JOURNAL OF SCHOOL HEALTH
American School Health Association

RESEARCH ARTICLE

Relationship of Nutrition and Physical Activity Behaviors and Fitness Measures to Academic Performance for Sixth Graders in a Midwest City School District

JANE U. EDWARDS, PhD, RD[a,b] LOIS MAUCH, MS[c] MARK R. WINKELMAN[d]

ABSTRACT

BACKGROUND: To support curriculum and policy, a midwest city school district assessed the association of selected categories of nutrition and physical activity (NUTR/PA) behaviors, fitness measures, and body mass index (BMI) with academic performance (AP) for 800 sixth graders.

METHODS: Students completed an adapted Youth Risk Behavior Surveillance Survey (NUTR/PA behaviors), fitness assessments (mile run, curl-ups, push-ups, height, and weight) with results matched to standardized scores (Measures of Academic Progress [MAP]), meal price status, and gender. Differences in mean MAP scores (math and reading) were compared by selected categories of each variable utilizing 1-way analysis of variance. Associations were determined by stepwise multiple regression utilizing mean MAP scores (for math and for reading) as the dependent variable and NUTR/PA behaviors, fitness, and BMI categories as independent variables. Significance was set at $\alpha = 0.05$.

RESULTS: Higher MAP math scores were associated with NUTR (more milk and breakfast; less 100% fruit juice and sweetened beverages [SB]) and PA (increased vigorous PA and sports teams; reduced television), and fitness (higher mile run performance). Higher MAP reading scores were associated with NUTR (fewer SB) and PA (increased vigorous PA, reduced television). Regression analysis indicated about 11.1% of the variation in the mean MAP math scores and 6.7% of the mean MAP reading scores could be accounted for by selected NUTR/PA behaviors, fitness, meal price status, and gender.

CONCLUSION: Many positive NUTR/PA behaviors and fitness measures were associated with higher MAP scores supporting the school district focus on healthy lifestyles. Additional factors, including meal price status and gender, contribute to AP.

Keywords: physical activity; physical fitness; nutrition; academic performance.

Citation: Edwards JU, Mauch L, Winkelman MR. Relationship of nutrition and physical activity behaviors and fitness measures to academic performance for sixth graders in a midwest city school district. J Sch Health. 2011; 81: 65-73.

Received on August 05, 2009
Accepted on July 13, 2010

A primary goal for schools is to promote positive learning outcomes as measured by academic indicators. Assessments are now required by local school districts to meet specific academic goals mandated by the No Child Left Behind Act of 2001(Public Law 107-110) administered and assessed by the US Department of Education. In response to the rising prevalence of obesity in our nation's youth, local school districts have also been mandated by federal legislation (Public Law 108-265) to develop ''local wellness policies'' administered by the US Department of Agriculture without mandated outcomes. Some school districts may view the time and resources needed to promote healthy weights, good nutrition, and fitness as being in direct conflict to meeting academic goals. Assessments are needed to determine associations between lifestyle behaviors and academic outcomes to allow school districts to make informed

[a]Former: Assistant Professor, Department of Health, Nutrition & Exercise Sciences, North Dakota State University, Fargo, ND 58105.
[b]Current: (buildahealthyplate@gmail.com), 376 Quarry Hill Road, #326, South Burlington, VT 05403.
[c]Physical Education Specialist, (mauchl@fargo.k12.nd.us), Fargo Public Schools, 1725 N. Broadway, Fargo, ND 58102.
[d]Winkelman Consulting®, (mrwinkelman@cableone.net), P.O. Box 11375, Fargo, ND 58106.
Address correspondence to: Jane U. Edwards, (buildahealthyplate@gmail.com), 376 Quarry Hill Road, #326, South Burlington, VT 05403.
This project was financially supported by a Coordinated School Health Grant received by Fargo Public Schools, Fargo, ND 58102.

decisions for curriculum and policy to promote learning.

Beverages

US children and youth, 2-19 years old, had a mean consumption of between 10% and 15% of total calories (kcal) from sweetened beverages (SB) and 100% fruit juice (FJ) for 1999-2004.[1] Sweetened beverages included soda, sports drinks, energy drinks, lemonade, and other fruit drinks. Between 1988-1994 and 1999-2004 an increased mean caloric intake occurred for all children and youth from SB (204 to 224 kcal/person/day) and from100% FJ (38 to 48 kcal/person/day).[1] Among youth, 6-11 years old, who consumed SB for 1999-2004, a mean intake of 20.5 oz of SB per day was found (equivalent to 229 kcal or 11% of total kcal) and a mean intake of 10.4 oz of 100% FJ (equivalent to 136 kcal or 7% of total kcal).[1] The increased use of SB and associated increased caloric intake has been suggested to be a contributing factor in the rising prevalence of overweight in the population.[2]

Sweetened beverage intake increased (4.8% to 10.3% of kcal) and milk intake decreased (13.2% to 8.3% of kcal) for children ages 2-18 years in the United States, between 1977-1978 and 1999-2001.[3] The percentage of females, ages 12-19 years, who drank milk, was reduced from 72% in 1977-1978 (mean intake 303 g/day) to 50% in 1994-1996 (mean intake 189 g/day).[4] Adolescent females who did not drink milk had inadequate intakes of calcium as well as vitamin A, phosphorus, folate, and magnesium.[4] A potential biologic mechanism for calcium and dairy in energy metabolism has been investigated but what role this food group and associated nutrients exert in the increasing prevalence of obesity in the population is not well understood.[5] Thus, changing food patterns, related to the types and amounts of beverages by school-age children, have been found to influence calorie and nutrient intake and be associated with weight status but have not been investigated relative to their relationship with academic performance (AP).

