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Impact of physical activity, diet quality and stress on cardiometabolic health in school employees

Nicole S. Schultz[a,*], Kenneth K.H. Chui[b], Christina D. Economos[a], Alice H. Lichtenstein[a,b,c], Stella L. Volpe[d], Jennifer M. Sacheck[e]

[a] *Friedman School of Nutrition Science and Policy, Tufts University, 150 Harrison Avenue, Boston, MA 02111, United States*
[b] *Department of Public Health & Community Medicine, Tufts University School of Medicine, 136 Harrison Avenue, Boston, MA 02111, United States*
[c] *Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, 711 Washington Street, Boston, MA 02111, United States*
[d] *Department of Human Nutrition, Foods, and Exercise, Virginia Tech, 295 West Campus Drive, Blacksburg, VA 24061, United States*
[e] *Milken Institute School of Public Health, George Washington University, 950 New Hampshire Ave NW, Washington, DC 20052, United States*

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ABSTRACT

Among school employees, it has been reported that poor physical and mental health, as well as high stress and large workloads, have resulted in high absenteeism and low retention. The consequences of unhealthy behaviors and stress can extend to students, impacting academic achievement and school costs. Our objective was to examine the impact of school employees' physical activity (PA), diet quality and perceived occupational stress on cardiometabolic health, and explore how stress may influence the impact of PA and diet on health.

In this cross-sectional study, employees from lower-income Massachusetts schools participated in Wellness Assessments (2015–2016), including measured height, weight, and lipids [total (TC), high-density lipoprotein (HDL-C), low-density lipoprotein (LDL-C)]. Self-administered surveys were used to collect demographic, stress, PA and 24-hour food intake data. Linear regression models were used to examine the relationship among health behaviors (PA and diet), stress and cardiometabolic health. An interaction between stress and health behaviors was also explored.

Seventy-four employees (66% teachers) participated. Overweight/obesity (mean BMI: 25.6 kg/m^2), high TC and LDL-C were observed in 47%, 4%, and 34%, respectively, and moderate-to-vigorous PA (MVPA) was low (median: 17 min/day). Positive associations were identified between MVPA and cardiometabolic health, but not diet. The effect of MVPA on BMI was modified by stress (p-for-interaction = 0.001), with higher levels of stress associated with a diminished protective association between MVPA and BMI.

Higher levels of PA were associated with more favorable cardiometabolic health, with increasing levels of stress minimizing the beneficial effect of PA on BMI.

1. Introduction

School employees serve as role models for students, yet existing research documents overweight/obesity, low physical activity (PA), poor diets, and adverse cardiovascular health among this population (Hartline-Grafton et al., 2009; Webber et al., 2012). Poor mental health has also been reported (American Federation of Teachers, 2017), with high stress and large workloads yielding high absenteeism and low retention (Bogaert et al., 2014; Eaton et al., 2007). Consequences of unhealthy behaviors and stress can extend to students, impacting academic achievement and school costs (Greenberg et al., 2016). While interventions to improve student health behaviors are abundant, programs for school employees are lacking (Galemore, 2000). The degree to which successful programs targeting school employees influences student behavior remains unknown, yet is a promising avenue to enhance child obesity prevention efforts.

Abbreviations: BMI, Body Mass Index; FLEX, Fueling Learning Through Exercise; HEI, Healthy Eating Index; HDL-C, High-density Lipoprotein Cholesterol; IPAQ, International Physical Activity Questionnaire; JCQ, Job Content Questionnaire; LDL-C, Low-density Lipoprotein Cholesterol; MVPA, Moderate-to-vigorous Physical Activity; PA, Physical Activity; TC, Total Cholesterol.

[*] Corresponding author.
E-mail addresses: Nicole.s.schultz@gmail.com (N.S. Schultz), Kenneth.Chui@tufts.edu (K.K.H. Chui), Christina.Economos@tufts.edu (C.D. Economos), Alice.Lichtenstein@tufts.edu (A.H. Lichtenstein), stellalv@vt.edu (S.L. Volpe), Jsacheck25@email.gwu.edu (J.M. Sacheck).

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PA engagement, healthy dietary patterns and stress reduction are known contributors to positive cardiometabolic health (Kivimaki et al., 2013; Physical Activity Guidelines Advisory Committee, 2008.). Moderate-to-vigorous physical activity (MVPA) has a well-established, dose-dependent positive effect on cardiometabolic health, and diets high in refined grains and added sugar and low in fruits, vegetables, and fiber are associated with obesity and co-morbidities (Nicklas et al., 2012). Alternatively, high stress, often defined as job strain (the combined effects of high work demands and minimal freedom to deal with demands), can lead to physiological illness (Karasek et al., 1981), and is prominent in the education profession (Greenberg et al., 2016).

