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Increasing Inequality in Physical Activity Among Minnesota Secondary Schools, 2001–2010

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Abstract

Background: Two Healthy People 2020 goals are to increase physical activity (PA) and to reduce disparities in PA. We explored whether PA at the school level changed over time in Minnesota schools and whether differences existed by demographic and socioeconomic factors.

Methods: We examine self-reported PA (n = 276,089 students; N = 276 schools) for 2001–2010 from the Minnesota Student Survey linked to school demographic data from the National Center for Education Statistics and the Rural–Urban Commuting Area Codes. We conducted analyses at the school level using multivariable linear regression with cluster-robust recommendation errors.

Results: Overall, students who met PA recommendations increased from 59.8% in 2001 to 66.3% in 2010 ($P < .001$). Large gains in PA occurred at schools with fewer racial/ethnic minority students (0%–60.1% in 2001 to 67.5% in 2010, $P < .001$), whereas gains in PA were comparatively small at schools with a high proportion of racial/ethnic minority students in 2001 (30%–59.2% in 2001 to 62.7% in 2010).

Conclusions: We found increasing inequalities in school-level PA by racial/ethnic characteristics of their schools and communities among secondary school students. Future research should monitor patterns of PA over time and explore mechanisms for patterns of inequality.

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Keywords

school health; health disparities; racial/ethnic disparities; socioeconomic position

Establishing regular physical activity (PA) early in life is a national health priority that is expected to lead to improved health and longevity.[1–5] In 2008, the US Department of Health and Human Services released recommendations that encouraged children and adolescents to accumulate 60 or more minutes of moderate to vigorous PA each day.[6] Children in the United States under the age of 10 years are generally physically active and many meet these recommendations, but PA drops off dramatically as children move into middle and late adolescence,[7,8] making this period an important developmental window for intervention. The US Healthy People 2020 national health goals[9] include increasing the proportion of children and adolescents who meet or exceed federal guidelines for aerobic activity (Goal PA 3.1).

Schools are a critical setting for ensuring that children and adolescents meet national health goals and achieve recommended levels of activity.[2,10–14] School leaders can create opportunities for students to be physically active every day through required physical education courses with a trained physical education specialist, interscholastic and intramural sports programs, and through integrating PA promotion into health education courses.[10] In combination, these strategies result in higher levels of activity among individuals.[15,16]

In addition to the basic activity recommendations for children and adolescents, an overarching goal of Healthy People 2020 across its various health behavior targets is to achieve health equity, eliminate disparities [eg, by gender, race/ethnicity, socioeconomic position (SEP), place of residence], and improve the health of all groups. Significant disparities in PA among youth exist.[17,18] For example, boys are more likely than girls to be active during preadolescence and adolescence.[17] In addition, adolescents with higher SEP are more likely to be active than those with lower SEP, although the literature is not consistent on this finding.[19] However, no clear evidence of significant disparities exists by race/ethnicity. Some studies using self-reported PA measures suggest that white adolescents are more active than racial/ethnic minorities.[20,21] Other studies using accelerometers to objectively measure activity do not observe similar racial/ethnic disparities and find more activity among blacks compared with whites, at least among younger boys.[18] More recent evidence suggests that patterns of racial/ethnic differences may be shifting over time.[17] However, no studies to date have examined whether disparities exist at the school level—a level that may better reflect opportunities for structural change to increase activity—or tracked these patterns over time.

This study examined trends over time (2001–2010) in PA at the school level and demographic and socioeconomic factors associated with meeting the recommendations for PA. Our hypothesis was that PA at the school level changed over time. We also hypothesized that the change over time in PA at the school level differed by racial/ethnic and socioeconomic composition of the school in 2001. We used data from the Minnesota Student Survey (MSS). The MSS is unique among school-based surveys compared with those undertaken in other states in which it attempts to survey a census of students and schools in

the state. The methodology used for the MSS has been relatively consistent over a significant period of time. The availability of data at a large number of diverse schools, the repeated surveying of the same schools over time, and consistency in methods provide an opportunity to assess patterns and change over time at the school level. In addition, the time period assessed included an economic recession in 2007–2009, providing an opportunity to examine the effect of this secular event on PA.