Breakfast

Breakfast consumption has been suggested to enhance cognition and AP, both for standardized scores and grades, through various effects on memory function but also by improving school attendance and reducing tardiness rates.[6] The suggested physiologic mechanisms whereby breakfast may affect cognition and AP include metabolic changes due to availability of energy and other nutrients to the central nervous system and related changes in hormone and neurotransmitter levels, as well as the long-term effects of regular breakfast consumption on overall nutritional status.[7] Children who consume breakfast, compared to breakfast skippers, have higher daily average intake of micronutrients, including vitamins A and C, riboflavin, calcium, iron, and zinc.[6] An inverse association between regular breakfast consumption and overweight has been indicated in cross-sectional analysis.[8,9] However, longitudinal analysis indicated a positive relationship between regular breakfast consumption and a gain in body mass index (BMI) for overweight children, but a negative association for those initially of normal weight.[9]

Television

Increasing weekday television screen time and cable movie channel availability was found to increase the odds of poorer AP (self-report) in a cross-sectional survey of middle school (MS) children (grades 5-8) in the northeastern United States.[10] A cross-sectional study of MS students (grades 6-7) from the Boston area found that parental restriction of television time resulted in more time reading and doing homework, whereas a television in the child's bedroom resulted in less time reading.[11]

Fitness and Physical Activity

Quasi-experimental interventions have found that adding extra time for physical education (PE) within the school day does not diminish AP, either for grades or for standardized scores, and may be associated with improved fitness and/or health measures.[12] A cross-sectional study of a national sample of Australian children, 7-15 years old, found school ratings of scholastic ability to be correlated with self-reported PA as well as with fitness measures but failed to find an association of AP with an objective measure of physical work capacity.[13] The California Department of Education found overall fitness scores (FITNESSGRAM®) associated with improved achievement on standardized scores (reading and math) for all fifth-, seventh-, and ninth-grade students statewide.[14] Similar findings of a positive relationship between number of fitness tests passed (FITNESSGRAM®) and standardized scores (math and English) were seen in Massachusetts for fourth-, sixth-, and eighth-grade students.[15]

A positive relationship between physical activity (PA) and cognition was suggested by a meta-analysis of available studies with MS (grades 6-8) and elementary school students.[16] Physiological mechanisms suggested to elucidate the association between PA, fitness, and cognition include the following: (1) exercise may increase cerebral blood flow increasing the supply of glucose and oxygen to the brain; (2) both acute and chronic exercise may influence neurotransmitter levels with potential effects on memory and psychological state; and/or (3) exercise may increase the vasculature

in the cerebral cortex and reduce vascular diffusion distances.[17]

Weight

A national sample from The Early Childhood Longitudinal Study found lower standardized scores (math and reading) in overweight children at the end of first grade compared to non-overweight children, but these differences were eliminated when socioeconomic status (SES) and behavioral variables were considered.[18] From 7 schools in California, MS students, 11-14 years old, were found to have a negative relationship between BMI and self-reported grades, but not recorded grades.[19] From a large suburban MS outside Philadelphia, overweight students, grades 6 and 7, were found to have lower reading grades, standardized scores, and fitness scores compared to their non-overweight peers without control for SES.[20] Thus, it has been difficult to clarify the relationship between weight status and AP due to the influence of SES and other confounding factors.

The relationship between weight and AP may also be confounded by fitness and health variables. A significant relationship was found between weight and statewide standardized scores in an initial analysis of a fifth-grade sample from West Virginia, but this relationship was eliminated when cardiovascular disease (CVD) risk as well as fitness measures were added, with the final model indicating an association of fitness, blood pressure, gender, and SES variables with standardized scores.[21] Third- and fifth-grade students from 4 schools in one-school district in Illinois were found to have a positive correlation between fitness measures, specifically aerobic fitness (FITNESSGRAM®), and standardized scores (total, math, and reading) and a negative correlation between BMI and AP.[22]

Thus, the purpose of the study was to describe differences and associations for standardized scores (math and reading) for sixth-grade (SG) students in a midwest city school district by selected categories of nutrition/physical activity (NUTR/PA) behaviors, fitness measures, and BMI, matched to gender and meal price status. This information can facilitate informed decisions by the school district related to curriculum and policy to support optimal student outcomes related to both health and academics. Currently there are no other cross-sectional investigations of the relationship of a range of NUTR/PA behaviors, matched to fitness measures and AP.

