Overweight, Diet, Physical Activity, and Hypertension in Low-Income School-Aged Children

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Abstract

The purpose of this cross-sectional, descriptive study was to examine overweight as an independent risk factor for hypertension (HTN) in children, as well as associations among body mass index (BMI), blood pressure, diet, and physical activity. Study participants included 1,284 students in grades five to eight in three school districts in rural northern California. Analysis of variance was used to test for differences in BMI and blood pressure based on diet and physical activity. Pearson's correlation was used to assess the relationships among blood pressure, BMI, dietary, and physical activity variables. Multiple regression analysis was used to determine independent risk factors for BMI and systolic blood pressure. Forty-four percent of the students were ≥ 85th percentile BMI-for-age. With one blood pressure reading, 28% met the criteria for either pre-hypertension or hypertension using standardized criteria for age, gender, and height. HTN rates were significantly higher for overweight vs. normal weight children (p=.001). Fruit and vegetable intake decreased significantly by grade (p =.001). Regression results showed that soda consumption was an independent risk factor for BMI (p =.001) and that BMI was an independent risk factor for HTN (p=.001). Findings support the need for nutrition education and physical activity promotion programs in these three school districts.

Introduction

The prevalence of childhood overweight has increased strikingly over the last two decades (CDC, 2000). Overweight is defined by the Center for Disease Control and Prevention (CDC) as a Body Mass Index (BMI)-for-age >95th percentile, specific for gender. Utilizing NHANES data, Ogden and coworkers reported that 15% of six- to eleven-year-old children and 16% of 12 – 19 year old adolescents are overweight in the United States (Ogden, Flegal, Carroll, Johnson, 2002). In addition, approximately 15% of children and adolescents are at-risk for overweight, defined by the CDC as between the 85th and 95th percentile BMI-for-age, specific for gender. The California Center for Public Health Advocacy (CCPHA) analyzed data from the California Department of Education's 2001 California Physical Fitness Test and reported that 27% of California's youth (5th, 7th, and 9th graders) are overweight or at-risk for overweight (CCPHA, 2002). These data

are organized and reported by legislative districts. Assembly District 3, which encompasses the residential area of the study participants, reported that 20% of 5th, 7th, and 9th grade children are overweight or at-risk for overweight and 30% are unfit.

The National Heart, Lung, and Blood Institute (NHLBI) and National High Blood Pressure Education Program (NHBPEP) released updated US guidelines for hypertension (HTN) and pre-hypertension (pre-HTN) in children and adolescents in 2004 (NHLBI, 2004). The new guidelines stress that both HTN and pre-HTN are significant health concerns.

Mutner and colleagues used representative samples of children and adolescents, aged eight – 17 years, from NHANES III conducted in 1988-1994 (n=3496) and NHANES 1999-2000 (n=2086) to examine trends in blood pressure over the last decade (Muntner, He, Cutler,

Wildman, Whelton, 2004). These researchers found that along with the increasing prevalence of overweight, blood pressure in children has also increased. Several large studies report that overweight children and adolescents are more likely to have elevated blood pressure levels (Freedman, Dietz, Srinivasan, Berenson, 1999; Sorof, Poffenbarger, Franco, Bernard, Portman, 2002; Sorof, Lai, Turner, Poffenbarger, Portman, 2004).

Researchers have reported a reduced prevalence of HTN in adults consuming a diet high in fruits and vegetables with the most well known study being the Dietary Approaches to Stop Hypertension (DASH) trail. Both the high fruit and vegetable diet (eight to 10 servings of fruit and vegetables daily) and the DASH eating plan (high in fruits, vegetables, low-fat dairy and low in saturated and total fat) significantly reduced blood pressure levels (Appel, Moore, Obarzanek, Vollmer, Svetkey, Sacks et al., 1997). There is a dearth of studies that investigate specifically fruit and vegetable consumption and the association with the prevalence of high blood pressure among youth. Simons-Morton and colleagues found that both systolic (SBP) and diastolic blood pressure (DBP) levels were inversely associated with specific micronutrients (calcium, magnesium, and potassium) and fiber in 662 children aged eight – eleven years who had elevated LDL cholesterol levels (Simons-Morton, Hunsberger, Van Horn, Barton, Robson, McMahon et al., 1997). Fruits and vegetables can be rich sources of micronutrients and fiber. In a more recent study, Moore and coworkers (2005) reported similar associations between blood pressure and diet in youth. Utilizing eight years of follow-up data from the Framingham Children's study (1986), which consisted of 95 children initially three – five years of age, researchers reported children consuming more fruits and vegetables or more dairy products during the preschool years had smaller yearly SBP gains throughout childhood. When reaching early adolescence, children with a higher consumption of fruits, vegetables, and dairy products had an adjusted mean SBP (106 ± 2.9 mmHg) lower than that of children who consumed lower intakes (113 ± 1.5

mmHg) (Moore, Singer, Bradlee, Djousse, Proctor, Cupples et al., 2005).

