After School Physical Activity and Eating Behaviors of Middle School Students in Relation to Adult Supervision

(Research Article)

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INTRODUCTION

It is well acknowledged that the prevalence of obesity in children has risen substantially over the past three decades. Although this prevalence trend has flattened over the past several years, childhood obesity remains to be a major problem in the United States (US). The high prevalence of childhood obesity experienced today is due to complex social, environmental, and policy changes that have influenced eating and physical activity behaviors. For example, many urban and suburban communities are designed in such a way that walking, bicycling and other physical activities are discouraged. There are fewer opportunities today for children to be active during school, after school, and going to and from school than a generation ago. The data indicate that 62% of children aged 9-13 years do not participate in any organized physical activity during their non-school hours, and that 23% do not engage in any free-time physical activity. Children spend less of their free time in physical activity outdoors and more free time being sedentary, either watching TV or playing video games, than in years past.

Evolutions in family life have caused changes in children’s eating patterns. The family can have both negative and positive effects on children’s eating behaviors. Cross sectional studies have shown that children and adolescents who regularly eat dinner with the family are less likely to be overweight and more likely to have healthier eating habits. However, modern families experience pressure to minimize food costs and to shorten food acquisition and preparation time, which has lead many families to regularly consume unhealthy processed foods that are more conveniently acquired and prepared for consumption than home prepared fresh foods. Studies have shown that busy
households, wherein families dine out for meals, subject children to foods that are high in energy density, as well as high in sodium\(^9\).

Over the last two decades, the number of working parents has increased dramatically, in that 75\% of mothers with school-aged children are now currently employed\(^{15}\). Both parents also work an increasingly larger number of hours during the week\(^{15}\). This means that the number of children forced to care for themselves has also increased dramatically. In 2006, it was reported that 17.8\% of children ages 9-11 years were taking care of themselves\(^{16}\). The size of the family has an impact on health behaviors as well. Children in small families have healthier eating patterns than children in large families\(^8\). Presumably, the larger the family, the less likely a child’s eating habits will be directly supervised by an adult\(^8\). Other researchers found that lack of adult supervision caused unsupervised children to participate in less physical activity and consume larger amounts of unhealthy foods than supervised children\(^{15}\). Adult supervision, therefore, seems to be a key in promoting healthy eating as well as physical activity patterns in children.

It appears like two major factors that have contributed to the increase in childhood obesity over the past three decades are: a community environment that discourages physical activity and healthy eating, and a family environment where adults are less able to supervise childhood behaviors. Therefore to influence/impact rates of childhood obesity, one must examine the children’s environment, with particular focus on how children spend their time. Better understanding of how children spend their time, and under what circumstances they participate in healthy or unhealthy behaviors will help in the design of more effective childhood obesity interventions. Therefore, the purpose of
this study was to examine the physical activity patterns, eating behaviors, and social environment of overweight (OW) and normal weight (NW) middle school children between the hours of 3:00 PM and 12:00 AM, when children are most likely to engage in behaviors unsupervised by adults. The working hypothesis for this study was that during these after-school hours OW children are less active, have poorer eating behaviors, and have a weaker social environment for health behaviors than NW children.

**METHODS**

**Study Design**

After-school physical activity patterns, eating behaviors and social environment were examined simultaneously in middle school students. Physical activity was measured objectively through accelerometry and recorded subjectively by each student with an activity diary. Students also recorded their eating behaviors and social environment in the diary. Weight comparisons (OW vs. NW) and gender comparisons were made to identify possible determinants of obesity in middle school students.

**Participants**

This study was approved by the Institutional Review Board for Human Research at the George Washington University Medical Center. Three middle schools (grades 6-8) were selected for this study, because it is well known that physical activity declines among youth as they grow through adolescence\(^4,17,18\). One middle school (DC) was selected from the inner city of Washington DC, a second school (VA) was selected from a mid-sized town located in northern Virginia, and the third school (GA) was selected from a rural agricultural community in Georgia. These three sites were selected to
represent an urban metropolis, a “blue collar” town, and a farming community. The per capita income for the DC site was unknown, for the VA site $23,552, and $13,657 for the GA site. Although direct generalizability to the entire American population may not be possible with this sampling technique, these three sample cities represent three distinct cross-sections of the American population.

