Preventive Medicine 121 (2019) 62–67

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Access to credentialed elementary physical education teachers in California and students' cardiorespiratory fitness

Hannah R. Thompson[a,*], Bhaani K. Singh[a], Ana Ibarra-Castro[a], Gail Woodward-Lopez[b], Kristine A. Madsen[c]

[a] UC Berkeley School of Public Health, 2115 Milvia Street, Third Floor, Berkeley, CA 94704, United States of America
[b] Nutrition Policy Institute, 2115 Milvia Street, Fourth Floor, Berkeley, CA 94704, United States of America
[c] UC Berkeley School of Public Health, 2121 Berkeley Way #5302, Berkeley, CA 94720, United States of America

ARTICLE INFO

Keywords:
Physical education
Elementary schools
Cardiorespiratory fitness
Health disparities

ABSTRACT

Physical education (PE) can improve student health. Schools with credentialed PE teachers receive more PE. However, many schools have reduced PE funding, resulting in fewer teachers and potentially poorer student health. We examined if PE teachers are equally available across school districts, and if availability is associated with higher student cardiorespiratory fitness. We contacted California districts educating students in grades K-6 (n = 894) to determine the number of credentialed elementary PE teachers per district in 2016–17. Public datasets provided demographics and student fitness. Generalized linear models examined associations between district-level demographic characteristics and PE teacher-to-student ratio. Linear regression assessed the relationship between PE teacher-to-student ratio and student fitness. Seventy-five percent of districts (n = 669) responded. On average, there were 0.6 PE teachers for every 500 students, including the half (51%) of districts without elementary PE teachers. Each additional100 students of all racial/ethnic backgrounds in the district was associated with a 0.1% (95% CI −0.2%, −0.1%) decrease in the ratio. Each 10% increase in African American and Latino students was associated with 29% (95% CI −47%, −5%) and 18% (95% CI −31%, −3%) decreases in the ratio, respectively. Each additional PE teacher per 500 students was associated with a 3% increase in aerobically fit students (95% CI 1%, 4%). Elementary PE teachers are lacking in California, particularly in districts with a high proportion of African American and Latino students, which may be contributing to health disparities. Creative action to fund PE should be explored to ensure all students benefit from quality PE.

1. Introduction

School physical education (PE) provides a valuable opportunity to increase students' health-enhancing physical activity levels (Racette et al., 2015; Mooses et al., 2017), increase cardiovascular fitness (Calahorro-Canada et al., 2017), and improve scholastic achievement (Rasberry et al., 2011). As of 2016, due to PE's demonstrated positive impact on youth health, 86% of U.S. states require elementary schools to provide PE, and nearly 40% of states mandate a minimum number of PE minutes students should receive (Shape America and the American Heart Association, 2016). However, without funding or resources, schools, particularly at the elementary level, are often non-compliant with state PE laws; thus, students do not receive adequate PE (Thompson et al., 2013).

In California, the state with the largest number of public school students in the U.S., half of elementary school districts do not comply with the state elementary PE law mandating students in grades 1–6 get the equivalent of 20 min of PE/day (Sanchez-Vaznaugh et al., 2012; California Department of Education, 2018a). Further, non-compliant districts have a higher proportion of Latino and African-American students and a higher proportion of students who qualify for free or reduced-price meals (a proxy for socio-economic status) (Sanchez-Vaznaugh et al., 2012). Students in non-compliant districts are also less likely to meet physical fitness standards (Sanchez-Vaznaugh et al., 2012). This likely contributes to racial/ethnic- and income-related health disparities, which need to be addressed (Samuels et al., 2011).

Teachers and administrators describe the lack of credentialed elementary PE teachers as the primary barrier to complying with PE laws in California (Thompson et al., 2015, 2018). With limited funding for credentialed PE teachers, and lower priority for PE than for traditional academic subjects, the job of teaching PE often falls to classroom

* Corresponding author.
E-mail addresses: Thompsonh@berkeley.edu (H.R. Thompson), anagtejeda@berkeley.edu (A. Ibarra-Castro), gwlopez@ucanr.edu (G. Woodward-Lopez), madsenk@berkeley.edu (K.A. Madsen).

https://doi.org/10.1016/j.ypmed.2019.01.021
Received 6 August 2018; Received in revised form 28 December 2018; Accepted 27 January 2019
Available online 11 February 2019

teachers (Woodward-Lopez et al., 2010). However, credentialed PE teachers (who have at least a year of PE-specific training) and classroom teachers (who typically have a multi-subject teaching credential, which usually involves only a few hours of PE-specific training) are differently equipped to deliver PE classes (Thompson et al., 2013, 2015). Having a credentialed PE teacher is associated with greater amounts of PE (Turner et al., 2014) as well as greater daily moderate to vigorous physical activity (MVPA) among elementary students (Carlson et al., 2013).

