Journal of Healthy Eating and Active Living
2022, Vol. 2, No. 3, pgs. 97-112

Physical Education Teachers' Perceived Effectiveness in Association with Student Attendance, Teacher Adaptability, External Educational Supports, and Teaching Format During the COVID-19 Pandemic

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Abstract

Spring 2020 pandemic-control policies included an abrupt shift to remote teaching, which may have affected physical education (PE) teachers' perceived effectiveness. This study examined K-12 PE teachers' perceived effectiveness in association with student attendance, teacher adaptability, PE supports, teaching format (in-person, remote synchronous, remote asynchronous, etc.), and teacher- and school-level demographics at three time points (pre-pandemic 2019-early 2020, Spring 2020, 2020-2021 school year). An electronic survey was developed by an expert panel and distributed to U.S. public school PE teachers (convenience sampling via school health-related organizations). For analyses, teacher perceived effectiveness was dichotomized (very/extremely effective= "1"; not at all/slightly/moderately effective= "0"). Logistic regression models assessed associations between perceived effectiveness and independent variables (student attendance, teacher adaptability, PE supports, teaching format, and demographic variables) at each time point. Respondents (n=134; M age=46) were mostly female (62%), general PE teachers (82%, versus adapted), had a graduate degree (66%), had >11 years of teaching experience (63%), and from 26 states. Perception of being very/extremely effective was highest pre-pandemic 2019-early 2020 (93%), lowest in Spring 2020 (12%), and recovered somewhat in 2020-2021 (45%). During the 2020-2021 school year, teachers had greater odds of perceiving they were more effective if they reported having higher student attendance (OR 1.06 [CI:1.02-1.09], p>.001) and higher adaptability (OR 1.22 [CI: 1.09-1.37], p>.001), adjusting for gender, education level, years of experience, grade level taught, and Title I status. Professional development opportunities are needed for remote teaching of PE to enhance teachers' adaptability and perceived effectiveness during potential future school closures.

Keywords: Physical education, COVID-19 pandemic, teachers, remote teaching, distance learning, teacher effectiveness

Schools are recognized as a logical setting for improving student physical activity (PA) behaviors, skills, values, and beliefs, since students spend a majority of their time there (IOM, 2013). Opportunities to improve these behaviors include physical education (PE) and other school-based PA opportunities (e.g., before or after school PA programs), which are beneficial to student health and academic outcomes and can have long-term positive effects on PA habits into adulthood (Bailey, 2006; Kuhn et al., 2021; Trudeau et al., 1999). Spring 2020 pandemic-control policies included school closures, which forced schools to change how instruction was delivered and affected whether and how students received PE and other PA opportunities provided by schools (Pavlovic et al., 2021). As a result, most PE teachers shifted to remote teaching, where trial-and-error methods were used to implement PE virtually (Jeong & So, 2020). During this time, many PE teachers adapted to implementing PE online by focusing on providing PA opportunities at home and outdoors while encouraging student self-monitoring and goal setting (Gobbi et al., 2020). However, PE teachers also reported implementation challenges, including difficult communication with students, lack of student participation, limited student access to virtual content and technology, difficulty meeting students' needs, and having a remote work arrangement (Centeio et al., 2021; Pavlovic et al., 2021). Studies have demonstrated how these challenges, along with the isolation of remote teaching, negatively impacted PE teachers' perceived effectiveness of their teaching and student learning (Chan et al., 2021; Mercier et al., 2021).

Teacher effectiveness can be defined in terms of growth in student learning and is closely tied to PE program effectiveness (Burroughs et al., 2019; Goe, 2007; McKenzie & Lounsbery, 2014). Interventions to enhance PE teacher effectiveness have shown to increase student PA while in PE (Powell et al., 2016). Additionally, it is recommended that a measure of PE teacher effectiveness include student engagement in PA both in and outside of PE (McKenzie & Lounsbery, 2013). Student engagement has been found to predict teacher effectiveness as measured by course evaluations, but student attendance is required for students to be engaged (Richmond et al., 2015). Overall, student attendance declined during the COVID-19 pandemic, and school districts that were not providing in-person instruction had even lower attendance rates than school districts that provided in-person instruction during the 2020-2021 school year (Carminucci et al., 2021).

The abrupt change in teaching format could be another factor related to teachers' perceived effectiveness. Prior to the pandemic, one study reported that classroom teachers were unprepared for remote teaching in a virtual format, as the majority of teacher preparation programs did not formally prepare teachers for this mode of program delivery (Rehn et al., 2018; Graziano & Bryans-Bongey, 2018). During the pandemic, PE and classroom teachers perceived a decrease in their teaching effectiveness and noted a lack of social interaction due to remote learning formats which were synchronous (i.e., real-time online instruction), asynchronous (i.e., online independent learning) or hybrid (i.e., combination of in-person instruction and either synchronous or asynchronous remote learning) (Chan et al., 2021; Flack et al., 2020; Hamilton et al., 2021; Mercier et al., 2021).

During COVID-19-related school closures, adapting to remote teaching was crucial for PE teachers, as PE is a unique subject in which demonstration by the teacher and practice by students are required to learn skills. Adaptability is the ability to adapt to a changing environment and is an attribute necessary for change (Lehman et al., 2002). The ability to adjust instructional practices to meet student needs is known as a characteristic of effective teaching that promotes student engagement and positive student outcomes (Collie & Martin, 2016; Darling-Hammong, 2005; Williams & Baumann, 2008). Teacher adaptability for in-service teachers can be strengthened by professional development that includes active learning, effective instruction application, and reflection (Parsons et al., 2016). For preservice teachers, adaptability can be enhanced through educational psychology units in teacher education courses, scenario-based learning, and engagement with in-service teachers (Granziera et al., 2016). Since PE teachers were forced to adapt to remote teaching during the pandemic, it is essential to understand how their perceived adaptability may have related to their perceived effectiveness during this time.

Prior to the pandemic, studies showed that the presence of external supports including equipment, facilities and funding, school and district leadership, school and district policies, and professional development were necessary for effective PE implementation (Government Accountability Office, 2012; Carson et al., 2014; Agron et al., 2010; Chriqui et al., 2013; Braga et al., 2017). During the pandemic, changes in the presence of these factors could have affected teachers' perceived effectiveness. One qualitative study showed that professional development for remote teaching, administrative support, and equipment were necessary for successful implementation of PE during the pandemic (Vilchez et al., 2021). Furthermore, a survey of 226 teachers from three U.S. states found that teachers lacked professional development for remote teaching specific to PE (Johnson et al., 2021). However, less is understood about how the presence or absence of these supports could have related to teachers' perceived effectiveness throughout the pandemic.

