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The Whole-of-School Approach to Physical Activity:

Findings From a National Sample of U.S. Secondary Students

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Abstract

Introduction—The IOM recommends schools adopt a Whole-of-School (WOS) approach—one that is comprehensive, coordinated, and provides opportunities for students to be active before, during, and after school. This study examined, in a nationally representative sample of secondary students in the conterminous U.S.: (1) the degree of implementation of a WOS approach; and (2) the association between WOS implementation and student physical activity.

Methods—A WOS index—based on six school practices—was calculated using self-reported school administrator data gathered in 2010 and 2011 ($N=1,031$). Student-level data were obtained from nationally representative samples of eighth, tenth, and 12th grade students during the same years (eighth grade, $n_{\text{schools}}=96$, $n_{\text{students}}=3,689$; tenth/12th grades, $n_{\text{schools}}=178$, $n_{\text{students}}=4,670$). Multilevel Poisson models were estimated in 2013–2014 to examine the relationship between the WOS index and self-reported physical activity.

Results—Few students attended schools with high WOS index scores. Middle school students attending schools with higher WOS index scores were physically active for at least 60 minutes on more days than students attending schools with lower WOS index scores ($\exp[\beta]=1.031$, 95% CI=1.008, 1.054). The WOS index score was not associated with physical activity among high school students.

Conclusions—This study finds that many schools are not offering the full array of practices comprising a WOS approach to physical activity, especially at the high school level. Yet, middle school students could have increased physical activity levels if schools were to implement a WOS approach to physical activity.

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Introduction

Physical activity (PA) during childhood confers multiple benefits, including increased bone mineral density, improved mental health, lower adiposity, improved markers of cardiovascular health, and improved academic performance.^{1–8} Nevertheless, most children in the U.S. and throughout the world are insufficiently active.^{9–12} The U.S. DHHS recommends that adolescents engage in at least 60 minutes of PA each day, with most being a moderate- or vigorous-intensity aerobic activity.¹³ Yet, this recommendation is met by only about half of U.S. adolescents.¹⁰

In 2013, the IOM, a U.S. non-governmental organization that provides health advice to policymakers and the public, issued a report outlining six recommendations to improve programs and policies for physical education (PE) and PA before, during, and after school.¹⁴ One recommendation included adopting a Whole-of-School (WOS) approach where administrators, teachers, and parents advocate for and implement comprehensive and coordinated approaches to PA to provide all students with opportunities to be physically active while on school grounds. Specifically, in addition to time dedicated to PE classes, which has declined dramatically the past few decades,¹⁵ the IOM suggests that schools provide opportunities for moderate- to vigorous-intensity PA (MVPA) throughout the school day and outside of school hours on school grounds. They recommend that opportunities for at least 60 minutes of activity be made available daily, with at least half occurring during school hours. The IOM report builds on calls by other organizations for the development of comprehensive approaches to PA in schools.^{5,16–20}

The extent to which a WOS approach has been adopted in secondary schools in the U.S. and the association between the WOS approach and student PA levels in a nationally representative sample are not yet clear. Thus, this study aims to address these gaps by examining, in a nationally representative sample of secondary students in the conterminous U.S.: (1) the degree of implementation of a WOS approach; and (2) the association between WOS implementation and student-level PA.

Methods

Study Sample

Student-level data were obtained from nationally representative cross-sectional samples of eighth, tenth, and 12th grade public school students in the conterminous U.S. collected by the Monitoring the Future (MTF) study during the 2010–2011 and 2011–2012 school years. Details of the study are available elsewhere.^{21,22} Briefly, self-administered paper-and-pencil questionnaires were administered to students during a normal class period. Participation rates for all schools averaged 96.0% with replacement (i.e., substituting a similar school when the initially sampled school declined to participate); response rates for students averaged 91.0%, 86.5%, and 83.0% for eighth, tenth, and 12th grades, respectively, with most nonresponse due to absenteeism (explicit refusal rates, <1%).