Fruit and vegetables are part of a healthy diet and appear to reduce future risk of chronic disease, such as certain cancers and cardiovascular disease (Hyson, 2004). Results from the 1994-1996 Continuing Survey of Food Intakes by Individuals (CSFII) indicate that U.S. children come up short of fruit and vegetable recommendations. Assessed through two 24-hour recall in-person interviews, daily fruit and vegetable consumption averaged 3.8 servings among six to eleven year old boys and 3.7 servings among six to eleven year old girls (n=1311) (USDA, 1996). Findings from the 1999 California Children's Healthy Eating and Exercise Practices Survey (CalCHEEPS), which utilized a two-day food diary, showed that California children, ages nine to eleven years old, were consuming an average of 3.2 servings of fruits and vegetables on a usual school day, and only one fifth of these children ate the recommended five servings per day (Keihner, Garbolino, Hudes, 2004).

Soda consumption has increased dramatically in the last 20 years (Calvadini, Siega-Riz, Popkin, 2000). Ludwig and colleagues' longitudinal trial results indicate that children with higher soda and other sugar-sweetened beverage intake have higher BMIs than children with lower intakes (Ludwig, Peterson, Gortmaker, 2001). Similarly, Berkey and coworkers reported the consumption of sugar-sweetened beverages was associated with BMI gains during the corresponding year in a prospective cohort study of nine- to fourteen-year-old boys and girls participating in the U.S. Growing Up Today Study (Berkey, Rockett, Field, Gillman, Colditz, 2004). In addition, a positive association has been observed between soda and blood pressure in adolescents, such that high soda consumption rates are associated with higher blood pressure values. The authors suggest that the caffeine in sodas may increase blood pressure and, thereby, increase the risk of HTN (Savoca, Evans, Wilson, Harshfield, Ludwig, 2004).

While physical activity has many benefits, physical inactivity is associated with negative

health implications. According to the American Heart Association (AHA), physical inactivity is a major risk factor for coronary artery disease. It also increases the risk of stroke and other major cardiovascular risk factors including obesity, high blood pressure, and diabetes. The AHA recommends that children and adolescents participate in at least 60 minutes of moderate to vigorous physical activity every day (AHA, 2004).

The Youth Risk Behavior Surveillance System (YRBSS) results indicate that 33% of U.S. students in grades nine to twelve had not participated in either sufficient vigorous or moderate physical activity during the seven days preceding the survey (CDC, 2004). According to 1999 CalCHEEPS data, only 46% of Californian children were getting an average of 60 minutes of moderate and vigorous physical activity combined daily (Keihner, Foerster, Sugerman, Oppen, Hudes, 2002). Additionally, in 2002 the California Center for Public Health Advocacy (CCPHA) reported that 40% of Californian 5th, 7th, and 9th graders were unfit. As stated previously, 30% of children in Assembly District 3, which encompasses the residential area of the study participants, are unfit (CCPHA, 2002).

The current study assessed the rate of overweight, HTN, and pre-HTN in ten low-income schools from three school districts in rural Northern California. The primary purpose of this study was to examine overweight as an independent risk factor for HTN and pre-HTN in children. A secondary purpose was to examine associations among soda and fruit and vegetable consumption, level of physical activity, body mass index, and blood pressure.

Methods

Study Participants and Method of Selection

For this cross-sectional descriptive study, a school-based health screening was performed on 1,284 students in grades five through eight from ten schools in three different school districts in rural northern California. Participating schools represent a variety of ethnicities reflective of the ethnic make-up of the geographical area. Only those students who returned a signed parental permission slip were able to participate. This research was approved by the California State University, Chico Human Subjects Committee.