Factors at the teacher- and school-level could also be related to teachers' perceived effectiveness of their teaching and student learning during the pandemic. Teacher-level factors studied in relation to effectiveness during non-pandemic times include gender, education level, and years of experience. In one study using a survey to evaluate teacher effectiveness, men reported higher perceived effectiveness than women (Roy & Halder, 2018). However, another study found that gender and education level were not correlated with teacher effectiveness (Slater et al., 2012). Years of experience has been found to be related to teacher effectiveness in that teachers with more experience were more effective than teachers with less experience (Buela & Joseph, 2015; Slater et al., 2012).

Factors at the school-level that may be related to teacher effectiveness include school level and title I status (i.e., a status designated to a school by a federal program that provides financial assistance to schools with large populations of children from low-income families to ensure that all children meet challenging state academic standards) (U.S. Department of Education, 2019). Studies have found that middle school teachers were less effective (measured via teacher observations) than elementary school teachers in Math and English and language arts (ELA) and other research has shown that school socioeconomic status was positively related to students' achievement (Mihaly & Mccaffrey, 2015; Akay & Karadag, 2019; Xuan et al., 2019).

Although other studies examined PE teacher effectiveness during the pandemic, this study sought to understand how the abrupt transition to remote teaching in Spring 2020 affected teachers' perceived effectiveness of their teaching and student learning before and at two timepoints during the pandemic (Chan et al., 2021; Mercier et al., 2021). The purpose of this study was to examine PE teachers' perceived effectiveness in association with student attendance, student engagement, teacher adaptability, external PE supports, and teaching format, while controlling for teacher- and school-level demographics at three time points: pre-pandemic 2019-early 2020, during Spring 2020 school closures, and in the 2020-2021 school year following the onset of the pandemic. We hypothesized that perceived effectiveness would be associated with higher student attendance, higher teacher adaptability, having more external supports for PE, and teaching in-person without physical distancing at all three time points.

Methods

Study Design

An electronic survey that assessed PE teacher effectiveness, student attendance and engagement, teacher adaptability, external supports for teaching, teaching format, and teacher- and school-level demographics was developed by an expert panel from the Centers for Disease Control and Prevention's (CDC) Physical Activity Policy Research Evaluation Network (PAPREN) school wellness working group. Survey items were found through literature searches and adapted from established measures. The survey was pilot tested by in-service PE teachers for feedback on wording/phrasing that needed to be adjusted and the time it took to complete. Questions assessed outcomes at three time points (i.e., pre-pandemic 2019-early 2020, during Spring 2020, and in the 2020-2021 school year). Outcomes were assessed retrospectively for pre-pandemic 2019-early 2020 and Spring 2020, while 2020-2021 data were collected in real time. The electronic survey was posted to social media platforms (e.g., Twitter) and sent via email to PE teachers in the U.S. by PE related organizations, including the Society for Health and Physical Educators (SHAPE) America, SHAPE Maryland and California, Active Schools, the National Consortium for Physical Educators for Individuals with Disabilities (NCPEID), and the Maryland and West Virginia State Departments of Education. The survey was disseminated between November 2020 and May 2021. One organization resent the survey each month with their monthly newsletter and the social media post was re-shared multiple times. We ensured that participants did not respond to the survey multiple times by examining IP addresses and their corresponding survey answers to ensure uniqueness of responses. Participants provided consent by clicking on the survey link, and IRB approval was granted by the University of Maryland School of Medicine (HP-00093542).

Measures

PE teachers' perceived effectiveness

Given the participant burden of using a full scale to assess effectiveness, we adapted a previously-used single-item measure to assess PE teachers' perceived effectiveness during the pandemic at three time points (Mercier et al., 2021). The item read "How effective did you perceive your teaching and student learning of PE at each time point?" Responses were on a five-point Likert-type scale ranging from 1 (not at all effective) to 5 (extremely effective). Effectiveness was dichotomized for analysis and reporting below so that 1 included 'very effective' and 'extremely effective' and 0 included 'moderately effective,' 'slightly effective,' and 'not at all effective.' The variable was dichotomized this way so that our findings would show associations with the "ideal" answers (i.e., very and extremely effective).

Estimated percent of student attendance

Teachers were asked to estimate the percent of student attendance using a single item that read "Please estimate the percent of students that attended your PE and/or adapted PE class at each time point." Responses were on a continuous sliding scale from 0 to 100 percent.

Estimated percent of student engagement

Estimated percent of student engagement was assessed using a single item that read "Please estimate the percent of students that were engaged in your PE and/or adapted PE class at each time point." Responses were on a continuous sliding scale from 0 to 100 percent. As a preamble to the question, we defined engagement as "the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught" (The Glossary of Education Reform, 2016).

PE teacher adaptability

Teacher adaptability was assessed via a total of five items, including four adapted items from the Texas Christian University Organizational Readiness Scale (TCU ORC-D4) (Lehman et al., 2002). For example, the TCU ORC-D4 question "You are able to adapt quickly when you have to make changes" was slightly modified to "You have been able to adapt quickly to make changes to implement PE and/or adapted PE during the pandemic." Additionally, one question was added by the authors to examine teachers' adaptability for using technology that read "You have been able to adapt to using online or app-based physical activity assessments to monitor student physical activity during

PE." Responses were on a five-point Likert type scale ranging from 1 (strongly disagree) to 5 (strongly agree). For analysis purposes, one item was reverse coded: "You have sometimes been too cautious or slow to implement PE and/or adapted PE during the pandemic." Based on the TCU ORC-D4 scoring guide, scores were obtained by summing the responses, dividing the sum by the number of items included (i.e., 5), then multiplying by 10 to rescale scores from 10 to 50.

External PE supports

Teachers self-reported the environmental, leadership and wellness team, policy, and professional development supports that were available for PE at each time point. Participants indicated whether each support was present before, during, or in the school year following the pandemic. Items were based on supports identified in a conceptual model for school-wide physical activity (Carson et al., 2014). Responses were summed to create a sum score for each time point, with higher scores indicative of more supports (items listed in Table 3).

Teaching format

Teaching format was self-reported for each time point. Options included: (a) teaching in-school without physical distancing, (b) teaching in-school with physical distancing, (c) hybrid (both in-person and remote) learning, (d) synchronous remote learning, (e) asynchronous remote learning, and (f) PE not permitted. Participants could select more than one format for each time point.

Demographics

Teachers self-reported teacher-level demographic variables including gender, primary role (general PE teacher, adapted PE teacher, or both), age, level of education, years of teaching experience, and the state they taught in. Teachers also self-reported school-level demographic variables including grade level taught (i.e., elementary, middle, multiple grade levels), Title I status, total student enrollment, and the number of full- and part-time PE teachers at their school. Data on school district locale and race/ethnicity were collected from the National Center for Education Statistics (NCES) based on zip code, if provided.