The California Department of Education (CDE) does not track the number of credentialed PE teachers working in California public elementary schools. Thus, it is unclear if significant disparities exist in availability of PE teachers based on differences in demographic characteristics between districts; however given the known differences in PE law compliance between high versus low income districts, as well as between districts with higher proportions of students of color versus districts with a higher proportion of white students, this is likely (Sanchez-Vaznaugh et al., 2012). To the extent that greater availability of credentialed PE teachers is associated with greater fitness, this has significant implications for health disparities.

The aims of this study were to determine: 1) the ratio of credentialed elementary PE teachers to students in the nation's largest state; 2) if PE teachers are equally distributed across districts, based on district demographic characteristics; and 3) if the ratio of PE teachers to students is associated with student cardiorespiratory fitness. Quantifying this oft-cited barrier to PE provision is necessary to appropriately advocate for increased interventions and resources to improve PE in public elementary schools.

2. Methods

2.1. Study population

All California public school districts that educated elementary students in grades K-6 during the 2016–17 school year (n = 894) were eligible for participation. Districts educating students in grades K-6 were the focus of this study because elementary students are the least likely to receive PE (Shape America and the American Heart Association, 2016) and because the state's elementary PE law applies to students in grades 1–6 (California Department of Education, 2018a). Districts that did not serve elementary students (K-6) were excluded, including 5 districts that only educated 6th grade students in middle schools (6th–8th grade) or secondary schools (6th–12th). The UC Berkeley Committee for the Protection of Human Subjects deemed this to be non-human subjects' research.

2.2. Data collection

Publicly available school district contact information, including district email addresses and phone numbers, were downloaded from the CDE website (California Department of Education, 2018b). Researchers contacted district secretaries via phone and asked to speak with the person/department best equipped to answer questions related to elementary PE and staffing. If someone could not be reached by phone, or if a respondent preferred to respond online, researchers emailed an online survey link to district contacts.

The survey contained 8 questions related to the number of PE teachers in the district and took approximately 5 min to complete. Responses to 1) “Are there any single-subject credentialed PE teachers who teach in the district's elementary schools (yes/no);” and 2) “If yes, how many single-subject credentialed elementary PE teachers are on staff in the district?” were used to determine the number of full-time employees (FTEs) in the district dedicated to elementary PE. Single-subject credentialed elementary PE teachers are hereafter referred to as “PE teachers.” PE teachers that only taught 6th graders in traditional middle (6–8th grades) or secondary (6–12th grades) schools, were not counted.

Publicly available school-level demographic data were downloaded from the CDE website (California Department of Education, 2018b). District-level values were calculated for: 1) total K-6 student enrollment (excluding students enrolled in traditional middle (6–8th grades) or secondary (6–12th grades) schools; 2) percent of African-American, Asian, Latino, and white students; and 3) percent of students who are eligible for free or reduced priced meals (FRPM; which includes students who are eligible to receive FRPM based on applying for the National School Lunch Program, as well as students who are automatically eligible for free meals based on their foster, migrant, or homeless status, or their participation in California's food stamp program) – a proxy for student socio-economic status. Race/ethnicity and FRPM variables were weighted by school-level student enrollment.

California administers the FitnessGram® (The Cooper Institute, 2014a), a series of fitness tests, to all 5th grade students annually. To assess aerobic capacity, schools can choose to have students complete a 1-mile run or the Progressive Aerobic Cardiovascular Endurance Run (PACER) test (The Cooper Institute, 2014b; California Department of Education, 2018c); there is no direct measure of oxygen uptake. Per FitnessGram protocol, a student is considered to be in the “Healthy Fitness Zone” (HFZ) for aerobic capacity if their mile-run or PACER score meets criterion-referenced standards for appropriate cardio-respiratory fitness based on their age and sex (California Department of Education, 2017d). School-level student FitnessGram data were downloaded from the CDE website (California Department of Education, 2018e). For each school district, the percent of 5th grade students in the HFZ for aerobic capacity were calculated, (weighted by number of students who took the test at each school) for all students.