To our knowledge, the relationship between health behaviors and cardiometabolic health, and whether stress impacts this relationship, has not been studied in school employees. Understanding health behaviors of this population is necessary to develop successful health-promotion programs, which can provide a foundation for further exploration of the link between staff and student health. The primary study objective was to examine the effect of PA, diet quality and stress on cardiometabolic risk factors among school employees, and explore the interaction between stress and health behaviors. We hypothesized that cardiometabolic risk would be inversely associated with PA and diet quality, and positively associated with stress.

2. Methods

2.1. Participants

Study participants were recruited from seven elementary schools enrolled in the Fueling Learning Through Exercise (FLEX) study, a group randomized controlled trial designed to investigate the effect of two school-based physical activity (PA) interventions on academic achievement in elementary schoolchildren (Sacheck, 2015). FLEX schools were from socioeconomically disadvantaged, racially diverse school districts in Massachusetts (greater than 40% of students qualifying for free or reduced-price lunch and/or greater than 40% non-Caucasian). All full-time employees were eligible for participation and were recruited by e-mails and flyers placed in school mailboxes. The only exclusion criterion was pregnancy. Based off of a recent study, the pre-study calculation of required sample size to detect a relationship between PA and cardiometabolic outcomes was 72 (Oyeyemi & Adeyemi, 2013).

2.2. Data collection procedures

Thirteen Wellness Assessments (1 to 3 per school) were conducted between November 2015 and June 2016. Wellness Assessments were conducted before or after school. All participants received a $25 gift card for participation and a copy of their results.

2.2.1. Demographics

Participants completed a demographics questionnaire, which included age, sex, race/ethnicity, employee classification, smoking status, marital status, household size and composition, and education level as well as questions on whether individuals were taking cholesterol-lowering medication and engaging in regular physical activity. Additionally, respondents were asked if they were aware of the FLEX study, and if so, whether it had influenced any of the following: awareness of their own PA levels, their own PA engagement, promotion of student PA, or a combination of the three.

2.2.2. Anthropometrics

Height and weight were measured in triplicate using standard methods (Lohman, Roche, & Martorell, 1988.). Height was measured using a portable stadiometer (Model 214, Seca Weighing and Measuring Systems, Hanover, MD) with the head in the Frankfurt plane to the nearest 1/8 in.. Weight was measured using a portable digital electronic scale (PS-6600 ST, Befour Inc., Saukville, WI) to the nearest 0.25 lb. Body mass index (BMI) was calculated as weight in kilograms/height in meters squared and used to determine weight status, interpreted according to the Centers for Disease Control and Prevention (Centers for Disease Control and Prevention, 2011).

2.2.3. Cardiometabolic biomarkers

Blood samples were obtained using a non-fasting finger stick method and transferred into a cassette sample well for validated measures of total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) concentrations (Cholestech LDX Analyzer, Alere, Waltham, MA) (Alere Cholestech LDX, 2018). These data were used to calculate TC/HDL-C and non-HDL-C/HDL-C ratios, and determine cardiometabolic risk status. Increased cardiovascular risk was determined according to the following criteria: TC $>$ 200 mg/dL, LDL-C $>$ 100 mg/dL, and HDL-C $<$ 40 mg/dL in men and $<$ 50 mg/dL in women (National Cholesterol Education Program, 2001).

2.2.4. Physical activity and diet

The long version of the validated International PA Questionnaire (IPAQ) was used to obtain information about PA levels (Craig et al., 2003). Recreational PA was used to determine whether participants met the Physical Activity Guidelines of 150 min of moderate PA, 75 min of vigorous PA, or an equivalent combination, per week (Physical Activity Guidelines Advisory Committee, 2008). An Automated Self-Administered 24-hour dietary recall system (ASA24, National Cancer Institute, Bethesda, MD) was used to obtain dietary information, which has been validated against standardized interviewer-administered 24-hour recalls (Kirkpatrick et al., 2014; National Cancer Institute, 2018). Data collected were used to calculate the Healthy Eating Index (HEI) 2015 score, which measures how closely food choices align with the 2015 to 2020 United States Dietary Guidelines. The score components, which sum to 100, include total fruit, whole fruit, vegetables, greens and beans, whole and refined grains, total protein foods, fatty acids (mono- and polyunsaturated to saturated fat ratio), seafood and plant-based protein foods, sodium, and kilocalories from saturated fat and added sugar. A score of 100 suggests perfect adherence to the 2015 United States Dietary Guidelines, and indicate a high quality diet.

2.2.5. Perceived occupational stress

Perceived occupational stress, assessed by job strain and referred to throughout as “stress,” was measured by the commonly used, validated Job Content Questionnaire (JCQ) (Karasek et al., 1998). The Job Strain model states that psychological strain, and resulting physiological illness, results from the combined effects of high work demands and low decision latitude, or freedom to deal with demands (Karasek et al., 1981). Job strain is expressed as a ratio of Psychological Demands to Decision Latitude, with smaller scores indicating lower strain. Possible score ranges are 24 to 96 for Decision Latitude and 12 to 48 for Psychological Demands. This model has been shown to strongly predict both job-related mental strain symptoms, such as depression and exhaustion, as well as physiological outcomes, such as elevated blood pressure and myocardial infarction (Karasek et al., 1981; Kivimaki et al., 2013).