Methods

Participants

Student data for this study were drawn from the MSS. The MSS is a voluntary and anonymous self-report survey administered every 3 years to Minnesota students in grades 6, 9, and 12 attending public, charter, and tribal schools. The survey is administered as a collaborative effort by the Minnesota Departments of Education, Health, Human Services, and Public Safety to examine health risk and protective factors. For the purposes of this study, we used MSS data for 9th- and 12th-grade students from surveys conducted in 2001, 2004, 2007, and 2010. Surveys prior to this time period did not include all variables of interest. The 2013 survey was excluded because there were significant changes to its design that reduced comparability including survey modality (partially conducted online) and a shift in the grades in which students were surveyed. We further limited our analysis to students enrolled in regular schools (not alternative, special education, tribal, correction, or other) as designated by the Minnesota Department of Education.

Most Minnesota public school districts participated in the survey. The school district participation rate was 91% in 2001, 88% in 2004, 91% in 2007, and 88% in 2010. The survey administration employed passive parental consent, and students provided verbal assent. As a percent of statewide enrollment, the student participation rate ranged from 72.0% to 75.7% in grade 9 and 55.3% to 58.6% in grade 12 for each of the survey years. Additional details concerning the survey methodology are available elsewhere.[22,23] The University of Minnesota Institutional Review Board reviewed and approved this secondary data analysis (1007E85315).

To allow estimation of longitudinal trends over time, we further restricted our sample to schools that participated in the MSS each year. For purposes of this analysis, we excluded grades in schools if they had fewer than 20 students who participated in the MSS in a given year. A total of 43 schools had fewer than 20 survey respondents in a given year and were removed from the analysis. These criteria resulted in an analysis sample of N = 276 schools.

Measures

Physical Activity.—PA and sedentary behaviors were assessed among individual students using the following question: “On how many of the last 7 days did you exercise or participate in sports or other activities that made you sweat or breathe hard for at least 20 minutes?” Response choices were 0–7 days. A similar question was previously used in the Centers for Disease Control and Prevention Youth Risk Behavior Survey[20,24] and the National Health Interview Survey.[25] From this question, we created 2 binary variables. The

first variable was an indicator of whether the student met the recommended levels for vigorous PA of 3 or more days per week (coded as 1) compared with fewer than 3 days per week (coded as 0). The national recommendations for PA changed in 2008 to a higher standard and measurement strategies changed to reflect those shifts. However, the measure used in this study reflects the recommended levels of PA at the baseline year for the time period, which was a standard measure of activity at the time when the first wave of data were collected for this study. A second binary measure of inactivity was created using 0 days per week of vigorous activity (coded as 1) compared with any days of activity (coded as 0). Student-level binary activity measures were aggregated to the school level to create a continuous measure of the proportion of survey respondents who met criteria for vigorous PA or inactivity over the total MSS respondents in each school.

Individual-Level Variables.—Student responses to the MSS were used for the variables such as sex (male or female), grade (9 or 12), and race/ethnicity [multiple responses were allowed and were categorized as follows: American Indian, black or African American, Hispanic or Latino, Asian American or Pacific Islander, white, mixed race (checked more than 1), and I don't know/no answer]. In addition, the 2007 and 2010 surveys asked students about their own participation in the free/reduced-price lunch (FRPL) program and their height and weight. Based on the self-reported height and weight responses, we created a binary measure that reflected whether the student body mass index (BMI) was equal to or greater than the 85th percentile on the Centers for Disease Control and Prevention BMI-for-age growth charts.