School-level data were collected by the Youth, Education, and Society (YES) study,^{23–25} one component of Bridging the Gap (www.bridgingthegapresearch.org). Following student

survey administration, surveys were mailed to school administrators in MTF schools to collect data on school practices in place during that school year. The response rates were 79.3% (2011) and 85.6% (2012). To improve the precision of the WOS prevalence estimate, yearly school-level data were also obtained from a supplemental sample, a separate nationally representative sample of public schools in the conterminous U.S. (hereafter referred to as the supplemental sample). Schools in the supplemental sample only were invited to complete annual surveys for 3 consecutive years. Supplemental sample schools provided no student-level data and thus were not included in the multilevel models. The response rates for the supplemental sample were 85.6% (2011) and 85.8% (2012), with replacement. The University of Michigan Behavioral Sciences IRB approved the MTF study and exempted the YES study.

Measures

Student-level PA was measured by the question: *During the last 7 days, on how many days were you physically active for a total of at least 60 minutes per day? (Add up all the time you spent in any kind of PA that increased your heart rate and made you get out of breath some of the time.)* Responses ranged from 0 to 7 days. This question has been shown to have acceptable validity and reliability in middle school (MS) and high school (HS) students.^{26,27}

Six different school practices, reported by the school administrator (most often the principal), comprise the WOS index. Schools were classified as having shared use if any outside organizations or individuals were allowed to use any school grounds or indoor facilities for PA or sports programs outside of school hours. Schools were classified as having intramurals sports, interscholastic sports, or active transport, respectively, if any student: (1) participated in intramural sports or PA clubs (not including PE) sometime during the school year; (2) participated in interscholastic or varsity sports sometime during the school year; or (3) walked or biked between home and school. Schools were classified as having breaks for activity if they offered opportunities for PA during the school day, other than in PE. Finally, schools were classified as having PE if students spent an average of at least 225 minutes per week in PE (the minimum recommended amount of time for PE).²⁸ The WOS index was calculated as the sum of available practices in a particular school and thus ranged from 0 to 6.

Student-level control variables obtained from the MTF student survey included sex, race/ethnicity (white, black, Hispanic, or other race/ethnicity), parents' education (a parent with some college education versus all others), household composition (living with both parents versus all others), and urban/rural status (living on a farm or in the country versus all others). School-level control variables obtained from the YES administrator survey included percentage of students eligible for free and reduced-price lunch, number of students enrolled in the school, region (Midwest, West, Northeast, South), year of study (2011 versus 2012), and tenth versus 12th grade (in the combined tenth/12th grade analyses).

Statistical Analysis

To evaluate the prevalence of the WOS approach in U.S. public MSs and HSs, school-level data from 480 unique MSs (eighth grade) and 551 unique HSs (tenth/12th grades) from the

MTF school sample and YES supplemental school sample were analyzed. The analyses accounted for repeated measures of schools in the YES supplemental sample and were weighted to represent the percentage of students exposed to these school-level characteristics.

To examine the association between the WOS index and self-reported PA, a series of multilevel models were estimated using the Generalized Linear Latent and Mixed Models (GLLAMM) program^{29–31} in Stata, version 13. Survey weights were appropriately scaled and applied at the student and school levels.^{32,33} Consistent with previous research,^{34–36} we estimated separate eighth grade and tenth/12th grade models predicting the number of days that a student was physically active for at least 60 minutes. Initial diagnostic analyses indicated that the continuous count outcome did not meet linear regression assumptions; thus, Poisson regression with a logarithmic link was used.

