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Original Research

Examining associations between school-level determinants and the implementation of physical activity opportunities

Derek W. Craig,[1,*] Timothy J. Walker,[1] Shreela V. Sharma,[2] Paula Cuccaro,[1] Natalia I. Heredia,[1] Andjelka Pavlovic,[3] Laura F. DeFina,[3] Harold W. Kohl,III, [4,5] Maria E. Fernandez[1]

[1]Department of Health Promotion and Behavioral Sciences, The University of Texas Health Science Center at Houston School of Public Health, 7000 Fannin Street, Houston, TX 77030, USA,
[2]Department of Epidemiology, Human Genetics, and Environmental Sciences, The University of Texas Health Science Center at Houston School of Public Health, 1200 Pressler Street, Houston, TX 77030, USA,
[3]Division of Youth Education, The Cooper Institute, 12330 Preston Road, Dallas, TX 75230, USA,
[4]Department of Kinesiology and Health Education, The University of Texas at Austin, 2109 San Jacinto Boulevard, Austin, TX 78712, USA,
[5]Department of Epidemiology, Human Genetics, and Environmental Sciences, The University of Texas Health Science Center at Houston School of Public Health, 1616 Guadalupe Street, Austin, TX 78701 USA,

[*]Correspondence address. Department of Health Promotion and Behavioral Sciences, Center for Health Promotion and Prevention Research, University of Texas Health Science Center at Houston School of Public Health, 7000 Fannin Street, Houston, TX, 77030 USA. E-mail: Derek.W.Craig@uth.tmc.edu

Abstract

School-based physical activity (PA) opportunities can help students engage in greater amounts of daily PA, meet PA guidelines, and lead to improved health and educational outcomes. However, we do not completely understand the organizational challenges to implementing these opportunities successfully. This exploratory study examined associations between school-level determinants and the implementation of school-based PA opportunities. We analyzed cross-sectional survey data from schools (n = 46) participating in the Healthy Zone School Program (HZSP) (Dallas, Texas, USA) during 2019–2020. Respondents completed an electronic survey that included measures of school-level determinants (e.g. culture, leadership, priority) and the implementation of school-based PA opportunities. We used linear regression models to examine associations between determinants and implementation outcomes (number of PA opportunities delivered, perceived overall success of each PA program/activity used). After adjusting for campus type (i.e. elementary, middle, high, K-12), student race/ethnicity, and percentage of economically disadvantaged students, no constructs were associated with the number of PA opportunities implemented. Linear regression models suggest access to knowledge and information (β = 0.39, P = .012, 95% CI = 0.24–1.44) and implementation climate (β = 0.34, P = .045, 95% CI = 0.02–1.59) were positively associated with the success of school-based PA opportunities. Our findings provide suggestive evidence that access to knowledge and information and a supportive school climate may improve the overall success of PA opportunities provided to students. Future research should examine additional school-level determinants to understand their importance to implementation and inform the development of strategies to improve schools' capacity for implementing PA opportunities successfully.

Lay summary

School-based physical activity (PA) opportunities (e.g. programs, activities, policies) help students engage in greater amounts of daily PA, meet national PA guidelines, and lead to improved health and educational outcomes. However, we do not completely understand the organizational challenges to implementing these opportunities successfully. This study explored what factors contribute to schools' ability to provide PA opportunities throughout the school year. We administered a survey to schools participating in the Healthy Zone Schools program during the 2019–20 academic year to assess the relationship between school-level determinants (e.g. culture, leadership, priority) and implementation outcomes related to school-based PA opportunities (e.g. number of programs and activities implemented, overall success of programs/activities implemented). We found no evidence of an association between determinants and the number of PA programs and activities implemented. However, we identified implementation climate and access to knowledge and information as key drivers of implementation success. This information can be used to develop implementation strategies that improve PA opportunities offered by schools.

Keywords: physical activity; implementation; schools; determinants

Implications

Practice: A climate that supports implementation and access to program- and activity-related information may improve the success of physical activity (PA) opportunities delivered by schools.
Policy: Policymakers must consider the factors that impact implementation when developing policies for PA opportunities to increase the likelihood of their success.
Research: Research should examine additional school-level factors to understand their role in the implementation process and inform the development of implementation strategies to address key factors.