2.3. Statistical analysis

There is no recommended PE teacher-to-student ratio in California (or nationally). As a benchmark for what it would take for 1 PE teacher to provide a school with the mandated 100 min/week, we use a ratio of 1 teacher per 500 students. With 1800 min (6 h/day) of teacher instruction time in a typical school week, a full-time PE teacher could theoretically provide the weekly 100 min of PE mandated by law to 18 classes. With the California average K-6 class size of 25 students (California Department of Education, 2018f), 450 students would get the legally mandated number of minutes per week from a single PE teacher (a ratio of 1 PE teacher for every 450 students). A ratio of 1 teacher per 500 students is generously rounded up from 450. The number of elementary PE teachers per 500 elementary students within each district was calculated by multiplying the ratio of PE teachers teaching in elementary schools to total district enrollment in grades K–6 by 500.

To assess the association between the number of PE teachers per 500 students and district-level demographic characteristics, we used a generalized linear model with a gamma distribution (to account for the fact that the number of PE teachers within a district cannot be negative and has a right-skewed distribution); a log link; and robust standard errors (to account for the fact that 50% of districts had zero credentialed PE teachers on staff) (M & N, 1989). Coefficients from the model represent the ratio: (number of PE teachers per 500 students given a one-unit change in the covariate)/(number of PE teachers per 500 students given no change in the covariate). We interpret the coefficients as the percent change in the number of PE teachers per 500 students for each one-unit change in the covariate of interest.

To examine the association between student fitness and the PE teacher-to-student ratio, we used a linear regression model.

The GLM and linear regression models adjusted for: 1) total K-6 student enrollment (excluding students enrolled in middle (6–8th grades) and secondary (6–12th grades) schools); 2) district-level student race/ethnicity; and 3) district-level student FRPM status.

All statistical analyses were conducted at the district level.

3. Results

Out of 894 school districts contacted, 669 (75%) completed the

Table 1
Demographic information, California school districts serving elementary (K-6th grade) students[a].

	All CA school districts (n = 894)	Study sample districts (n = 669)	Non-participating school districts (n = 225)	*p*-Value[b] for difference between study and non-participating districts
District-level K-6[c] student enrollment (mean ± SD)	3667 ± 12,523	3716 ± 14,018	3521 ± 6257	0.841
Student race/ethnicity (% ± SD)				
African American	2.7 ± 5.2	2.5 ± 4.7	3.1 ± 6.4	0.112
Asian	5.0 ± 9.5	5.0 ± 9.5	5.0 ± 9.6	0.999
Latino	44.6 ± 28.5	45.1 ± 28.3	43.2 ± 29.1	0.388
White	38.5 ± 26.1	38.4 ± 25.9	38.9 ± 26.9	0.815
Students who qualify for free or reduced priced meals (% ± SD)	55.5 ± 25.9	55.8 ± 25.9	54.8 ± 25.7	0.631
5th grade students in the Healthy Fitness Zone for aerobic capacity[d] (% ± SD)	63.3 ± 16.7	63.5 ± 16.6	62.8 ± 16.9	0.625

[a] Includes districts that educated students in K-5/6, K-8, or K-12 schools during the 2016–17 school year.
[b] *p*-Values calculated using unpaired *t*-tests.
[c] Excludes 6th grade students educated in middle (6–8th grades) or secondary (6–12th grades) schools.
[d] The state-wide fitness test, the FITNESSGRAM, uses Healthy Fitness Zones to evaluate fitness performance of fifth graders. These zones are criterion-referenced standards and represent minimum levels of fitness for age and sex that offer protection against the diseases that result from sedentary living. Aerobic capacity reflects the maximum rate of oxygen uptake and use during exercise.

survey. On average, it took approximately 15 attempted contacts via phone or e-mail (range 1 to 25) per district to reach someone who was willing to participate. One hundred and eighty-one school districts (20%) did not respond and 20 (2%) refused participation. There were no statistically significant differences in district demographic characteristics between districts that did and did not participate (Table 1).