METHODS

Subjects and Procedure

Eight hundred SG students (91.5% of 874 eligible) attending Fargo Public Schools (FPS) (district total of about 11,000 students) completed a 20-question survey during March 2005 related to NUTR/PA behaviors adapted from the Youth Risk Behavior Surveillance Survey (YRBSS).[23] FPS mailed information to parents about the survey with the opportunity to elect student nonparticipation. Student participation was by passive assent as approved by the institutional review board. No information is available about those students who chose to not participate or who were absent on the day of survey administration. The adapted YRBSS survey was administered and collected in individual classrooms in 8 schools by personnel trained by the principal investigator. Students included a school-assigned personal identification number on the adapted YRBSS to allow data matching. Fitness tests were administered during a PE class by teachers as a routine component of the FPS curriculum during April and May 2005. Measures of Academic Progress (MAP) standardized tests were conducted by FPS during spring 2005.[24]

Instruments

The frequency of NUTR/PA behaviors were self-reported using questions adapted from the YRBSS. A national sample of high school (HS) students completes the YRBSS on odd-numbered years to determine trend data for states and for the nation. The Centers for Disease Control & Prevention (CDC) does not mandate a national sample of MS students; however, states may elect to include this population. Overall reliability of the YRBSS for MS has been suggested to be good, although some items may need further evaluation.[25] Although the validity for the YRBSS questions relating to nutrition behaviors has not been determined, the utilization of this tool for the current study allows comparisons to FPS trend data[26] and other cross-sectional data.[27] Validity studies of the YRBSS questions relating to PA behaviors indicate an underestimation of the proportion reporting moderate PA and an overestimation of the proportion reporting vigorous PA.[28] The YRBSS questions related to television viewing have been determined to be both reliable and valid.[29]

FITNESSGRAM®, developed by the Cooper Institute, was developed to measure various aspects of fitness and assessed with criterion-referenced standards, or Healthy Fitness Zones (HFZ) (Table 1).[30] The measurement techniques recommended by FITNESSGRAM® were used to determine aerobic capacity (timed mile run), muscle strength (push-ups for upper body and curl-ups for abdominal), height, and weight. The fitness measure for flexibility called ''sit and reach'' was not analyzed due to a discrepancy in measuring techniques across schools. BMI, calculated as weight in kilograms divided by height in meters squared, was determined for each child and

Table 1. **FITNESSGRAM® Healthy Fitness Zone Qualification Standards**

	BOYS Healthy Fitness Zone			GIRLS Healthy Fitness Zone		
Age	One-mile run (Minutes and Seconds)	Curl-up* (No. complete)	Push-up** (No. Complete)	One-mile run (Minutes and Seconds)	Curl-up* (No. complete)	Push-up** (No. Complete)
11	11:00-8:30	18-36	8-20	12:00-9:00	15-29	7-15
12	10:30-8:00	21-40	10-20	12:00-9:00	18-32	7-15
13	10:00-7:30	24-45	12-25	11:30-9:00	18-32	7-15

*Abdominal muscle strength and endurance.
**Upper body muscle strength and endurance.
Needs improvement indicates that more time was required to finish the mile run and/or fewer numbers of curl-ups or push-ups were completed, when compared to the Healthy Fitness Zone (HFZ) Qualification Standard.
Exceeds indicates the mile run was completed in less time and/or that more curl-ups or push-ups were completed, when compared to the HFZ Qualification Standard.

categorized for weight status utilizing Growth Charts developed by CDC specific for age and gender.[31]

The MAP tests are state-aligned computerized measures developed by the Northwest Evaluation Association to reflect the instructional level of each student and determine academic progress over time.[24] The MAP tests have been determined to be valid and reliable.

Meal price status was used as a surrogate for SES, a potential confounding factor affecting AP.[32]

Data Analysis

SPSS version 13.0 software was used for analysis. The proportion of students within selected categories of the following variables was determined: NUTR/PA behaviors; fitness measures; BMI classifications; gender; and meal price status. The numbers of students who completed various aspects of the data set varied from 500 to 800 (see Table 2). A complete data set was available for 346 students. Mean substitution was used to impute missing values. One-way analysis of variance (ANOVA) was used to compare differences in mean MAP scores (math and reading) for selected categories of NUTR/PA behaviors, fitness measures, gender and F&V meal price status. Relationships were determined by stepwise multiple regression (SMR) comparing mean MAP math scores (and mean MAP reading scores), as dependent variables, with selected categories of NUTR/PA behaviors, BMI, fitness measures, gender, and meal price status as independent variables. Regression analysis criteria utilized the probability of $F \leq 0.05$ to enter and $F \geq 0.10$ to remove variables. Significance was set at $\alpha = 0.05$.

RESULTS

Proportions for Descriptors, NUTR/PA Behaviors, and Fitness Measures (Table 2)

A total of 800 sixth graders completed the survey with 694 indicating gender (51.7% female). The MPS, a surrogate indicator for SES, indicated 80% ''full price,'' 6.5% ''reduced price,'' and 13.5% ''free,'' which was similar to the total FPS. The mean age was 11.76 years (95% CI 11.72-11.79). Females, when compared to males, had a slightly higher proportion eligible for free school meals.

For NUTR behaviors, less than one-half drank 3 or more glasses of milk/day; about one-fourth drank more than 12 oz SB/day; about one-fifth drank 2 or more servings of 100% FJ; about one-third of the students met the suggested level of 5 or more servings of fruits and vegetables (F&V) each day. For food patterns, more than two-thirds ate both breakfast on 5 or more days/week and a meal with their family on the previous day. Females, when compared to males, had a significantly lower proportion drinking both milk and SB, eating F&V and eating breakfast.

For PA behaviors about one-third of the students met the recommendation of 60 minutes of PA each day; about one-fourth reported 30 minutes of moderate PA; more than four-fifths reported 20 minutes of vigorous PA; about one-fourth reported watching 3 or more hours of television on schools days; and more than three-fourths reported playing on one or more sports teams (ST) in the last year. Females, when compared to males, had a lower proportion getting 60 minutes of PA/day, meeting moderate PA recommendations and being on ST.

For weight status, $28.9\% \pm 0.8\%$ were either obese ($12.5\% \pm 0.6\%$) or overweight ($16.4\% \pm 0.7\%$). Females, when compared to males, had a slightly lower proportion overweight.