For grade-specific models, a series of nested models were estimated: (0) an empty model; (1) a two-level random intercept model with no covariates; (2) a two-level random intercept model with student-level covariates; (3) a two-level random intercept model with student- and school-level covariates (excluding the WOS index); and (4) a two-level random intercept model with all student- and school-level covariates and the WOS index. To evaluate the significance of the random intercept, Models 0 and 1 were compared using the deviance difference test.³⁷ To estimate the proportion of between-school variance in the PA outcomes, the intraclass correlation (ICC) was calculated. Subsequent nested models were compared using the deviance difference test to determine the proportion of student- and school-level variance explained by the additional respective covariates. All analyses were conducted in 2013–2014.

A series of additional analyses were conducted to evaluate underlying assumptions of the presented models. First, because approximately 15% of both MS and HS samples were eliminated during listwise deletion, models incorporating multiply imputed student-level data were evaluated. Second, because the WOS index score treated schools with item nonresponse to any index component as not having the practice (as opposed to dropping the school from the analysis), models implementing listwise deletion on the WOS index components were evaluated. Eight MSs and 292 eighth grade students and 21 HSs and 718 tenth/12th grade students were removed as a result.

Results

As shown in Table 1, very few students—7% of MS students and <1% of HS students—attended schools offering all six WOS index components. Slightly more than one third of MS students and about 12% of HS students attended schools offering at least five of six practices. Few students—5% in MSs and 13% in HSs—attended schools offering two or fewer practices.

In the eighth and tenth/12th grade models, 726 and 829 students, respectively, were excluded from the analyses owing to item nonresponse. Thus, the analytic samples included 3,689 eighth grade students in 96 schools and 4,670 tenth/12th grade students in 178

schools. Grade-specific descriptive statistics for the student analytic samples are shown in Table 2. The eighth grade sample consisted of 47% boys, 74% living with both parents, 18% living in rural areas, and 76% reporting some parental college education; self-reported racial/ethnic classification included 56% white, 13% black, 18% Hispanic, and 14% other (Asian, American Indian, and multiple ethnicities). More than one quarter (27%) of eighth graders reported PA for at least 60 minutes for all of the last 7 days and just more than half (56%) for at least 5 of the last 7 days. Distributions for the tenth/12th grade sample were similar, except that fewer HS students (22%) reported being active for at least 60 minutes on all of the past 7 days. The Appendix provides the characteristics of the schools these students attended.

The ICC for the number of days in the last 7 days that eighth graders were physically active for at least 60 minutes was 0.027, indicating that 2.7% of the total variability in the PA outcome occurred between schools (Table 3). Model fit statistics suggested that each successive set of variables significantly improved model fit: student-level covariates explained 53.5% of the school-level variance (Model 1), school-level covariates not including WOS (Model 2) explained 23.7% of the school-level variance, and the WOS index explained 44.4% of the school-level variance (Model 3). As shown in Table 4, the WOS index was significantly and positively associated with number of days physically active for at least 60 minutes for MS students ($\exp[\beta]=1.031$, 95% CI=1.008, 1.054). Furthermore, being male ($\exp[\beta]=1.197$, 95% CI=1.149, 1.248), living with both parents ($\exp[\beta]=1.054$, 95% CI=1.010, 1.100), and having a parent with at least some college education ($\exp[\beta]=1.055$, 95% CI=1.005, 1.107) were positively associated with PA. Those who self-identified their race/ethnicity as black reported fewer days of PA relative to those who self-reported their race/ethnicity as white ($\exp[\beta]=0.902$, 95% CI=0.843, 0.965). Finally, being in a school with a greater than average number of students eligible for free or reduced-price lunch ($\exp[\beta]=0.991$, 95% CI=0.983, 0.999) and with a greater than average school enrollment were negatively associated with PA ($\exp[\beta]=0.995$, 95% CI=0.990, 0.999).