The 669 participating districts reported a total of 1304 PE teachers in their districts (range 0 to 45 per district). Just over half (50.9%, n = 332) of districts had no elementary PE teacher on staff. There was an average of 0.6 PE teachers for every 500 students per district. Larger school districts (higher student enrollment) and districts with a higher percentage of African American and Latino students had fewer PE teachers per student (Table 2). Each additional 100 students in the district was associated with a 0.1% (95% CI −0.2%, −0.1%) decrease in the number of PE teachers per 500 students. Each 10% increase in African American and Latino students in the district was significantly associated with a 29.1% (95% CI −47.1%, −4.8%) and 18.2% (95% CI −30.8%, −3.4%) decrease in the ratio, respectively. Each 10% increase in Asian students in the district was associated with a 20.8% (95% CI −37.3%, 0.0%) decrease in the ratio, with a strong trend towards statistical significance ($p = 0.05$).

Across all districts, an average of 63% (SD ± 17%) of 5th grade students was in the HFZ for aerobic capacity (meaning these students are considered aerobically fit). Among districts with at least one PE teacher, the mean was 66% (SD ± 17%); among districts with no PE teachers, the mean was 61% (SD ± 16%). Each additional PE teacher per 500 students was significantly associated with a 2.8% increase in aerobically fit students (SE = 0.67%; 95% CI 1.4%, 4.1%), adjusting for district-level student enrollment, race/ethnicity, and FRPM.

4. Discussion

This is the first study to quantify the availability of PE teachers in California public elementary schools. Previous research identified the lack of elementary PE teachers as the primary barrier to both PE law compliance and quality PE class delivery (Thompson et al., 2015, 2018). We found an average of 0.6 PE teachers for every 500 elementary students (equal to 1 PE teacher for every 864 students) in California school districts serving students in grades K-5.

There is no recommended PE teacher-to-student ratio in California (or nationally), although 1 per 500 students is reasonable and has face validity, as described above. The current ratio of 0.6 PE teachers for every 500 students, which translates to 1 PE teacher to every 864 students, suggests that PE teacher staffing in California is deficient, but within reach, if concerted efforts were made to support hiring more teachers.

Nationally, only 8% of elementary schools do not have a PE teacher (Turner et al., 2014). However, in California, half of districts with elementary students do not have a PE teacher on staff. These districts contain 1378 schools educating students in grades K-6. The nearly 725,000 elementary students in these schools, 58% of whom qualify for FRPM, are not receiving PE taught by a credentialed PE teacher. This could have implications for these students' health, specifically their fitness.

Table 2
Adjusted[a] associations between district characteristics and district elementary PE-teacher-to-student ratio (per 500 students) (n = 651 districts[b]).

	% change in the PE teacher-to-student ratio (robust standard error)	95% CI
Per 100 student increase in district enrollment in grades K-6[c]	−0.1 (0.2)	−0.2, −0.1**
Per 10% increase in proportion of students in district by race/ethnicity		
African American	−29.1 (10.6)	−47.1, −4.8**
Asian	−20.8 (9.4)	−37.3, −0.0*
Latino	−18.2 (6.9)	−30.8, −3.4**
White	−14.6 (8.3)	−29.4, 3.2
Per 10% increase in students who qualify for free or reduced-price meals	1.2 (5.1)	−8.3, 11.6

[a] Ratios derived from generalized linear regression model with a gamma distribution and a log link, adjusting for all variables presented in the table and presented as % change in the PE teacher-to-student ratio.
[b] Includes California school districts that educated students in K-5/6, K-8, or K-12 schools during the 2016–17 school year.
[c] Excludes 6th grade students educated in middle (6–8th grades) or secondary (6–12th grades) schools.
* $p = 0.05$.
** $p < 0.05$.

PE teachers are not equally available across school districts in California. Districts with a higher student enrollment and a higher proportion of African American and Latino students have significantly fewer PE teachers. While there was an average of 0.6 PE teachers per 500 students overall in participating districts, there were only 0.5 PE teachers per 500 students in the districts in the highest quintile for both Latino and African-American students (data not shown). This finding is corroborated by previous research in California conducted by Sanchez-Vaznaugh et al. (2012), which showed that students in districts with a higher proportion of non-white students are less likely to receive adequate PE time and to meet physical fitness standards as compared to students in districts with more white students. Unequal availability of PE teachers may be contributing to race-related health disparities.