Cooperation was obtained from the school board, principal, and physical education teachers of the respective schools. Students were recruited for this study via class announcements. Researchers gave a 15 min presentation about the nature of the study to students in their physical education classes. Interested students were then given a parent authorization form and a child assent form to be completed and signed prior to participation in the study.

Protocol

The DC school had 57 out of 180 potential children participating; the VA school had 48 out of 200 potential children, and the GA school 36 of 204 students participating. All of the DC students were African American, 90% of the VA students were Caucasian with 10% African American, and 39% of the GA students were African American with 50% Caucasian and 11% Hispanic. None of the students were practicing weight control methods. Students were not given any monetary incentive to participate.

Researchers visited the school on the Monday of a full week of school to gather anthropometric data, equip the children with accelerometers, and provide instruction on completion of the activity logs. Monday morning the participants were taken into a private room from the rest of their physical education class, where their weight and height were obtained using a scale (Taylor Precision Tech #7506; Taylor Precision
Products, Oak Brook, IL) and stadiometer (Secca Portable Stadiometer #213; Secca, Hanover, MD) that were accurate to 0.25 lb (0.114 kg) and 0.25 in (0.64 cm) respectively. Children were classified as NW if their BMI for age and sex was ≥5% and <85% and as OW if their BMI for age and sex was ≥85%. Demographic data (height, weight, age, and gender) were input into a laptop computer so the participant could be fitted for an accelerometer. Participants were then fitted with an Actical accelerometer (Respironics Inc., Bend, OR, USA) attached to a waistband with a Velcro strap. The accelerometer was secured around the hips with the actual monitor lying just above the right iliac crest. Participants were shown how to remove the accelerometer at night and replace it in the morning. Children were told that the monitors were waterproof and thus could be worn while showering or swimming. Children were asked to keep the accelerometer on at all times from 3:00 PM until bed time on the days of the study.

The Actical accelerometer is sensitive to movement in all directions, and the storage capacity allows for several days of continuous monitoring\(^\text{19,20}\). The Actical accelerometer is valid for detection of low-energy movements as well as high-energy movements\(^\text{19,20}\).

Along with an accelerometer, each participant was given a 4-day activity diary to complete during the experimental week, from that Monday, beginning at 3:00 PM, until that Thursday at 12:00 AM. The activity diary was based on the Bouchard 3-day physical activity diary, which has been found to be both valid and reliable for estimating daily energy expenditure for ages 10-50 y\(^\text{21,22}\). The diary was modified so that 20-min time intervals were used, instead of 15-min intervals, for the participant to record the activities in which he/she took part. Our preliminary work with children this age suggested that
expanding the time frame from 15 to 20 min would help with compliance in completing the diary (Miller WC, unpublished data, 2010). The 20-min increments allowed for an assignment of a categorical value for the dominant activity in any given time frame. A further modification to the diary was that, in addition to recording the activity in which the child participated, the child also recorded his/her location, with whom he/she was with, and if there was adult supervision. Also included on the diary was an example of how to fill it out properly, with accompanying instructions. Researchers returned to the school on Friday to retrieve both the activity diaries and accelerometers.

**Compression and Coding of Data**

Researchers coded the responses on the returned activity diaries so that location was categorized as Indoors at Home, Indoors Out of Home, and Outdoors. The “with who” response was coded as either with a family member, with a friend, or alone. Adult supervision was defined as a person 18 y or older who was in the act of overseeing the adolescent. The supervising adult must have been within voice range of the child to be considered supervising. Distinct verbal and written instructions were given to the children on how to record where they were, who they were with, and if an adult was supervising. The researcher who coded the diary responses was given the same set of instructions for reporting as the children. The researcher then reviewed each returned diary for consistency between the instructions and the way the children completed the diary. If a discrepancy was found, the researcher either corrected the discrepancy (according to the written coding instructions), or eliminated that particular response from the database.
In addition, the participant’s activities were coded as either active or sedentary, where sedentary was defined as anything done sitting or lying down (including napping). Activities were also coded as eating (yes or no) and what type of food was being consumed (healthy food or unhealthy food). Eating fast food was classified separately because of the relationship between fast food consumption and obesity\textsuperscript{23}. Fruits, 100% fruit juice, vegetables, grains, lean meats, fish, and low-fat dairy (1% fat or lower) were classified as healthy foods. High-fat snacks (e.g., regular fat cheese, peanut butter, chips), sweets, sugared drinks, diet soda, high-sodium snacks (e.g., chips, crackers, pretzels), and high-calorie/low nutrient foods (e.g., pizza, macaroni and cheese) were classified as unhealthy foods. All of the codes were pre-determined and standardized by one investigator.