Data Collection Instrument and Procedures

A lifelong eating and activity patterns questionnaire was used to collect information on gender, ethnicity, and date of birth, as well as several questions and Likert statements concerning dietary consumption and physical activity levels. The survey questionnaire was field-tested for face and content validity and refined based on the results of this field-test. Trained researchers provided assistance and clarification to the students during the completion of the lifelong eating and activity patterns questionnaire when needed. Height and weight were measured by trained researchers for each student and BMI (kg/ht^2) was then calculated. The scale used was a standard medically approved dial scale with weight measured to the nearest whole pound. Height was measured with a standiometer and reported in inches to the nearest quarter inch. BMI percentile, age and gender specific, was determined using the most current pediatric anthropometric reference data (Kuczmarski, Ogden, Grummer-Strawn, 2000). Overweight is defined by the CDC as BMI-for-age >95th percentile and at-risk for overweight is defined as BMI-for-age >85th percentile.

A trained researcher or school nurse took blood pressure measurements. Blood pressure was taken while the participants were seated and after the completion of the questionnaire to assure that heart rate was at a resting rate. Three different sized cuffs were available for use, with the appropriate sized cuff being utilized for each participant. If the blood pressure reading was elevated, the measurement was repeated a second time. HTN is defined as systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) >95th percentile for age, gender, and height measured on three distinct occasions. Pre-HTN is defined as SBP and/or DBP between the 90th and 95th percentiles for age, gender, and height (NHLBI, 2004).

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (version 11.0, 2001, SPSS, Inc, Chicago, IL). Descriptive statistics are presented as counts, percentages, and means ± standard deviations. Chi square was used to examine differences between groups for a variety of selected variables. An independent samples t -test was used to assess for significant differences in mean BMI for students consuming greater than two sodas per day vs. those consuming less than two sodas per day. Analysis of variance (ANOVA) was used to test for differences in BMI and blood pressure based on fruit, vegetable, and soda consumption and physical activity patterns. Pearson's correlation coefficient was used to test for correlations among blood pressures, BMI, physical activity level, and fruit, vegetable, and soda consumption and multiple regression analysis was used to predict SBP and BMI from demographic, dietary, and physical activity variables. Statistical significance was assessed at $p < .05$.

Results

Participant characteristics are shown in Table 1. The sample was 52% male and 48% female. Thirty-one percent of the participants were enrolled in the fifth grade (n=396), 14% in the sixth grade (n=182), 25% in the seventh grade (n=322), and 30% in the eighth grade (n=384). The racial/ethnic composition of the sample was 43% Caucasian (n=509), 28% Hispanic (n=328), 18% Asian (n=210), 5% Native American (n=61), 3% African American (n=38), and 4% Other (n=44).

Table 1

Participant characteristics (n varies between 1,190 and 1,284)

Demographic	Number	Percent
Gender		
Male	646	52
Female	607	48
School District		
Chico	309	24
Thermalito	361	28
Gridley	614	48
Grade Level		
5th	396	31
6th	182	14
7th	322	25
8th	384	30
Ethnic Group		
Caucasian	509	43
Mexican-American	328	28
Asian	210	18
Native American	61	5
African American	38	3
Other	44	4

BMI characteristics for participants are shown in Figure 1. Fifty-six percent (n=705) of the participants were of normal weight (BMI-for-age < 84.9th percentile), 20% (n=253) were at-risk for overweight (BMI-for-age >85th – 94.9th percentile), and 24% (n=308) were overweight (BMI-for-age > 95th percentile). Hence, 44% of the study subjects were >85th percentile BMI-for-age.

For the sub-sample of students assessed for blood pressure (n=881), mean SBP was 109.4 $\pm$ 12.6 mmHg and mean DBP was 66.7 $\pm$ 9.2 mmHg (Table 2). Based on this single reading, 14% (n=122) had systolic and/or diastolic values indicative of pre-HTN (90 – 94.9th percentile). An additional 14% (n=123) had systolic and/or diastolic values indicative of HTN (>95th percentile).
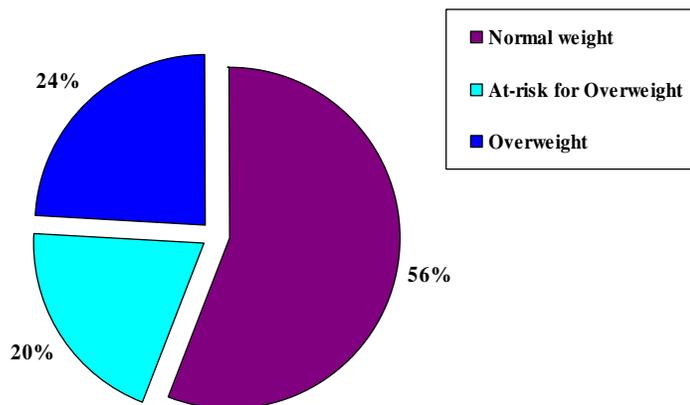

