



## Original article

# The association of fitness and school absenteeism across gender and poverty: a prospective multilevel analysis in New York City middle schools



Emily M. D'Agostino, DrPH<sup>a,\*</sup>, Sophia E. Day, MA<sup>b</sup>, Kevin J. Konty, PhD<sup>b</sup>,  
Michael Larkin, MA<sup>c</sup>, Subir Saha, PhD<sup>c</sup>, Katarzyna Wyka, PhD<sup>a</sup>

<sup>a</sup> CUNY Graduate School of Public Health and Health Policy, New York, NY

<sup>b</sup> NYC Department of Health and Mental Hygiene, Office of School Health, Queens, NY

<sup>c</sup> NYC Department of Education, Office of School Wellness, Brooklyn, NY

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## ABSTRACT

**Purpose:** One-fifth to one-third of students in high poverty, urban school districts do not attend school regularly (missing  $\geq 6$  days/year). Fitness is shown to be associated with absenteeism, although this relationship may differ across poverty and gender subgroups.

**Methods:** Six cohorts of New York City public school students were followed up from grades 5 to 8 during 2006/2007–2012/2013 ( $n = 349,381$ ). Stratified three-level longitudinal generalized linear mixed models were used to test the association between changes in fitness and 1-year lagged child-specific days absent across gender and poverty.

**Results:** In girls attending schools in high/very high poverty areas, greater improvements in fitness the prior year were associated with greater reductions in absenteeism ( $P = .034$ ). Relative to the reference group ( $>20\%$  decrease in fitness composite percentile scores from the prior year), girls with a large increase in fitness ( $>20\%$ ) demonstrated 10.3% fewer days absent (incidence rate ratio [IRR] 95% confidence interval [CI]: 0.834, 0.964), followed by those who had a 10%–20% increase in fitness (9.2%; IRR 95% CI: 0.835, 0.987), no change (5.4%; IRR 95% CI: 0.887, 1.007), and a 10%–20% decrease in fitness (3.8%; IRR 95% CI: 0.885, 1.045). In girls attending schools in low/mid poverty areas, fitness and absenteeism also had an inverse relationship, but no clear trend emerged. In boys, fitness and absenteeism had an inverse relationship but was not significant in either poverty group.

**Conclusions:** Fitness improvements may be more important to reducing absenteeism in high/very high poverty girls compared with low/mid poverty girls and both high/very high and low/mid poverty boys. Expanding school-based physical activity programs for youth particularly in high poverty neighborhoods may increase student attendance.

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## Introduction

Only 25% of youth aged 12–15 years meet the recommended daily 60 minutes or more of moderate to vigorous physical activity [1]. Schools in the United States have replaced physical education and recess with nonphysical instructional time due in part to an

increasing emphasis on high-stakes testing [2]. This raises particular concern given a well-established link between school-based physical activity and health [3–7], and potential associations with academics [8–11] and attendance [8,10–12].

Schools in high poverty areas, in particular, may hold a critical role in providing youth with safe and accessible physical activity [13,14]. Environmental factors, including area poverty and the built environment, are shown in the literature to be associated with children's tendency to participate in school- and neighborhood-based physical activity [13–16]. Neighborhood factors may contribute to opportunities for safe, attractive, and accessible physical activity [15,17]. School contextual factors may also impact community norms and attitudes pertaining to children's school absences [18,19]. Given one-fifth to one-third of students in high

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\* Corresponding author. Miami-Dade Department of Parks, Recreation and Open Spaces, 275 NW 2nd Street Rm 421 Miami, FL 33128. Tel.: 305-755-7938, 646-853-1223; fax: 305-755-7864.

E-mail address: [Emily.Dagostino@miamidade.gov](mailto:Emily.Dagostino@miamidade.gov) (E.M. D'Agostino).

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poverty, urban school districts do not attend school regularly (missing  $\geq 6$  days/year), high poverty subgroups may benefit from physical activity interventions. However, no literature has examined the potential modification of area poverty on the youth fitness-school absenteeism relationship.

Disparities in physical activity and absenteeism also persist across gender. Only 18% of high-school girls compared with 37% of boys are reported to meet physical activity guidelines [20]. Numerous studies demonstrate that low self-esteem in adolescent girls is significantly associated with both lower physical activity levels [21] and absenteeism [22,23]. However, no studies were identified that examined gender differences in the fitness-absenteeism relationship. Given this literature, nuanced research on gender differences in the association of fitness and student absenteeism is warranted.

This study examined gender differences by area poverty on the longitudinal fitness-absenteeism association in six cohorts of New York City (NYC) Department of Education (DOE) middle-school students each followed up consecutively over 4 years. It was hypothesized that improvements in fitness (cardiorespiratory, muscular endurance, and muscular strength fitness composite percentile scores) would predict lower subsequent absenteeism (1-year lagged days absent) after accounting for potential individual- and school-level confounders, clustering, and time-dependent interactions. It was further hypothesized that higher area poverty and female gender would predict a stronger magnitude of association of fitness and absenteeism.