Statistical Analysis

Descriptive analyses were performed for continuous variables by calculating means and standard deviations and for categorical variables by calculating frequencies. We were unable to calculate the response rate since we did not know the number of individuals on many of the PE-related organizations' listservs and were unable to know how many people came across the survey posted on social media. We assessed internal consistency using Cronbach's alpha for the adaptability scale. Binary logistic regression models were run to assess associations between the dependent variable (perceived effectiveness) and independent variables (% student attendance, teacher adaptability, PE supports, teaching format, and demographic variables) at each time point. We assessed multicollinearity and found that student engagement was correlated with student attendance (Pearson correlation, r=.5). Since we chose a more conservative threshold for excluding pairs of correlated predictors in the models (r=.5), engagement was excluded from the main analyses (Booth et al., 1994). The first model (pre-pandemic 2019-early 2020) included estimated % student attendance, teacher adaptability sum score, and PE support sum score for pre-pandemic 2019-early 2020. The second (Spring 2020) and third models (2020-2021 school year) included estimated % student attendance, adaptability sum score, PE support sum score, and teaching format. The fourth model (2020-2021 school year) included estimated % student attendance, adaptability sum score, PE support sum score, teaching format and adjusted for teacher gender, education level, years' experience, grade level taught, and school Title I status. Teaching format was not included in the first model because instruction was primarily in-person prior to the pandemic. Data were analyzed using SPSS version 26.

Results

Participant Characteristics

Table 1 shows participant characteristics. The sample included 134 public school PE teachers from 26 states from all four regions of the U.S. The mean age was 46 (SD=10.4), and most were female (62%), general PE teachers (82%), had a graduate degree (66%), and had between 0-10 years of teaching experience (37%). The schools where teachers worked were primarily elementary (66%), had Title I status (54%), had a midsize student enrollment (i.e., 400-1199 students; 52%), were in suburban locations (44%), and had a student racial/ethnic composition of >50% white students (65%). Participants' self-reported average number of full-time PE teachers working at their school was 2.17 and the average number of part-time PE teachers working at their school was .33.

Table 1. Sample characteristics (N=134)

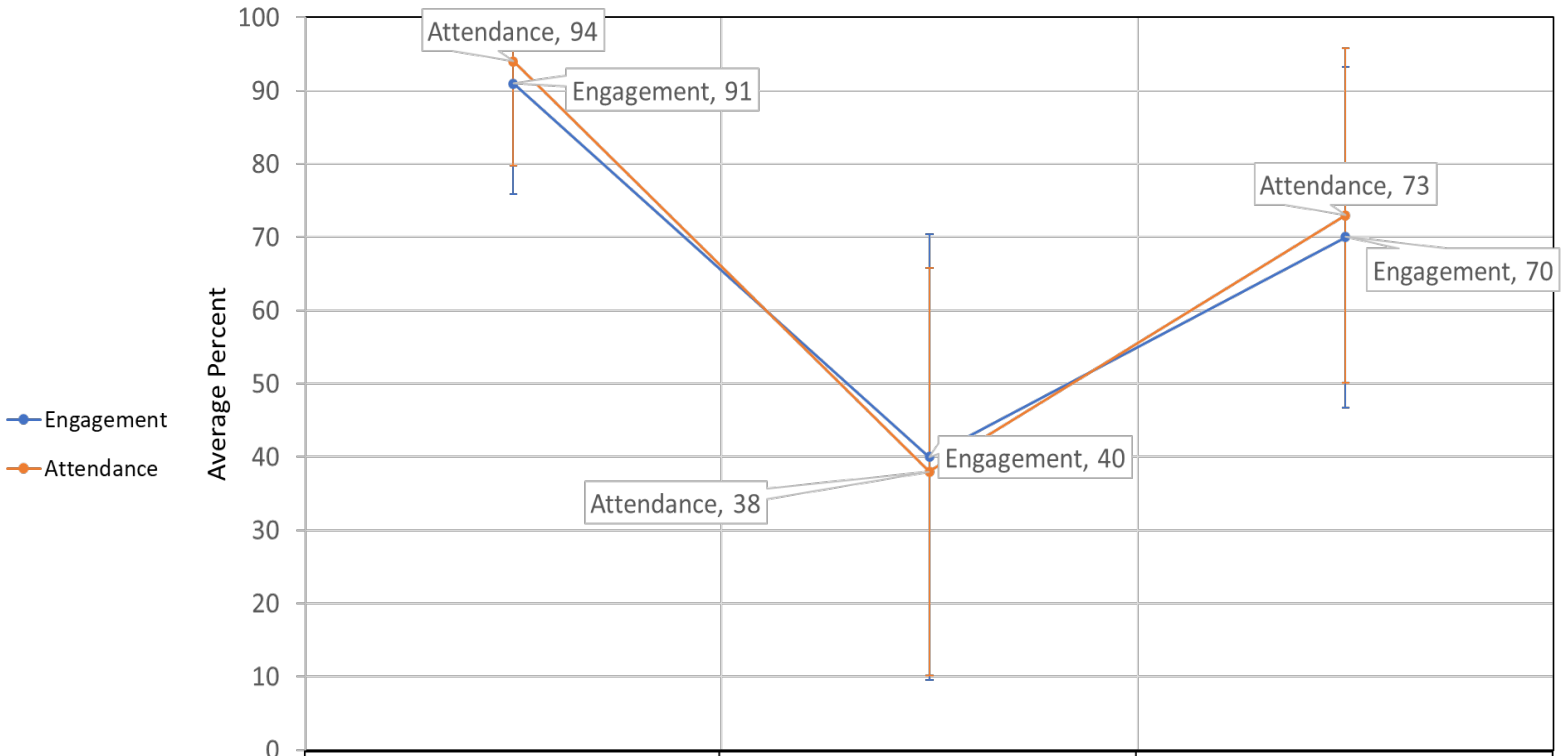
	N (%)
Gender (*n*=134)	
Male	47 (35%)
Female	83 (62%)
Non-binary	1 (1%)
Prefer not to answer	3 (2%)
Level of Education (*n*=134)	
No graduate degree	44 (33%)
Graduate degree	88 (66%)
Prefer not to answer	2 (1%)

Primary role (*n*=134)	
General physical education teacher	110 (82%)
Adapted physical education teacher	9 (7%)
Both	15 (11%)
Years of experience (*n*=133)	
0-10 years	49 (37%)
11-20 years	44 (33%)
21+ years	40 (30%)
Grade level taught (*n*=133)	
Elementary (K-5th grades)	88 (66%)
Secondary (6-12th grades)	46 (34%)
Title I School (*n*=133)	
Yes	72 (54%)
No	61 (46%)
School enrollment (*n*=133)	
0-399	42 (32%)
400-1199	69 (52%)
1200 or more	22 (17%)
District locale (*n*=117)*	
Rural	28 (21%)
Suburban	59 (44%)
Urban	30 (22%)
District race/ethnicity (*n*=113)*	
≥50% White	87 (65%)
≤50% White	26 (19%)
	M (range)
Age (*n*=131)	46 (range: 26-70)
# full-time PE teachers at school (*n*=131)	2.17 (range: 0-10)
# part-time PE teachers at school (*n*=132)	.33 (range: 0-3)
# of states PE teachers were located (*n*=134)	26

Note. The full analytic sample was 134. The sample size for characteristics varies due to incomplete responses. *Data was pulled from the National Center for Education Statistics based on zip code, if provided by participant.