Two-thirds or more of all students met or exceeded the HFZ for the 3 fitness tests. For the mile run, $77.6 \pm 1.6\%$ met either the HFZ ($46.2\% \pm 1.9\%$) or exceeds category ($31.4\% \pm 1.7\%$). For curl-ups, $84.7 \pm 0.6\%$ met either the HFZ ($17.1\% \pm 0.6\%$) or exceeds category ($67.6\% \pm 0.7\%$), and for push-ups, $66.1\% \pm 1.7\%$ either met the HFZ ($38.1\% \pm 1.7\%$) or exceeds category ($28.0\% \pm 1.6\%$). A similar proportion of males and females needed improvement to meet the HFZ for the mile run. Gender differences were seen in the proportion needing improvement

Table 2. **Proportions (±95% CI) for Selected Categories of Descriptors, Nutrition/Physical Activity Behaviors, and Fitness Measures***

Descriptors, Behaviors, Fitness Measures	Total Sample	Females	Males
Gender (No. of students)	(694)	(359)	(335)
Female	51.7 ± 0.8	100 ± 0.0	00.00
Male	48.3 ± 0.8	0.00 ± 0.0	100.0 ± 0.0
Meal price status (No. of students)	(800)	(359)	(335)
Free	13.5 ± 0.2	12.3 ± 0.6†	10.1 ± 0.8†
Reduced	6.5 ± 0.1	6.4 ± 0.4	6.6 ± 0.7
Full	80.0 ± 0.2	81.3 ± 0.7†	83.3 ± 1.0†
Milk (No. of students)	(797)	(358)	(333)
≥3 glasses/day	45.3 ± 0.3	43.9 ± 0.9†	49.8 ± 1.3†
Sweetened beverages (No. of students)	(796)	(359)	(334)
>12 oz/day	25.8 ± 0.3	21.4 ± 0.7†	27.8 ± 1.2†
100% Fruit juice (No. of students)	(791)	(355)	(330)
≥2 times/day	19.5 ± 0.3	20.3 ± 0.7	19.4 ± 1.1
Fruits and vegetables (No. of students)	(780)	(351)	(325)
≥5 servings/day	32.2 ± 0.4	31.1 ± 0.9†	34.5 ± 1.4†
Breakfast (No. of students)	(800)	(359)	(335)
≥5 days/week	71.4 ± 0.3	70.5 ± 0.8†	74.0 ± 1.2†
Ate meal with family (No. of students)	(789)	(357)	(329)
Yesterday	79.6 ± 0.3	79.6 ± 0.7	80.5 ± 1.1
PA ≥60 minute/day (No. of students)	(794)	(354)	(335)
≥5 days/week	35.6 ± 0.3	29.1 ± 0.8†	42.1 ± 1.3†
Vigorous PA ≥20 minute/day (No. of students)	(792)	(354)	(334)
≥3 days/week	85.6 ± 0.2	86.7 ± 0.6	87.4 ± 0.9
Moderate PA ≥30 minute/day (No. of students)	(800)	(359)	(335)
≥5 days/week	26.0 ± 0.3	23.1 ± 0.7†	28.7 ± 1.2†
TV viewing (No. of students)	(784)	(356)	(324)
≥3 hours/school day	25.0 ± 0.3	24.2 ± 0.8	24.4 ± 1.3
Sports teams (No. of students)	(786)	(355)	(326)
≥1 team/year	77.1 ± 0.3	76.3 ± 0.8†	82.2 ± 1.1†
BMI (No. of students)	(670)	(350)	(320)
Obese§	12.5 ± 0.6	12.3 ± 0.6	12.8 ± 1.0
Overweight‖	16.4 ± 0.7	15.4 ± 0.7†	17.5 ± 1.2†
Neither¶	71.0 ± 0.8	72.3 ± 0.9†	69.7 ± 1.4†
Milerun (No. of students)	(500)	(269)	(231)
Needs improvement#	22.4 ± 1.6	21.2 ± 1.8	23.8 ± 2.6
Healthy FZ**	46.2 ± 1.9	50.9 ± 2.2†	40.7 ± 3.0†
Exceeds††	31.4 ± 1.7	27.9 ± 2.0†	35.5 ± 3.0†
Curl-ups(No. of students)	(691)	(358)	(333)
Needs improvement#	15.3 ± 0.6	12.8 ± 0.6†	18.0 ± 1.0†
Healthy FZ**	17.1 ± 0.6	19.0 ± 0.7†	15.0 ± 1.0†
Exceeds††	67.6 ± 0.7	68.2 ± 0.8	67.0 ± 1.3
Push-ups (No. of students)	(515)	(263)	(252)
Needs improvement#	34.0 ± 1.7	36.5 ± 2.3†	31.3 ± 2.5†
Healthy FZ**	38.1 ± 1.7	37.3 ± 2.3	38.9 ± 2.6
Exceeds††	28.0 ± 1.6	26.2 ± 2.1	29.8 ± 2.4

*The ± value after each proportion indicates the margin of error based on a 95% confidence interval.
†Indicates gender difference for variable category.
§≥95th percentile for BMI by age and gender.
‖≥85th percentile up to the 95th percentile for BMI by age and gender.
¶Neither obese nor overweight (<85th percentile) for BMI by age and gender.
††See Table 1.
HFZ, Healthy Fitness Zone.

to meet the HFZ for curl-ups (higher for males) and push-ups (higher for females).

