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RESEARCH ARTICLE

US School-Based Physical Fitness Assessments and Data Dissemination

PATRICK KROCHMAL, BS[a] DAN M. COOPER, MD[b] SHLOMIT RADOM-AIZIK, PhD[c] KIM D. LU, MD, MS[d]

ABSTRACT

BACKGROUND: Low physical fitness (PF) levels during childhood affect healthy growth and development, and increase the risk of cardiovascular diseases. Physical education standards exist for nearly all states in the United States, but evaluation of PF in youth has yet to be systematic, reproducible, and harmonized. The purpose of this project was to describe publicly available data of school-based PF testing (SB-PFT).

METHODS: A list of state-mandated SB-PFT programs published by SHAPE 2016 was confirmed by contacting appropriate authorities. SB-PFT data were obtained through each state's department of education.

RESULTS: Sixteen states mandate SB-PFT, with 10 states providing publicly available data; 92% to 100% of states perform the pacer/mile, curl-up, and push-up; 54.2% to 78.5% of elementary and 44% to 66.5% of high-school youth are in the ''healthy fitness zone'' for aerobic capacity.

CONCLUSIONS: SB-PFT provided PF data in children across the United States. The variability and inconsistency in reporting and in the values, however, raises questions about the current status of SB-PFT data and its utility in assessing PF in children. The critical nature of PF assessments is highlighted in the current COVID-19 pandemic, during which physical education has been curtailed, and emerging data demonstrate worsening of the already low levels of PF in youth.

Keywords: physical fitness; school-aged children; fitness testing.

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Physical activity plays an essential role in healthy growth and development in children. Suboptimal levels of physical activity in children and adolescents over the past few decades, often accompanied by obesity, have become a worldwide public health issue and lead to a higher risk for the development of chronic diseases, such as type 2 diabetes, cardiovascular, and metabolic diseases.[1] Long before the widespread recognition of the obesity/physical inactivity pandemic, schools had emerged as a central component for obesity prevention and increasing physical activity among children and adolescents.[2] Physical education has been a standard part of the school curriculum for over a century in the United States as the benefits of physical fitness to child health, behavior, and learning have long been acknowledged and, more recently, corroborated with rigorous investigation.[3,4] The current COVID-19 pandemic has additionally emphasized the need for effective physical education in schools.[5] Early studies suggest that ''shelter-at-home'' policies may lead to profound reductions in physical activity of school-aged children and adolescents

[a]MD Candidate, (krochmp@amc.edu), Albany Medical College, 174 Siesta Avenue, Thousand Oaks, CA 91360.

[b]Associate Vice Chancellor for Clinical and Translational Science, (dcooper@hs.uci.edu), Principal Investigator, UC Irvine CTSA; Professor of Pediatrics, University of California, Irvine School of Medicine; Chair, University of California BRAID (Biomedical Research Acceleration, Integration, and Development), 101 Academy Way, Suite 150, Irvine, CA 92617.

[c]Executive Director, (saizik@hs.uci.edu) Pediatric Exercise and Genomics Research Center, Associate Professor, Department of Pediatrics, University of California, Irvine School of Medicine, 101 Academy Way, Suite 150, Irvine, CA 92617.

[d]Assistant Professor of Clinical Pediatrics, (kdlu@hs.uci.edu), University of California, Irvine School of Medicine Pediatric Exercise and Genomics Research Center, 101 Academy Way, Suite 150, Irvine, CA 92617.

Address correspondence to: Kim D. Lu, Assistant Professor of Clinical Pediatrics, (kdlu@hs.uci.edu), University of California, Irvine School of Medicine Pediatric Exercise and Genomics Research 101 Academy Way, Suite 150, Irvine, CA 92617.

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with concomitant weight gain.[6,7] Of note, obesity is a serious complicating comorbidity of the COVID-19 pandemic even in young adults.[8]