For tenth/12th grade, the ICC was 0.079 (Table 3). Model fit statistics suggested that each successive set of variables significantly improved model fit. However, the WOS index was not significant in the HS model and explained only 7.4% of the variance, much less than the 44.4% explained in MS. The same student-level covariates were significant in the same direction as those in the eighth grade model. Additionally, in the tenth/12th grade model, living in a rural area was associated with a greater number of days of PA ($\exp[\beta]=1.067$, 95% CI=1.026, 1.110), and PA increased between 2011 and 2012 ($\exp[\beta]=1.050$, 95% CI=1.001, 1.102). Finally, in the tenth/12th grade models, self-identifying as Hispanic was associated with fewer days of PA relative to those who self-identified as white ($\exp[\beta]=0.932$, 95% CI=0.880, 0.986), and 12th grade students reported fewer days of PA than did tenth grade students ($\exp[\beta]=0.830$, 95% CI=0.787, 0.875). The percentage eligible for free or reduced-price lunch was not significantly associated with days of PA in the tenth/12th grade models as it had been in eighth grade.

Additional models were estimated to test the assumptions of the main analysis. Models estimated on multiply imputed data and models in which listwise deletion was used on the WOS index resulted in similar estimates and substantively similar conclusions.

Discussion

This study found positive effects of increased opportunities for PA in MS students. For example, MS students attending schools with six WOS practices were active for at least 60 minutes on an extra one third of a day more per week than students attending schools with three practices (4.01 versus 3.66 days, respectively), controlling for the effect of all other covariates. On a population level, these small increases in activity can have important health effects.³⁸ Although multiple studies examining comprehensive approaches to PA in smaller samples of schools have found that such approaches lead to improvements in PA levels,^(e.g., 39–42) the current study is the first national study in the U.S. to examine this association in secondary students. Other research suggests that opportunities for multiple practices in a school day would be necessary to achieve at least 60 minutes of student PA while on school grounds. Bassett et al.⁴³ estimated that participation in mandated PE, activity breaks, and after-school programming would result in about 52 minutes of PA; thus, more than these three practices would be needed to reach 60 minutes of daily PA.

The findings support the IOM recommendation to adopt coordinated and comprehensive school programming, at least for MS students. However, the prevalence of students in schools offering all six WOS practices was very low, especially among HSs (7% in MSs and 1% in HSs). Although national estimates of some specific components of the WOS approach are available,⁴⁴ no other studies were found that provided estimates of the degree to which a WOS approach has been implemented in a U.S. sample of secondary students. None of these specific school practices are mandated by U.S. federal policy and only a minority of states have policies that require any of these school practices at recommended levels,⁴⁵ which may be a factor in the low prevalence of the adoption of these practices. U.S. federal law requires that all local educational agencies participating in the federal Child Nutrition Programs adopt and implement a wellness policy that has specific goals for PA. This requirement can be an important impetus for schools to evaluate their opportunities for PA.

The significant relationship between WOS and PA in this study applied to MS students only. The ICC in HSs suggests meaningful school-level variation in student PA; however, the WOS index explained only a small fraction of it. Studies have found that time constraints are an important barrier to PA for HS students and that support from peers and adults is an important facilitating factor.^{46–49} School PA practices that occur during the school day may help address time constraints faced by HS students (and help achieve the recommended minimum of 30 minutes of PA during the school day).¹⁹ Further, school practices that capitalize on support may facilitate more activity. For example, broadening support for intramural programming, which can accommodate students of all skill levels, may help increase PA levels in HS students. Finally, HS students with a positive attitude toward PA are more likely to be more active, suggesting that activities to increase a positive attitude toward PA could also be beneficial.⁵⁰

Limitations

The current study is not without limitations. First, self-reported PA often results in higher PA estimates relative to accelerometer-based reports.¹¹ Nevertheless, estimates of HS student PA levels in this study are identical to those reported from the Youth Risk Behavior

Surveillance System, suggesting consistency across different self-reported surveillance systems.¹⁰ In addition, estimates of PA were obtained at the day level, as is often done to assess compliance with PA recommendations. Estimates of daily minutes of PA per day might suggest an even greater effect, as meeting the threshold of 60 minutes per day would not be required for the outcome. Second, administrator responses are subject to bias and incomplete or inaccurate knowledge. In the MTF and YES school surveys, administrators were assured confidentiality and encouraged to speak with additional school staff when the information was unknown. Third, because the study is cross-sectional, a causal relationship cannot be established.