One-Way ANOVA of Mean MAP Scores for Selected Categories of Descriptors, NUTR/PA Behaviors, and Fitness Measures (Table 3)

Gender was associated with mean MAP math scores (higher males) and mean MAP reading scores (higher females). Ability to pay full price for school meals was associated with higher mean MAP scores (both math and reading).

Higher mean MAP math scores were associated with those students who drank more milk, less SB, less 100% FJ; ate breakfast more frequently, had more vigorous PA, watched less television, played on more ST, and had increased performance on the mile run.

Table 3. **One-Way ANOVA for Mean MAP Scores (Math and Reading) for Selected Categories of Descriptors, Nutrition/Physical Activity Behaviors, and Fitness Measures**

Descriptors, Behaviors, Fitness Measures	Selected Categories	MAP Math Scores				MAP Reading Scores			
			95% CI				95% CI		
		Mean (No. of Students)	Lower Bound	Upper Bound	Significance	Mean (No. of Students)	Lower Bound	Upper Bound	Significance
Gender	Female	225.13 (349)	223.79	226.47	.002*	218.86 (332)	217.68	220.03	.004*
	Male	228.27 (321)	226.84	229.71		216.20 (309)	214.80	217.59	
Meal price status	Free	218.49 (84)	215.75	221.22	.000*	210.78 (81)	208.04	213.52	.000*
	Reduced price	221.27 (49)	217.92	224.61		213.34 (47)	210.27	216.42	
	Full price	227.59 (617)	226.57	228.62		218.23 (583)	217.28	219.18	
Drinking milk	3+ glasses/day	227.26 (348)	225.86	228.66	.035*	217.76 (339)	216.46	219.07	.123
	<3 glasses/day	225.22 (399)	223.92	226.51		216.37 (369)	215.17	217.58	
Drinking sweetened beverages	>12 oz/day	223.90 (183)	222.04	225.76	.007*	214.35 (178)	212.48	216.21	.000*
	12 oz or less/day	226.94 (565)	225.84	228.03		218.01 (531)	217.02	219.00	
Drinking 100% fruit juice	2+ times/day	223.43 (143)	221.02	225.85	.005*	215.65 (139)	213.49	217.80	.104
	<2 times/day	226.89 (599)	225.86	227.92		217.49 (564)	216.52	218.46	
Eating fruits and vegetables	5+ servings/day	227.05 (235)	225.22	228.88	.298	217.62 (223)	215.98	219.27	.503
	<5 servings/day	225.96 (497)	224.83	227.08		216.97 (471)	215.91	218.03	
Eating breakfast	5+ days/week	227.33 (542)	226.23	228.44	.000*	217.53 (517)	216.53	218.53	.086
	<5 days/week	223.11 (208)	221.30	224.91		215.80 (194)	213.98	217.62	
Ate meal with family yesterday	Yes	226.43 (588)	225.33	227.53	.397	217.46 (560)	216.45	218.47	.200
	No	225.41 (153)	223.53	227.29		216.02 (143)	214.18	217.86	
PA 60+ minute/day	5+ days/week	227.31 (261)	225.60	229.03	.095	217.16 (255)	215.62	218.71	.952
	<5 days/week	225.62 (484)	224.48	226.75		217.11 (451)	216.03	218.19	
Vigorous activity 20+ minutes	3+ days/week	227.17 (642)	226.19	228.15	.000*	217.47 (614)	216.54	218.41	.021*
	<3 days/week	220.03 (101)	217.18	222.88		214.37 (91)	211.64	217.10	
Moderate activity 30+ minutes	5+ days/week	225.89 (193)	223.91	227.87	.742	215.41 (185)	213.59	217.22	.029*
	<5 days/week	226.25 (557)	225.18	227.33		217.64 (526)	216.63	218.65	
Watching TV	3+ hours/avg. day	223.51 (177)	221.54	225.48	.001*	214.06 (172)	211.97	216.15	.000*
	<3 hours/avg. day	227.16 (588)	226.07	228.25		218.22 (525)	217.27	219.17	
Playing team sports	1+ teams/12 months	227.20 (576)	226.14	228.26	.000*	217.43 (542)	216.46	218.40	.147
	0 teams/12 months	222.83 (162)	220.70	224.95		215.87 (157)	213.78	217.96	
Body mass index (BMI)	Obese[†]	225.72 (81)	222.88	228.56	.404	216.79 (78)	214.27	219.32	.703
	Overweight[‡]	225.72 (109)	223.42	228.01		218.29 (101)	216.27	220.30	
	Neither[§]	227.23 (456)	226.01	228.45		217.69 (440)	216.54	218.84	
Mile run	Needs improvement[‖]	224.16 (108)	221.77	226.55	.000*	217.97 (100)	215.81	220.13	.639
	HFZ[¶]	225.90 (221)	224.06	227.74		217.86 (207)	216.07	219.64	
	Exceeds[#]	230.25 (153)	228.27	232.24		219.04 (148)	217.14	220.94	
Curl-ups	Needs improvement[‖]	227.00 (101)	224.74	229.26	.147	216.47 (101)	214.27	218.67	.198
	HFZ[¶]	224.41 (108)	222.12	226.69		216.25 (103)	214.04	218.46	
	Exceeds[#]	227.09 (458)	225.85	228.33		218.15 (434)	217.02	219.28	
Push-ups	Needs improvement[‖]	225.82 (166)	224.02	227.62	.056	217.15 (166)	215.45	218.85	.332
	HFZ[¶]	225.41 (194)	223.33	227.49		216.65 (180)	214.61	218.69	
	Exceeds[#]	228.80 (136)	226.60	231.00		218.67 (129)	216.90	220.44	