Moreover, despite a current ratio of 0.6 PE teachers per 500 students, it's likely that PE teacher quantity in California is currently higher than it has been in the past decade. It is possible that with the recent rash of PE-related lawsuits implicating districts for being non-compliant with California PE law (Adams, 2015), that the PE teacher-to-student ratio has increased (Thompson et al., 2018). In fact, 20% of districts interviewed after a 2013 PE lawsuit reported hiring more PE personnel within their district as a result of the lawsuit, and the majority of districts reported increased priority for PE (Thompson et al., 2018). However, despite these gains, teachers and administrators in that study overwhelmingly reported that additional PE teachers would be the greatest facilitator to increasing PE law compliance and improving PE class quality (Thompson et al., 2018).

This is the first study to find a relationship between the number of PE teachers and student fitness. Previous research has shown that schools with a PE teacher offer higher-quality PE (Thompson et al., 2013) that is more consistent with national standards (including at least 150 weekly minutes of PE) (Turner et al., 2014) and that students in those schools accumulate greater daily MVPA (Carlson et al., 2013). In the present study, we found that the more PE teachers per students in a district, the better students' fitness. Not only is this important because youth fitness is associated with improved physical and emotional health (Janssen & Leblanc, 2010), but because fitness has important implications for scholastic performance; physically fit youth perform better academically than physically unfit youth (Institute of Medicine, 2013). Investing in PE teachers could be seen as a compelling investment in both student physical and academic health. Funding PE teachers in districts with a higher proportion of students of color is a critical first step, as unequal access to PE teachers in districts with a higher proportion of students of color may be contributing to health and academic disparities.

Further, increasing the availability of PE teachers is a wise long-term financial investment. Lee et al. (2017) modeled the economic impact of increasing the percentage of youth who meet recommended physical activity levels, demonstrating savings in billions of dollars annually for both direct medical costs and lost productivity. We estimate that in order to bring California elementary schools up to a ratio of 1 PE teacher per 500 students, the state would need to hire approximately 2600 additional PE teachers (based on the total K-6 enrollment of > 3 million students and the current 3934 employed PE teachers). This would cost $239 million (based on an average annual mid-career teacher salary of $92,000, including benefits) (California Department of Education, 2018g). In our study, each additional PE teacher per 500 students was associated with a relative 4.4% increase in the proportion of students who were physically fit; thus increasing by 0.4 teachers per 500 students (from the current 0.6 per 500 students, to get to 1 per 500) would be associated with a 1.8% relative increase in fit students. Using Lee's estimates (each 1% relative increase in the proportion of California elementary students who meet recommended physical activity levels translates to a medical cost savings of $203 million annually (Lee et al., 2017)) and based on the demonstrated positive link between increased physical activity levels and student cardio-respiratory fitness (Poitras et al., 2016), this would result in an estimated annual medical cost savings of $365 million. The medical care costs saved, alone, could easily justify the additional expense of supporting increasing staffing to achieve a state-wide PE teacher ratio of 1 to 500 students.

There is still a clear, demonstrated need for more PE teachers in California elementary schools, particularly in larger districts and districts with higher proportions of African American and Latino students. Because funding additional PE teachers will likely be challenging, creative action to take advantage of existing funding and/or to create new revenue streams for PE should be explored. New federal education legislation, the Every Student Succeeds Act (Executive Office of the United States President, 2015; Shape America, 2016), now enables schools to use federal funding for PE-related expenses, which districts could leverage. Using local monies is another potential approach to increase staffing. Data showing New York City public schools were not in compliance with state PE law (Office of the New York City Comptroller Scott M. Stringer, 2017) led the City to invest in PE Works, a $100 million, 4-year initiative to, among other things, ensure each of the city's > 700 elementary schools has a licensed and certified PE teacher (Fertig, 2016).

More creatively, other federal agencies, or even non-public entities, with vested interests in youth fitness and health, could help fund PE. According to a recent report, physical inactivity among US youth is contributing to an “unprecedented readiness problem” for the US armed forces (Roeder, 2017). Though likely politically controversial, the military could help fund PE teachers, much like they already help fund school-based Reserve Officers Training Corps' (ROTC) programs (which many districts allow to count for PE credit in high school). Additionally, if the 19 professional sports franchises in California (more than in any other state, most with non-profit arms, and all with a natural connection to physical activity) donated a small portion of ticket sales, this could also become a sustainable mechanism to support PE teacher staffing.

