Associations of Physical Activity and Dietary Behaviors With Children’s Health and Academic Problems

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ABSTRACT

BACKGROUND: We examined the associations of physical activities and dietary behaviors with children’s health and academic-behavioral problems.

METHODS: We employed a Community-wide Children’s Health Assessment and Planning Survey to examine physical activity, healthy meals, health status, and academic-behavioral problems in 3708 children 7 to 14 years of age. Statistical associations were examined with chi-square test and logistic regression analysis; we calculated odds ratios (ORs) and 95% confidence intervals (CIs).

RESULTS: Among these children, 30.2% were overweight-obese, 11.0% had academic problems, and 7.9% had behavioral problems. Children classified as healthy eaters were more likely to exercise \( \geq 4 \) days/week (79.1% vs 64.6%, OR: 2.08, 95% CI: 1.14 to 2.49), less likely to be overweight-obese (27.7% vs 44.6%, OR: 0.48, CI: 0.31 to 0.73), less likely to have academic problems (9.1% vs 16.1%, OR: 0.57, 95% CI: 0.41 to 0.79) and behavioral problems (6.9% vs 13.9%, OR: 0.46, 95% CI: 0.32 to 0.66) compared with their less healthy eating peers. Physical activity and healthy meals were associated with an improved health status (p < .001). However, the proportions of children taking unhealthy meals or choosing sedentary lifestyle increased as the cohorts progressed (p < .05) from childhood (7 to 8 years) to adolescence (13 to 14 years).

CONCLUSIONS: Healthy (or unhealthy) lifestyle behaviors are significantly interrelated. Children who take healthy meals and exercise often are associated with better health and fewer academic and behavioral problems. Unfortunately, taking unhealthy meals and sedentary lifestyle characterize a growing proportion of young adolescents. Thus, curbing unhealthy lifestyle behaviors should start in early childhood.

Keywords: behavioral problems; dietary choices; exercise; sedentary lifestyle.


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Sedentary lifestyle and unhealthy dietary behaviors are 2 important contributors to childhood and adolescent obesity. Obese children and adolescents have a higher prevalence of childhood asthma, sleep apnea, type-2 diabetes, renal injury, emotional problems, and adulthood overweight and other comorbidities. Previous data indicated that body mass index (BMI) and percentage body fat were negatively related to self-reported academic performance (ie, school grades) among children 11 to 14 years old and that low aerobic fitness and obesity were associated with low standardized test scores in fifth to ninth graders. Thus, childhood obesity and poor physical fitness are emerging as contributory factors that affect

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children’s academic performance or cognition.\textsuperscript{12,13} Nutritional studies implicated that breakfast habits (skipping vs consumption) were associated with nutritional status, body weight, and academic performance in children and adolescents.\textsuperscript{14} Food insecurity affected children’s academic performance and weight gain.\textsuperscript{15} Diet quality was also significantly associated with school performance.\textsuperscript{16} However, little is known about the association of lifestyle behaviors with children’s academic and behavioral problems at school. The interrelationship between the principal correctable lifestyle issues, physical inactivity, and unhealthy diets also remains to be explored. Lifestyle behaviors may reinforce one another. Children who are physically active may be more likely to eat healthy (and vice versa). This interrelationship between lifestyle behaviors could significantly affect children’s health and school performance. The purpose of this study was to examine the associations of healthy diets and physical activity with health status, body weight, academic problems, and behavioral problems in children.

METHODS

Participants

Analyses included 3708 children (1971 boys and 1737 girls) 7 to 14 years old whose parents participated in a Community-wide Children’s Health Assessment and Planning Survey sponsored by Cook Children’s Health Care System at Fort Worth. The cohort comprised 69.7% Caucasian, 19.2% Latino/Hispanic, 5.5% African American, 2.1% Asian/Pacific Islander, 0.5% American Indian/Alaska Native, and 3.0% unknown/multiracial children.