School-Level variables.—The proportion of students who were racial/ethnic minorities (ie, nonwhite) and the proportion of students who participated in the FRPL program were measured at the school level. We examined both proportions of racial/ethnic minorities and FRPL participation as continuous variables. These school-level data were drawn from the National Center for Education Statistics (NCES) Common Core of Data, as collected from administrative record systems at schools and made publicly available through the US Department of Education (http://nces.ed.gov/ccd/). NCES data were collected in the fall and matched with student-level data collected in the spring of the corresponding school year (eg, NCES data from fall of 2000 with MSS data from spring of 2001). We used the FRPL measure as a proxy for SEP of the school. Some authors have suggested that FRPL has some limitations as a measure of SEP[26]; however, it was our best available school-level measure, and it is frequently used in school-based studies. For each school in our sample, we created a measure of geographic location (city, suburb, small town, and rural) as defined using the Rural–Urban Commuting Area Codes from the 2000 US Census. The process of linking the NCES and Rural–Urban Commuting Area Codes data on school characteristics with MSS data is described in detail elsewhere.[23]

Data Analysis

We conducted descriptive statistics, bivariate associations, and multivariable analyses using Stata statistical software (StataCorp, College Station, TX). Apart from simple descriptive statistics of student data, all analyses were performed at the school level, with individual student responses aggregated within school to provide inferences at the school level. Chi-

square statistics and *F* tests were used to assess the bivariate association between school characteristics and school-level student characteristics over time.

The primary relationship of interest for this study was the association between activity (both the proportion of students who met guidelines and the proportion who were inactive) at the school level and the racial/ethnic composition and the socioeconomic status of each school (measured as FRPL participation at the school level), and whether that association was consistent over time. Linear regression with cluster-robust standard errors was used to estimate these associations. The proportion of students in a school who met guidelines was the dependent variable. The main predictors in each model were the proportions of racial/ethnic minority enrollment in 2001 and FRPL participation in 2001 and survey year. Analyses were adjusted for school location and school-level proportion of sex and grade. Interaction terms were fit between both racial/ethnic composition and FRPL in 2001 and year, to determine if secular trends in activity differed by school-level race/ethnicity or FRPL status in 2001. Year was modeled in analyses as a dummy variable to allow for nonlinear trends over time. Because the interaction between FRPL and year was not statistically significant, it was dropped from the final model. Finally, we estimated difference in differences models to assess whether change in PA at the school level was associated with change in the proportion of minority enrollment, adjusting for FRPL, school location, and school-level proportion of sex and grade. Proportion of minority enrollment was modeled as a continuous variable and is presented as model-based predicted plots for schools with low (0%), medium (15%), and high (30%) minority enrollment.

Results

The sample included 276,089 students across the 4 surveys. The sample was comprised of approximately half boys and slightly more students in grade 9, resulting from the higher response rate among students in grade 9. Most students reported their race/ethnicity was white. Approximately 1 in 4 students reported receiving FRPL at school for the years in which that question was asked in the MSS survey (2007 and 2010) and approximately 1 in 5 students were overweight (BMI ≥ 85th percentile; see Table 1). The schools in the final analysis were located throughout Minnesota, with 42.8% located in a city, 12.3% in a suburban area, 13.0% in a small town, and 31.9% in a rural area.

Among students attending secondary schools in Minnesota, we observed a significant increase in the proportion who met recommendations for vigorous PA. In 2001, the crude proportion of students reporting meeting the recommendation was 59.8% and had increased to 66.3% by 2010, a statistically significant change ($P < .001$). Similarly, the crude proportion of students who were sedentary was 17.7% in 2001 and 14.7% in 2010, a statistically significant decrease over time ($P < .001$). Participation in the FRPL increased from 22.0% in 2001 to 32.9% in 2010 ($P < .001$), as did the proportion of students who were racial/ethnic minorities from 9.8% in 2001 to 15.9% in 2010 ($P < .001$; see Table 2). The correlation at the school level between racial/ethnic composition and FRPL was strong and statistically significant ($r = .58$; $P < .001$). Schools with a high proportion of racial/ethnic minority students were more likely to be in urban locations.