*Significance $p < .05$.
[†] ≥95th percentile for BMI by age and gender.
[‡] ≥85th percentile up to the 95th percentile BMI by age and gender.
[§] Neither obese nor overweight (<85th percentile) BMI by age and gender.
[‖] Needs improvement compared to Healthy Fitness Zone qualification standards (see Table 1).
[¶] Met HFZ qualification standards (see Table 1).
[#] Exceeds compared to HFZ qualification standards (see Table 1).
HFZ, Healthy Fitness Zone.

Table 4. **Multiple Stepwise Regression Comparing Mean MAP Scores (Math and Reading) to Descriptors, Nutrition/Physical Activity Behaviors, and Fitness Measures**

Dependent Variable	Independent Variables	R^2
Mean MAP math scores	Meal price status	0.045
	Vigorous PA	0.067
	Breakfast	0.079
	Student gender	0.089
	100% Fruit juice	0.098
	Mile run	0.105
	Sweetened beverages	0.111
Mean MAP reading scores	Meal price status	0.035
	Television	0.049
	Student gender	0.060
	Sweetened beverages	0.067

Higher mean MAP reading scores were associated with those students who drank less SB, had more vigorous PA and moderate PA, and watched less television.

Multiple Stepwise Regression Comparing Mean MAP Scores to Descriptors, NUTR/PA Behaviors, and Fitness Measures (Table 4)

The variables associated with the mean MAP math scores in the regression model include the following: meal price status, moderate PA and vigorous PA, breakfast, gender, 100% FJ, mile run, and SB, together accounting for 11.1% of the variability, with meal price status contributing the greatest amount (4.5%). The variables associated with the mean MAP reading scores in the regression model (Table 4) include the following: meal price status, television, gender, and SB, together accounting for 6.7% of the variability with meal price status contributing the greatest amount (3.5%).

DISCUSSION

Beverages

A higher proportion of 2005 FPS SG students compared to a statewide Florida SG sample reported drinking $\geq$3 glasses of milk/day (45.3% $\pm$ 0.3% vs 24.2% $\pm$ 2.4%), while a similar proportion reported drinking >12 oz SB/day (25.8% $\pm$ 0.3% vs 24.9% $\pm$ 2.5%).[27] Comparing the 2005 FPS SG to 2003 FPS MS (seventh and eighth grades) indicated a similar proportion drinking milk (45.3% $\pm$ 0.3% vs 45.9% $\pm$ 3.8%) and a lower proportion drinking SB (25.8% $\pm$ 0.3% vs 40.2% $\pm$ 3.8%).[26] This study found that higher MAP math scores were associated with drinking more milk and less SB. Higher MAP reading scores were associated with less SB. The association between intake of SB and MAP scores, both math and reading, remained when considering all factors in the regression analysis. Increased SB and reduced milk intake for children and youth have been found to increase calories and reduce nutrient intake and be associated with weight gain but no comparable associations between AP and beverage intake were located in the literature.[1-4]

Breakfast

A higher proportion of 2005 FPS SG ate breakfast compared to 2003 FPS MS students (71.4% $\pm$ 0.3% vs 63.4% $\pm$ 3.7%).[25] There has been a reduction in the proportion of school children and youth who consume breakfast both overtime and with increasing grade level.[33] Similar trends for FPS were seen overtime with a reduced proportion of HS students reporting breakfast in 2003 (49.4 $\pm$ 3.1) compared to 1999 (56.0 $\pm$ 3.2), and a reduced proportion with increasing grade level for 2003 (63.4 $\pm$ 3.7 in MS vs 49.4 $\pm$ 3.1 in HS).[26] In this study, eating breakfast was associated with higher MAP math scores. Increased regularity of breakfast consumption has previously been found to be associated with improved AP both on standardized scores (total) and math grades as well as with improved attendance and reduced tardiness rates.[6,34,35]

Television

A similar proportion of 2005 FPS SG compared to 2003 FPS MS watched 3 or more hours of television on school nights (25.0 $\pm$ 0.3 vs 28.1 $\pm$ 3.4).[26] In this study, students watching television were found to have significantly lower MAP scores (math and reading) and this association remained for reading scores in the regression analysis. A relationship between time spent watching television and standardized scores has been seen in both cross-sectional and longitudinal analysis. A cross-sectional study of third-grade students from 12 public schools in California found that a television in their bedroom resulted in greater amounts of time spent watching television and lower standardized scores (reading, math, and language arts).[36] Longitudinal analysis of national data indicated that more time spent watching television daily before age 3 resulted in reduced standardized scores at age 6-7.[37]

Fitness and PA

The proportion reporting vigorous PA for 2005 FPS SG was similar to 2003 FPS MS (85.6 $\pm$ 0.2 vs 82.6 $\pm$ 2.9).[26] This study found that higher MAP math scores were associated with vigorous PA, playing on ST (one or more), and the mile run (higher performance). Both vigorous PA and the mile run remained associated with MAP math scores with regression modeling but the independent variables provided only a small percentage of the total variability ($R^2 = 0.111$). This study found that higher MAP reading scores were associated with vigorous PA but dropped out of the model with regression analysis.