Procedure

The survey was prepared after obtaining input and acceptance from community leaders and representative groups that included county judges, local mayors, Texas Department of State Health Services, county health departments, the Center for Community Health, United Way of Tarrant County, and a series of parent focus groups (a total of 8 groups with 7 to 10 parents/group). Community concerns, questions, and needs regarding children 0 to 14 years old were identified based on 13 meetings with community leaders, 12 community coalition task force meetings, 12 community listening sessions, and 7 meetings with the staff of Cook Children’s Health Care System. The surveys were administered by a combination of mail, phone, and the Internet in both English and Spanish (~12%). If there was no response to the initial mailed questionnaire, the household was then contacted and given the opportunity to complete the survey by phone. A total of 21,530 households in 6 north Texas counties served by Cook Children’s Health Care System were randomly selected and 7439 households completed the survey for 1 child either by mail (N = 3492), by phone (N = 3612), or by Internet (N = 335). The survey addressed health issues among both preschool and school aged children. This study used the survey that specifically addressed children with school-related issues. Thus, the analysis focused on a subset of 3708 school children 7 to 14 years old. Within this cohort, 2171 surveys included responses regarding academic problems and behavioral problems at school. The surveys began in September 2008 and were completed in January 2009.

Variables

Initial categories of health status (1) poor, (2) fair, (3) good, (4) very good, and (5) excellent were merged into poor-fair, good, and very-good/excellent for analysis. Body mass index percentile (PCT) was calculated from parent-reported weight and height using the method presented by the Centers for Disease Control and Prevention.\textsuperscript{17} The children’s BMI PCTs were categorized into normal weight (<85% BMI PCT) and overweight-obese (≥85% BMI PCT) for simplicity. Physical exercise levels were categorized as (1) no exercise (or sedentary), (2) exercise for 1 to 3 days (or less active), and (3) exercise for ≥4 days (or physically active) for ≥30 minutes/day during the prior week. Other categorical variables included as questions were (Yes or No): Do you think this child—“typically eats healthy meals,” “had academic problems at school” (mainly the grades), and “had behavioral problems at school” (including ≥1 fight during the past year, hurt him/herself, self-esteem problems, and other reported problems). The age groups were formed into 7 to 8, 9 to 10, 11 to 12, and 13 to 14 years of age. All data were obtained from the parents.

Statistics

A chi-square test contingency table was applied to examine the associations of healthy meals and physical activities with health status, BMI PCTs, academic problems, and behavioral problems. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated to quantify the differences. A logistic regression model was utilized for the estimation of ORs and CIs regarding the associations among 3 physical activity levels with health status, overweight-obese rate, academic problems, and behavioral problems. Also, a logistical regression fitting was analyzed to evaluate the influences (ie, independent variables) of (1) sex, (2) age, (3) health status, (4) BMI PCT, (5) physical activity levels, and
(6) healthy/unhealthy meals on predicting academic problems and behavioral problems among the children. SAS (version 9.1, Cary, NC) was applied for these analyses.

**RESULTS**

There were 83.0% (N = 3065) of the children 7 to 14 years old described as in very good/excellent health, 13.5% (N = 499) in good health, and 3.5% (N = 128) in poor-fair health. Among them, 30.2% (N = 1120) were overweight-obese and 80.6% (N = 2922) typically ate healthy meals. Children characterized as healthier eater were more likely to be physically active (OR: 2.08, p < .001) and less likely to be sedentary (OR: 0.32, p < .001) as compared with their less healthy eating peers (Figure 1). Of all children, 11.0% and 7.9% had academic problems and behavioral problems, respectively.

More children in the very good/excellent health group (86.1%) were physically active, as compared with those in the less active (74.6%) and sedentary groups (71.4%). The proportion of those who were overweight-obese was significantly lower in the physically active group (27.7%) than in the less active (37.6%) and sedentary groups (44.6%). Between the latter two groups, the proportion of children categorized as overweight-obese or in very good/excellent health was not statistically significant (Tables 1 and 2). Healthy meals were significantly associated with an improved health status (OR: 2.30, p < .001) and with reduced rate of overweight-obesity.