Estimated Attendance, Engagement, and Teaching Format

Figure 1 shows PE teachers' estimated percent of students that attended and were engaged in PE at each time point with the teaching format for each time point. Pre-pandemic 2019-early 2020, PE teachers' estimated attendance and engagement averaged 94% and 91% respectively, while 88% of teachers reported teaching in school without physical distancing. During the Spring of 2020, PE teachers' estimated attendance and engagement averaged 38% and 40% respectively while 48% of teachers reported asynchronous remote learning. During the 2020-2021 school year, PE teachers' estimated attendance and engagement averaged 73% and 70% respectively, while 77% of teachers reported teaching in more than one format.



	Before (*n*=100)	**Spring 2020** (*n*=96)	**2020-2021** (*n*=101)
In school - no physical distancing	88 (88%)	2 (2%)	1 (1%)
In school with physical distancing	1 (1%)	1 (1%)	2 (2%)
Hybrid learning	0	0	2 (2%)
Distance learning – synchronous	0	7 (7%)	16 (16%)
Distance learning – asynchronous	0	46 (48%)	2 (2%)
PE not permitted	0	1 (1%)	0
More than one format	11 (11%)	39 (40%)	78 (77%)

Figure 1: PE teachers' estimated percent of students that attended and were engaged in PE at each time point. Frequency of PE teaching format at each timepoint is shown in table below the figure.

PE Teachers' Perceived Effectiveness

PE teachers' perceptions of their effectiveness of teaching and student learning at each time point is shown in Supplementary Material 1. Pre-pandemic 2019-early 2020, 93% of teachers perceived their teaching and student learning to be very or extremely effective. During the Spring of 2020, only 12% of teachers perceived their teaching and student learning to be very or extremely effective. During the 2020-2021 school year, 45% of PE teachers perceived their teaching and student learning to be very or extremely effective.

PE Teacher Adaptability

Table 2 shows PE teachers' self-reported adaptability. 70% of teachers reported agreeing or strongly agreeing that they were able to adapt quickly to make changes to implement PE during the pandemic. 88% of teachers reported agreeing or strongly agreeing that they were willing to try new ideas to implement PE during the pandemic even if some staff members were reluctant. The average score for adaptability was 35.64 (range: 22-50) and the Cronbach's alpha was .57.

Table 2: PE teachers' self-reported Organizational Readiness for Change – Adaptability Scale

	Strongly disagree-uncertain (1-3)	Strongly agree / Agree (4-5)
1. Learning and using new procedures for implementing PE and/or adapted PE during the pandemic has been easy for you	79 (59%)	54 (40%)
2. You have been able to adapt quickly to make changes to implement PE and/or adapted PE during the pandemic	39 (29%)	94 (70%)
3. You have been willing to try new ideas to implement PE and/or adapted PE during the pandemic even if some staff members were reluctant	15 (11%)	118 (88%)
4. You have sometimes been too cautious or slow to make changes to implement PE and/or adapted PE during the pandemic	104 (78%)	29 (22%)
5. You have been able to adapt to using online or app-based physical activity assessments to monitor student physical activity during PE	52 (39%)	81 (60%)
Average score:	35.64 (Range: 22-50)	

Note. n=133. Cronbach's alpha=0.57

PE Supports

Table 3 shows self-reported supports for PE at each time point. Teachers averaged 9.72 supports pre-pandemic 2019-early 2020, 6.07 supports during the Spring of 2020, and 8.64 supports during the 2020-2021 school year.

Table 3. PE teachers' self-reported supports for PE at each timepoint

	Before	Spring 2020	2020-2021
Environment			
Access to online application or platform to track/monitor student physical activity during PE (*n*=101)	31 (31%)	33 (33%)	51 (51%)
Financial support for PE program needs (e.g., equipment, etc.; *n*=101)	67 (66%)	25 (25%)	48 (48%)
Time for planning and implementing PE (*n*=102)	84 (82%)	72 (71%)	86 (84%)
Use of gymnasium for PE (*n*=103)	91 (88%)	10 (8%)	48 (47%)
Use of school outdoor space for PE (*n*=102)	93 (91%)	13 (13%)	51 (50%)
Leadership and wellness teams			
Parent support for PE (*n*=102)	73 (72%)	45 (44%)	64 (63%)
Classroom teacher support for PE (*n*=101)	72 (72%)	54 (54%)	71 (70%)
School wellness team support for PE (*n*=100)	48 (48%)	32 (32%)	38 (38%)
School leadership support for PE (i.e., administration; *n*=102)	75 (74%)	58 (57%)	73 (72%)
District leadership support for PE (i.e., school board, superintendent; *n*=99)	55 (56%)	40 (40%)	49 (50%)
Policy supports			
School policies that ensured PE was provided (*n*=101)	89 (88%)	63 (62%)	83 (82%)
District policies that ensured PE was provided (*n*=100)	87 (87%)	60 (60%)	78 (78%)
Professional development			
Opportunities for professional development in online teaching/remote program delivery for PE (*n*=101)	22 (22%)	55 (55%)	72 (71%)
Opportunities for professional development for PE (other than online teaching/remote program delivery for PE; *n*=102)	78 (77%)	35 (34%)	46 (45%)
Average sum score (out of 14 items):	9.72	6.07	8.64

Note. 28 teachers stopped the survey halfway and did not provide responses to these questions, thus decreasing the sample size.