Introduction

Improving the health and well-being of youth has long been a priority for the public health and education sectors [1, 2]. These two sectors frequently serve the same children, underscoring the need for greater alignment, integration, and collaboration [3]. The Whole School, Whole Community, Whole Child (WSCC) model emphasizes collaboration between the public health and education sectors to address health in schools [4]. Physical activity (PA) is a key component of the WSCC model and an important contributor to overall health [4, 5]. Providing students with school-based PA opportunities is vital as they have been shown to improve health outcomes (e.g. health-related fitness, healthy body weight) [6–12] and educational outcomes (e.g. academic behaviors and achievement) [13–15]. However, there are numerous factors that can impact the implementation and success of PA opportunities that schools must consider.

Past qualitative studies have identified many school-level determinants (i.e. barriers and facilitators) to implementing PA opportunities. Lack of time [16, 17], competing educational priorities [18–23], insufficient resources [24–26], and staff turnover [24, 27, 28] have previously been identified as implementation barriers. Other studies have found school/district support [19, 29–31], staff engagement [32, 33], and school climate [24, 26, 34] to facilitate implementation. Despite the available evidence from qualitative studies, the impact school-level determinants have on implementation outcomes, as it relates to PA opportunities, has not been widely examined quantitatively [34, 35]. Available evidence suggests that school climate [25, 36], supportive school staff [23, 37], available resources [36, 38, 39], and training/implementation support [36, 38, 40, 41] are associated with implementing school-based PA opportunities successfully. However, past studies have considered a limited number of constructs from the vast implementation science literature and few were informed by implementation frameworks [36, 39, 42, 43].

Determinant frameworks can be used to systematically identify barriers and facilitators (i.e. determinants) to implementing school-based PA opportunities successfully [44, 45]. The Consolidated Framework for Implementation Research (CFIR) [46] and the $R = MC^2$ heuristic (Readiness = Motivation × Innovation-Specific Capacity × General Capacity) [47] are examples of two widely used determinant frameworks in implementation science. Both frameworks comprise multiple theoretical determinants previously found to influence implementation outcomes across various disciplines and settings. Within each framework, determinants are categorized within domains and can guide the assessment of potential barriers and facilitators to implementation. Data on what factors influence implementation can inform the design of implementation strategies and adaptations that enhance school-based PA opportunities. Despite their prominence throughout the implementation science literature, these two frameworks have been used less often to study the implementation of PA opportunities in the school setting. Therefore, the aim of this study was to examine the associations between school-level determinants (from CFIR and $R = MC^2$ heuristic) and the implementation of school-based PA opportunities. Specifically, we examined relations between school-level determinants and (i) the total number of PA opportunities implemented, and (ii) the self-reported success of PA opportunities implemented.

Methods

Study design and setting

The current study is based on cross-sectional survey data from schools participating in The Cooper Institute's (Dallas, Texas, USA) evidence-based Healthy Zone School Program (HZSP, https://www.healthyzoneschool.com/) [9, 48]. Data for this study were collected between April and May 2020 using a survey administered via Qualtrics. The purpose of the parent study was to evaluate the impact of the HZSP on the school environment and children's health fitness and academic performance. The study was approved by the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston School of Public Health (HSC-SPH-18-0549).

Healthy Zone School Program

The HZSP aims to create school environments that promote PA, healthy eating, and social-emotional well-being among students, staff, and the school community. Schools of all grade levels (i.e. elementary, middle, and high) and types (i.e. public, private, and charter) throughout the Dallas metropolitan area were eligible to apply for the program. Printed promotional materials, social media, the HZSP website, and word-of-mouth were used to encourage schools to apply for the HZSP. Additionally, the HZSP staff gave presentations to multiple School Health Advisory Committees in Metropolitan Dallas to further promote the program. The competitive selection process, completed by a review committee, focused on the evaluation of the school's current health practices, demographics and locations, and the potential and capacity to establish an optimal health-promoting environment.

