, the length and quality of PE classes are substantially compromised. During the past 2 decades, more states issued school PE-related regulations or further strengthened their existing laws as a way to promote PA in the school setting and prevent childhood obesity.[48] Despite this legislative progress, the proportion of children aged 6−17 years who engaged in 60 min or more of PA daily decreased from 26.0% in 2003 to 24.2% in 2016.[4] The gender disparity was also prominent—28.0% of boys met the guidelines-recommended level of PA, whereas only 20.2% of girls did.[4] The reduction in PA coincided with the rise in childhood obesity—the proportion of children aged 2−19 years who had obesity increased from 14.6% in 2000 to 18.5% in 2016.[49] PE contributes to the overall PA, but it is usually not sufficient by itself to help meet the PA levels recommended by the guidelines. There are many other factors, both within and beyond schools, that influence children's PA. Therefore, although state PE laws could serve as part of the solution to promote PE participation, the regulations alone, even if fully implemented in all states, fall short of reversing the downward trend in PA among children in the USA and the rising obesity epidemic.[4,49]

The state PE laws are unlikely to reach their potential bcause of design problems and implementation barriers. Previous research has found that differing aspects of the state PE laws affected PE attendance differently, and certain parts of the laws could be counterproductive, reducing rather than increasing students' PE attendance.[15] For example, some state PE laws require students' proficiency in specific motor-skill development through mandating fitness tests.[15] Those tests could raise concerns and anxiety, reinforce peer pressure and a competitive atmosphere among students, and manifest students' negative feelings, such as frustration or fear.[50−52] As a result, some students might skip PE to avoid testing.

State PE laws are as effective as the local schools and school districts that implement them. Previous research has documented that schools lack the resources and administrative capacity to comply fully with state PE regulations.[53] A study using data from a nationally representative sample of USA public elementary schools found that higher student-to-PE-teacher ratios contributed to students' not receiving adequate instruction, and the median budget for PE equipment was a mere USD500, with 30% of schools having no budget at all.[54] A school's financial health and capacity-building profoundly determine the effectiveness of state PE regulations.[54]

For middle and high school students, state PE policies tended to be more closely associated with girls' weekly PE attendance and PA than boys' weekly PE attendance and PA. It is possible that girls are less likely to take PE as an elective course, so that mandating PE increases girls' PE time more substantially than boys'.[31,33]

Some states have policy waivers that may exempt children from PE attendance in school. For example, in California, exemptions from PE courses may be granted to students for 2 years at any time during Grades 10−12 if the student has satisfactorily met any five of the 6 standards of the physical performance test.[7] In Nevada, a student is allowed to be exempt from taking a PE course based on a physical or mental condition, when supported by a written statement from a physician; based on religious beliefs, when supported by a written statement from a parent/guardian; or based on intentions of enrolling in a course comparable to PE.[7] These policy waivers could compromise students' participation in PE and their PA levels at school.

Several limitations of this review and the included studies should be noted. Despite the relatively large sample size of the included studies, all adopted an observational study design. Without randomization of policy assignment, study findings indicate only associations and should not be used to infer causality. As an important caveat, all relationships identified in our review between state PE laws and students' PE attendance and PA were associations instead of being causal. Among the 17 studies, only 5 studies were included in the meta-analyses (1 meta-analysis was based on 2 studies and the other based on 3 studies).[15−19] These 5 studies were unlikely to be representative of the 17 studies included in the review. The small number of studies included in the meta-analysis confined the generalizability of the pooled effect estimates to the child population nationwide. PE- and PA-related outcomes were based

primarily on self-reports, which are subject to recall error and social desirability bias.[53,55] State PE laws affected students' PE attendance and PA throughout schools and school districts. Various factors at the school and district levels, such as teacher and staff qualification and availability, gym and equipment accessibility, financial capacity, and student and parental engagement, may mediate the influence of state PE laws.[55] Additionally, few studies examined the interactions and dynamic relationships between state PE regulations and school- or district-level determinants. Most studies assessing PE laws across states adopted a simplistic classification scheme—the absence or presence of laws and whether they were weak or strong. This classification scheme can be too coarse to capture the many nuances and various aspects of PE laws.

5. Conclusion

This study systematically reviewed the influence of state laws governing PE on PE attendance and PA among students in the USA. The presence and strength of state PE laws were positively associated with students' PE attendance and the frequency and duration of PA during PE classes and throughout the school day. Based on the available evidence, states should implement strong PE laws to increase PE attendance and promote PA engagement among school students. Future studies should adopt objective measures for PE and PA participation, differentiate distinct aspects of state PE regulations and their independent influences, and examine the roles that schools and school districts play in mediating the influence of state PE laws on students' PE attendance and PA.

Authors' contributions

RA designed the study and wrote the manuscript; JL and RL conducted the title and abstract screening and full-text review, constructed summary tables, and performed meta-analyses. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jshs.2020.09.004.

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