Characteristics Associated with Teachers' Perceived Effectiveness

Table 4 presents the results of the adjusted logistic regression models that examined characteristics associated with teachers' perceived effectiveness. In model 1, there were no significant associations with teachers' perceived effectiveness pre-pandemic 2019-early 2020. In model 2 during the spring of 2020, asynchronous remote learning (Adj. OR .01, p=.012) was significantly associated with teachers' perceived effectiveness, meaning that teachers were .01 times less likely to perceive themselves to be very or extremely effective if they were in an asynchronous remote learning format versus not. In model 3 during the 2020-2021 school year, higher student attendance (Adj. OR 1.05, p=001) and higher adaptability scores (Adj. OR 1.19, p<.001) were significantly associated with teachers' perceived effectiveness, meaning that teachers who reported higher rates of student attendance and adaptability scores had 1.05 and 1.19 times the odds of perceiving themselves as very or extremely effective, respectively. In model 4 during the 2020-2021 school year, higher student attendance (OR 1.06, p<.001) and higher adaptability scores (OR 1.22, p<.001) remained significantly associated with teachers perceived effectiveness after adjusting for covariates.

Table 4. Adjusted logistic regression models for attendance, adaptability, PE support, demographics, and PE format in relation to perceived effectiveness

Dichotomized Effectiveness Score	**Model 1: Dichotomized Effectiveness Before (*n*=100)**	**Model 2: Dichotomized Effectiveness Spring 2020 (*n*=97)**	**Model 3: Dichotomized Effectiveness 2020-2021 (*n*=100)**	**Model 4: Dichotomized Effectiveness Adjusted model (2020-2021; *n*=99)**
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Estimated % student attendance	.94 (.80-1.10)	1.02 (.98-1.06)	**1.05 (1.02-1.07)****	**1.06 (1.02-1.09)****
Adaptability score	.32 (.94-1.06)	1.07 (.89-1.28)	**1.19 (1.08-1.31)****	**1.22 (1.09-1.37)****
PE support sum score	.76 (.81-1.34)	1.38 (.93-2.05)	1.00 (.85-1.18)	.96 (.80-1.16)
PE Delivery Format (see Note)				
PE offered in school no physical distancing		8.60 (.11-660.51)	1.66 (.34-8.01)	1.72 (.28-10.39)
PE offered in school with physical distancing		2.31 (.03-211.40)	.45 (.11-1.76)	.38 (.07-1.99)
Remote learning – synchronous		.17 (.01-2.84)	.70 (.21-2.30)	.77 (.20-2.93)
Remote learning - asynchronous		**.01 (.00-.40)***	.78 (.20-3.01)	1.55 (.31-7.73)
Hybrid learning		.19 (.00-17.86)	1.14 (.29-4.54)	1.43 (.26-7.67)
More than one format		8.88 (.15-509.90)	2.67 (.45-15.93)	1.96 (.27-14.09)
Gender (ref: male)				--
Female				2.17 (.64-7.39)
Education level (ref: no graduate degree)				--
Graduate degree				1.86 (.54-6.47)
Years experience (ref: 0-10 years)				--
11-20 years				2.40 (.62-9.27)
20+ years				2.06 (.53-8.08)
Grade level taught (ref: K-5)				--
Secondary schools (grades 6-12)				.87 (.19-3.89)
Title I status (ref: not a Title I school)				--
Title I school				2.57 (.69-9.57)

Note. *p<.05 **p<.01. Significant regression coefficients are in bold fonts. Dependent variable: Teachers' perceived effectiveness dichotomized (1=very or extremely effective; 0=not at all – moderately effective). Each item under PE delivery format was a separate variable; the referent group for each delivery format was "No." Model 1 adjusted for PE support sum score. Models 2 and 3 adjusted for PE support sum score and PE delivery format. Model 4 adjusted for PE support sum score, PE delivery format, gender, education level, years of experience, grade level taught, and Title I status.

Discussion

This study examined PE teachers' perceived effectiveness in association with student attendance, teacher adaptability, external supports for PE, teaching format (in-person, remote synchronous, remote asynchronous, etc.), and teacher- and school-level demographics at three time points in a national sample of PE teachers. We found that teacher effectiveness, adaptability, student attendance and engagement, and external PE supports all decreased during Spring 2020 and partially rebounded during the 2020-2021 school year. We also found that student attendance and teacher adaptability were positively associated with teachers' perceived effectiveness during the 2020-2021 school year, highlighting the importance of supporting and strengthening teachers' adaptability for changing teaching formats from in-person to remote teaching. With the significant declines seen in children's PA from before to during the pandemic, it will be important to address these issues to continue providing PE and other school-based PA opportunities in case of future school closures (Kuhn et al., 2022). Presented below are implications and future directions for research and practice regarding PE teachers' perceived effectiveness during remote teaching.

Teacher effectiveness, adaptability, student attendance and engagement, and external PE supports showed a substantial decline in Spring 2020 and rebounded in the 2020-2021 school year. The results showed that teacher effectiveness decreased during Spring 2020, which is in line with other studies that found that PE teachers perceived themselves to be less effective (Chan et al., 2021; Mercier et al., 2021). Likewise, declines in student attendance and engagement reported in the present study were also in line with national data showing substantial declines in student attendance and enrollment during the 2020-2021 school year (Carminucci, 2021). The number of PE supports declined during Spring 2020 as well. Although outcomes rebounded during the 2020-2021 school year, they did not return to pre-pandemic levels. These declines may indicate that schools were not prepared for the abrupt transition to remote teaching. In the future, teachers should be offered more professional development for remote teaching so that they are better able to adapt to changes in the mode of program delivery, for both synchronous and asynchronous formats, thereby improving the amount of PA opportunities provided to students. Synchronous remote learning may more closely simulate in-person instruction and help to increase teachers' perceived effectiveness when online PE is necessary.

This study demonstrated that teachers' perceived effectiveness was negatively associated with asynchronous remote learning during Spring 2020 but was positively associated with their estimated student attendance and perceived adaptability during the 2020-2021 school year. During Spring 2020, most teachers (48%) reported using asynchronous remote learning, which may have catered better to students who did not have easy internet access. Although the asynchronous format may have been perceived as more flexible for teachers compared to the synchronous format, teachers perceived themselves to be less effective while teaching in this format (Hamilton et al., 2021). Since the odds ratio for asynchronous remote learning was small (.01), the odds were not much worse than teachers would feel less effective during asynchronous remote learning. However, the odds were stronger that teachers would feel effective when they scored higher on adaptability and perceived student attendance to be higher, which highlights the importance of strengthening teachers' adaptability through additional professional development so that they can adjust to student needs and continue providing effective instruction and PA opportunities. This finding is in line with previous research, since the ability to adjust instructional practices to meet student needs is a characteristic of effective teaching (Collie & Martin, 2016). The finding that student attendance was associated with teacher effectiveness was not surprising. Perhaps teachers perceived students who attended the class to also be engaged by participating and interacting with the content, which could have led them to perceive that their instruction was effective (Richmond et al., 2015). In the adjusted model, demographic variables were not associated with teachers' perceived effectiveness suggesting that all teachers were affected by the pandemic regardless of demographics. Although 66% of teachers held a graduate degree, the results are in line with previous research that showed no associations between level of education and teacher effectiveness (Slater et al., 2012).