### Table 1. Associations of Physical Activities and Healthy Meals With Health, Weight, and Academic and Behavioral Problems

<table>
<thead>
<tr>
<th>Physical Activity Levels</th>
<th>Healthy Meals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Health status</td>
<td></td>
</tr>
<tr>
<td>Poor-fair and good</td>
<td>28.6%</td>
</tr>
<tr>
<td>N = 26</td>
<td>N = 198</td>
</tr>
<tr>
<td>Very good/excellent</td>
<td>71.4%</td>
</tr>
<tr>
<td>N = 65</td>
<td>N = 582</td>
</tr>
<tr>
<td>Weight problems</td>
<td></td>
</tr>
<tr>
<td>Normal weight</td>
<td>55.4%</td>
</tr>
<tr>
<td>N = 51</td>
<td>N = 488</td>
</tr>
<tr>
<td>Overweight-obese</td>
<td>44.6%</td>
</tr>
<tr>
<td>N = 41</td>
<td>N = 294</td>
</tr>
<tr>
<td>p value</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Academic problems</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>22.6%</td>
</tr>
<tr>
<td>N = 12</td>
<td>N = 45</td>
</tr>
<tr>
<td>No</td>
<td>77.4%</td>
</tr>
<tr>
<td>N = 42</td>
<td>N = 335</td>
</tr>
<tr>
<td>p value</td>
<td>.013</td>
</tr>
<tr>
<td>Behavioral problems</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>15.1%</td>
</tr>
<tr>
<td>N = 8</td>
<td>N = 46</td>
</tr>
<tr>
<td>No</td>
<td>84.9%</td>
</tr>
<tr>
<td>N = 45</td>
<td>N = 334</td>
</tr>
<tr>
<td>p value</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*Significant difference between ≥4 days and no exercise and between yes and no with healthy meals at p < .05.
†Significant difference between ≥4 days and 1 to 3 days at p < .05.
Overweight-obese rate was inversely related to health status (p < .001); only 23.4% of the children in very good/excellent health were overweight-obese.

Both physical activity and healthy meals were significantly associated with reduced academic and behavioral problems at school (Table 1). Sedentary children were associated with higher percentages of academic (22.6%, p < .005) and behavioral problems (15.1%, p < .023), as compared with physically active children. Children who typically took healthy meals were associated with fewer academic (9.8%, p < .001) and behavioral problems (6.9%, p < .001) as compared with less healthy eater. Not surprisingly, having academic problems and behavioral problems at school were significantly associated. Academic problems occurred in 51.0% of the children who had behavioral problems and 7.5% of the children who had no behavioral problems (OR: 12.88, 95% CI: 8.93 to 15.59, p < .001). The children’s academic problems were most significantly predicted by the health status (p < .001), followed by their sex (p = .003), age (p = .012), and healthy diets (p = .023), but not by the physical exercise levels (p = .245) or BMI PCTs (p = .539) in the logistic regression fitting. Their behavioral problems at school were most significantly predicted by the health status (p < .001), followed by their sex (p < .001), physical activities (p < .004), and diets (p = .004), but not by their age (p = .102) or BMI PCTs (p = .998) according to the logistic regression analysis.

More boys (33.9%) than girls (26.4%) were overweight-obese (OR: 1.43, 95% CI: 1.24 to 1.65, p < .001). However, there was no gender- or age-related difference in the health status between boys and girls. More boys than girls had academic (12.9% vs 8.6%, OR: 1.57, 95% CI: 1.16 to 2.13, p < .001) and behavioral problems (10.9% vs 5.2%, OR: 2.23, 95% CI: 1.55 to 3.20, p < .001).

Overall, 76.0% (N = 2774) of the children were physically active and only 2.5% (N = 92) were sedentary. However, as the groups aged, more children were classified as sedentary (p < .001) and fewer children (p < .001) were classified as physically active (Figure 2). The proportions of sedentary children (ie, no exercise) increased progressively across age groups from 1.3%, 1.6%, 2.5%, to 4.2%. The ORs for being sedentary (with 13 to 14 years as reference) increased from a low of 0.30 (95% CI: 0.15 to 0.59, p < .001) in years 7 to 8 to 0.37 (95% CI: 0.24 to 0.69, p < .002) in years 9 to 10 and 0.59 (95% CI: 0.36 to 0.97, p = .039) in years 10 to 11 group. Concurrently, the
proportions of the children who were physically active decreased from 80.6% (OR: 1.59, 95% CI: 1.27 to 1.99, p < .001), 74.4% (OR: 1.11, 95% CI: 0.91 to 1.37, p = .303), 77.9% (OR: 1.35, 95% CI: 1.11 to 1.66, p = .004), to 72.3%, respectively, as the age groups progressed from 7 to 8 years, 9 to 10 years, 11 to 12 years, to 13 to 14 years. Fewer girls than boys were physically active. The decline of physical activity levels associated with increasing age was greater in girls than boys (Figure 2).