The activity diary was only completed from 3:00 PM to 12:00 AM for 4 days, giving a total of 27 consecutive 20-min time intervals per day, and 108 total time intervals per participant. Since the activity diary was divided into 20-min time increments, data from the accelerometer was also compiled in 20 minute time intervals to give the total activity counts for each corresponding activity diary time interval. If there were 3 consecutive time intervals (60 consecutive min) of accelerometer data for where activity counts were measured to be zero, information obtained from the activity diary was used to determine whether the participant was sedentary or just not wearing the monitor. If the activity diary reported a period of being awake when there were no accelerometer counts, it was assumed that the participant was not wearing the accelerometer, and the corresponding time interval for accelerometer data was voided. Data collection for the day stopped when the accelerometer registered zero counts and the
child recorded going to bed for the night on the activity diary. Therefore, the data set includes only activity data for the time a child was awake between 3:00 PM and 12:00 AM. Empty time cells were not included in data analysis.

A reliability coefficient of 0.80 was previously recorded for students in grades 1-6 and of 0.70 for grades 7-12, when wearing the accelerometer for 4-5 days. This study examined after-school weekday activities, and so a 4 day range was deemed appropriate. The need to match children’s activity, adult supervision, and eating behaviors to accelerometer counts led to extending the Bouchard 3 day activity diary to 4 days to accommodate the accuracy and reliability of the Actical accelerometer.

**Statistical Analyses**

All statistical procedures were performed with the Systat® Statistical software package (version 12, Chicago, IL, US). Values are reported as mean ± SD. Statistical significance was set at p<.05. Sample data were tested for normal distribution using the Kolmogorov-Smirnov test and for equal variance using the Levene median test. The two-sample t-test was used to make mean group comparisons between the NW and OW and between boys and girls. ANOVA with repeated measures was used to make mean group comparisons for accelerometer counts across time periods. ANOVA was used to make group mean comparisons among schools and among races for the demographic variables and accelerometer counts, and to make comparisons among ages for accelerometer counts. A Tukey pairwise comparison was used if an ANOVA produced a significant F value. The Chi Square test was used to compare differences in the frequency counts between groups for the categorical data reported in the activity diaries (i.e., time spent in each of 19 categories of activity). A test for equality of two proportions was used to test
for differences in prevalence ratios or percentages between two groups. Simple correlation coefficients were used to measure the strength of association between two quantitative variables.

RESULTS

The demographic information for the participants is presented in Table 1. There were no age differences between the NW and OW groups or between the genders. The VA children were 5-7 months younger than children at the other two sites, and the African-American children were 2-5 months older than the Caucasians and Hispanics. The children at the DC school were significantly taller, heavier, and had a higher BMI than the children at the other two sites.

The total physical activity measures, expressed as average accelerometer counts per min for the entire time frame (3:00 PM to 12:00 AM), are shown in Figure 1. There were no significant group differences in average accelerometer counts from 3:00 PM to 12:00 AM when comparing the NW to OW, boys to girls, schools, races or age groups. Energy expenditure algorithms for children using the Actical Accelerometer were derived by Freedson et al.\textsuperscript{25} When these algorithms were applied to the data, there were no significant differences in estimated energy expenditure for any of the comparable groups. In fact, the range in energy expenditure for all groups was very narrow, ranging from $0.017 \pm 0.002$ to $0.019 \pm 0.002$ kcal per kg body weight per min (group data not shown). This amounted to an average of $530 \pm 344$ kcal expended from 3:00 PM to 12:00 AM or approximately 1.0 kcal per min during that time frame.
The correlation coefficient for the relationship between the accelerometer counts within each of the 27 time intervals across the 4 days and the frequency of positive responses (in the activity diaries) for being active over the same time was 0.82 (p<.001). The plot of accelerometer counts for all children over time is shown in Figure 2. Physical activity was highest between 3:00 PM and 6:40 PM. After 6:40 PM, physical activity began to decline, to where at 7:00 PM the decrease in activity was significantly lower than at its peak time (3:00 PM to 5:00 PM). Physical activity continued to decline until 11:00 PM.