In multivariable models, we observed several statistically significant patterns in the data. PA was statistically significantly higher over survey years; however, there was an interaction between year (in particular, 2010) and minority enrollment in the school. The proportion of minority students at the school level in 2001 was not significantly associated with a school's average PA in 2001, 2004, or 2007. However, in 2010, increases in PA were less pronounced or even reversed for those schools with higher proportions of minority students in 2001. Specifically, we observed that a 1% higher minority enrollment in 2001 was associated with the following effects on PA in each year—2001: −.03 [95% confidence interval (CI), −.1 to .03; $P = .34$]; 2004: −.05 (95% CI, −.1 to .0; $P = .07$); 2007: −.07 (95% CI, −.14 to −.0; $P = .04$); and 2010: −.18 (95% CI, −.26 to −.10; $P < .01$). That is, schools with few racial/ethnic minority students in 2001 had significantly higher levels of activity in 2010 compared with schools that enrolled a larger proportion of minority students in 2001. FRPL in 2001 was not associated with PA. Large increases in PA occurred at schools with low minority enrollment in 2001, whereas changes in activity at schools with high minority enrollment in 2001 were comparatively small. To illustrate the change in activity over time by school-level racial/ethnic composition, we estimated predicted proportions of PA at each survey year for differing levels of racial/ethnic composition (see Figure 1). Schools with no racial/ethnic minority students (0%) had 60.1% of their students meet PA recommendations in 2001 and 68.2% do so in 2010. Conversely, in schools with 15% racial/ethnic minority students in 2001, 59.6% of students met PA recommendations in 2001 and 65.4% did so in 2010. Schools with 30% racial/ethnic minority students in 2001 went from 59.2% in 2001 to 62.7% in 2010.

We conducted an analysis of difference in differences to examine the relationship between change in PA and change in proportion of minority enrollment over the study period. We found no association between these variables adjusting for FRPL, school location, and proportion of students by grade and sex.

Discussion

On average, the proportion of students who met or exceeded recommended levels of PA increased from 59.8% in 2001 to 66.3% in 2010 among students attending secondary schools in Minnesota. However, this overall increase masked some important inequalities. Schools that enrolled almost entirely white students in 2001 experienced large increases in PA at the school level, from 60.1% in 2001 to 67.5% in 2010. This finding is consistent with the overall increase in activity in Minnesota. However, students attending schools with higher levels of racial/ethnic minority students in 2001 did not experience similar increases in activity (59.2% in 2001 to 62.7% in 2010). These findings suggest that inequality in PA by racial/ethnic minority composition at the school level widened over the study period, improving only in schools with historically white students. Increasing inequality in PA may contribute to subsequent health disparities for health outcomes associated with PA, including cardiovascular disease, type 2 diabetes, bone health, and some cancers,[6] and significant racial/ethnic disparities exist across many of these health outcomes.[27]

Importantly, an overall increase in the average racial/ethnic minority composition and in FRPL participation in Minnesota schools occurred during this time period. As an indicator

of SEP at the school level, increased FRPL is consistent with the economic recession that occurred during the study period. In our analysis, we adjusted for geographic location of schools and FRPL at the school level. Neither of these variables were independently associated with PA. This finding differs from previous research among adults, which found significant differences in activity by geographic location and SEP.[28]

The recession of 2007–2009 was a significant secular event that occurred in the middle of our study period, and the impact of that economic downturn was likely experienced differentially across communities in Minnesota.[29] Other studies have shown that the recession had significant impacts on health with declines in resources available through local health departments,[30] a decline in utilization of health services and preventive services.[31,32] At the individual level, unemployment (a common outcome of economic recessions) is consistently associated with indicators of poor health,[33] and parental unemployment is associated with poor health among their children.[34,35]

Our study did not explore the specific mechanisms through which school-level racial/ethnic composition or SEP may influence PA. However, theoretical frameworks and some supporting evidence provide possible directions to pursue in future research.[36–38] PA appears to be patterned by school policies about how activity during the school day is structured, perceived dangers related to crime and violence, and adequate facilities for being physically active (eg, gyms, athletic fields, parks).[39] Our findings of increased PA in some communities may reflect school-level improvements. These could include school resources such as new school buildings with modern facilities for PA, resources for maintaining and promoting school physical education programs, or parents who are engaged in schools and are interested in promoting PA. Alternatively, family-level resources afforded by higher SEP may have a direct impact on PA by providing time and resources to be physically active, and also through modeling of PA by parents and other family members. Future research should explore these possibilities as they have the potential to influence policies and other efforts to promote PA.