Throughout the 3-year program, all participating schools are offered educational materials, trainings, and community resources to support the coordination and delivery of school-based programs and activities. The HZSP also offers schools a variety of resource-based webinars and access to an online

portal that provides guidance on best practices for implementing health-promoting initiatives. Participating schools are eligible to receive financial incentives (up to $7000 over 3 years) for implementing activities that help facilitate an environment that is supportive of healthy behaviors. Annual program activities required for funding include: (i) signing a district-level participation contract, (ii) attending the annual programmatic orientation event, (iii) creating/sustaining a school wellness committee, (iv) administration of FitnessGram (i.e. an assessment of cardiorespiratory and musculoskeletal fitness), (v) implementing relevant health-related programs and activities, and (vi) completing the HZSP survey. Schools that successfully complete the required annual activities are eligible for a year-end promotion which provides additional recognition opportunities in the form of media attention and school signage that indicates their designation as a Healthy Zone School. Additional details about the HZSP have been published elsewhere [9].

Participants

Data for the current study were collected from schools actively participating in the HZSP during the 2019–2020 school year. The HZSP survey was distributed to 48 of the 50 schools—two schools closed permanently during the school year and did not participate. To be included in the study, schools must have completed the annual HZSP survey and had school-level descriptive and demographic data available with the Texas Education Agency (TEA) [49]. One representative from each participating school, commonly a physical education teacher, completed the annual HZSP survey. Respondents consented electronically prior to completing the survey.

Measures

The annual HZSP survey includes questions about (i) existing school committees and policies, (ii) the use of school-based PA and healthy eating programs and activities, (iii) school-level implementation constructs, and (iv) overall reflections on the HZSP. For the current study, we focused the analysis on the survey questions related to school-level implementation constructs and the use of PA programs and activities implemented. We collected school-level variables from the TEA website that were thought to influence the implementation and success of PA programs and activities to control for in the subsequent analyses. Specifically, we obtained data on campus type (i.e. elementary, middle, high, K-12), Title 1 status (defined as a minimum of 40% of the students qualify for free or reduced lunch), percentage of economically disadvantaged students enrolled, and percentage of students served by race/ethnic categories. The study sample consisted of mostly elementary schools (n = 38), which led us to collapse three campus types (K-12, n = 2; middle, n = 4; and high schools, n = 4) into an "Other" category. We also used TEA's race/ethnicity data to generate a new variable that categorized schools into one of four groups based on student demographic information: majority Black (≥50% enrolled), majority Hispanic (≥50% enrolled), majority White (≥50% enrolled), Other/Diverse (no race/ethnicity group ≥50%).

We also examined nine implementation constructs from CFIR and the $R = MC^2$ heuristic (available resources, compatibility, culture, implementation climate, access to knowledge and information, leadership, learning climate, priority, and resource utilization). These constructs align with improving our understanding of the context and characteristics of organizations (e.g. schools) that influence the likelihood of implementation success [50, 51]. Information on constructs, definitions, theoretical sources, and the number of questions for each construct is provided in Table 1. The items used to measure implementation constructs were informed by existing measures [52, 53] or adapted from previously developed measures and were added secondarily to the existing HZSP survey. Items that were adapted had previously been tested in other settings for reliability and/or validity prior to being added to the HZSP survey [52–55]. We adapted items to be context (e.g. school) and innovation-specific (e.g. PA programs) and had the HZSP staff review the items for face validity before distribution. Example items are included in Table 2 (see Supplementary File for a complete list). A 5-point Likert scale (strongly disagree-strongly agree) was used to assess the implementation constructs and composite scores were generated for each construct using the mean score between questions.

Participants used a discrete list provided by HZSP staff to select the PA programs and activities implemented at their school during the 2019–2020 school year (e.g. Select the programs/activities your school used this past year. [Yes-Used, No-Not used]). *Programs* were defined as initiatives that consist of a planned series of events that occur on multiple occasions (e.g. running club, food logging). *Activities* were defined as one-time events that do not require continued participation over time (e.g. family fitness night, health fair). We directed the respondent to answer an additional question about the overall success for each program or activity that was reportedly used (e.g. Please indicate the overall success of the program/activity). We measured the overall success question using a 10-point scale (Not successful at all, 1, to Extremely successful, 10).

Statistical analysis

We completed descriptive analyses for the study sample using school-level data from TEA. We also completed preliminary data screening to assess the distributions of the implementation constructs (independent variables) and the number and success of programs and activities implemented (dependent variables). Then, we used Spearman's rank correlation coefficients to examine the relation between school-level implementation constructs and (i) the total number of PA programs and activities implemented, and (ii) the overall program/activity success rating. We considered correlation coefficient values ≥0.40 (moderate effect) to be suggestive of a relationship between implementation constructs and implementation outcomes [56, 57]. Implementation constructs with a correlation coefficient ≥0.40 were examined further using linear models.