4.1. Limitations

Several study limitations deserve mention. A quarter of eligible districts did not participate in this study, which could bias our findings, if districts who did not participate were either more or less likely to have PE teachers on staff. However, there were no statistically significant differences in district demographic characteristics between districts that did and did not participate, signaling that responding districts were representative of all districts as a whole. Secondly, PE teacher data are self-reported; incomplete knowledge of PE program implementation practices and staffing could have contributed to inaccurate reporting of PE teacher quantity. In addition, data were collected at the district, not school level, precluding more precise examination of associations between school-level PE teacher quantity and demographic characteristics. Further, the FitnessGram is only taken by 5th grade students, limiting our ability to examine the relationship between PE teacher provision and student fitness in all elementary grades. Data on students' participation in other school-level interventions that could impact students' aerobic capacity (e.g. recess time, after-school sports participation) is not publicly available, so also could not be included in this analysis. Finally, it is possible that credentialed PE teachers (who have more PE-related training than classroom teachers), more correctly administered the FitnessGram test, or encouraged students to push themselves harder, which may contribute to the relationship between PE teacher availability and students' aerobic capacity.

4.2. Conclusions

There are too few PE teachers in California public elementary schools, and they are not distributed equally among districts. Half of districts do not have an elementary PE teacher on staff and having a higher proportion of African American and Latino students within the district is associated with fewer PE teachers per student. Districts with a higher PE teacher-to-student ratio have more aerobically fit students. It is therefore likely that the lack of PE teachers in many districts is contributing to health disparities. Additional randomized research to