Figure 1
Body mass index characteristics of school-age children (n = 1,266)

Table 2
Blood pressure characteristics of school age children (n = 881)[a]

Blood Pressure Characteristics	Mean ± SD	Number	Percent
Systolic Blood Pressure	109.4 ± 12.6		
<50th percentile[b]		334	38
≥50th -89.9th percentile[b]		361	42
≥90th - 94.9th percentile[c]		71	8
≥95th percentile[d]		104	12
Diastolic Blood Pressure	66.9 ± 9.2		
<50th percentile[b]		262	30
≥50th -89.9th percentile[b]		481	55
≥90th - 94.9th percentile[c]		83	10
≥95th percentile[d]		43	5
Blood Pressure Category			
<50th percentile[b]		127	15
≥50th -89.9th percentile[b]		497	57
≥90th - 94.9th percentile[c]		122	14
≥95th percentile[d]		123	14

[a] percentile based on gender, age, and height with blood pressure category incorporating both systolic & diastolic blood pressures; [b] normotension; [c] pre-hypertension; [d] hypertension

At 24% (n=13) and 20% (n=11), Native Americans had significantly higher rates of pre-HTN and HTN, respectively, compared to all other ethnicities (p=.001). In comparison, rates of pre-HTN and HTN varied between 11 – 14% and 11 – 18%, respectively for Caucasian, Asian, and Hispanic participants.

As shown in Figure 2, rates for HTN (>95th percentile) and pre-HTN (85th - 94.9 percentile) were significantly higher for overweight (BMI-for-age > 85th percentile) vs. normal weight children (p=.001). Of the 14% of the sample in the pre-HTN group, approximately 65% were > 85th percentile BMI-for-age, and of the additional 14% who were in the HTN group, 78% were > 85th percentile BMI-for-age.

One-way ANOVA results indicated that fruit and vegetable intake differed significantly by grade, such that as grade increased, consumption decreased (P=.001). Post-hoc comparisons indicated that the number of fruit servings per day for eighth graders (2.6 $\pm$ 1.0) was significantly less than that of seventh (3.0 $\pm$ 1.1), sixth (3.0 $\pm$ 1.2), and fifth graders (3.3 $\pm$ 1.3), and fifth graders' intake was significantly higher than the other three grades (Fig. 3). Post-hoc comparisons also indicated that the number of vegetable servings per day for eighth graders (2.2 $\pm$ 1.2) was significantly less than that of seventh (2.6 $\pm$ 1.1), sixth (2.6 $\pm$ 1.2), and fifth graders (2.7 $\pm$ 1.4). Grades denoted with different letters in Figure 3 are significantly different with regard to number of fruit and vegetable servings per day.
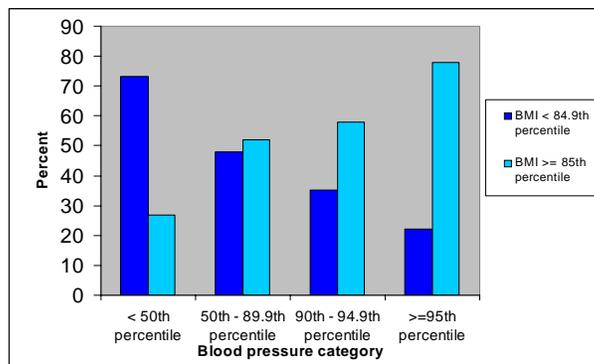

Figure 2
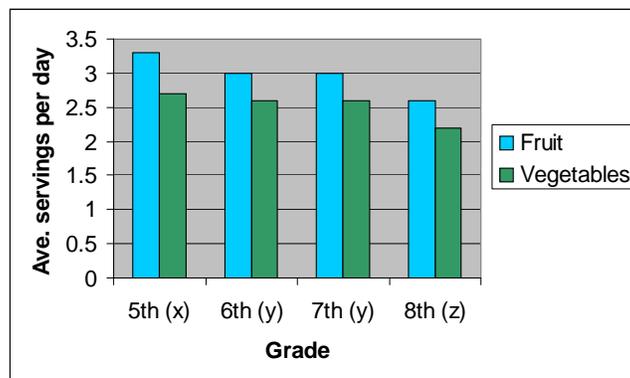Blood pressure category rates for BMI groups (p=.001)