Strengths and Limitations

This study had several strengths and limitations. This study examined variables at three time points to describe changes over time, however we used a self-report survey that required participants to retrospectively answer questions, which may have resulted in recall bias. We may have also encountered common method bias, in which constructs may share some degree of variance due to being collected by the same respondents (Podsakoff et al., 2003). Although the single-item measure used to assess teacher effectiveness had practical value alongside the inclusion of multiple measures in the survey (e.g., student engagement), and the item was previously used in another study among PE teachers during the pandemic, it was not validated and may lack conceptual rigor. However, the single-item measures were pilot-tested prior to data collection. We recommend that more robust scales be used in follow-up research about teaching and learning during the COVID-19 pandemic, as well as other future events that may bear upon school systems in similar ways (Kyrgiridis et al., 2014). The convenience sample was not ideal, but it was diverse in terms of grade level taught and years of experience and represented teachers from 26 states. Our sample (n=134; M age=46; 62% female; 66% graduate degree; 63% >11 years of teaching experience) was comparable to a larger randomly selected sample from a nationally representative study (n=407; M age=42; 49% female; 58% advanced degree; M years of teaching experience=15 years) (Webster et al., 2020). However, most of the data (68%) came from respondents in three states, which may limit generalizability.

Conclusions

The present study provides useful information about trends in PE teachers' practices and perceptions in tandem

with the COVID-19 pandemic, which greatly disrupted teaching practices and student learning. The results highlight the importance of enhancing teachers' adaptability through additional professional development for remote teaching so that they are better able to adapt to changes in the mode of program delivery, for both asynchronous and synchronous formats. Ensuring that effective PE instruction is provided during remote learning may benefit students' health and academic outcomes, and may positively influence their PA behaviors into adulthood (Bailey, 2006; Trudeau et al., 1999). Future research should use qualitative approaches to help enrich our understanding of these practices and perceptions and inform the evolving discourse surrounding recommendations for teaching PE remotely.

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Acknowledgments

This work is a product of the Physical Activity Policy Research and Evaluation Network (PAPREN), a thematic network of the CDC's Prevention Research Center network. PAPREN is supported by Cooperative Agreement Number U48DP006381 from CDC. The findings and conclusions in this paper are those of the author(s) and do not necessarily represent the official position of the CDC. The authors have no conflicts of interest. The authors would like to acknowledge and thank members of the PAPREN school wellness working group for their contributions to the study design and survey development. The authors would also like to thank SHAPE America, SHAPE Maryland and California, Active Schools, the National Consortium for Physical Educators for Individuals with Disabilities, and the Maryland and West Virginia State Departments of Education for disseminating the survey on our behalf.

Conflicts of Interest
The authors have no conflicts of interest.

Author Contributions
Conceptualization, All; Methodology, All; Analysis, A.K., E.R., J.C.; Writing – Original Draft, A.K.; Writing – Reviewing and Editing, All.

Human Subjects Statement
The Institutional Review Board at the University of Maryland School of Medicine approved this study.

References

Agron, P., Berends, V., Ellis, K., & Gonzalez, M. (2010). School Wellness Policies: Perceptions, Barriers, and Needs Among School Leaders and Wellness Advocates*. *Journal of School Health*, *80*(11), 527-535. https://doi.org/10.1111/j.1746-1561.2010.00538.x

Akay, E., & Karadag, E. (2019). Multilevel Analyses of Student, Parent, and School Indicators of Achievement in High School Transition in Turkey. *School Community Journal*, *29*(2), 31-62.

Bailey, R. (2006). Physical Education and Sport in Schools: A Review of Benefits and Outcomes. *Journal of School Health*, *76*(8), 397-401. https://doi.org/10.1111/j.1746-1561.2006.00132.x

Booth, G., Niccolucci, M., & Schuster, E. (1994). Identifying Proxy Sets in Multiple Linear Regression: An Aid to Better Coefficient Interpretation; Research paper INT (USA). *US Department of Agriculture, Forest Service, Rocky Mountain Research Station: Ogden, UT, USA*.

Braga, L., Jones, E., Bulger, S., & Elliott, E. (2017). Empowering teachers to implement innovative content in physical education through continuous professional development. *Teacher Development*, *21*(2), 288-306. https://doi.org/10.1080/13664530.2016.1235608

Buela, S., & Joseph, M. C. (2015). Relationship between personality and teacher effectiveness of high school teachers. *The International Journal of Indian Psychology*, *3*(1), 57-70.

Burroughs, N., Gardner, J., Lee, Y., Guo, S., Touitou, I., Jansen, K., & Schmidt, W. (2019). A Review of the Literature on Teacher Effectiveness and Student Outcomes. In *Teaching for Excellence and Equity: Analyzing Teacher Characteristics, Behaviors and Student Outcomes with TIMSS* (pp. 7-17). Springer International Publishing. https://doi.org/10.1007/978-3-030-16151-4_2

Carminucci, J., Hodgman, S., Rickles, J., & Garet, M. (2021). *National Survey of Public Education's Response to COVID-19: Student Attendance and Enrollment Loss in 2020-21*. A. I. f. R. (AIR). https://www.air.org/sites/default/files/2021-07/research-brief-covid-survey-student-attendance-june-2021_0.pdf

Carson, R. L., Castelli, D. M., Beighle, A., & Erwin, H. (2014). School-based physical activity promotion: a conceptual framework for research and practice. *Childhood obesity (Print)*, *10*(2), 100-106. https://doi.org/10.1089/chi.2013.0134

Centeio, E., Mercier, K., Garn, A., Erwin, H., Marttinen, R., & Foley, J. (2021). The Success and Struggles of Physical Education Teachers While Teaching Online During the COVID-19 Pandemic. *Journal of Teaching in Physical Education*, *40*(4), 667-673. https://doi.org/10.1123/jtpe.2020-0295

Chan, W.-k., Leung, K. I., Học, C. K., Wuc, W., Lam, K. Y., Wong, N. L., Chan, C.-y. G., Leung, K. M., & Tse, A. C.-Y. (2021). Effectiveness of online teaching in physical education during covid-19 school closures: A survey study of frontline physical education teachers in Hong Kong. *Journal of Physical Education and Sport*.

Chriqui, J. F., Eyler, A., Carnoske, C., & Slater, S. (2013). State and district policy influences on district-wide elementary and middle school physical education practices. *Journal of public health management and practice : JPHMP*, *19*(3 Suppl 1), S41-48. https://doi.org/10.1097/PHH.0b013e31828a8bce

Collie, R. J., & Martin, A. J. (2016). Adaptability: An important capacity for effective teachers. *Educational Practice and Theory*, *38*(1), 27-39. https://doi.org/10.7459/ept/38.1.03

Darling-Hammong, L., Bransford, J. (2005). *Preparing teachers for a changing world: What teachers should learn and be able to do*. Jossey-Bass.