All procedures were approved by the Tufts University Institutional Review Board, as well as by school district research offices, as appropriate. Written informed consent was obtained from all participants.

2.3. Statistical methods

SAS 9.3 (SAS Institute Inc., Cary, NC) was used to conduct all statistical analyses. The rate of type I error was set at 5%. Descriptive statistics were compiled and tabulated. Skewness of each cardiometabolic risk factor was assessed prior to the analyses. Linear regression models were used to examine the relationship between health behaviors (weekly minutes of MVPA and HEI-2015 score), stress (job strain score) and cardiometabolic risk factors (BMI, TC, HDL-C, LDL-C, TC/-C and non-HDL-C/HDL-C). For each cardiometabolic risk factor, unadjusted and three adjusted models were used. Independent variables included: (Model 1) MVPA and HEI, (Model 2) MVPA, HEI and stress, and (Model 3) MVPA, HEI, stress and interaction terms (MVPA × stress and HEI × stress). Models 1 through 3 were adjusted for the following covariates: sex, age, race/ethnicity, employee classification (teacher vs. staff), smoking status, marital status, household size, and education level. When Model 3 interaction terms did not reach statistical significance, Model 2 was used to interpret the impact of MVPA, HEI and stress on cardiometabolic risk factors. A multi-level model adjusting for school level effects was not implemented due to the very low intra-class correlation coefficients of the studied outcomes.

To facilitate the presentation of how stress modifies the impact of MVPA on the dependent variable in models with a significant interaction, we developed nine scenarios of high, medium and low stress, and high, moderate and low levels of MVPA, using their corresponding 25th, 50th and 75th percentiles. For each scenario, the predicted outcomes were then derived using Model 3, and subsequently visualized for interpretation.

3. Results

3.1. *Sample characteristics*

School employees (N = 120) participated in this study, which corresponded to 23% of possible school employees (120/522). Six of the seven schools were FLEX intervention schools, with one control school. Average school size was approximately 588 students (range: 328 to 892), with over 60% of students in all but one school (48%) considered to be High Needs (Massachusetts Department of Elementary and Secondary Education, 2015). Schools had an average of 75 staff members (range: 45 to 109), of which approximately 45 were teachers (range: 25 to 68). Seventy-four participants completed all measures. Most participants were women (91%), teachers (66%), non-smokers (80%) and under 40 years of age (55%). Participants were highly educated, with over 70% having achieved a graduate degree (Table 1). Of the 66 participants from the FLEX intervention schools, 43.9% were aware of the FLEX Study, with a majority of participants aware of FLEX indicating that it had influenced awareness of their own PA levels, their own PA engagement, promotion of student PA, or a combination of the three.

Anthropometric and cardiometabolic risk factors are reported in Table 2. While 47% of the study population experienced overweight/obesity, only 4% had high TC concentrations ($>$200 mg/dL) and 5% had low HDL-C concentrations (Men: $<$40 mg/dL, Women: $<$50 mg/dL). Thirty-four percent of the participants had elevated LDL-C concentrations ($>$100 mg/dL). The average TC/HDL-C and non-HD-CL/HDL-C were 2.8 and 1.8, respectively (optimal TC/HDL-C $<$ 3.5), reflecting relatively high HDL-C concentrations. Nine percent of the participants reported taking cholesterol lowering medications.

Table 1
Participant Characteristics (N = 74), Massachusetts Elementary School Employees, 2015–2016.

Age, years (mean, range)	40.7 (22.3, 74.4)
Women (%)	90.5
Race/Ethnicity (%)	
White	93.2
Non-White[a]	6.8
Smoking Status (%)	
Never Smoked	80%
Currently Smoke	1%
Smoked but Quit	19%
Role (%)	
Teacher	66.2
Other[b]	33.8
Married or Domestic Partnership (% yes)	51.4
Children in Household (% yes)	18.9
Graduate Degree (% yes)	71.6
Aware of FLEX[c] Study (% yes)	43.9

[a]: Non-white: African American, American Indian/Alaska Native, Native Hawaiian/Other Pacific Islander,
Asian, and Other.

[b]: Other: Principal, Assistant Principal, Nurse, Reading Specialists, Physical Education, Special Education

[c]: FLEX: Fueling Learning Through Exercise

Table 2
Anthropometric and Cardiometabolic Risk Factors, Self-Reported Physical Activity and Perceived Stress in Massachusetts Elementary School Employees (N = 74), 2015–2016.