Across the United States, there are currently standardized metrics used to assess the effectiveness of teaching in traditional academic subjects, reading, music, and the visual arts (https://nces.ed.gov/nationsreportcard/reading/). National Assessment of Educational Progress scores are publicly available at national, state, and school district levels. Given schools' commitment to physical education, it is surprising that there are no standardized approaches to measuring physical fitness in the school setting and no mandated school-based physical health assessment. A 2012 Institute of Medicine report on fitness measures and health outcomes in youth recommended national surveys of health-related fitness and the use of fitness tests in schools. However, a Centers for Disease Control and Prevention (CDC) report revealed that only 14 states, including the District of Columbia, collected student fitness assessment data at the state level, and approximately half of these states made the school or district-level data publicly available.[9] Furthermore, the Shape of the Nation report in 2016 evaluated the state of physical education and physical activity in the American education system highlighting the ''large disparity in state requirements and implementation affect children's ability to engage in and benefit from these programs.''[10] The success of school-based physical education programs has been mixed due, in part, to the myriad of challenges to schools, including inadequate funding, lack of trained physical educators, and competing demands to achieve performance standards in traditional academics.[11] However, little research has examined the current state of SB-PFT in children and adolescents across the United States.

To begin to bridge this gap in knowledge, we investigated states that mandate SB-PFT and provide public access to their data, with the aim to understand the characteristics of SB-PFT data in the United States and provide state-by-state comparisons of physical health from elementary through high school-aged children.

METHODS

A retrospective cross-sectional study was performed to examine mandated SB-PFT in the United states and publicly available data from states were confirmed by referencing *Shape State of a Nation, Status of Physical Education in the USA 2016*[10] and by contacting each state department head of physical education. Sixteen states mandated physical fitness assessments to evaluate student physical health, and among those 16 states, 10 states provided publicly available data (Table 1 and Figure 1).

Physical Fitness Measures

Specific fitness assessments offered for each of the fitness components were examined (aerobic capacity, body composition, upper body strength, abdominal strength, flexibility, and trunk lift) by state. The ''Healthy Fitness Zone'' concept was developed by the Cooper Institute in 1992 to classify fitness performance into discrete zones: ''Healthy Fitness Zone'' (HFZ), ''Needs Improvement,'' and ''Needs Improvement—Health Risk,'' allowing for more personalized feedback.[12] The Cooper Institute is a non-profit enterprise established in 1970 with the vision to ''prove that exercise is medicine'' (http://www.cooperinstitute.org/about/). The aerobic fitness component of the HFZ is based on the conversion of either the mile run (units of time) or the 20-m shuttle run (units of the number of shuttles completed) to an estimate of maximal oxygen uptake [estimated $\dot{V}O_2max$, often expressed as ml O_2/min/kg (body weight)]. The HFZ is a criterion-based, rather than percentile-based, scaling metric currently based on data obtained in 2011.[13] All of the states included the percentage of students in the HFZ for the various fitness components. However, the publicly available data differed in terms of the details of data presented, including total numbers, males and females separately, individual grade levels or level of education (elementary, middle, or high school), and individual school or summary data (Table 1).

The percentage of students tested was determined using the total student population by referencing each state department's report on their respective department of education website.

The distribution of fitness assessment results was referenced from Shape State of the Nation.[10]

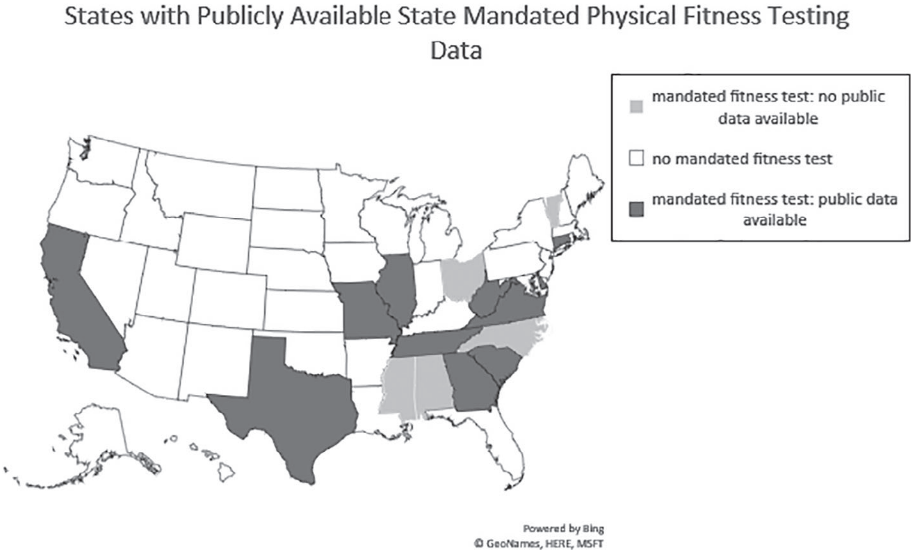
Data Analysis

Data characteristics are presented from 10 states with publicly available data for the 2016-2017 school year. All available data were extracted directly from each state's summary reports and/or data files; means and 95% confidence intervals were calculated when individual school-level data were available without the total numbers of students tested. Grade level data were combined to calculate means by the elementary, middle, and high school when available. Comparative statistics were not performed on these data given the variability of available data.