Flack, C. B., Walker, L., Bickerstaff, A., Earle, H., & Margetts, C. (2020). Educator perspectives on the impact of COVID-19 on teaching and learning in Australia and New Zealand. *Pivot Professional Learning*.

Gobbi, E., Maltagliati, S., Sarrazin, P., di Fronso, S., Colangelo, A., Cheval, B., Escriva-Boulley, G., Tessier, D., Demirhan, G., Erturan, G., Yüksel, Y., Papaioannou, A., Bertollo, M., & Carraro, A. (2020). Promoting Physical Activity during School Closures Imposed by the First Wave of the COVID-19 Pandemic: Physical Education Teachers' Behaviors in France, Italy and Turkey. *Int J Environ Res Public Health*, *17*(24). https://doi.org/10.3390/ijerph17249431

Goe, L. (2007). The Link between Teacher Quality and Student Outcomes: A Research Synthesis.

Granziera, H., Collie, R. J., & Martin, A. J. (2016). Adaptability: An Important Capacity to Cultivate among Pre-Service Teachers in Teacher Education Programmes. *Psychology Teaching Review*, *25*(1), 60-66.

Graziano, K. J., & Bryans-Bongey, S. (2018). Surveying the National Landscape of Online Teacher Training in K–12 Teacher Preparation Programs. *Journal of Digital Learning in Teacher Education*, *34*(4), 259-277. https://doi.org/10.1080/21532974.2018.1498040

Hamilton, F. A., Skelley, D. L., & Hile, K. A. (2021). A Whole New World: PreK-12 Teachers' Perceptions of Instruction during a Pandemic. *Journal of Curriculum, Teaching, Learning and Leadership in Education*, *6*(1), 6.

Jeong, H.-C., & So, W.-Y. (2020). Difficulties of Online Physical Education Classes in Middle and High School and an Efficient Operation Plan to Address Them. *International Journal of Environmental Research and Public Health*, *17*(19), 7279. https://www.mdpi.com/1660-4601/17/19/7279

Johnson, J., Daum, D., & Norris, J. (2021). I Need Help! Physical Educators Transition to Distance Learning During COVID-19 [Article]. *Physical Educator*, *78*(2), 119-137. https://doi.org/10.18666/tpe-2021-v78-i2-10866

Kuhn, A. P., Kowalski, A. J., Wang, Y., Deitch, R., Selam, H., Rahmaty, Z., Black, M. M., & Hager, E. R. (2022). On the Move or Barely Moving? Age-Related Changes in Physical Activity, Sedentary, and Sleep Behaviors by Weekday/Weekend Following Pandemic Control Policies. *International Journal of Environmental Research and Public Health*, *19*(1), 286. https://www.mdpi.com/1660-4601/19/1/286

Kyrgiridis, P., Derri, V., Emmanouilidou, K., Chlapoutaki, E., & Kioumourtzoglou, E. (2014). Development of a Questionnaire for Self-Evaluation of Teacher Effectiveness in Physical Education (SETEQ-PE). *Measurement in Physical Education and Exercise Science*, *18*(2), 73-90. https://doi.org/10.1080/1091367X.2013.866557

Lehman, W. E., Greener, J. M., & Simpson, D. D. (2002). Assessing organizational readiness for change. *J Subst Abuse Treat*, *22*(4), 197-209. https://doi.org/10.1016/s0740-5472(02)00233-7

McKenzie, T. L., & Lounsbery, M. A. (2013). Physical education teacher effectiveness in a public health context. *Research quarterly for exercise and sport*, *84*(4), 419-430.

McKenzie, T. L., & Lounsbery, M. A. (2014). The pill not taken: Revisiting physical education teacher effectiveness in a public health context. *Research Quarterly for Exercise and Sport*, *85*(3), 287-292.

Medicine, I. o. (2013). In H. W. Kohl, III & H. D. Cook (Eds.), *Educating the Student Body: Taking Physical Activity and Physical Education to School*. National Academies Press (US)

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Mercier, K., Centeio, E., Garn, A., Erwin, H., Marttinen, R., & Foley, J. (2021). Physical Education Teachers' Experiences With Remote Instruction During the Initial Phase of the COVID-19 Pandemic. *Journal of Teaching in Physical Education*, *40*(2), 337-342. https://doi.org/10.1123/jtpe.2020-0272

Mihaly, K., & Mccaffrey, D. F. (2015). Grade-Level Variation in Observational Measures of Teacher Effectiveness. In *Designing Teacher Evaluation Systems* (pp. 7-49). https://doi.org/10.1002/9781119210856.ch2

Office, U. S. G. A. (2012). *K-12: School-based physical education and sports programs.* Washington, DC Retrieved from https://www.gao.gov/assets/gao-12-350.pdf

Parsons, A. W., Ankrum, J. W., & Morewood, A. (2016). Professional Development to Promote Teacher Adaptability [Article]. *Theory Into Practice*, *55*(3), 250-258. https://doi.org/10.1080/00405841.2016.1173995

Pavlovic, A., DeFina, L. F., Natale, B. L., Thiele, S. E., Walker, T. J., Craig, D. W., Vint, G. R., Leonard, D., Haskell, W. L., & Kohl, H. W. (2021). Keeping children healthy during and after COVID-19 pandemic: meeting youth physical activity needs. *BMC Public Health*, *21*(1), 485. https://doi.org/10.1186/s12889-021-10545-x

Podsakoff, P., Mackenzie, S., Lee, J., & Podsakoff, N. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. 88 (5), 879–903. In.

Powell, E., Woodfield, L. A., & Nevill, A. M. (2016). Increasing physical activity levels in primary school physical education: The SHARP Principles Model. *Preventive Medicine Reports*, *3*, 7-13.

Pulling Kuhn, A., Stoepker, P., Dauenhauer, B., & Carson, R. L. (2021). A Systematic Review of Multi-Component Comprehensive School Physical Activity Program (CSPAP) Interventions. *American Journal of Health Promotion*, *35*(8), 1129-1149. https://doi.org/10.1177/08901171211013281

Reform, T. G. o. E. (2016). *Student Engagement*. https://www.edglossary.org/student-engagement/

Rehn, N., Maor, D., & McConney, A. (2018). The specific skills required of teachers who deliver K–12 distance education courses by synchronous videoconference: implications for training and professional development. *Technology, Pedagogy and Education*, *27*(4), 417-429. https://doi.org/10.1080/1475939X.2018.1483265

Richmond, A. S., Berglund, M. B., Epelbaum, V. B., & Klein, E. M. (2015). a+(b1) Professor–student rapport+(b2) humor+(b3) student engagement=(Ŷ) Student ratings of instructors. *Teaching of Psychology*, *42*(2), 119-125.