BMI, kg/m^2 (mean ± SD)	25.6 ± 5.1
Weight Status[a] (%)	
Underweight	1.4
Normal Weight	51.4
Overweight	28.4
Obese	18.9
Plasma Lipids, mg/dL (mean ± SD, range)	
Total Cholesterol	180 ± 32 (126, 264)
LDL Cholesterol	91 ± 27 (36, 156)
HDL Cholesterol	67 ± 16 (27, 101)
TC/HDL-C	2.8 ± 0.9 (1.6, 6.7)
Non-HDL-C/HDL-C	1.8 ± 0.9 (0.6, 5.7)
Cardiometabolic Risk Status[b] (%)	
High Total Cholesterol	4.1
High LDL Cholesterol	33.8
Low HDL Cholesterol	5.4
Recreational PA, min/day (mean ± SD)	
Walking	22.2 ± 43.6
Moderate	7.5 ± 13.9
Vigorous	17.8 ± 22.9
Meeting PA Guidelines[c] (%)	47.3
Sitting Time, hours (median, range)	
Weekday	4 (0.2–12)
Weekend	4 (0.0–10)
Perceived Occupational Stress (mean ± SD, median: possible range)	
Psychological Demands	34.5 ± 6.1 (30: 12, 48)
Decision Latitude	73.7 ± 8.5 (60: 24, 96)
Job Strain (mean ± SD)	0.47 ± 0.09

BMI: Body Mass Index, LDL: Low-Density Lipoprotein, HDL: High-Density Lipoprotein, TC: Total Cholesterol, HDL-C: HDL Cholesterol; PA: Physical Activity

[a]: According to the Centers for Disease Control and Prevention (2011): Underweight $<$ 18.5; Normal 18.5–24.9; Overweight 25.0–29.9; Obese 30+

[b] TC $>$ 200; LDL-C $>$ 100; HDL-C $<$ 40 (men) and HDL-C $<$ 50 (women) (National Cholesterol Education Program, 2001.)

[c]: PA Guidelines: 150 min/week of moderate, 75 min/week of vigorous or an equivalent combination (Physical Activity Guidelines Advisory Committee, 2008.)

3.2. *Health behaviors*

While 68% answered “yes” to engaging in regular PA, only 47% met the Physical Activity Guidelines (Physical Activity Guidelines Advisory Committee, 2008). The median accumulated self-reported PA was 120 min of MVPA per week, the majority of which was walking (Table 2).

The average HEI-2015 score was 58 out of 100. While consumption of reported added sugar intake was low (11 ± 10 g), this population reported diets high in saturated fat (23 ± 15 g) and low in fiber (18 ± 9 g). Forty-seven percent of total energy was derived from carbohydrates (203 ± 93 g), with the remaining 19% from protein (78 ± 35 g) and 34% from fat (67 ± 33 g; 20% mono- and polyunsaturated). Mean total energy was reported to be 1714 ± 675 kcal (kcals).

3.3. *Perceived occupational stress*

Stress, measured by job strain, was expressed as a ratio of

Psychological Demands to Decision Latitude (Strain = 0.47 ± 0.09), with higher demand and less freedom to make decisions yielding higher stress (Table 2). The average Psychological Demand score (34.5 ± 6.1) was higher than the median possible score (30; Range 12 to 48), yet the average Decision Latitude score (73.7 ± 8.5) was also higher than the median possible score (60; Range 24 to 96) (Karasek et al., 1998).

3.4. Relationship between health behaviors, stress and cardiometabolic health

Linear regression results for the cardiometabolic risk factors that reached significance are presented in Table 3. Physical activity was associated with HDL-C concentration ($p = 0.01$), TC/HDL-C ($p = 0.03$), and non-HDL-C/HDL-C ($p = 0.03$). For every additional 30 min per week of MVPA, participants were estimated to increase HDL-C by 0.9 mg/dL and decrease TC/HDL-C and non-HDL-C/HDL-C ratios by 0.03. The association between diet quality (HEI) and TC/HDL-C approached significance ($p = 0.08$), while HEI was not significantly related to the remaining cardiometabolic risk factors ($p > 0.05$).

Although there were no statistically significant associations between stress and cardiometabolic risk factors, stress modified the relationship between PA and BMI (p-for-interaction = 0.001). Results of the 9 MVPA/stress combinations suggested that individuals with low and moderate stress may experience a protective association between PA on BMI. However, for those with high stress, we observed higher BMI with increasing levels of PA. As such, our results suggest a diminished protective effect of PA on BMI as stress increased (Fig. 1).

4. Discussion

While the overall cardiometabolic health of this sample was more favorable than limited existing evidence (Webber et al., 2012), results highlighted low levels of PA, diets high in saturated fat and low in fiber, and high rates of overweight/obesity. Both the percentage of school employees meeting the PA guidelines, as well as HEI score, were comparable to national findings (U.S. Department of Health and Human Services, 2015), suggesting that, along with the nation as a whole, the school employees surveyed have significant room to improve PA levels and adherence to Dietary Guidelines. Stress was also comparable to national averages, with Psychological Demand and Decision Latitude scores slightly higher in our sample relative to a national sample, reflecting the demanding nature of the school employee role (Karasek et al., 1998).