RESULTS

Sixteen US states have mandated SB-PFT representing approximately 49% of K-12 students in the United States (Table 1). Ten states have publicly available fitness data with data available for 2016 to 2017. Table 1 includes details of specific fitness assessment used, grade levels tested, and details of data available.

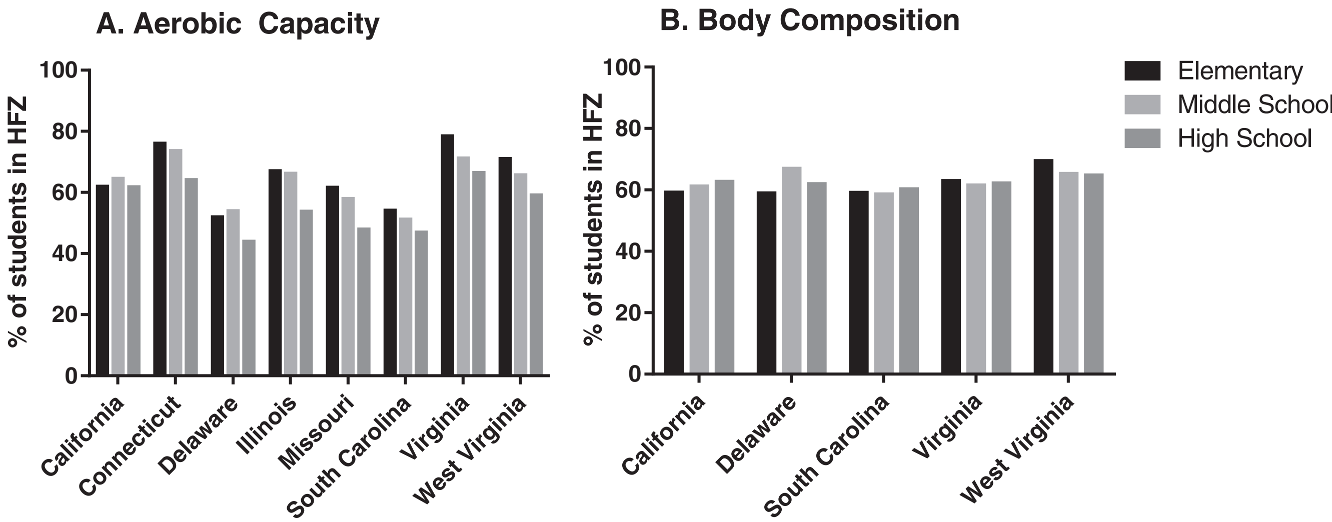
Table 1. **States with Mandated Fitness Testing**



States	Grades Tested	Publicly Available	Fitnessgram	Data available and comments
Alabama https://www.alsde.edu/sec/isvcs/hpe/pages/home.aspx	2-12			Alabama Physical Fitness Assessment
California Cde.ca.gov	5/7/9	x	x	Summary reports available by total, sex, race/ethnicity, socioeconomic status, county
Connecticut Portal.ct.gov/SED/Physical-Education http://edsight.ct.gov/SASPortal/main.do	4/6/8/10	x	§	Summary reports available by total, district, school
Delaware Doe.k12.de.us	4/7/9/10†	x	x	Summary reports by total, by sex, includes number of students
Georgia Gadoe.org	1-12‡	x	x	Summary data by sex- only for aerobic capacity (grades 4-12) and body composition (grades 1-12) Individual data by school, district, sex (no grade level)
Illinois Isbe.net	5/7/10	x	x	Summary reports available as well as individual school-level data
Mississippi https://www.mdek12.org	5/HS			No particular assessment tool required
Missouri Dese.mo.gov	5/7/9	x	x	Raw school-level data available (N of students not available)
North Carolina Dpi.nc.gov	1-9			No particular assessment tool required
Ohio Education.ohio.gov	5/8/12			No particular assessment tool required
South Carolina Scaledown.org/Fitnessgram	2/4/8	x	x	Summary data available by sex and total
Tennessee tn.gov	4/6/8/9			Fitness assessment using the PACER.
Texas Tea.texas.gov	3-12	x	x	Summary data and individual school-level data include sex, total students tested
Vermont Education.vermont.gov	4/7/9		x	Vermont Physical Education Assessment began in 2018-2019
Virginia Doe.virginia.gov	4-12	x	x	Summary data available includes sex, total tested
West Virginia Wvde.us	4-12	x	x	School-level data available with N's