Next, we used a series of multiple linear regression models to explore the variation in implementation outcomes as it relates to schools' readiness for implementation. We examined the association between statistically significant implementation constructs and the number of PA programs/activities used as well as their overall success rating. We used a bootstrapping method (random resampling with replacement, reps = 100) in each regression model to account for the small sample size and distribution of the data. We completed all analyses using STATA 15.1 and used a P-value of <.05 to indicate statistically significant associations.

Table 1 Constructs, definitions, implementation framework, and number of items

Construct name	Definition	Theoretical sources	Number of questions
Available resources	The level of resources dedicated for implementation and ongoing operations, including money, training, education, physical space, and time	CFIR	4
Compatibility	The degree of tangible fit between meaning and values attached to the intervention by involved individuals, how those align with individuals' own norms, values, and perceived risks and needs, and how the intervention fits with existing workflows and systems	CFIR, $R = MC^2$	4
Culture	Norms, values, and basic assumptions of a given organization	CFIR, $R = MC^2$	6
Implementation climate	The absorptive capacity for change, shared receptivity of involved individuals to an intervention, and the extent to which use of that intervention will be rewarded, supported, and expected within their organization	CFIR, $R = MC^2$	4
Access to knowledge and information	Ease of access to digestible information and knowledge about the intervention and how to incorporate it into work tasks	CFIR	5
Leadership	Whether power authorities articulate and support organizational activities	$R = MC^2$	4
Learning climate	A climate in which: (i) leaders express their own fallibility and need for team members' assistance and input; (ii) team members feel that they are essential, valued, and knowledgeable partners in the change process; (iii) individuals feel psychologically safe to try new methods; and (iv) there is sufficient time and space for reflective thinking and evaluation.	CFIR	5
Priority	Individuals' shared perception of the importance of the implementation within the organization	CFIR, $R = MC^2$	4
Resource utilization	How discretionary/uncommitted resources are devoted to innovations	$R = MC^2$	4

Table 2 Example survey items

Example items
• In general, when our school decides to use a PA program or activity, we have the necessary support in terms of training (available resources)
• School staff are expected to help deliver PA programs (implementation climate)
• Our school leadership supports ongoing PA programs (leadership)
• Using PA programs is one of our school's top priorities (priority)
• We regularly take time to consider ways to improve how we do things (learning climate)
• School staff know how to get good information about PA programs (access to knowledge and information)

Results

Forty-six schools (92%) completed the HSZP survey. The most common campus type in the sample was elementary (79%, n = 38), and 56%, (n = 28) of the schools were designated as Title 1. Two schools were missing data on the self-reported PA program/activity success rating, while the remaining schools had complete data on all variables of interest (i.e. implementation constructs, number of PA programs/activities implemented, PA program/activity success ratings). Additional descriptive information is found in Table 3.

On average, schools scored highest on compatibility ($\bar{x}$ = 4.63, SD = 0.71) and learning climate ($\bar{x}$ = 4.58, SD = 0.61) and scored lowest on available resources ($\bar{x}$ = 3.72, SD = 0.94). Elementary schools ($\bar{x}$ = 4.28) reported slightly higher scores across all implementation constructs in comparison to schools categorized as K-12, middle, and high schools ($\bar{x}$ = 4.16). Despite the full range of each scale being used, the composite scores for most implementation constructs were positively skewed (see Table 4).

Preliminary data screening indicated that the total number of PA programs and activities implemented were normally distributed. Schools reported implementing between 5 and 6 PA programs/activities during the school year ($\bar{x}$ = 5.30, SD = 1.96, range = 1.5–9.5), with slightly more programs ($\bar{x}$ = 5.76) than activities ($\bar{x}$ = 4.85) delivered. PA breaks (n = 36), school-wide signage (n = 33), and running clubs (n = 30) were the most frequently implemented *programs*, whereas award ceremonies (n = 31), community walks (n = 28), and walk-to-school events (n = 26) were the most frequently implemented *activities*. Over half of the sample (52%) reported implementing at least five PA programs/activities. Elementary schools reported implementing a significantly greater number of programs/activities ($\bar{x}$ = 5.70, SD = 1.88) compared to K-12, middle, and high schools ($\bar{x}$ = 3.67, SD = 1.44). Among the programs/activities implemented by schools, respondents self-reported an average program/activity success rating of 8.17 (SD = 1.78, range = 1.36–10). In terms of overall success, schools rated the PA programs and activities implemented similarly (8.32 vs. 8.03, respectively).