Table 2 shows the percentage distribution of time between 3:00 PM and 12:00 AM spent in different activities and under different environmental situations. Middle school children spent over three-fourths of their after school hours being sedentary, and approximately 80% of that sedentary time was spent being under adult supervision. Eighty-five percent of children’s eating time was supervised by an adult, while 19% to 26% of that adult supervised eating was spent eating unhealthy foods. The OW children spent more time being active while less time sedentary and less time supervised than the NW children. The OW children also spent less time eating unhealthy food than the NW children. The OW children spent less of their after school time being supervised and less sedentary time supervised than NW children. OW girls spent more time being active, but also more time eating than OW boys. OW girls spent more of their eating time consuming healthy foods than OW boys.

Simple correlations revealed that the amount of time spent being active was positively related to time spent with friends for both the NW and OW children (Table 3). Active time was also related to time spent with family, but the relationship was stronger
for the NW compared to the OW children. In contrast, time spent being sedentary was positively related to time spent being supervised for both the NW and OW children. Sedentary time was more strongly related to time spent alone for the NW children compared to the OW children. Time spent eating healthy food was positively related to time spent with family, while time spent eating unhealthy food was related to time spent with friends for the NW and OW children. Time spent eating unhealthy food was inversely related to time spent being under adult supervision as well as inversely related to time spent being alone for both the NW and OW children; but the strength of these relationships differed between groups.

DISCUSSION

After School Physical Activity Levels

The amount of physical activity achieved (expressed as either activity counts or kcal) throughout the after school hours was similar between the NW and OW groups. Physical activity was highest from 3:00 PM to 6:40 PM, and then declined throughout the evening and night time (Figure 2). This is not surprising in that the common routine for middle school children in the US is free time immediately after school, dinner time, home and family time, followed by quiet time and bed time.

Several other studies concur that the most active time in a child’s day is immediately after school. However, none of these studies were as complete and detailed as the present study. None of these studies sampled children from three distinct demographic areas (e.g., urban, rural blue collar, rural agricultural). Each of these studies sampled children from only one geographical location. None of these studies performed
an hour-by-hour analysis of physical activity levels. The few studies that evaluated physical activity with reference to time grouped the data into blocks of time\textsuperscript{27,29,34}. The time blocks analyzed were broad, either representing total time out of school\textsuperscript{24} or the block of time immediately after school until 6:00 PM and then again from 6:00 PM until 9:00 or 10:00 PM\textsuperscript{28,29,31}. Separating time frames at 6:00 PM may not have captured the best representation of physical activity patterns, because physical activity in these children decreased very rapidly from 5:00 to 7:00 PM.

More interesting than the time of day when activities happened might be the amount of time children devoted to different types of active or sedentary behaviors. These middle school children spent over three-fourths of their after school time sedentary (Table 2). This translates into spending 6.8 hours between 3:00 PM and 12:00 AM either sitting or lying down. Furthermore, most of the children’s sedentary time was spent being supervised by an adult (Table 2).

Other researchers have suggested that the home environment created by parents likely influences the choices made by adolescents about physical activity\textsuperscript{32}. According to behavioral economic theory, a child’s choice to be sedentary or active depends on the ease of access to sedentary activities in the home\textsuperscript{32}. For instance, having many televisions in the home, or easy access to video games and computers leads to less time in an active environment. On the other hand, households that have dogs, for example, promote greater amounts of physical activity\textsuperscript{32}. Other research supports this theory in that more than two-thirds of 5th and 6th graders surveyed said they would chose to be more physically active if given the choice to do so\textsuperscript{35}. At the same time, these children
reported that spending time with family was a major reason why they engaged in screen-related activities.