† Grades 9/10 together.
‡ Grades 1-3 assessments are for practice only except for body composition. All fitness assessments begin in grade 4.
§ Uses Connecticut Physical Fitness Assessment; 4 components; criterion-referenced standards for HFZ.

Figure 1. **Percentage of Children in HFZ by State and School Level. (A) represents aerobic capacity and (B) represent body composition**



Specific fitness tests offered by states are illustrated in Figure S1 (n = 13). Three states mandate fitness assessments but no specific tests are required (Mississippi, North Carolina, and Ohio). The majority of states offer the pacer and the mile for aerobic fitness, curl-ups, and push-ups for muscle strength and endurance (92%-100%). Body mass index (BMI) is mandatory in 46% of states and optional in 15% of states. Between 54% and 62% of states offer testing of strength and flexibility including the back saver sit and reach, trunk lift, and modified pull up.

The percentage of children in HFZ by fitness category by the elementary, middle, and high school for each state by fitness category is illustrated in Figure 1 and Table 2. Overall, levels of aerobic fitness decrease from younger to older children.

Table 3 and Figure 2 present sex differences by the elementary, middle, and high school for each state by fitness component. In general, males have higher percentage in HFZ compared to females for aerobic capacity across school levels.

Only 4 states had information available on the percentage of students tested that illustrates the marked differences by states and school level (Figure S2). At the elementary level, 54% to 97% of students were tested for aerobic capacity in contrast to 7% to 91% at the high school level.

The distribution of fitness assessment data varies by state among states with mandated fitness assessments (Figure S3). Overall, 62% of states report the fitness assessment results at the school level to students, parents, or principals and 6.3% of states do not share the results.

DISCUSSION

This is the first study, to the best of our knowledge, that reviewed and summarized publicly available, school-based fitness assessment data across multiple states. There is significant inconsistency among the 16 states with mandated SB-PFT, including the grade level when testing was performed, the type of fitness tests offered, and to whom fitness data were reported. The availability of school-based PF assessments in publicly available datasets stands in marked contrast to the availability of data focused on levels of reading, mathematics, and other essential learning subjects in America's schoolchildren and adolescents. One need only examine recently generated reports from the US Department of Education National Assessment of Educational Progress (NAEP https://nces.ed.gov/nationsreportcard/) to view a robust, well-curated, and useful approach to key evaluation and data focused on the effectiveness of schools. As noted by the NAEP, "The National Assessment of Educational Progress (NAEP) provides a common measure of student achievement across the country. Policymakers, educators, the assessment community, and the media use NAEP to improve education. NAEP data informs educational policy and practice by: reporting the achievement of various student groups, analyzing NAEP results in the context of educational experiences; and providing tools and resources for data analysis."

A similar approach to national youth fitness surveys including SB-PFT in schools is needed to advance our understanding of fitness among youth and health outcomes.[14] Most recently, a scientific statement from the American Heart Association emphasized the

Table 2. **Percentage of Children in HFZ by State, School Level, and Fitness Category**

	California	Connecticut	Delaware	Illinois	Missouri	South Carolina	Virginia	West Virginia
Elementary school								
Abdominal strength	70.9	83.3	73	74.04	67.1 (65.7, 68.6)	64.0	84.3	80.7
Upper body strength	63.6	71.6	65	61.05	58.9 (57.6, 60.3)	55.5	75.3	66.9
Flexibility	71.9	84.6	72	69.40	65.2 (63.8, 66.6)	67.1	84.3	80.9
Middle school								
Abdominal strength	79.6	83.2-84.2	81	80.60	65.8 (63.6, 68.0)	73.4	89.1	80.2
Extensor strength	87.3	nd	65	nd	nd	80.5	89.4	87.7
Upper body strength	66.6	72.1-72.9	64	65.96	59.1 (57.2, 60.9)	63.0	77.5	67.8
Flexibility	79.8	78.9-80.4	67	72.5	63.9 (61.8, 66.0)	75.7	85.3	82.0
High school								
Abdominal strength	82.6	87.3	77	83.42	54.6 (52.3, 56.8)	74.6	90.4	79.9
Extensor strength	89.7	nd	83	nd	nd	80.1	91.6	84.1
Upper body strength	70.9	75.5	60	68.40	51.4 (49.3, 53.6)	60.3	77.5	69.8
Flexibility	62	83.6	75	75.82	53.1 (50.8, 55.3)	73.9	83.8	79.3