The WOS index can be created with different definitions and items. In our study, schools with any student participation in intramural and interscholastic sports and active transport were considered to have these practices (i.e., administrator reported greater than 0% participation) because the opportunity was available and there is not a commonly accepted minimum threshold of participation in these activities. The measure of PE required exceeding a threshold of weighted minutes of PE per student (calculated based on minutes of PE per class, academic term system and class schedule, and proportion of students reported to take PE) but did not require specific proportions of MVPA (e.g., 50%). The study's "breaks for activity" measure (assessed as yes or no) was not synonymous with "PA breaks" (5–10 minute breaks from classroom instruction with directed PA); open-ended responses by administrators describing these breaks indicate they included practices such as activity at lunch or recess (these were not separately assessed on the questionnaire). Finally, other school practices might be important for increasing PA but are not included in our WOS index (e.g., PE teacher training, educational activities).

Conclusions

The current study's findings support the suggestion that a comprehensive set of PA practices can result in greater PA levels, at least among MS students. More research is needed to understand the effect of school practices on PA among HS students. The current study also demonstrates that, in the U.S., few secondary students are in schools with a large number of practices consistent with the WOS approach. In order to combat the epidemic of childhood obesity, more needs to be done to help schools implement a comprehensive set of practices supporting PA.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1Weighted Prevalence of Whole-of-School (WOS) Index Score^a by Grade

8th grade (N _{schools} =480)			10th/12th grades (N _{schools} =551)		
	%	Cumulative %		%	Cumulative %
0	0.3	0.3		0.5	0.5
1	0.7	1.0		2.0	2.5
2	4.2	5.2		10.6	13.1
3	22.3	27.5		34.6	47.7
4	38.3	65.8		40.7	88.4
5	27.4	93.2		10.9	99.3
6	6.8	100.0		0.8	100.0
Mean [95% CI]	4.07 [3.98, 4.16]		3.49 [3.41, 3.57]		

^aSum of available physical activity practices in a school

Table 2

Demographic Characteristics of the Student-Level Analytic Sample by Grade

Demographic	8th grade (N _{students} =3,689)		10th/12th grades (N _{students} =4,670)	
	N	(Weighted %)	N	(Weighted %)
Sex (male)	1,799	(46.9)	2,305	(49.0)
Live with both parents	2,755	(74.1)	3,420	(72.7)
Live in rural area	598	(17.7)	854	(19.9)
Race/ethnicity				
White	2,128	(55.6)	2,837	(60.1)
Black	460	(12.7)	505	(11.4)
Hispanic	593	(17.6)	743	(16.4)
Other	508	(14.1)	585	(12.1)
Parental education (some college or more)	2,796	(76.0)	3,491	(73.1)
Grade (12th grade)	—	—	1,313	(28.4)
Number of days physically active				
0	190	(5.2)	457	(9.9)
1	183	(5.1)	333	(7.4)
2	365	(9.6)	515	(10.8)
3	435	(12.3)	548	(11.6)
4	460	(12.1)	503	(10.9)
5	675	(18.6)	795	(16.8)
6	389	(10.6)	474	(10.5)
7	992	(26.6)	1,045	(22.2)

Table 3

School-Level Random Components From Multilevel Poisson Regression Models

Number of days physically active (Poisson)	8th grade			10th/12th grade		
	School-level random variance ^a	Model Deviance	Model DF	School-level random variance ^a	Model Deviance	Model DF
Empty Model	—	2,420,683.2	1	—	3,178,808.2	1
Model 0 ^c	0.127	2,415,597.6	2	0.343	3,159,216.0	2
Model 1 ^c	0.059	2,388,650.6	9	0.103	3,093,777.4	10
Model 2 ^c	0.045	2,384,646.6	15	0.108	3,091,471.2	16
Model 3 ^c	0.025	2,383,507.2	16	0.100	3,091,372.4	17
ICC ^d	0.027	—	—	0.079	—	—
Proportion of school-level variance explained ^e	0.444	—	—	0.074	—	—

Note: Boldface indicates statistical significance ($p < 0.05$).