## Methods

### Data sources and study population

Data for this study were drawn from the NYC FITNESSGRAM (Fitnessgram) data set jointly managed by NYC DOE and Department of Health and Mental Hygiene (DOHMH) [24]. It includes annual fitness assessments collected by DOE for approximately 870,000 NYC public school students per year (grades K–12) starting from 2006–2007. This study was approved by the City University of New York and DOHMH Institutional Review Boards and was determined by these boards to be public health surveillance that is not research and therefore exempt from the requirement for obtaining written informed consent.

The Fitnessgram is based on the Cooper Institute's FitnessGram, which is demonstrated to have both strong reliability and validity [25]. Fitnessgram performance tests provide a health assessment related to present and future health outcomes. NYC schools are mandated to have  $\geq 85\%$  of eligible students to complete the Fitnessgram assessment each year. Inclusion criteria for this study consisted of enrollment in a NYC public school for  $\geq 2$  consecutive years while in grades 6–8 during the study period (2006/07–2012/13) while attending a school that collected Fitnessgram measurements (for sample selection flow chart see Appendix Fig. 1). Student cohorts were defined based on year of initiating grade 6. Change in fitness data from grades 5–6, 6–7, and 7–8 were paired with days absent per year for grades 6, 7, and 8, respectively. The final sample included 349,381 unique students nested in 624 schools (mean school population = 541 students; standard deviation [SD] = 632). Students in grades 6, 7 and 8 contributed 204,583, 257,201, and 213,482 student-years, respectively.

## Measures

The primary exposure was a categorical variable representing age- and gender-specific percent change in fitness composite percentile scores based on the sum of percentile scores for the

Progressive Aerobic Cardiovascular Endurance Run, and muscular strength and endurance (curl-up and push-up) tests [24]. Scores were converted to percentiles to account for expected improvements in performance with increasing age and gender. The fitness variable was categorized as more than 20% increase, 10–20% increase, less than 10% change, 10–20% decrease, and more than 20% decrease in performance from the prior year consistent with longitudinal research on fitness and academic outcomes drawing from the Fitnessgram data set [9].

The primary outcome for this analysis was child-level number of days absent per year. Annual enrollment and attendance records were matched to Fitnessgram results by a unique student identifier.

Gender was based on parent report. Consistent with NYC DOHMH guidelines [26], a school neighborhood's socioeconomic status was defined according to American Community Survey 2007–2012 data as the percentage of households in the school zip code living below the federal poverty threshold (low [ $<10\%$ ], medium [ $10\%–20\%$ ], high [ $>20\%–30\%$ ], and very high [ $>30\%$ ] area poverty) [27].

Covariates included time, race/ethnicity, place of birth, change in obesity status, and school size. These covariates are shown in the literature to predict both fitness and absenteeism [8,28–30]. Time (calendar year) at height and weight measurement was treated as a continuous variable. Race/ethnicity was based on parent report and was grouped into five categories: Hispanic, non-Hispanic black, non-Hispanic white, Asian/Pacific Islander, and other (including multiple races). A binary school size variable was based on count of individuals attending each student's school. Per the literature, schools with less than 400 students were considered small schools, and schools with 400 or more students were considered non-small schools [30].

Change in obesity status from the prior year (obese to not obese, consistently not obese, consistently obese, and not obese to obese) was also included as a potential confounder based on the literature [9]. Body mass index (BMI) is collected annually as part of the Fitnessgram curriculum. Obesity was defined as having a BMI  $\geq 95$ th percentile for youth in the same gender and age group according to Centers for Disease Control and Prevention guidelines [31]. Change in obesity status was chosen as a covariate in lieu of change in BMI percentile to capture meaningful shifts in body composition associated with school outcomes [32].

### Statistical methods

Descriptive statistics were computed to summarize sample characteristics. Next, trends in absenteeism (days absent) by fitness, grade, and demographic characteristics were examined.

Mixed-models methodology was used to assess between-school variability in student absenteeism. First, to determine the extent of variation in absenteeism at the school level, unconditional three-level longitudinal linear mixed models with random intercepts were fit to the data for all students and stratified by gender. The school-level intraclass correlation (ICC) was calculated as the ratio of the variance for the school, divided by the sum of the three variance parameter estimates, represented as  $\sigma^2_{\text{school}}/(\sigma^2_{\text{student}} + \sigma^2_{\text{school}} + \sigma^2_{\epsilon})$ . Although univariate distributions for the days absent variable demonstrated a long right-tailed Poisson distribution, the ICC was calculated based on a linear mixed model given the ICC is not well defined for Poisson models [33].

Next, the longitudinal association of change in fitness and lagged number of days absent per year was assessed by fitting stratified negative binomial longitudinal mixed models [34,35] with random intercepts, the exposure, child-specific change in fitness from the prior year, and an offset term representing total instructional days per school year. Crude and adjusted models were

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