Figure 3
Fruit and vegetable intake by grade level (p=.001)

Bivariate correlations were computed between BMI, SBP, and the following lifestyle statements: "I usually eat ___ fruit servings per day.", "I usually eat __ vegetable servings per day.", "I usually drink __ regular sodas per day.", and the Likert statement, "I usually get at least one hour of physical activity per day." The results are shown in Table 3. A moderate, positive correlation was seen between BMI and SBP, such that as BMI increased, SBP increased (r=.45, p=.001). BMI was inversely correlated with fruit consumption (r= -.08, p=.027), vegetable consumption (r= -.08, p=.025), and physical activity (r= -.12, p=.001), such that as fruit and vegetable consumption and physical activity level decreased, BMI increased. A positive association was observed between BMI and soda consumption, such that as soda consumption increased, BMI also increased (r= .20, p=.002). SBP was also positively associated with soda consumption, such that as soda consumption increased, SBP increased (r= .19, p=.003), and negatively associated with fruit consumption, such that as fruit consumption decreased, SBP increased (r= -.12, p=.013). Both fruit and vegetable consumption were positively correlated with the statement "I usually get at least one hour of physical activity per day." (r=.15, p=.001 and r=.15, p=.001, respectively). In contrast, soda consumption was inversely associated with physical activity levels (r= -.27, p=.001).

Table 3
Correlations among BMI, systolic blood pressure, diet, and physical activity

	BMI	SBP	I usually eat ___ fruit servings/day	I usually eat ___ veg. servings/day	I usually drink___ regular sodas/day
BMI					
SBP	.448**				
I usually eat ___ fruit servings/day	-.076*	-.109*			
I usually eat ___ veg. servings/day	-.077*	-.057	.537**		
I usually drink ___ regular sodas/day	.202*	.194**	-.222**	-.197**	.202*
I usually get ≥ 1 hr. of physical activity/day	-.129**	-.081	.152**	.154**	-.269**

 * p<.05, ** p<.01, *** p<.001.

There were significant differences in reported consumption of fruit between BMI percentile groups (p=.05), such that students with a BMI-for-age > 85th percentile consumed fewer fruit servings per day. Sixty-two percent of those with a normal BMI (< 84.9th percentile) reported consuming five or more servings of fruit per day versus 19% of those between the 85 – 94.9th BMI percentile and 19% of those greater than 95th BMI percentile. Participants who consumed greater than three servings of fruit per day had a mean BMI one unit less than those who consumed less than three fruit servings per day (21.7 vs. 22.6; P=.017).

Students who consumed greater than two sodas per day (n=61) had a mean BMI 2.2 units greater than those who consumed less than two sodas per day (23.1 vs. 20.9; P=.004). In addition, students consuming greater than two sodas per day had a mean SBP 6.6 mmHg higher than

those who consumed less than two sodas per day (112.8 vs. 106.2; p=.002).

There was a significant difference in usual number of minutes of physical activity per day by fruit consumption groups. Among students who reported consuming 1 serving of fruit per day, (n=81) approximately 31% were physically active for 60 minutes or more per day, while of those consuming three or more servings per day (n=121), approximately 64% reported being physically active for 60 minutes or more per day (p=.001). Similar results were seen for number of minutes of physical activity per day and vegetable consumption. Among those consuming one serving of vegetables per day (n=137) approximately 39% reported being physically active for 60 minutes or more per day, while for those consuming five or more servings per day (n=75), approximately 65% reported being physically active for 60 minutes or more per day (p=.003).