On a positive note, when children were outside, they spent about 60% of their time being active. This suggests that one area of focus in combating childhood obesity is to have children spend more time outside. Social support from parents and other family members has also been identified as one of the most important determinants of participation in all forms of physical activity, including sports, structured exercise and active leisure in and outside the home\textsuperscript{33}. Parents are responsible for providing different kinds of support in the form of transportation, equipment, paying activity fees, encouraging their children to be active, and playing with their children; all of which promote physical activity\textsuperscript{33}.

**Physical Activity Patterns in NW versus OW**

It may seem a surprise that the OW children spent more time being active than the NW children. This self-report data could infer a potential reporting bias where OW children overestimated their active behaviors. However, the accelerometer counts for the OW and NW children were similar. It may be that when the NW children were physically active, their intensity of activity was greater than that of the OW children. Under this scenario, OW children would have needed to accumulate more active time at their lower activity intensity in order to accrue the same number of accelerometer counts as the NW.

Other investigators have shown that NW children do spend more time in moderate- to-vigorous activities than OW children\textsuperscript{26,34,36,37}. Three of these studies were consistent in finding that NW children were more active than OW children overall, and
accrued more minutes of moderate-to-vigorous activity throughout the day than OW children\textsuperscript{26,34,36}. However, Purslow et al. did not find any relationship between weight status and total daily activity or moderate-to-vigorous activity for girls\textsuperscript{37}. Furthermore, these same investigators did not find any relationship between sedentary activity and weight status for either boys or girls.

None of the previous studies used subjective and objective measures of physical activity simultaneously\textsuperscript{26,34,36,37}. We monitored physical activity simultaneously with objective measures (accelerometers) and subjective measures (activity diaries). The correlation coefficient between the average accelerometer counts per min and the average frequency of positive responses for being active on the diaries during each of the 27 time frames was high ($r = 0.82$) for the OW children. This suggests that the OW children were recording their activity time accurately.

The OW girls reported spending more time being active than the OW boys, when their estimated energy expenditure was the same. However, it may well have been that the activities reported by the OW girls were associated with lower intensity activities such as chores and activities of daily living, while those of the OW boys were associated with short bouts of vigorous activity, such as organized games or sports\textsuperscript{38}. Preliminary data support this theory, in that girls scored lower than boys on the leisure index of the Fels Physical Activity Questionnaire\textsuperscript{39} when their total scores for the questionnaire were equivalent (Miller WC, Redmond JG, Vaux-Bjerke AT, unpublished data, 2010).

OW girls spent less of their outside time being active than OW boys (Table 2). This may have occurred because the outdoor environment is more favorable to boy’s activities than girl’s activities\textsuperscript{32}. Roemmich et al. \textsuperscript{32} discovered that the built environment
affects boys and girls differently. These researchers reported a positive relationship between the percentage of recreational park area in a neighborhood and physical activity for boys, but no such relationship for girls.

**Dietary Patterns and Behaviors**

The great majority of time children spent eating was under direct adult supervision and/or with a family member (Table 2). Approximately 60% of children’s total eating time was spent eating healthy food (Table 2). When children ate alone, they spent 60% of that time eating unhealthy food. These data support the idea that parents feel is important to feed their children well so they will grow to be big and strong\(^{13}\). This may be the case with the OW children, in that they spent more of their eating time consuming healthy foods than the NW children (Table 2). On the other hand, it may be that the parents of the NW children were not taking enough caution to feed their children well, thinking that their NW child will grow with his/her body, and that overweight is not their child’s concern\(^ {13}\). Regardless, approximately 40% of both OW and NW children’s eating time was spent consuming unhealthy foods, while most of this time was under direct adult supervision. The reason why so much unhealthy eating was allowed under adult supervision cannot be determined at this time. Adult caregivers may need more knowledge, encouragement, skills, or assistance in food preparation and how to reduce children’s access to unhealthy foods while providing children more and easier access to healthy foods.