^a School-level random variance in Model 0 represents random variation in schools whereas variance in Models 1 through 3 represents residual variance conditional on model covariates.

^b p -value represents the significance of the deviance difference test comparing successive models.

^c Model 0: random intercept only; Model 1: random intercept and student-level covariates; Model 2: random intercept and student- and school-level covariates; Model 3: random intercept, student- and school-level covariates, and school-level whole-of-school index score.

^d Intraclass correlations are defined as the ratio of between-school variability (i.e., Model 0) to total variability (between-school variability + within-school variability).

^e The proportion of school-level variance explained after addition of the whole-of-school index score, calculated as $[\text{variance}(\text{Model } 2) - \text{variance}(\text{Model } 3)] / \text{variance}(\text{Model } 2)$.

Table 4

Adjusted Estimates From Multilevel Poisson Regression Models

Model variables	8th grade				10th/12th grades							
	Est.	SE	p-value	exp(Est.)	95% CI	Est.	SE	p-value	exp(Est.)	95% CI		
Student level												
Sex (male)	0.180	0.021	<0.001	1.197	1.149	1.248	0.249	0.020	<0.001	1.282	1.233	1.334
Live with both parents	0.052	0.022	0.017	1.054	1.010	1.100	0.059	0.019	0.002	1.061	1.021	1.102
Live in rural area	0.025	0.025	0.326	1.025	0.976	1.077	0.065	0.020	0.001	1.067	1.026	1.110
Race/ethnicity												
Black	-0.103	0.035	0.003	0.902	0.843	0.965	-0.108	0.041	0.008	0.898	0.829	0.972
Hispanic	-0.042	0.034	0.214	0.959	0.898	1.024	-0.071	0.029	0.014	0.932	0.880	0.986
Other	-0.050	0.031	0.108	0.951	0.894	1.011	-0.067	0.037	0.069	0.935	0.870	1.005
White (reference)												
Parental education (some college or more)	0.054	0.025	0.029	1.055	1.005	1.107	0.057	0.026	0.026	1.058	1.007	1.113
School level												
WOS index score	0.030	0.011	0.008	1.031	1.008	1.054	0.011	0.017	0.529	1.011	0.978	1.044
Grade (12 th)	—	—	—	—	—	—	-0.187	0.027	<0.001	0.830	0.787	0.875
Year (2012)	0.034	0.022	0.122	1.034	0.991	1.080	0.049	0.025	0.045	1.050	1.001	1.102
% free or reduced price lunch/10	-	0.00	0.023	0.991	0.98	0.99	-	0.00	0.324	0.994	0.98	1.00
Region	0.009	4			3	9	0.006	6			2	6
Midwest	0.022	0.026	0.385	1.022	0.972	1.075	-0.006	0.033	0.859	0.994	0.932	1.061
West	0.023	0.037	0.528	1.024	0.952	1.101	0.027	0.039	0.481	1.028	0.952	1.109
Northeast	-0.055	0.037	0.134	0.946	0.880	1.017	0.062	0.038	0.105	1.064	0.987	1.147
South (reference)												
# students enrolled/100	-0.005	0.002	0.013	0.995	0.990	0.999	-0.003	0.002	0.166	0.997	0.993	1.001
Constant	1.208	0.049	<0.001	3.347	3.038	3.687	1.180	0.069	<0.001	3.254	2.840	3.728

Note: Boldface indicates statistical significance ($p < 0.05$).