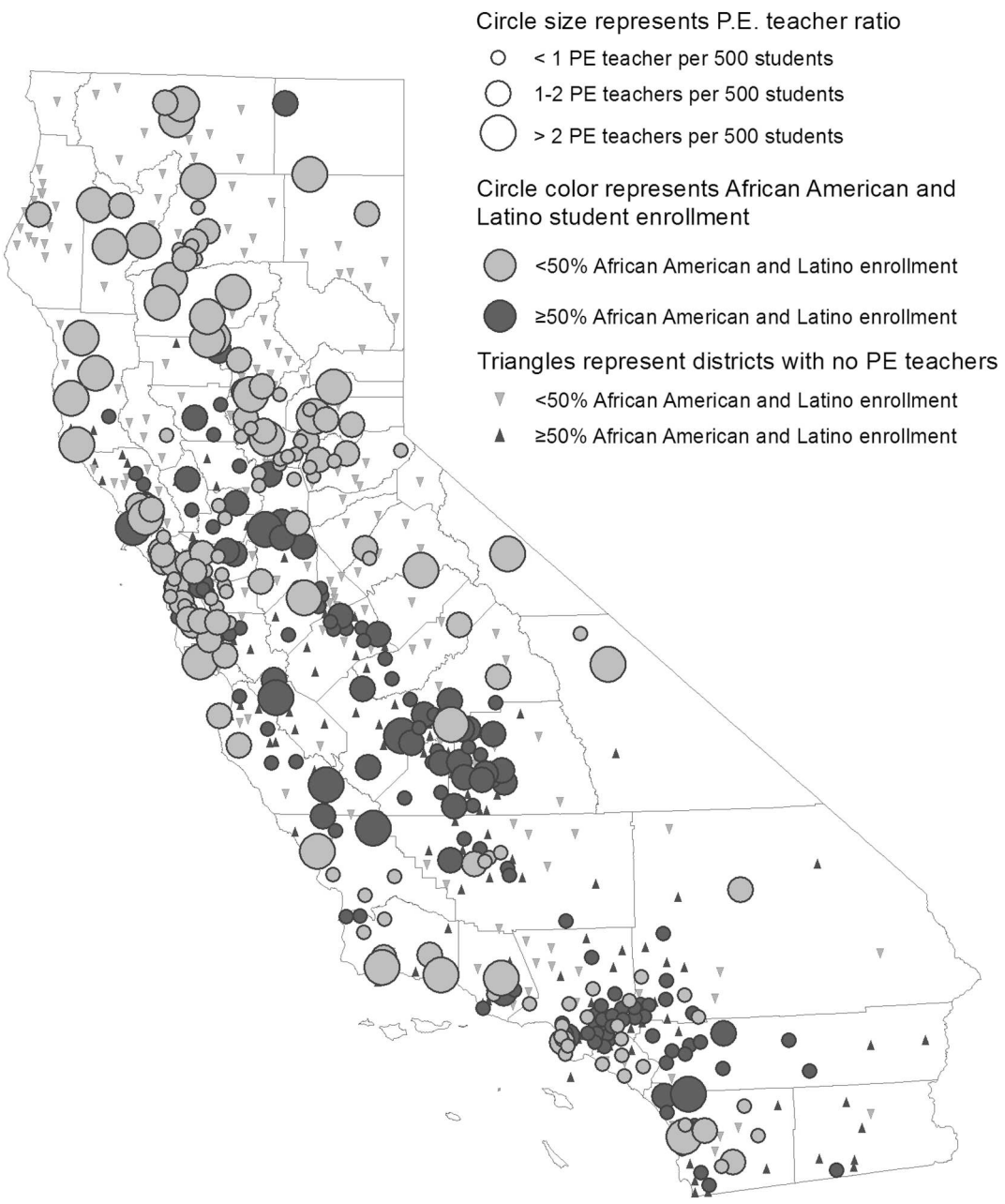

Fig. 1. Geographic distribution of PE teachers across California.

build the evidence on the impact of PE teacher availability on student fitness, as well as simultaneous creative action to increase support for PE teachers, could ensure schools have the appropriate staffing to comply with existing PE laws and successfully implement PE to the benefit of all students' health.

Conflict of interest

None.

Acknowledgments

This work would not have been possible without the generosity of the school personnel who were willing to speak with us about PE in their school districts. We would also like to thank Evan Talmage for creating Fig. 1. This research was supported, in part, by the Robert Wood Johnson Foundation Evidence for Action Program (grant nos. 73420 and 75088).

References

Adams, J.M., 2015. Lawsuit agreement to force schools to provide physical education. EdSource Available at. https://edsource.org/2015/lawsuit-agreement-to-force-schools-to-provide-physical-education/73544, Accessed date: 10 January 2017.
Calahorro-Canada, F., Torres-Luque, G., Lopez-Fernandez, I., Carnero, E.A., 2017. Is physical education an effective way to increase physical activity in children with lower cardiorespiratory fitness? Scand. J. Med. Sci. Sports 27 (11), 1417–1422.
California Department of Education Physical education FAQs. Available at. https://www.cde.ca.gov/pd/ca/pe/physeducfaqs.asp, Accessed date: 18 July 2018.
California Department of Education Dataquest state education data reporting. Available at: http://data1.cde.ca.gov/dataquest/, Accessed date: 30 October 2015.
California Department of Education Physical fitness testing. Available at. http://www.cde.ca.gov/ta/tg/pf/, Accessed date: 5 February 2017.
California Department of Education FITNESSGRAM: Healthy Fitness Zone charts. Available at: https://www.cde.ca.gov/ta/tg/pf/healthfitzones.asp, Accessed date: 31 October 2018.
California Department of Education Physical fitness testing (PFT). Available at: https://www.cde.ca.gov/ta/tg/pf/, Accessed date: 12 June 2018.
California Department of Education Average class size - CalEdFacts. Available at. https://www.cde.ca.gov/ds/sd/dr/cefteachavgclssize.asp, Accessed date: 19 June 2018.
California Department of Education Average salaries & expenditure percentage -