Our findings indicated that MVPA is associated with cardiometabolic health, including BMI, HDL-C concentration, TC/HDL-C and non-HDL-C/HDL-C. Despite literature supporting the negative impact of poor diet quality and high stress on cardiometabolic health (Kivimaki et al., 2013; Nicklas et al., 2012), neither were associated with cardiometabolic health in this sample. However, stress was shown to modify the relationship between MVPA and BMI, suggesting that stress may play a role in cardiometabolic health, potentially by way of impacting health behaviors of school employees.

In addition to the importance of PA to cardiometabolic health, the relationship between stress and cardiometabolic health has been well-studied (Nyberg et al., 2013). While the high stress of teachers has been previously documented (Greenberg et al., 2016), there has been a recent rise in literature highlighting the growing stress among teaching professionals (American Federation of Teachers, 2017), with teachers reporting one of the highest rates of job stress, yielding burnout, poor performance, and high turnover (Greenberg et al., 2016). Cited factors that influence stress include school leadership and culture, job demands, work resources and support, and social-emotional competence (Greenberg et al., 2016). While our findings did not support the direct relationship between stress and cardiometabolic health, our exploratory analysis suggested the relationship between MVPA and BMI differed across levels of stress. It can be postulated that increasing stress may decrease the benefits of PA on BMI, either as a result of direct neuroendocrine effects of chronic stress, or indirect behavioral effects, such as overeating, lack of PA and alcohol consumption (Brunner, Chandola, & Marmot, 2007). Diet quality, however, did not differ across PA or stress levels in this sample, yet the narrow range of HEI scores may have limited our ability to assess this relationship. Alternatively, it may be that higher stress in individuals with overweight/obesity may drive them to exercise more for stress relief.

The results of this study, together with the increasing literature calling for stress reduction and health promotion solutions for educators, have important implications. The development of effective policies and programs targeting school employee well-being can improve both teacher performance and student academic achievement, as well as produce cost savings for schools. Low academic achievement has been linked to teacher stress and depressive symptoms, and behavioral problems have been linked to teacher burnout (Hoglund, Klingle, & Hosan, 2015; McLean & McDonald Connor, 2015). Alternatively, a survey of over 78,000 students revealed that higher teacher engagement predicted higher student engagement, which ultimately predicted higher student achievement (Gordon, 2010). While much of the recent stress is reported to originate from stricter academic standards, the

Table 3

Significant Findings of Linear Regression Models Assessing Association between Health Behaviors and Cardiometabolic Outcomes in Massachusetts Elementary School Employees (N = 74), 2015–2016.

Model Predictors	BMI	HDL-C	TC/HDL-C	Non-HDL-C/HDL-C
	Model 3	*Model 2*	*Model 2*	*Model 2*
PA	−0.050 (−0.080, −0.019)**	0.027 (0.007, 0.047)*	−0.001 (−0.002, −0.0001)*	−0.001 (−0.002, −0.0001)*
HEI	−0.176 (−0.624, 0.272)	−0.089 (−0.344, 0.167)	0.012 (0.001, 0.0256)	0.012 (−0.002, 0.025)
Stress	−34.06 (−95.85, 27.73)	−29.97 (−65.58, 11.63)	0.538 (−1.500, 2.577)	0.633 (−1.405, 2.672)
PA × Stress	0.104 (0.043, 0.165) **	—	—	—
HEI × Stress	0.300 (−0.636, 1.235)	—	—	—
F	2.54	2.82	3.86	3.81
P	0.007	0.004	0.0002	0.0003
R^2	0.38	0.360	0.436	0.433

PA: Physical Activity (min/day), HEI: Healthy Eating Index (2015 Score), BMI: Body Mass Index (kg/m^2), TC: Total Cholesterol (mg/dL), HDL-C: High-Density Lipoprotein Cholesterol (mg/dL)

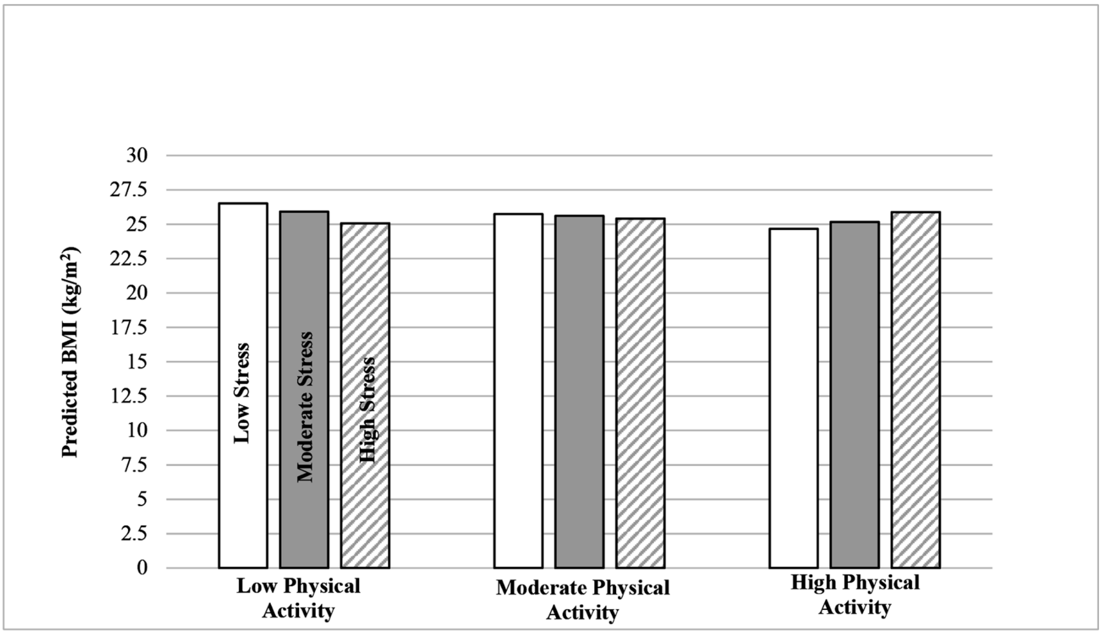
Values reported are β estimates (95% CI)