CT, middle school range of grades 6 and 8 averages.
MO, average and 95% CI calculated from school-level data available, no N's.
SC, body composition for elementary school includes grades 2 and 5. Average calculated from grade-level data available by sex.
VA, mean calculated from grade-level data for males and females; elementary school includes grades 4-5; middle school includes grades 6-8; high school includes grades 9-12.
WV, averages calculated from number of students tested per grade by school.
nd, no data.

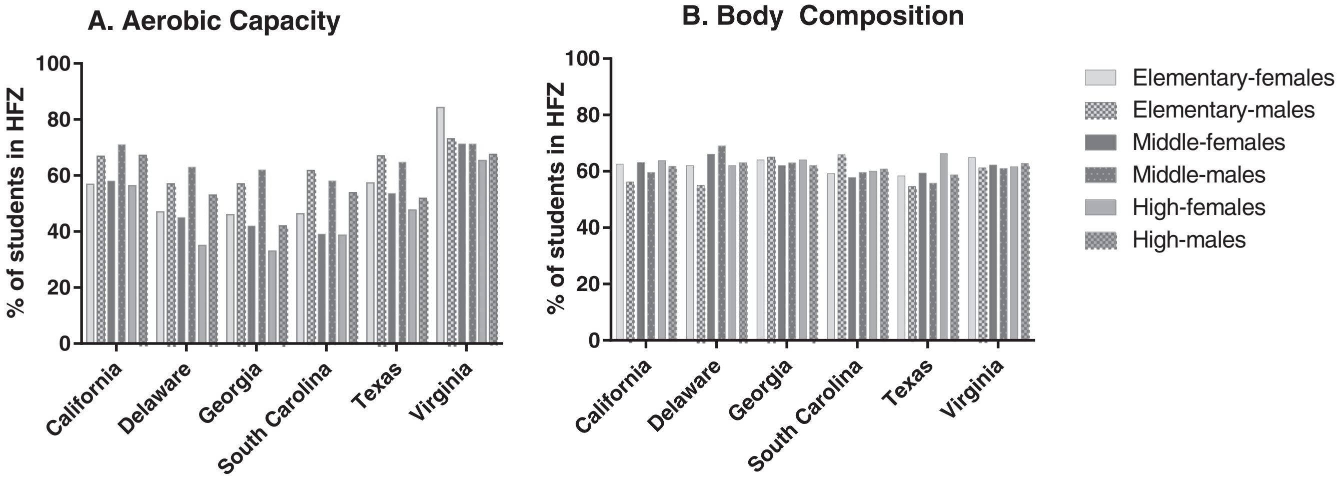
Table 3. **Percentage of Children in HFZ by Sex**

	California		Delaware		Georgia		South Carolina		Texas		Virginia	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Elementary school												
Abdominal strength	70.7	71.1	71	74	66 (64-67)	68 (67-69)	62.1	65.9	77.5	78.3	84.0	84.6
Upper body strength	60.8	66.2	59	72	52 (50-53)	65 (64-66)	47.8	63.1	68.6	74.7	72.6	77.9
Flexibility	77.1	67.0	75	68	72 (71-73)	68 (67-69)	63.8	60.2	77.9	69.4	87.1	81.7
Middle school												
Abdominal strength	78.1	80.9	79	83	73 (71-74)	76 (75-78)	72.5	74.3	79.4	82.2	88.5	89.7
Extensor strength	89.5	85.1	71	60	88 (76-100)	85 (72-97)	83.2	78.0	88.4	84.6	91.7	87.4
Upper body strength	66.4	66.8	66	63	65(63-67)	65 (64-67)	65.6	60.7	76.6	75.4	77.9	77.1
Flexibility	84.0	75.8	69	66	73 (72-75)	71 (70-73)	73	69.9	82.1	76.7	87.9	82.9
High school												
Abdominal strength	81.4	83.7	76	77	73 (71-75)	75 (73-77)	73.7	75.4	79.8	79.2	89.8	91.1
Extensor strength	91.7	87.8	86	81	93 (4-182)	98 (88-108)	82.6	77.8	92.2	90.6	92.7	90.7
Upper body strength	70.9	70.9	66	54	70 (68-72)	62 (60-64)	65.6	56.5	79.4	70.7	78.7	75.4
Flexibility	85.2	83.3	68	83	62 (59-64)	81 (79-83)	65.8	73.0	78.8	79.1	84.2	83.4