A number of studies also report a positive association between aerobic capacity and AP, measured with either standardized scores or grades.[22,38,39] A positive correlation between aerobic fitness (FITNESSGRAM®) and standardized scores (total, math, and reading) were found for third- and fifth-grade students from an Illinois school district.[22] Volunteer SG students from a single public school in Michigan, who reported vigorous PA (3-day PA recall), were found to have higher academic grades when compared to students not reporting vigorous PA, although no differences were seen in standardized scores.[38] Higher aerobic capacity (FITNESSGRAM®) for children has been found to be positively related to a faster speed of cognitive processing and reaction time suggested to influence attention and working memory.[39]

Weight

A lower proportion of FPS SG was obese (12.5% ± 0.6%) compared to NHANES, 2003-2004 (18.8% ± 1.3% for 6-11-year olds).[40] The combined proportion of those obese and overweight was also lower for FPS SG (28.9% ± 0.8%) compared to NHANES, 2003-2004 (37.2% ± 1.9% for 6-11-year-olds).[40] The current study found no association between weight classification and MAP scores. The interactions between weight, fitness, CVD risk factors, SES, and other social and behavioral issues make it difficult to determine whether there is a direct association between childhood weight status and AP.[18-22]

Limitations

There are a number of limitations identified for this study. There is no knowledge of the students who did not participate, although the number was small. For the adapted YRBSS, there are no reported validation studies for questions related to nutrition behaviors and there has been a suggested need to revise the questions related to moderate PA and vigorous PA. The fitness tests were measured as a component of FPS curriculum by trained classroom teachers but without a research protocol for consistency of methodology between teachers and schools. Although 800 SG students completed the adapted YRBSS questions, smaller numbers completed the various individual fitness tests (n = 500-691) and all segments of data collection (n = 346). The regression analysis indicated that only a small percentage (R^2) of the variability in MAP scores in the overall model was due to the NUTR/PA behaviors and fitness variables. Cross-sectional observational studies demonstrating an association between the dependent and the independent variables do not provide evidence of causality.

Conclusion

Several variables related to NUTR/PA behaviors and fitness measures were found to be associated with MAP math scores (vigorous PA, breakfast, 100% FJ, mile run, and SB) and MAP reading scores (television and SB). Meal price status and gender remained important variables for AP. Thus, the school district has information to support the promotion of positive NUTR/PA behaviors within the school and community to enhance AP as well as student fitness and health.

IMPLICATIONS FOR SCHOOL HEALTH

The current study supports the concept that positive health behaviors related to NUTR/PA as well as fitness enhance AP. This suggests that it is justifiable for schools to expend time and resources to promote healthy lifestyles to support AP. Committed school and community leaders can be encouraged to fully develop and implement ''wellness policies'' promoting healthy school environments where nutritious foods and increased opportunities for being physically active are available and supported.

Human Subjects Approval Statement

This study was approved by North Dakota State University Institutional Review Board, Fargo, ND 58105.

REFERENCES

1. Wang YC, Bleich SN, Gortmaker SL. Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among US children and adolescents, 1988-2004. *Pediatrics.* 2008;121:e1604-e1614. Available at: http://www.pediatrics.org/cgi/content/full/121/6/e1604. Accessed January 18, 2010.
2. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. *Am J Clin Nutr.* 2006;84:274-288.
3. Nielsen SJ, Popkin BM. Changes in beverage intake between 1977 and 2001. *Am J Prev Med.* 2004;27:205-210.
4. Bowman SA. Beverage choices of young females: changes and impact on nutrient intakes. *J Am Diet Assoc.* 2002;102:1234-1239.
5. Teegarden D. The influence of dairy product consumption on body composition. *J Nutr*. 2005;135:2749-2752.
6. Rampersaud GC, Pereira MA, Girard BL, Adams J, Metzl JD. Breakfast habits, nutritional status, body weight, and academic performance in children. *J Am Diet Assoc*. 2005;105:743-760.
7. Pollitt E, Matthews R. Breakfast and cognition: an integrative summary. *Am J Clin Nutr*. 1998;67(suppl):804S-813S.
8. Timlin MT, Pereira MA, Story M, Neumark-Sztainer D. Breakfast eating and weight change in a 5-year prospective analysis of adolescents: Project EAT (Eating Among Teens). *Pediatrics.* 2008;121:e638-e645. Available at: http://www.pediatrics.org/cgi/content/full/121/3/e638. Accessed January 18, 2010.
9. Berkey CS, Rockett HRH, Gillman MW, Field AE, Colditz GA. Longitudinal study of skipping breakfast and weight change in adolescents. *Int J Obes*. 2003;27:1258-1266.
10. Sharif I, Sargent JD. Association between television, movie, and video game exposure and school performance. *Pediatrics.*