Results from bivariate Spearman correlations are presented in Table 5. Correlations between each implementation construct and the total number of PA programs/activities implemented were below 0.20, suggesting weak or no associations. Conversely, significant positive associations were found between six implementation constructs (resource availability, implementation climate, access to knowledge, leadership, priority, and organizational culture) and self-reported success ratings for PA programs and activities implemented by

Table 3 Descriptive information for schools participating in Healthy Zone School Program, 2019–2020

Variable	Total sample (n = 48)
Cohort (%, n)	
7 (began program fall 2018)	39.6 (19)
8 (began program fall 2019)	27.1 (13)
9 (began program fall 2020)	33.3 (16)
Campus type (%, n)	
Elementary	79.2 (38)
Non-elementary	20.8 (10)
Average student enrolment (mean, SD)	767.1 (663.6)
Title 1 (%, n)	56.0 (28)
Percent English Language Learner (mean, SD)	23.2 (20.3)
Percent economically disadvantaged students served (mean, SD)	46.1 (31.7)
School race/ethnicity (%, n)	
Majority White (≥50%)	18.8 (9)
Majority Black (≥50%)	4.2 (2)
Majority Hispanic (≥50%)	29.2 (14)
Diverse (no single race/ethnicity ≥50%)	47.9 (23)

Table 4 Descriptive information for variables of interest

	Mean (SD)	Range
Implementation constructs		
Access to knowledge	4.08 (0.82)	1.40–5.00
Compatibility	4.63 (0.71)	1.00–5.00
Leadership	4.38 (0.85)	1.00–5.00
Learning climate	4.58 (0.61)	2.00–5.00
Implementation climate	4.13 (0.77)	1.25–5.00
Culture	4.27 (0.71)	1.83–5.00
Priority	4.24 (0.78)	1.00–5.00
Resource availability	3.72 (0.94)	1.00–5.00
Resource utilization	4.29 (0.78)	1.00–5.00
Number of PA programs/activities implemented	5.30 (1.96)	1.50–9.50
PA program/activity success rating	8.17 (1.78)	1.36–10.00

Implementation constructs were measured on a 5-point scale; Program/Activity Success Ratings were measured on a 10-point scale.

schools. Among these constructs, implementation climate (ρ = 0.51, P < .01), access to knowledge and information (ρ = 0.49, P < .01), leadership (ρ = 0.48, P < .01), and priority (ρ = 0.44, P < .01) had correlations ≥0.40 and met criteria for inclusion in subsequent regression models.

Results from regression models are presented in Table 6. Multiple linear regression models using a bootstrap resampling technique (reps = 100) revealed implementation climate (β = 0.34, SE = 0.04, P = .045, 95% CI = 0.02–1.56) and access to knowledge and information (β = 0.39, SE = 0.34, P = .012, 95% CI = 0.18–1.50) were positively and significantly associated with PA program/activity success when controlling for campus type, race/ethnicity, and % ED. A final model combining both significant predictors suggested that no evidence of a statistically significant association remained between either implementation construct (implementation climate and access to knowledge and information) and the program/activity success rating when controlling for school characteristics.

Discussion

This study investigated the association between constructs from two prominent implementation frameworks (CFIR, $R = MC^2$ heuristic) and the number and success of PA programs and activities implemented by schools participating in the HZSP. Our findings indicate no evidence of a significant association between any of the constructs under study and the number of PA programs/activities implemented. Despite the lack of a significant association in the combined model, our study provides suggestive evidence that implementation climate (CFIR, $R = MC^2$) and access to knowledge and information (CFIR) may be associated with the success of the PA programs and activities implemented. While further investigation is needed, these findings suggest that a school climate that supports implementation and access to program- and activity-related information may enhance school-based PA opportunities.