Our study capitalized on the unique opportunity to study school-level disparities using the MSS. Unlike school-based surveys in other states that sample students and schools from the larger population, the MSS attempted to assess all students in grades 9 and 12 in all schools in Minnesota using consistent methodology over time. Despite this design advantage, Minnesota differs from other states in ways that may limit the generalizability of our findings. The overall population of Minnesota is predominantly white, particularly in rural areas.[40] In contrast, urban centers such as the greater Twin Cities metropolitan area are becoming more racially/ethnically diverse.[41] Despite this diversity, Minnesota schools tend to be segregated on racial/ethnic and socioeconomic lines, have considerable socioeconomic and health disparities, and have significant gaps in academic achievement between white and racial/ethnic minority students.[42,43] Most other states have predominantly white rural areas and similar concentrations of racial/ethnic minorities in urban centers.[40] To the extent that these conditions occur in other states, we believe our findings have some relevance outside Minnesota.

There are some important limitations to consider when interpreting these data. The activity measure relied on student self-report, which likely overestimates the proportion of the population who meet recommendations for activity.[44] The activity recommendations prior to 2008 emphasized at least 3 days per week of moderate- to vigorous-intensity activity for at least 20 minutes per day.[45] The shifts in both recommendations and the metrics by which those behaviors are assessed and tracked have resulted in different conclusions about the degree to which PA goals are being met, depending on the recommendations and the measure used.[46] These findings ranged from more than 2 in 3 youth meeting the prior recommendation to only about 1 in 3 meeting the new standard.[46] Assessing patterns among groups and change over time in those patterns requires consistent methodology. Our measure of PA is tied to recommendations for PA that existed prior to the 2008 Physical Activity Guidelines for Americans and do not reflect those current guidelines.[6] In addition, other measures used in our study may be subject to imprecision, misclassification, or differential misclassification. The direction of the potential bias across all these measures is difficult to predict. Finally, it is possible in the MSS for a student in ninth grade to be surveyed again when they are in 12th grade. The MSS is an anonymous survey, and there is no way to identify or link the individual respondents to adjust for this. However, the MSS is intended to be a census those grades within schools. For our school-level analyses, the correlation between students is statistically less important. However, our temporal analyses are conflated with possible cohort trends. As is well known in the age-period-cohort literature, there is no statistical solution for this problem.

The measure of FRPL at the school level is commonly used as an indicator of SEP, although some researchers have suggested that its meaning is vague and the mechanisms of action are poorly articulated, particularly when used for individual students.[26] Both of these measures changed significantly in our sample over time. The recession of 2007–2009 likely impacted FRPL enrollment, and we anticipate the effect of the recession to differ by community, and therefore by school, as we observed in our data. Some schools may have also engaged in additional efforts to identify and enroll more eligible students in FRPL. Despite the weakness of the FRPL measure, it was the only measure available to us, and it is widely used in national reports on school performance using the NCES data and in health and educational research, and can facilitate comparison and interpretation with other findings.

Although these weaknesses may reduce confidence in our findings, there are several aspects to our study design and analysis that are strong and provide a unique addition to the scientific literature. To our knowledge, this analysis is the first to examine school-level inequalities in PA. The design of MSS provides consistent sampling, measurement, and survey administration in a large and diverse sample of schools. The same schools are surveyed in MSS over time allowing assessment of change. Our study design and collaboration facilitated linking individual-level student survey responses with school and community characteristics and allowed us to conduct this unique analysis.[23]

We found evidence that attainment of PA recommendations became more unequal over time, and this was specifically patterned by racial/ethnic composition of the school. However, the specific mechanisms are unclear and deserve further study. It is not clear whether the patterning by racial/ethnic composition is a reflection of specific discrimination or less direct

factors, such as unequal distribution of factors that may improve PA facilities, equipment and training, and resources for specialized instruction (eg, physical education teachers, sport team coaches, intramural program supervisors) that may have an instrumental effect on PA. The inequality we observed in this study is subtle, as it results from greater increases in PA among advantaged schools rather than a decrement in disadvantaged schools. More research is needed moving forward to monitor inequalities in PA. Examining activity levels at earlier ages and assessing the role of parents and other family members in supporting and facilitating activity may be warranted. Additional efforts should explore improved measures of activity and identify potential mechanisms that can facilitate and improve PA, particularly among schools that serve a high proportion of racial/ethnic minority students.