2006;118(4):e1061-e1070. Available at: http://www.pediatrics.org/cgi/content/full/118/4/e1061. Accessed January 18, 2010.
11. Wiecha JL, Sobol AM, Peterson KE, Gortmaker SL. Household television access: associations with screen time, reading, and homework among youth. *Ambul Pediatr*. 2001;1: 244-251.
12. Trudeau F, Shephard RJ. Physical education, school physical activity, school sports and academic performance. *Int J Behav Nutr Phys Act.* 2008;5:10. doi:10.1186/1479-5868-5-10. Available at: http://www.ijbnpa.org/content/5/1/10. Accessed January 18, 2010.
13. Dwyer T, Sallis JF, Blizzard L, Lazarus R, Dean K. Relation of academic performance to physical activity and fitness in children. *Pediatr Exerc Sci*. 2001;13:225-237.
14. Grissom JB. Physical fitness and academic achievement. *J Physiologyonline*. 2005; 8:11-25. Available at: http://www.asep.org/files/Grissom.pdf. Accessed January 18, 2010.
15. Chomitz VR, Slining MM, McGowan RJ, Mitchell SE, Dawson GF, Hacker KA. Is there a relationship between physical fitness and academic achievement? Positive results from public school children in the northeastern United States. *J Sch Health*. 2009;79:30-37.
16. Sibley BA, Etnier J. The relationship between physical activity and cognition in children: a meta-analysis. *Pediatr Exerc Sci*. 2003;15:243-256.
17. Etnier JL, Salazar W, Landers DM, Petruzzello SJ, Han M, Nowell P. The influence of physical fitness and exercise upon cognitive functioning: a meta-analysis. *J Sport Exerc Psychol*. 1997;19:249-277.
18. Datar A, Sturm R, Magnabosco JL. Childhood overweight and academic performance: national study of kindergartners and first-graders. *Obes Res.* 2004;12:58-68.
19. Huang TT, Goran MI, Spruijt-Metz D. Associations of adiposity with measured and self-reported academic performance in early adolescence. *Obesity (Silver Spring).* 2006;14: 1839-1845.
20. Shore SM, Sachs ML, Lidicker JR, Brett SN, Wright AR, Libonati JR. Decreased scholastic achievement in overweight middle school students. *Obesity (Silver Spring)*. 2008;16: 1535-1538.
21. Cottrell LA, Northup K, Wittberg R. The extended relationship between child cardiovascular risks and academic performance measures. *Obesity (Silver Spring).* 2007;15:3170-3177.
22. Castelli DM, Hillman CH, Buck SM, Erwin HE. Physical fitness and academic achievement in third- and fifth-grade students. *J Sport Exerc Psychol*. 2007;29:239-252.
23. Centers for Disease Control and Prevention. Methodology of the youth risk behavior surveillance system. *MMWR Morb Mortal Wkly Rep.* 2004;53(RR-12), 3-5.
24. Northwest Evaluation Association. Measures of Academic Progress (MAP). Available at: http://www.nwea.org. Accessed January 18, 2010.
25. Zullig KJ, Pun S, Patton JM, Ubbes VA. Reliability of the 2005 middle school Youth Risk Behavior Survey. *J Adolesc Health*. 2006;39:856-860.
26. Edwards JU, Magel R. Use of the Youth Risk Behavior Survey to monitor trends for nutrition and physical activity in a midwest city school district. *J Sch Health*. 2007;77:351-358.
27. Zapata LB, Bryant CA, McDermott RJ, Hefelfinger JA. Dietary and physical activity behaviors of middle school youth: the Youth Physical Activity and Nutrition Survey. *J Sch Health*. 2008;78:9-18.
28. Troped PJ, Wiecha JL, Fragala MS, et al. Reliability and validity of YRBS physical activity items among middle school children. *Med Sci Sports Exerc*. 2007;39:416-425.
29. Schmitz KH, Harnack L, Fulton JE, et al. Reliability and validity of a brief questionnaire to assess television viewing and computer use by middle school children. *J Sch Health*. 2004;74:370-377.
30. Welk GJ, Meredith MD. *FITNESSGRAM®/ACTIVITYGRAM® Test Administration Manual.* 4th ed. Dallas, TX: The Cooper Institute; 2007.
31. National Center for Health Statistics. 2000 CDC Growth Charts: United States. Available at: http://www.cdc.gov/GROWTH CHARTS. Accessed January 18, 2010.
32. Ackerman BP, Brown ED. Income poverty, poverty co-factors, and the adjustment of children in elementary school. *Adv Child Dev Behav*. 2006;34:91-129.
33. Siega-Riz A, Popkin BM, Carson T. Trends in breakfast consumption for children in the United States from 1965-1991. *Am J Clin Nutr*.1998;67(suppl):748S-756S.
34. Meyers AF, Sampson AE, Weitzman M, Rogers BL, Kayne H. School Breakfast Program and school performance. *Am J Dis Child*. 1989;143:1234-1239.
35. Kleinman RE, Hall S, Green H, et al. Diet, breakfast, and academic performance. *Ann Nutr Metab*. 2002;46(suppl 1): 24-30.
36. Borzekowski DLG, Robinson TN. The remote, the mouse, and the no. 2 pencil: the household media environment and academic achievement among third grade students. *Arch Pediatr Adolesc Med*. 2005;159:607-613.
37. Zimmerman FJ, Christakis DA. Children's television viewing and cognitive outcomes: a longitudinal analysis of national data. *Arch Pediatr Adolesc Med*. 2005;159:619-625.
38. Coe DP, Pivarnik JM, Womack CJ, Reeves MJ, Malina RM. Effect of physical education and activity levels on academic achievement in children. *Med Sci Sports Exerc*. 2006;38: 1515-1519.
39. Hillman CH, Castelli DM, Buck SM. Aerobic fitness and neurocognitive function in healthy preadolescent children. *Med Sci Sports Exerc*. 2005;37:1967-1974.
40. Ogden CL, Carroll MD, Curtin LR, et al. Prevalence of overweight and obesity in the United States, 1999-2004. *J Am Med Assoc*. 2006;295:1549-1555.