Both linear regression models adjusted for age, sex, race/ethnicity, classification, smoking status, marital status, education, and household size.

Model 2: Includes independent variables: PA, HEI and Stress

Model 3: Includes independent variables and interaction terms: PA, HEI, Stress, PA × Stress and HEI × Stress

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$



Linked Data

Scenario	X axis	Y axis
LPA LS	9	26.52
LPA MS	8	25.92
LPA HS	7	25.08
MPA LS	6	25.74
MPA MS	5	25.61
MPA HS	4	25.42
HPA LS	3	24.67
HPA MS	2	25.17
HPA HS	1	25.89

Fig. 1. Relationship between perceived occupational stress and body mass index (BMI) across physical activity levels in Massachusetts elementary school employees (N = 74), 2015–2016.

implications of improving teacher well-being are twofold, with resulting improvements in student achievement further reducing the stress caused by academic mandates. This may be particularly important in socioeconomically disadvantaged, racially diverse school districts, such as those involved in FLEX, given that upholding academic standards in a challenging environment can magnify stress levels.

In addition, with the current focus on child obesity prevention and health promotion efforts in schools, teachers are more aware of importance of PA and diet quality on overall health, yet lack resources and support to change behavior. This heightened awareness may not only enhance participation in school employee wellness programs, which will ultimately lead to their success, but also provide a timely context in which schools define best practices for healthy school work environments and truly make an impact on both educator health and student achievement. A study assessing the efficacy of a district-wide wellness program (2011–2012) showed favorable changes in cardiometabolic health among participants, combined with savings of $3.60 for every dollar spent (Merrill & LeCheminant, 2016; Merrill & Sloan, 2014), demonstrating the high potential for these programs.

Our study provides an essential foundation for future researchers seeking to understand the impact of stress on health behaviors and health outcomes in school employees. This study was conducted at a critical time during which interventions to improve student health and achievement are growing. Though not widely studied, the relationship between school employee health and student behaviors and achievement has been observed (Hoglund et al., 2015; McLean & McDonald Connor, 2015). As such, this research can highlight opportunities to improve school employee health, which in turn can positively impact the success of student interventions.

Despite its significance, the current study has several limitations. First, the analysis is cross-sectional, eliminating the ability to determine a causal relationship between studied health behaviors and cardiometabolic risk factors. Secondly, PA and dietary intake data were collected by way of self-report, introducing the potential for over-reporting or under-reporting, respectively. In addition, the lack of magnitude of the interaction between health behaviors and stress limited the ability to detect the potential relationship between these variables, but this study provides an estimate for a larger scale study. Individual cardiometabolic risk factors were used for this analysis; however, analyzing cardiometabolic risk as a composite score is more favorable. Future studies should consider analyzing cardiometabolic risk using a composite score. Blood pressure should also be included in analyses of cardiometabolic risk. Furthermore, while participants were drawn from varying schools and districts, generalizability of findings may still be limited. However, despite a predominantly female sample, the gender discrepancy is representative of school personnel statewide. Lastly, while recruitment strategies were implemented to reduce the potential for selection bias, it is possible that individuals who choose to participate in a wellness-related study differ from those who choose not to participate, leading to a relatively healthy sample and reducing the ability to detect significant associations. Similarly, schools that chose to participate in the larger FLEX study may differ from those that did not, despite recruitment from a variety of school districts and locale.

Future research should seek to determine effective approaches to increase PA and diet quality, and decrease stress, amidst busy schedules of school employees, while further understanding the impact of stress on health and health behaviors.

4.1. Conclusions

Our results suggest that, while this population had generally favorable cardiometabolic health, PA and diet quality were low. Increasing PA was significantly associated with better cardiometabolic outcomes, with increasing levels of stress minimizing the beneficial impact of PA on BMI. Our results support the need for PA promotion among school employees, alongside efforts to improve diet quality and reduce stress.