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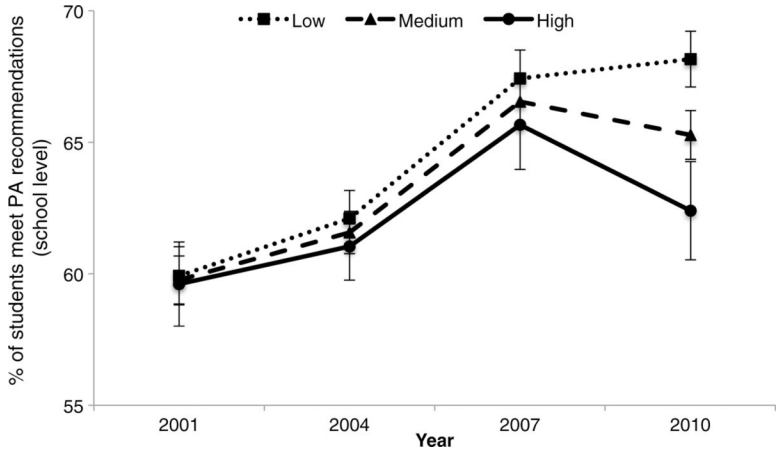

Figure 1 —.

Proportion of students who meet recommended levels of PA by racial/ethnic minority enrollment, 2001–2010. PA indicates physical activity.

Table 1

Demographic Characteristics of Students in the Minnesota Student Survey, 2001–2010

	Year			
	2001	**2004**	**2007**	**2010**
N	66,464	68,951	70,230	70,444
Sex, %				
Boys	49.3	49.1	49.4	49.7
Girls	50.7	50.9	50.6	50.3
Grade, %				
9	58.0	57.0	56.8	56.0
12	42.0	43.0	43.2	44.0
Race/ethnicity, %				
American Indian	0.8	1.1	1.0	1.1
Black or African American	2.8	3.9	4.9	5.5
Hispanic or Latino	1.8	2.6	3.4	4.2
Asian American or Pacific Islander	4.8	4.8	5.3	5.7
White	84.1	81.2	77.6	75.3
Mixed race (checked more than 1)	3.7	4.3	5.9	6.4
No answer (I don’t know)	1.9	2.2	1.9	1.9
Free/reduced-price lunch, yes, %	N/A	N/A	21.2	25.7
Physically active,[a] yes, %	60.1	61.8	66.7	66.0
Sedentary,[b] yes, %	17.1	16.1	13.4	14.3
BMI,[c] yes, %	N/A	N/A	22.2	21.8

Abbreviations: BMI, body mass index; N/A, not applicable.

[a] 3 or more days per week of vigorous physical activity of 20 or more minutes per day.

[b] 0 days per week of vigorous physical activity of 20 or more minutes per day.

[c] ≥85th percentile of height for weight.

Table 2

Characteristics of Schools in the Minnesota Student Survey, 2001–2010 [School Level; Mean (SD); N = 276]

	Year				
	2001	**2004**	**2007**	**2010**	***P*-value**
Free/reduced-price lunch	22.0 (13.9)	25.3 (14.1)	28.4 (14.7)	32.9 (15.6)	<.001
Minority	9.8 (15.1)	11.6 (16.0)	13.9 (17.5)	15.9 (19.0)	<.001
Physically active	59.8 (7.2)	61.8 (6.8)	66.9 (7.1)	66.3 (7.2)	<.001
Sedentary	17.7 (5.1)	16.8 (4.6)	13.8 (4.5)	14.7 (4.8)	<.001
Overweight	N/A	N/A	23.8 (6.0)	23.8 (6.3)	.97

Abbreviation: N/A, not applicable.