CalEdFacts. Available at: https://www.cde.ca.gov/fg/fr/sa/cefavgsalaries.asp, Accessed date: 6 November 2018.
Carlson, J.A., Sallis, J.F., Norman, G.J., et al., 2013. Elementary school practices and children's objectively measured physical activity during school. Prev. Med. 57 (5), 591–595.
Executive Office of the United States President, December 2015. Every Student Succeeds Act: A Progress Report on Elementary and Secondary Education. The White House, Washington, DC.
Fertig, B., 2016. Mayor's budget adds $100 million for physical education in schools. WNYC New York Public Radio. Available at. https://www.wnyc.org/story/mayors-budget-adds-100-million-physical-education-schools/, Accessed date: 18 July 2018.
Institute of Medicine, May 2013. Educating the student body: taking physical activity and physical education to school. Concensus report. Available at. http://www.nationalacademies.org/hmd/Reports/2013/Educating-the-Student-Body-Taking-Physical-Activity-and-Physical-Education-to-School.aspx, Accessed date: 2 August 2018.
Janssen, I., Leblanc, A.G., 2010. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int. J. Behav. Nutr. Phys. Act. 7, 40.
Lee, B.Y., Adam, A., Zenkov, E., et al., 2017. Modeling the economic and health impact of increasing children's physical activity in the United States. Health Aff. (Millwood) 36 (5), 902–908.
M, P., N, J.A., 1989. Generalized Linear Models, 2nd edition. Chapman and Hall, London, England.
Mooses, K., Pihu, M., Riso, E.M., Hannus, A., Kaasik, P., Kull, M., 2017. Physical education increases daily moderate to vigorous physical activity and reduces sedentary time. J. Sch. Health 87 (8), 602–607.
Office of the New York City Comptroller Scott M. Stringer, 2017. Dropping the ball: disparities in physical education in New York City schools. May 2015. Available at. Bureau of Policy and Research. https://comptroller.nyc.gov/wp-content/uploads/documents/Phys_Ed.pdf, Accessed date: 28 December 2017.
Poitras, V.J., Gray, C.E., Borghese, M.M., et al., 2016. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. Appl. Physiol. Nutr. Metab. 41 (6 Suppl. 3), S197–S239.
Racette, S.B., Dill, T.C., White, M.L., et al., 2015. Influence of physical education on moderate-to-vigorous physical activity of urban public school children in St. Louis, Missouri, 2011–2014. Prev. Chronic Dis. 12, E31.
Rasberry, C.N., Lee, S.M., Robin, L., et al., 2011. The association between school-based physical activity, including physical education, and academic performance: a systematic review of the literature. Prev. Med. 52 (Suppl. 1), S10–S20.
Roeder, T. Too fat to fight: military threatened by childhood obesity. Available at. https://www.military.com/daily-news/2017/10/15/too-fat-to-fight-military-threatened-by-childhood-obesity.html, Accessed date: 18 July 2018.
Samuels, S., Garcia, R., Strongin, S., et al., 2011. Physical education is a right: the Los Angeles Unified School District case study (Policy Report 2011). available at. http://www.cityprojectca.org/blog/archives/11646.
Sanchez-Vaznaugh, E.V., Sanchez, B.N., Rosas, L.G., Baek, J., Egerter, S., 2012. Physical education policy compliance and children's physical fitness. Am. J. Prev. Med. 42 (5), 452–459.
Shape America Every Student Succeeds Act. Available at. http://www.shapeamerica.org/advocacy/essa.cfm/, Accessed date: 12 April 2017.
Shape America and the American Heart Association, 2016. Shape of the nation report: status of physical education in the USA. Available at: http://www.shapeamerica.org/advocacy/son/2016/upload/Shape-of-the-Nation-2016_web.pdf, Accessed date: 20 September 2017 (2016).
The Cooper Institute The FitnessGram®. Available at. http://www.cooperinstitute.org/fitnessgram, Accessed date: 30 October 2018.
The Cooper Institute The FitnessGram® Aerobic Capacity Tests. Available at. http://www.cooperinstitute.org/fitnessgram/aerobic-capacity, Accessed date: 30 October 2018.
Thompson, H.R., Linchey, J., Madsen, K.A., 2013. Are physical education policies working? A snapshot from San Francisco, 2011. Prev. Chronic Dis. 10, E142.
Thompson, H.R., Haguewood, R., Tantoco, N., Madsen, K.A., 2015. Lessons learned: a strategic alliance to improve elementary physical education in an urban school district. Prog. Community Health Partnersh. 9 (3), 363–370.
Thompson, H.R., Singh, B.K., Reed, A., et al., 2018. Impact of litigation on compliance with California physical education laws in elementary schools. J. Phys. Act. Health 1–9.
Turner, L., Johnson, T.G., Slater, S.J., Chaloupka, F.J., 2014. Physical activity practices in elementary schools and associations with physical education staffing and training. Res. Q. Exerc. Sport 85 (4), 488–501.
Woodward-Lopez, G., Diaz, H., Cox, L., 2010. Physical Education Research for Kids (PERK): A Study of the California Task Force on Youth and Workplace Wellness. Public Health Institute.