This conclusion seems reasonable, because the data show that adolescents watching television during family meals have lower quality diets than adolescents not watching television during family meals\(^ {12}\). Moreover, watching television during family
meals was associated with healthier adolescent eating than not eating meals as a family at all. In addition, children whose parents set limits on unhealthy food consumption and screen time have better eating behaviors and more physical activity than children without parental limits \(^{35,40}\).

The OW children spent more time consuming healthy foods and less time consuming unhealthy foods than the NW children. At first this finding may seem counterintuitive. However, there are some possible explanations for this perplexing result. The tool used to record dietary behavior was not a food diary, food frequency questionnaire, or any other type of standardized dietary analysis tool. The activity diary was a behavior diary, which recorded if the children were eating, the time they spent eating, and what type of food they were eating. Thus, the amount of food consumed during any given time period was not recorded. The energy content of the food consumed was not known. Nor was the speed of food consumption. An example of a scenario that would fit the data would be if an OW child consumed a large candy bar, while a NW child consumed a few hard mint candies. It would take the OW child much less time to eat the candy bar, which contained more energy, than the NW child would spend sucking on a few mints, which contained less energy. An alternative, that cannot be ignored, is that the OW children were bias in reporting their food intake. Unfortunately, the study design did not provide a mechanism to validate food intake recording validity beyond that of self-report.

OW girls reported spending more of their eating time consuming healthy foods than OW boys (Table 2). The key to healthier eating for the OW girls may be that they spent less of their eating time alone, when compared to OW boys. On the other hand, the
OW girls spent more of their sedentary time eating than OW boys. So, although OW girls were spending more time eating than OW boys, the girls were consuming healthier foods.

**Study Limitations**

The results of this study are limited to students who volunteered to participate. The database generated does not provide a way to determine whether non-volunteer students would have been characterized differently from these volunteers. African Americans were overrepresented in the database, whereas Hispanics were underrepresented. However, these racial proportions probably did not bias the data, because there were no significant differences found for activity among the races. A power analysis to determine the number of students needed to truly detect a significant difference if there was one was not conducted. Therefore, non-significant results should be interpreted with caution as there may have been too few students to see a difference. The three study sites, representing three distinct cross-sections of the population may not be representative of the entire population. In spite of these limitations, the data provide the first detailed examination of how after-school activities of middle school students may affect their weight.

**IMPLICATIONS FOR RESEARCH AND PRACTICE**

The data from this research provides several suggestions for foci of interventions in the fight against childhood obesity. From the standpoint of physical activity, middle school aged children should be encouraged to spend time with their friends and family members rather than spending time alone. However, the data show that more adult
supervision does not guarantee more physical activity for the child. Adult caretakers should learn how to be more physically engaged with their children, rather than just supervise sedentary behavior. Alternatively, supervising adults can encourage after school physical activity for children, even if the adult is not able to participate directly. With regard to healthier eating, middle school aged children should be encouraged to eat under the direct supervision of an adult and to eat meals with their families. Adults should also better structure the home food environment such that children have easy access to healthy foods, limited access to unhealthy foods, and are given direction and encouragement to eat healthy foods when unsupervised. Children should also be discouraged from eating while alone. In order to implement these mediators of healthy eating and physical activity more effectively than we are now, a concerted effort needs to occur. This effort needs to promote more social interactions among children, family members, friends, and adult caretakers, where physical activity and healthy eating are more likely to occur.