CRediT authorship contribution statement

Nicole S. Schultz: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Visualization, Writing - original draft, Funding acquisition, Project administration, Writing - review & editing. **Kenneth K.H. Chui:** Methodology, Writing - review & editing. **Christina D. Economos:** Writing - review & editing. **Alice H. Lichtenstein:** Funding acquisition, Writing - review & editing. **Stella L. Volpe:** Writing - review & editing. **Jennifer M. Sacheck:** Funding acquisition, Conceptualization, Supervision, Writing - review & editing.

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Appendix A

Power Analysis. A recent paper examining the relationship between PA and cardiovascular risk factors was used to determine the adequate sample size for this study (Oyeyemi & Adeyemi, 2013). In adults 18 to 65 years of age, Oyeymi and colleagues detected a significant correlation of $r = -0.32$ between BMI and MVPA. A PROC POWER command (SAS 9.3, SAS Institute Inc., Cary, NC) was used to determine the sample size necessary to detect a significant association between health behaviors and weight status at $\alpha = 0.05$ and $\beta = 0.80$, which was calculated to be $N = 72$.

Appendix B

Linear regression results

Table B.1.
Linear Regression Models Assessing Association between Health Behaviors (Physical Activity, Diet Quality and Stress) and Body Mass Index in Massachusetts Elementary School Employees ($N = 74$), 2015–2016.

Model Predictors	**BMI**		
	Model 1	*Model 2*	*Model 3*
PA	0.0005 (−0.006, 0.008)	0.0005 (−0.007, 0.008)	−0.050 (−0.080, −0.019)**
HEI	−0.036 (−0.121, 0.049)	−0.041 (−0.130, 0.047)	−0.176 (−0.624, 0.272)
Stress	—	3.143 (−10.20, 16.49)	−34.06 (−95.85, 27.73)
PA × Stress	—	—	0.104 (0.043, 0.165) **
HEI × Stress	—	—	0.300 (−0.636, 1.235)
F	1.88	1.72	2.54
P	0.060	0.084	0.007
R^2	0.253	0.260	0.38

PA: Physical Activity (min/day), HEI: Healthy Eating Index (2015 Score), BMI: Body Mass Index (kg/m^2).
Values reported are β estimates (95% CI)
All linear regression models adjusted for age, sex, race/ethnicity, classification, smoking status, marital status, education, and household size.
Model 1: Includes independent variables: PA and HEI
Model 2: Includes independent variables: PA, HEI and Stress
Model 3: Includes independent variables and interaction terms: PA, HEI, Stress, PA × Stress and HEI × Stress
$^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table B.4.
Linear Regression Models Assessing Association between Health Behaviors (Physical Activity, Diet Quality and Stress) and High-Density Lipoprotein Cholesterol in Massachusetts Elementary School Employees (N = 74), 2015–2016.

Model Predictors	**HDL-C**		
	Model 1	*Model 2*	*Model 3*
PA	0.026 (0.006, 0.047)*	0.027 (0.007, 0.047)*	0.105 (0.011, 0.199)*
HEI	−0.134 (−0.383, 0.115)	−0.089 (−0.344, 0.167)	0.101 (−1.284, 1.487)
Stress	—	−29.97 (−65.58, 11.63)	28.32 (−162.7, 219.4)
PA × Stress	—	—	−0.162 (−0.350, 0.027)
HEI × Stress	—	—	−0.424 (−3.316, 2.469)
F	2.85	2.82	2.66
P	0.005	0.004	0.005
R^2	0.340	0.360	0.391

PA: Physical Activity (min/day), HEI: Healthy Eating Index (2015 Score), HDL-C: High-Density Lipoprotein Cholesterol (mg/dL).
Values reported are β estimates (95% CI)
All linear regression models adjusted for age, sex, race/ethnicity, classification, smoking status, marital status, education, and household size.
Model 1: Includes independent variables: PA and HEI
Model 2: Includes independent variables: PA, HEI and Stress
Model 3: Includes independent variables and interaction terms: PA, HEI, Stress, PA × Stress and HEI × Stress
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table B.3.
Linear Regression Models Assessing Association between Health Behaviors (Physical Activity, Diet Quality and Stress) and Low-Density Lipoprotein Cholesterol in Massachusetts Elementary School Employees (N = 74), 2015–2016.

Model Predictors	LDL-C		
	Model 1	*Model 2*	*Model 3*
PA	−0.008 (−0.046, 0.029)	−0.008 (−0.045, 0.029)	0.094 (−0.080, 0.269)
HEI	0.341 (−0.114, 0.796)	0.396 (−0.075, 0.868)	−0.171 (−2.750, 2.408)
Stress	—	−32.96 (−104.1, 38.21)	−68.95 (−424.6, 286.7)
PA × Stress	—	—	−0.209 (−0.561, 0.142)
HEI × Stress	—	—	1.178 (−4.207, 6.563)
F	1.63	1.56	1.46
P	0.113	0.128	0.156
R^2	0.227	0.238	0.261

PA: Physical Activity (min/day), HEI: Healthy Eating Index (2015 Score), LDL-C: Low-Density Lipoprotein Cholesterol (mg/dL).
Values reported are β estimates (95% CI)
All linear regression models adjusted for age, sex, race/ethnicity, classification, smoking status, marital status, education, and household size.
Model 1: Includes independent variables: PA and HEI
Model 2: Includes independent variables: PA, HEI and Stress
Model 3: Includes independent variables and interaction terms: PA, HEI, Stress, PA × Stress and HEI × Stress
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table B.2.
Linear Regression Models Assessing Association between Health Behaviors (Physical Activity, Diet Quality and Stress) and Total Cholesterol in Massachusetts Elementary School Employees (N = 74), 2015–2016.