Roy, R. R., & Halder, U. K. (2018). Teacher effectiveness: A self-report study on secondary school teachers. *International Journal of Research and Analytical Reviews*, *5*(24), 36-46.

Slater, H., Davies, N. M., & Burgess, S. (2012). Do Teachers Matter? Measuring the Variation in Teacher Effectiveness in England*. *Oxford Bulletin of Economics and Statistics*, *74*(5), 629-645. https://doi.org/https://doi.org/10.1111/j.1468-0084.2011.00666.x

Trudeau, F., Laurencelle, L., Tremblay, J., Rajic, M., & Shephard, R. J. (1999). Daily primary school physical education: effects on physical activity during adult life. *Medicine & Science in Sports & Exercise*, *31*(1). https://journals.lww.com/acsm-msse/Fulltext/1999/01000/Daily_primary_school_physical_education__effects.18.aspx

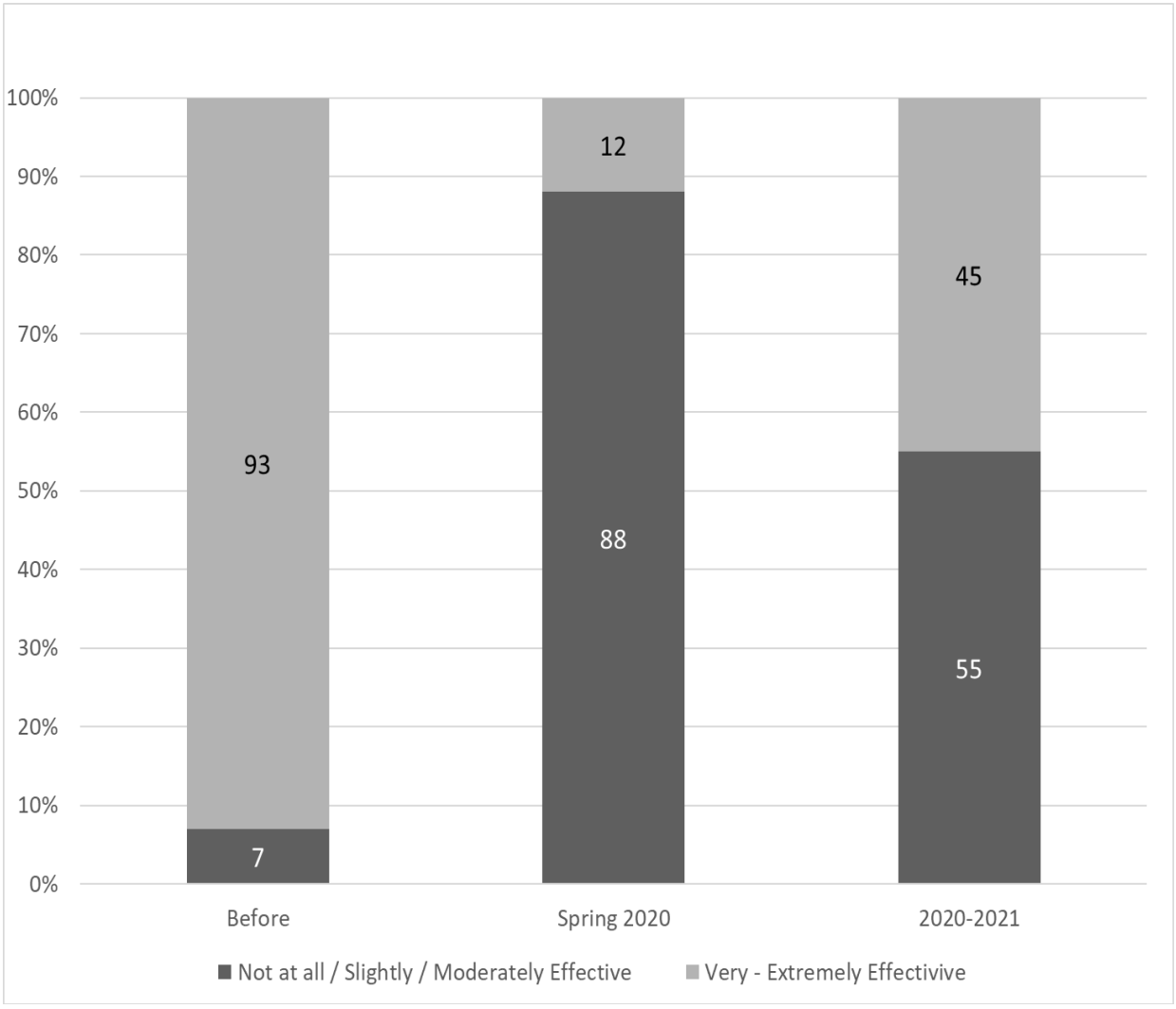
U.S. Department of Education, N. C. f. E. S. (2019). *Study of the Titel I, Part A Grant Program Mathematical Formulas (NCES 2019-016), Education Summary, Introduction, and Chapter 1*.

Vilchez, J. A., Kruse, J., Puffer, M., & Dudovitz, R. N. (2021). Teachers and School Health Leaders' Perspectives on Distance Learning Physical Education During the COVID-19 Pandemic. *The Journal of school health*, *91*(7), 541-549. https://doi.org/10.1111/josh.13030

Webster, C. A., Mîndrilă, D., Moore, C., Stewart, G., Orendorff, K., & Taunton, S. (2020). Measuring and Comparing Physical Education Teachers' Perceived Attributes of CSPAPs: An Innovation Adoption Perspective. *Journal of Teaching in Physical Education*, *39*(1), 78-90. https://doi.org/10.1123/jtpe.2018-0328

Williams, T. L., & Baumann, J. F. (2008). Contemporary research on effective elementary literacy teachers. 57th yearbook of the National Reading Conference,

Xuan, X., Xue, Y., Zhang, C., Luo, Y., Jiang, W., Qi, M., & Wang, Y. (2019). Relationship among school socioeconomic status, teacher-student relationship, and middle school students' academic achievement in China: Using the multilevel mediation model. *PloS one*, *14*(3), e0213783. https://doi.org/10.1371/journal.pone.0213783



Supplementary Material 1: PE teachers' (*n*=108) perceptions of their effectiveness of teaching and student learning at each time point. Variable was dichotomized in regression model: 1=very/extremely effective and 0=not at all-moderately effective.