As shown in Figure 4, mean BMI increased significantly as average number of minutes of physical activity per day decreased (p=.001). Those students physically active for 60 minutes or more per day (n=404) had a significantly lower mean BMI (21.3 $\pm$ 4.7) compared to students who were either physically active 0 – 29 minutes per day (n=126; 22.8 $\pm$ 5.3) and those physically active 30 – 59 minutes per day (n=321; 22.5 $\pm$ 5.4).
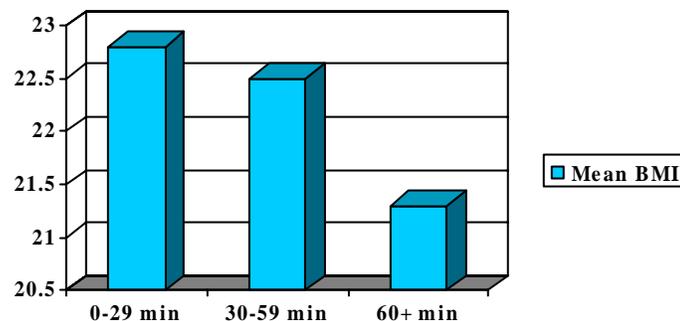

Figure 4
Mean BMI for minutes of physical activity per day groups (p=.001)

Multiple regression was used to assess predictors of BMI. The regression model included age, gender, physical activity level in minutes per day, and usual fruit, vegetable, and soda consumption. Together these variables explained 11% of the variance in BMI, with age and soda consumption making significant independent contributions (F=14.22, p=.001).

Multiple regression was also utilized to assess whether BMI was predictive of SBP independent of age, ethnicity, and various dietary and physical activity variables. The baseline model included BMI, age, gender, and usual soda consumption. Together these variables explained 36% of the variance in systolic blood pressure, with only BMI and age making a significant independent contribution (F=25.78, p=.001). A secondary model with BMI and age removed showed that soda consumption is predictive of SBP in this study sample (F=9.07, p=.003) with soda consumption explaining 4% of the variance in systolic blood pressure.

Discussion
The results of this needs assessment revealed that the rate of pediatric overweight and at-risk for overweight in these three low-income schools is disturbingly high with 44% of participants above the 85th percentile BMI-for-age. This is higher than the national average of 31% of children and adolescents >85th percentile BMI-for-age (Ogden et al., 2002). It is also higher than the reported rate of overweight and at-risk for overweight among California's youth, 26.5%, and in Assembly District 3, 19.6%, according to the 2001 California Physical Fitness Test for 5th, 7th, and 9th graders (CCPHA, 2002).

Based on a single reading for the sub-sample of students assessed for blood pressure (n=881), 14% had systolic and/or diastolic values indicative of pre-HTN (90 – 94.9th percentile). An additional 14% had systolic and/or diastolic values indicative of HTN (> 95th percentile). This is less than the 19% > 95th percentile reported by Sorof and coworkers (2004) for a single blood pressure reading. The differences in hypertension rates may be attributed to a higher percent of African American participants (22%) in the Sorof et al study versus only 3% for the current study. Rates of HTN are known to be higher among African Americans (Sorof et al., 2004). No comparative data are available for rates of pre-HTN among children.

BMI was associated with all the variables included in the bivariate correlation (SBP; fruit, vegetable, and soda consumption; and physical activity). This finding and that of the regression analysis supports the research hypothesis that there would be significant associations among these variables. As stated previously, study results indicate that participants who consume greater than three servings of fruit per day have a significantly lower mean BMI compared to those who consume less than three servings per day (21.7 vs. 22.6; P=.017). These results are similar to those of Bernard and colleagues, who reported that significantly fewer servings of fruit and vegetables were consumed by overweight school children than normal-weight children (Bernard, Lavallee, Gray-Donald, Delisle, 1995). The finding from the current study also supports prior research suggesting a protective relationship between fruit consumption and BMI. After adjusting for caloric intake, however, the magnitude of the effect was diminished and no longer significant (Field, Gillman, Rosner, Rockett, and Colditz, 2003).

The current study found that soda consumption was an independent risk factor for overweight. This supports the findings of Ludwig and colleagues' longitudinal trial showing that children (n=548) with higher soda and other sugar-sweetened beverage intakes had a higher mean BMI compared to those with lower intakes. Each additional daily serving of sugar-sweetened beverages was associated with an increased risk of obesity of 60% (Ludwig et al., 2001). Similarly, Berkey and coworkers reported that the consumption of sugar-sweetened beverages was associated with BMI gains during the corresponding year in a prospective cohort study (n=10,000) of boys and girls, age nine – 14 years, participating in the U.S. Growing Up Today Study (Berkey et al., 2004).