Providing access to knowledge is an important component of successful implementation. Improving access to knowledge can help motivate staff to become more engaged in the implementation process and lead to more favorable implementation outcomes [58]. However, research quantifying the association between access to knowledge and information and PA programming success is limited, with most evidence stemming from qualitative studies. Access to knowledge and information was previously found to be associated with the implementation of a school-based active transportation intervention, but only among schools that reported that programming was unlikely to continue the following year [59]. This finding is similar to the present study where third-year schools tended to score higher on the access to knowledge construct. This finding supports the importance of developing ongoing program-related training and distributing capacity-building resources (e.g. implementation guides, toolkits) to ensure all staff members understand the unique features of each program/activity being implemented [60]. Furthermore, researchers must be thoughtful in their approach to addressing access to knowledge and information as doing so in isolation may be insufficient for the long-term sustainability of the program/activity.

Our findings also revealed implementation climate was associated with the success of PA programming. This finding is consistent with multiple studies that have used CFIR in the school setting to examine factors influencing PA-related programming [36, 59, 61]. School climate is a key determinant of whether elementary school teachers implement classroom-based approaches for increasing PA [36] and is essential to supporting the implementation of youth running programs [61], active transportation interventions [59], and school PA policies [43]. We defined implementation climate similar to the aforementioned studies and collected data from similar job types (e.g. physical educators, classroom teachers, head

Table 5 Spearman's correlation coefficients

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Resource availability	1.000										
(2) Implementation climate	0.501	1.000									
(3) Leadership	0.378	0.715	1.000								
(4) Access to knowledge	0.508	0.721	0.653	1.000							
(5) Priority	0.405	0.683	0.636	0.624	1.000						
(6) Org culture	0.274	0.667	0.704	0.593	0.596	1.000					
(7) Learning climate	0.214	0.537	0.511	0.519	0.488	0.775	1.000				
(8) Resource utilization	0.419	0.468	0.478	0.601	0.501	0.607	0.666	1.000			
(9) Compatibility	0.218	0.292	0.503	0.368	0.490	0.545	0.661	0.527	1.000		
(10) Num. of PA Prog/Act implemented	0.117	0.192	0.187	0.136	0.171	0.111	0.050	0.170	0.122	1.000	
(11) PA Prog/Act success	0.335	0.510*	0.476*	0.486*	0.444*	0.365	0.099	0.037	0.052	0.091	1.000

PA, Physical Activity; Prog, Program; Act, Activity.
*Indicates correlation >0.40 for inclusion in subsequent regression models.

Table 6 Bootstrap regression results for theoretical determinants

PA program/activity success	Standardized coefficients	Std. error	*P*-value	95% CI
Model 1				
Climate	0.34	0.41	.04*	0.02–1.59
Model 2				
Access to knowledge and information	0.39	0.30	<.01**	0.24–1.44
Model 3				
Leadership	0.32	0.39	.08	−0.09 to 1.43
Model 4				
Priority	0.27	0.47	.20	−0.32 to 1.53

Models for each theoretical determinant statistically controlled for school-level characteristics including campus type, percent economically disadvantaged, and race/ethnicity.
**$P < .01$;
*$P < .05$.

teachers/principals) further supporting our findings. Collectively, this information would suggest that school administrators should create and maintain an environment where staff are supported and rewarded for implementing PA programs and activities [36].

In addition to implementation climate and access to knowledge and information, bivariate Spearman correlations indicated available resources, leadership, priority, and culture were significantly related to implementation success. However, each of these constructs failed to reach statistical significance in regression models when controlling for school-level variables. Although studies examining these constructs quantitatively are lacking, qualitative studies support the importance of these constructs having previously identified them as determinants of implementation for school-based PA opportunities [19, 62, 63]. Additional studies should examine these constructs further as it is plausible that larger sample sizes are needed to detect significant associations.

There are several possible explanations for the lack of association between school-level determinants (i.e. implementation constructs) and implementation outcomes. First, the COVID-19 pandemic, which began during the spring semester of 2020, may have hindered the validity of survey data. The pandemic led some schools in Texas to begin shutting down in March/April 2020. Data collection procedures during the pandemic remained consistent with past assessments regardless of how schools were operating (i.e. in-person, virtual, hybrid) given that the survey was completed online and instructed respondents to report on programs/activities implemented by schools up until the time of survey administration (mid-April 2020). Schools with earlier shutdown dates may have reported implementing fewer programs/activities if they were unable to offer end-of-year school events that included PA components (e.g. field day, program celebrations). Additionally, operating in a virtual or hybrid environment likely prohibited schools from implementing new programs or activities while adapting to a new learning environment and the challenges associated with virtual instruction.