Model Predictors	**TC**		
	Model 1	*Model 2*	*Model 3*
PA	0.022 (−0.022, 0.066)	0.023 (−0.021, 0.067)	0.189 (−0.015, 0.391)
HEI	0.171 (−0.367, 0.709)	0.262 (−0.292, 0.815)	−0.049 (−3.049, 2.950)
Stress	—	−53.71 (−137.3, 29.86)	−31.57 (−445.2, 382.1)
PA × Stress	—	—	−0.339 (−0.748, 0.070)
HEI × Stress	—	—	0.617 (−5.645, 6.880)
F	1.60	1.62	1.62
P	0.120	0.109	0.101
R^2	0.224	0.245	0.281

PA: Physical Activity (min/day), HEI: Healthy Eating Index (2015 Score), TC: Total Cholesterol (mg/dL).
Values reported are β estimates (95% CI)
All linear regression models adjusted for age, sex, race/ethnicity, classification, smoking status, marital status, education, and household size.
Model 1: Includes independent variables: PA and HEI
Model 2: Includes independent variables: PA, HEI and Stress
Model 3: Includes independent variables and interaction terms: PA, HEI, Stress, PA × Stress and HEI × Stress
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table B.5.
Linear Regression Models Assessing Association between Health Behaviors (Physical Activity, Diet Quality and Stress) and Total Cholesterol to High-Density Lipoprotein Cholesterol Ratio in Massachusetts Elementary School Employees (N = 74), 2015–2016.

Model Predictors	**TC/HDL-C**		
	Model 1	*Model 2*	*Model 3*
PA	−0.001 (−0.002, −0.0001)*	−0.001 (−0.002, −0.0001)*	−0.002 (−0.007, 0.004)
HEI	0.013 (0.00002, 0.026)*	0.012 (0.001, 0.0256)	0.003 (−0.072, 0.078)
Stress	—	0.538 (−1.500, 2.577)	−0.742 (−11.08, 9.592)
PA × Stress	—	—	0.001 (−0.010, 0.011)
HEI × Stress	—	—	0.019 (−0.138, 0.175)
F	4.24	3.86	3.21
P	0.0001	0.0002	0.0009
R^2	0.433	0.436	0.436

PA: Physical Activity (min/day), HEI: Healthy Eating Index (2015 Score), TC: Total Cholesterol (mg/dL), HDL-C: High-Density Lipoprotein Cholesterol (mg/dL).

Values reported are β estimates (95% CI)

All linear regression models adjusted for age, sex, race/ethnicity, classification, smoking status, marital status, education, and household size.

Model 1: Includes independent variables: PA and HEI

Model 2: Includes independent variables: PA, HEI and Stress

Model 3: Includes independent variables and interaction terms: PA, HEI, Stress, PA × Stress and HEI × Stress

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table B.6.
Linear Regression Models Assessing Association between Health Behaviors (Physical Activity, Diet Quality and Stress) and Non-High-Density Lipoprotein Cholesterol to High-Density Lipoprotein Cholesterol Ratio in Massachusetts Elementary School Employees (N = 74), 2015–2016.

Model Predictors	Non-HDL-C/HDL-C		
	Model 1	*Model 2*	*Model 3*
PA	−0.001 (−0.002, −0.0001)*	−0.001 (−0.002, −0.0001)*	−0.002 (−0.007, 0.003)
HEI	0.013 (0.00001, 0.026)*	0.012 (−0.002, 0.025)	0.003 (−0.072, 0.078)
Stress	—	0.633 (−1.405, 2.672)	−0.717 (−11,0.05, 9.616)
PA × Stress	—	—	0.001 (−0.009, 0.011)
HEI × Stress	—	—	0.019 (−0.137, 0.175)
F	4.17	3.81	3.17
P	0.0001	0.0003	0.001
R^2	0.429	0.433	0.434

PA: Physical Activity (min/day), HEI: Healthy Eating Index (2015 Score), HDL-C: High-Density Lipoprotein Cholesterol (mg/dL).

Values reported are β estimates (95% CI)

All linear regression models adjusted for age, sex, race/ethnicity, classification, smoking status, marital status, education, and household size.

Model 1: Includes independent variables: PA and HEI

Model 2: Includes independent variables: PA, HEI and Stress

Model 3: Includes independent variables and interaction terms: PA, HEI, Stress, PA × Stress and HEI × Stress

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

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