BMI increased significantly as number of minutes of physical activity per day decreased. These findings are in agreement with those by Patrick and coworkers (2004). These researchers used baseline data for adolescents (n=878; ages 11 – 15 years) from the Patient-Centered Assessment and Counseling for Exercise Plus Nutrition Project and identified an inverse relationship between BMI and physical activity levels. Adolescents with a BMI-for-age > 85th percentile participated in significantly fewer minutes per day of vigorous physical activity than those with a BMI-for-age < 85th percentile (Patrick, Norman, Calfas, Sallis, Zabinski, Rupp, Cella et al., 2004). Utilizing data from NHANES III, Forshee and colleagues also reported a strong negative correlation between BMI and participation in team sports or exercise programs for male and female adolescents (Forshee, Anderson, Storey et al., 2004).

The results of this study supported the research hypothesis that there would be a significant difference in the prevalence of pre-HTN and HTN in school-aged children between those with a BMI-for-age > 85th percentile and those

with a BMI-for-age < 85th percentile. As the rate of overweight increased, the rate of elevated blood pressure also increased. The prevalence of elevated blood pressure increased across increasing BMI groups, even within the normal-weight percentile range, indicating a step gradient relationship between BMI and blood pressure. These study results support the growing body of literature demonstrating the link between child overweight and elevated blood pressure. Freedman and coworkers, utilizing the Bogalusa Heart Study data, reported that overweight children (n=9,167; ages five – 17 years) were 4.5 times more likely to have elevated SBP and 2.4 times more likely to have elevated DBP than their leaner counterparts (Freedman et al., 1999). Similarly, Sorof and coworkers (2002) found elevated blood pressure rates to be more prevalent in adolescents with a BMI-for-age > 95th percentile (33%) than in those with a BMI-for-age < 95th percentile (11%) in a school-based health screening (Sorof et al., 2002). In a more recent screening, Sorof and colleagues (2004) reported that based on three readings, children (n=5102; age 10 – 19 years) with a normal BMI (<85th percentile) had an elevated blood pressure prevalence of 2.6%, compared to a prevalence rate of 10.7% for overweight children (BMI-for-age >95th percentile). This association held to be significant when adjusted for gender, ethnicity, overweight, and age (Sorof et al., 2004).

SBP was correlated with both fruit and soda consumption, supporting the research hypothesis that there would be significant associations between high blood pressure and dietary factors. Moore and coworkers (2005) reported similar associations among blood pressure and diet. Utilizing eight years of follow-up data from the Framingham Children's study (1986), which consisted of 95 children initially three to five years of age, researchers reported that children consuming more fruits and vegetables or more dairy products during the preschool years had smaller yearly SBP gains throughout childhood. When reaching early adolescence, children with a higher consumption of fruits, vegetables, and dairy products had an adjusted mean SBP (106 $\pm$ 2.9 mmHg) lower than that of children who consumed lower intakes (113 $\pm$ 1.5 mmHg)

(Moore, et al., 2005). Simons-Morton and colleagues (1997) found that both SBP and DBP were significantly inversely associated with some micronutrients (calcium, magnesium, and potassium) and fiber in 662 hypercholesterolemic children ages eight to 11 years (Simons-Morton et al., 1997).

Soda was found to be linked to elevated blood pressure in our sample of low income students. These findings support those of Savoca and colleagues (2004) who observed a positive association between blood pressure and soda in adolescents, such that high soda consumption rates are associated with higher blood pressure values. These authors suggest caffeine intake may increase blood pressure and thereby increase the risk of HTN (Savoca et al., 2004).

There were some key limitations to this study. The information regarding dietary and physical activity habits was self-reported. Younger participants may have biased their responses in order to give the "right" answer. Data were used for only one blood pressure screening. According to the updated guidelines for HTN and pre-HTN in children and adolescents (NHBLI, 2004), children should be screened three times before being diagnosed with either pre-hypertension or hypertension. Hence, it is understood that reported rates of pre-HTN and HTN are above actual values.

Conclusions
At 44%, the rate of at risk for overweight and overweight (> 85th percentile BMI-for-age) for these low-income students is significantly above the national rate of 31%. HTN rates are significantly higher and physical activity levels significantly lower for overweight vs. normal weight children. Fruit and vegetable intake decreased significantly by grade between fifth and eighth grades. Soda was found to be an independent risk factor for overweight. In addition, BMI and soda were found to be risk factors for elevated SBP. These findings suggest that nutrition education and physical activity promotion programs are needed in these school districts. It is recommended that parents, teachers, and school district personnel make efforts to promote physical activity and fruit and

vegetable consumption among students in and out of school. Efforts also need to be directed at decreasing the availability of soda both at home and at school.

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