Another possible explanation is the degree to which the survey respondents were involved in implementing the PA programs and activities. Schools were in charge of selecting which staff member completed the HZS survey. The HZS survey assesses a range of school-level constructs requiring respondents to be familiar with PA programming efforts going on throughout the school. For example, PE teachers possess expertise in the curriculum and programming they provide but may not be as knowledgeable as an administrator or classroom teacher regarding the barriers and facilitators to how their school supports after-school PA opportunities and implementing classroom-based PA approaches. The HZSP

staff encouraged designated survey respondents to communicate with colleagues within the school while completing the survey to improve the accuracy and validity of the data collected. However, given the varying roles and responsibilities of staff within each school it is possible that survey respondents may have been unfamiliar with their school's PA programming, which would have biased our results towards the null.

Strengths

Our study has several strengths. First, we used a theoretically informed approach to examine constructs from two prominent determinant frameworks from the implementation science literature (CFIR, $R = MC^2$ heuristic). Our study is novel as it is among the first to quantitatively examine constructs from CFIR and the $R = MC^2$ heuristic and their association with implementing school-based PA opportunities. Constructs under study were known to be positively associated with implementation and survey questions were informed by existing measures or adapted from previously developed measures. This study is also unique in that it examined the implementation and success of *multiple* PA programs and activities used by schools throughout the school year. This approach adheres to the WSCC model and provides insights into how schools operate in the real world as opposed to studying PA opportunities in isolation. Additionally, we used an analytic approach that was appropriate for the exploratory nature of the study. We conducted Spearman's rank correlations to gain a better understanding of the relations between predictors and outcomes while limiting the number of variables added to our regression models to only variables that were statistically significant or considered theoretically meaningful. Finally, we applied a bootstrapping method (random resampling with replacement) to replicate a larger sample size ($n = 100$) to improve the accuracy of our standard error and confidence interval estimates as well as reduce our chances of committing a Type I error.

Limitations

Our study also has several limitations that should be considered. First, the survey was completed by a single representative which may bias the findings of our measure of overall success. Administering the survey to multiple staff within a school would improve our understanding of the many facets of school-based implementation. Second, our analytic sample was limited to the 46 schools that completed the survey which may influence the accuracy of our findings thus making it important to interpret them cautiously. The sample consisted of mostly elementary schools (79%, $n = 38$) which also limits our ability to generalize the findings to a broader context. In addition, since this is an exploratory study that seeks to identify factors associated with implementation, it is appropriate to conduct analyses in a way that better balances the probability of committing a type I error with that of committing a type II error. While we maintained an alpha level of $P < .05$ (for individual comparisons), we did not add a Bonferroni correction for experiment-wide error rate as it would have inappropriately increased the type II error probability [64]. Finally, while we recognize assessing nutrition provides a more holistic view of the school environment, for the purpose of this study we only considered the implementation of PA programs and activities. Future studies should explore what determinants are associated with implementing programs and activities that promote PA and nutrition as these health behaviors are often addressed together.

Conclusions

This study contributes important information to the growing field of PA implementation. Our findings suggest that access to knowledge and information and implementation climate appear to be important to the success of PA programs/activities implemented by schools. Furthermore, despite regression models suggesting the lack of a statistically significant association, Spearman correlation results provide suggestive evidence of additional constructs (e.g. leadership, priority) that should be studied further. This information can be used to develop and select strategies that target these constructs to improve the implementation of school-based PA programs and activities.

Supplementary Material

Supplementary material is available at *Translational Behavioral Medicine* online.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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Human Rights

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the

1964 Helsinki declaration and its later amendments or comparable ethical standards. The parent study was approved by the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston (HSC-SPH-18-0549).

Informed Consent

This study was a secondary analysis of previously collected data and informed consent was therefore not required. Informed consent was obtained from all individual participants included in the parent study.

Welfare of Animals

This article does not contain any studies with animals performed by any of the authors.

Transparency Statements

(1) This study was not formally registered. (2) The analysis plan was not formally pre-registered. (3) De-identified data from this study are not available in a public archive. De-identified data from this study will be made available (as allowable according to institutional IRB standards) by emailing the corresponding author. (4) Analytic code used to conduct the analyses presented in this study are not available in a public archive. They may be available by emailing the corresponding author. (5) Materials used to conduct the study are not publicly available.

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