GA, school-level data were averaged; the number of students was not available for individual schools. Range represents 95% CI N = 315 high schools, N = 395 middle schools, N = 1125 elementary schools.
SC, body composition for the elementary school includes grades 2 and 5.
VA, mean calculated from grade-level data; elementary school includes grades 4-5; middle school includes grades 6-8; high school includes grades 9-12.

importance of regular assessments of cardiorespiratory fitness (CRF) in children, and supporting school policies to improve CRF for the health and cognitive benefits.[15] School-based fitness assessments have the potential to provide valuable evidence of physical fitness levels in children across various ages, school levels, and other socio-demographic characteristics and, over time, in response to interventions or policy changes.[16,17] However, there is confusion regarding the use of these SB-PFT data. For example, in a 2014 document found on the CDC website,[18] it is stated, ''Schools, school districts, or states might use this data to identify the percentage of students in the population who are in the Healthy Fitness Zone and the percentage of students who need improvement on the various fitness components.'' Yet, a few paragraphs later, in the same document, it is stated, ''*It is not the goal of the Presidential Youth Fitness Program (PYFP) to have schools collect fitness assessment data for states and school districts to monitor the percent of students in their population achieving fitness goals*.'' While the Fitnessgram is the most commonly used SB-PFT, a few authors have suggested that Fitnessgram should be continuously monitored and scrutinized.[19,20] Moreover, we and others have highlighted the challenges and potential inaccuracies that can occur (often resulting from

Figure 2. **Percentage of Children in HFZ by State, School Level for Boys and Girls. (A) represents aerobic capacity and (B) represent body composition. For Georgia, school-level data were averaged; the number of students was not available for individual schools and range represents 95% CI**



issues such as collinearity involved in the conversion equations) when estimating $\dot{V}O_2max$ using testing modalities that do not involve actual measurements of oxygen uptake.[21] If SB-PFT is ever to be used as a metric for population-based assessment of fitness in youth, robust, and interoperable standards and protocols will be an essential component.

In this study, the percentage of elementary-aged children in HFZ for aerobic capacity ranged from 54.2%-78.5% to 44%-66.5% for high school adolescents among states. Overall, aerobic capacity was lower in females compared to males and decreased with school grade level, consistent with other studies.[22,23] There was less variability across school grade levels and no clear sex differences for children in the HFZ for body composition, which was surprising given the relationships between body composition and aerobic fitness, as well as known sex differences in BMI across ages.[24,25] Bai et al. analyzed 192, 848 children through the NFL PLAY 60 Fitnessgram project and found similar differences in aerobic capacity by sex and grade level, ranging from 37.6% to 62.1% of boys in HFZ and 26.1% to 49.1% of girls in HFZ.[22] The authors also found less variability by age and sex for the achievement of the BMI HFZ, ranging from 52.7% to 65%, consistent with our findings. Nationally representative data on aerobic fitness in adolescents demonstrate a decline over time in both males and females highlighting the need to monitor and ensure that adolescents have sufficient opportunities for physical activity and exercise.[26,27] In addition, the proportion of students tested among the 4 states with available data (Figure S2) declined significantly in the older grades. One factor influencing these trends could be the generally fewer PE classes offered in upper grades, especially at the high school level where in many states PE is not required.