REFERENCES


15. U.S. Census Bureau: American Fact Finder. Available at: 


Table 1: Anthropometric and Ethnic Data for Middle School Students

<table>
<thead>
<tr>
<th>Group</th>
<th>All (n=141)</th>
<th>NW (n=105)</th>
<th>OW (n=36)</th>
<th>Boys (n=39)</th>
<th>Girls (n=102)</th>
<th>DC School (n=57)</th>
<th>VA School (n=48)</th>
<th>GA School (n=36)</th>
<th>African American (n=76)</th>
<th>Caucasian (n=61)</th>
<th>Hispanic (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>12.4±0.8</td>
<td>12.4±0.9</td>
<td>12.4±0.7</td>
<td>12.4±0.8</td>
<td>12.5±0.8</td>
<td>12.1±0.7†</td>
<td>12.8±0.8</td>
<td>12.6±0.9‡</td>
<td>12.1±0.7</td>
<td>12.3±0.5</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>54.6±15.0</td>
<td>48.4±8.6</td>
<td>72.4±15.7*</td>
<td>54.6±14.2</td>
<td>59.9±17.1†</td>
<td>50.1±12.0</td>
<td>52.0±12.6</td>
<td>58.3±16.9</td>
<td>50.4±11.3</td>
<td>46.4±5.5</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>158.7±9.6</td>
<td>158.0±8.4</td>
<td>160.8±12.5</td>
<td>159.5±10.5</td>
<td>161.0±10.7†</td>
<td>156.0±8.8</td>
<td>158.7±8.2</td>
<td>161.0±10.4‡</td>
<td>156.7±8.3</td>
<td>152.4±4.6</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>21.5±4.8</td>
<td>19.2±2.0</td>
<td>27.9±4.5*</td>
<td>21.0±4.8</td>
<td>21.6±4.8</td>
<td>23.0±5.8†</td>
<td>20.4±3.3</td>
<td>22.4±5.5‡</td>
<td>20.3±3.3</td>
<td>19.9±1.6</td>
<td></td>
</tr>
</tbody>
</table>

All = all participants; NW = normal weight; OW = overweight. Values are mean ± SD. *Significantly different from NW group (p<.001). †Significantly different from other schools (p<.05). ‡Significantly different from other races (p<.05). ANOVA was used to test for significant group differences among schools and races. Independent t-tests were used to test for significant group differences between OW and NW and between genders.
Table 2: Percent Use of After School Time for Middle School Students

<table>
<thead>
<tr>
<th>Category</th>
<th>All</th>
<th>NW</th>
<th>OW</th>
<th>OW Boys</th>
<th>OW Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Time spent eating</td>
<td>9.0</td>
<td>9.6</td>
<td>7.3</td>
<td>5.4</td>
<td>8.3†</td>
</tr>
<tr>
<td>% Time spent with a family member</td>
<td>36.8</td>
<td>39.2</td>
<td>29.2*</td>
<td>30.6</td>
<td>28.5</td>
</tr>
<tr>
<td>% Time spent with friends</td>
<td>18.9</td>
<td>19.7</td>
<td>16.5</td>
<td>12.6</td>
<td>18.5†</td>
</tr>
<tr>
<td>% Time spent alone</td>
<td>44.3</td>
<td>41.1</td>
<td>54.3*</td>
<td>56.8</td>
<td>53.0†</td>
</tr>
<tr>
<td>% Time spent sedentary</td>
<td>76.0</td>
<td>77.3</td>
<td>70.1*</td>
<td>78.4</td>
<td>68.6†</td>
</tr>
<tr>
<td>% Time spent being active</td>
<td>24.0</td>
<td>22.7</td>
<td>29.9*</td>
<td>21.6</td>
<td>31.4†</td>
</tr>
<tr>
<td>% Time spent supervised</td>
<td>83.7</td>
<td>85.8</td>
<td>77.5*</td>
<td>78.9</td>
<td>76.8</td>
</tr>
<tr>
<td>% Time spent outside</td>
<td>15.1</td>
<td>15.5</td>
<td>14.6</td>
<td>15.6</td>
<td>14.1</td>
</tr>
<tr>
<td>% Outside time being active</td>
<td>60.6</td>
<td>61.4</td>
<td>58.6</td>
<td>65.3</td>
<td>56.2†</td>
</tr>
<tr>
<td>% Eating time eating healthy food</td>
<td>59.1</td>
<td>55.0</td>
<td>71.9*</td>
<td>56.9</td>
<td>76.7†</td>
</tr>
<tr>
<td>% Eating time eating unhealthy food</td>
<td>40.9</td>
<td>45.0</td>
<td>28.1*</td>
<td>43.1</td>
<td>23.3†</td>
</tr>
<tr>
<td>% Eating time supervised</td>
<td>85.2</td>
<td>85.7</td>
<td>83.4</td>
<td>78.5</td>
<td>80.4</td>
</tr>
<tr>
<td>% Supervised eating time eating unhealthy food</td>
<td>21.1</td>
<td>20.7</td>
<td>22.0</td>
<td>26.2</td>
<td>19.4†</td>
</tr>
<tr>
<td>% Eating time with a family member</td>
<td>70.2</td>
<td>70.6</td>
<td>69.1</td>
<td>64.6</td>
<td>70.4</td>
</tr>
<tr>
<td>% Family eating time eating unhealthy food</td>
<td>25.6</td>
<td>25.7</td>
<td>25.1</td>
<td>23.8</td>
<td>25.6</td>
</tr>
<tr>
<td>% Eating time alone</td>
<td>18.9</td>
<td>18.7</td>
<td>19.5</td>
<td>30.8</td>
<td>15.8†</td>
</tr>
<tr>
<td>% Alone eating time eating unhealthy food</td>
<td>60.8</td>
<td>59.9</td>
<td>61.2</td>
<td>61.0</td>
<td>61.4</td>
</tr>
<tr>
<td>% Sedentary time eating</td>
<td>10.9</td>
<td>11.5</td>
<td>9.9*</td>
<td>6.8</td>
<td>10.3†</td>
</tr>
<tr>
<td>% Sedentary time supervised</td>
<td>86.6</td>
<td>87.7</td>
<td>83.3*</td>
<td>82.3</td>
<td>83.8</td>
</tr>
</tbody>
</table>
All = all participants, NW = normal weight; OW = overweight. *Significantly different from NW group (p<.05). †Significantly different from OW boys (p<.05). A test for quality of two proportions was used to test for significant differences in prevalence ratios or percentages between two comparable groups.
Table 3: Relationships Between Social Interaction Time and Eating or Activity Time for Middle School Students