Previous studies have utilized the Fitnessgram's HFZ standards as a tool to assess physical health in specific populations or within individual states.[28-31] In this study, we extended this investigation further to compare Fitnessgram data across many different states and grade levels in the United States. However, the variability and inconsistency of available data across states were considerable and we were not able to directly compare fitness assessment results across states. The grade levels included in each state's respective fitness report differed substantially, for example, in California, which tests grades 5, 7, and 9, and Texas, which mandates testing in grades 3 to 12. Some states included data for the individual grade levels and other states grouped elementary, middle, and high-school levels. There were also differences in how states presented males and females—together or separately. Another example where there was a discrepancy in the summary versus the school-level data occurred in Georgia. The individual school-level data had an average of 46% in HFZ for elementary-aged females and 63% in HFZ for elementary-aged males compared to the Governor's report of 50.8% and 63%, respectively, for the same groups. There is clearly a need for standardized and harmonized approaches for SB-PFT to ensure robust, reproducible data essential to understanding physical fitness in children. In addition, we were surprised that individual SB-PFT results are not available to all participants and their families (Figure S3) despite the development of the Fitnessgram as the ''first student fitness report card'' allowing students and their families to track and understand their child's physical fitness levels.

Limitations

Limitations to this study revolve around the publicly available data. Only 10 states provided publicly available data despite 16 states mandating physical fitness assessments. Some states, such as Alabama, kept data private from the public but allowed students and parents to access it through a portal login at their respective school. Vermont has newly implemented the Fitnessgram since 2018 and therefore did not have data available to the public during the time of the study. Publicly available data did not share a standardized format on what information to include and the variability in data available between states was incompatible in some areas as previously discussed. In addition, we did not assess other factors known to affect fitness in children, including race and ethnicity, socio-economic status, and environment, due to lack of this data in most of the states.[32,33] Lastly, we chose to focus on a cross-sectional analysis, but longitudinal trends would be important to evaluate as well as the impact of any interventions such as the NFL PLAY 60 Fitnessgram project.[34]

Conclusions

Within each reporting state, SB-PFT provided data across multiple grades and about different components of physical fitness in school-aged children. The variability and inconsistency in reporting and in the SB-PFT values themselves, however, raised questions about the suitability of the current implementation of SB-PFT to compare PF between regions or to identify trends in PF in school-aged children. However, given the data is already collected across many states, there is potential for SB-PFT to be a useful biomarker in assessing child health with standardized approaches. New approaches are needed to address data quality, interoperability, consistency, and reporting if SBFT is to become a force in improving physical fitness in children and adolescents in this critical period. Finally, these individual data need to be easily available to children and their families in tracking and understanding their child's physical fitness.

IMPLICATIONS FOR SCHOOL HEALTH AND EQUITY

Assessing PF in school-aged children and adolescents should be integrated into the K-12 curriculum alongside traditional academic subjects, such as reading and math. SB-PFT (testing and reporting) that is robust, reproducible, and harmonized could be a valuable tool in understanding the PF status of children across the United States and help guide new policies to promote children's health. As a result of this research, we recommend the following actions to improve SB-PFT:

- Improve the willing participation, engagement, and acceptance of fitness testing and provide outreach to promote the value of SB-PFT as a marker of physical health and fitness to students and their families.
- Enhance support (eg, provide time and compensation for training) and understanding of the importance of SB-PFT to school staff.
- Provide national/state standardized training and resources to school staff that will ensure reproducibility and quality data in fitness testing methodology including involving simple, straight forward approaches to setting up tests, implementing, monitoring, and frequency of testing.
- Ensure standard reporting of data collection and review of data quality to confirm reliability to compare and monitor trends among schools.
- Implement routine sharing of fitness testing results to all stakeholders.
    - To students and their families to monitor individual progress
    - At school level to monitor and improve PE programming
    - At local/state/national level to monitor child fitness levels and help shape regional and national policies
- The COVID-19 pandemic highlights the urgent need for mandating and reporting fitness profiles across all states longitudinally to understand the short- and long-term effects of the pandemic on the health of children in the United States.

Human Subjects Approval Statement

This project was viewed as exempt by the UCI Institutional Review Board due to de-identified nature of the data.

Conflict of Interest

The authors declare no conflicts of interest.

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SUPPORTING INFORMATION

The following Supporting Information is available for this article:

Figure S1. Specific Fitness Tests Offered by States with Mandated SB-PFT (n = 13). Three states mandate fitness assessments but no specific tests required. Tests grouped by fitness component: aerobic capacity, body composition, abdominal strength and endurance, upper body strength & endurance, extensor strength & flexibility, and flexibility. BMI* includes states were BMI is optional.

Figure S2. Percentage of Students Tested by State and School Level. Data presented for aerobic capacity (A) and body composition (B).

Figure S3. Where/who Fitness Assessment Results are Reported. (n = 16)

Additional supporting information may be found online in the Supporting Information section at the end of the article.