<table>
<thead>
<tr>
<th>Category</th>
<th>All</th>
<th>NW</th>
<th>OW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active time vs. time with friends</td>
<td>0.64</td>
<td>0.65</td>
<td>0.62</td>
</tr>
<tr>
<td>Active time vs. time with family</td>
<td>0.46</td>
<td>0.49</td>
<td>0.36*</td>
</tr>
<tr>
<td>Sedentary time vs. time supervised</td>
<td>0.76</td>
<td>0.76</td>
<td>0.76</td>
</tr>
<tr>
<td>Sedentary time vs. time alone</td>
<td>0.88</td>
<td>0.90</td>
<td>0.80*</td>
</tr>
<tr>
<td>Time spent eating healthy vs. time with family</td>
<td>0.87</td>
<td>0.88</td>
<td>0.81</td>
</tr>
<tr>
<td>Time spent eating unhealthy vs. time with friends</td>
<td>0.89</td>
<td>0.90</td>
<td>0.87</td>
</tr>
<tr>
<td>Time spent eating unhealthy vs. time supervised</td>
<td>-0.82</td>
<td>-0.87</td>
<td>-0.78*</td>
</tr>
<tr>
<td>Time spent eating unhealthy vs. time alone</td>
<td>-0.66</td>
<td>-0.68</td>
<td>-0.59*</td>
</tr>
</tbody>
</table>

All = all participants; NW = normal weight; OW = overweight. Values are correlation coefficients (p< .01). *Significantly different from NW group (p<.05). †Significantly different from OW boys (p<.05). A test for quality of two proportions was used to test for significant differences in prevalence ratios or percentages between the NW and OW groups.
Figure 1: *Group Comparisons for Average Accelerometer Counts per Minute from 3:00 AM to 12:00 AM in Middle School Students*. All = all participants; NW = normal weight; OW = overweight; DC = District of Columbia students; VA = Virginia students; GA = Georgia students; AA = African American, Cau = Caucasian; His = Hispanic; 11, 12, 13, and 14 = respective student ages. Values represent the mean ± SD for the respective groups. ANOVA was used to test for group mean differences. Group numbers are reported in Table 1.
Figure 2: *Time Plot of Accelerometer Counts from 3:00 PM to 12:00 AM in Middle School Students*. Values represent the mean ± SD for the entire student sample.

ANOVA with repeated measures was used to test for significant within group differences across time.