There were 19.4% (N = 702) of the children who typically took less healthy meals, and within the cohort, this percentage increased proportionally across age groups (p < .001 based on Spearman correlation coefficient). Correspondingly, the ORs for taking healthy meals (as compared with 13 to 14 years) gradually declined across age groups: 1.66 (95% CI: 1.30 to 2.13, p < .001) in 7 to 8 years, 1.34 (95% CI: 1.07 to 1.68, p = .012) in 9 to 10 years, and 1.14 (95% CI: 0.92 to 1.41, p = .233) in 11 to 12 years group (Figure 3). There was no sex effect on these age-related trends (p = .218).

DISCUSSION

This study offers 2 novel findings. First, lifestyle behaviors such as physical activities and healthy diets are not only positively associated with children’s weight and health outcomes as intuitively expected, but they are also significantly associated with fewer academic and behavioral problems at school. Second, lifestyle behaviors in children are significantly interrelated such that more children appear to become sedentary and to take unhealthy meals as they progress from childhood into adolescence.

Association With Healthy/Unhealthy Meals

This study is the first to describe that unhealthy meals are statistically associated with the children’s academic problems and behavioral problems at school. The prevalence (Table 1) and the probability (Table 2) of having academic or behavioral problems were significantly lower in the children classified as healthier eaters. Furthermore, this effect was significantly associated with a decrease in the overweight-obese category from 35.5% to 29.1% (p < .001). Consistent with this trend, healthier eaters were more likely in very good/excellent health (86.0% vs 72.7%). The mechanism responsible for the association between healthy meals and fewer academic problems in children remains unknown. However, it is logical that healthy students should perform better academically and the clear association between healthy meals and better health (as predicted by the logistic regression analysis) may be key to improve school participation, performance and thus, to facilitate educational attainment.18

Children who took healthy meals were more likely to be physically active and less likely to be sedentary when compared with their counterparts who took less healthy meals (Figure 1). These data suggest that healthy lifestyle behaviors are positively interrelated, which could include other contributory factors such as self-esteem. Physical fitness and lower adiposity are associated with better academic performance in children.10,11 The interactions observed in this study between healthy lifestyle behaviors, such as physical activity and healthy meals, and school performance may represent an underappreciated benefit.

Association With Physical Activities

Academic performance in children has been negatively linked with higher adiposity and lower physical fitness.10,11 The current analyses confirm prior reports (Table 1) and suggest that the beneficial academic and behavioral influences are interdependent and reinforced by the lifestyle behaviors. The incidence of academic and behavioral problems in sedentary children was 10% to 12% higher than that in their physically active peers. In addition to its direct health benefit, a physically active lifestyle has a positive effect on children’s self-esteem and health risk behaviors.6,19 More frequent physical activity may also reinforce desirable behavioral consequences by redirecting the excess energy of youth. These positive interactive influences could explain the relationship between physical activity and both reduced academic and behavioral problems in children.
The percentage of children in very good/excellent health was 86.1% in the physically active group, which was significantly reduced to 74.6% in the less active group and 71.4% in the sedentary group. The proportion of overweight-obese children was significantly increased from 27.7% in the physically active group to 37.6% in the less active group and 44.5% in the sedentary group. Although any physical activity should be beneficial, the differences between the sedentary and less active groups were not statistically significant. Thus, additional work is required to determine whether there is a threshold or optimal dose-response effect. Currently, the analyses indicate that ≥30 minutes of physical activity daily for ≥4 days/week may be optimal. Despite this uncertainty, the combined strategy of healthy dietary choices and physical activity should logically lower caloric intake, increase energy expenditure and thus, effectively stem the increasing prevalence of overweight-obesity in children.

Interrelation of Lifestyle Behaviors

These data suggest that in childhood, healthy lifestyle behaviors are intimately interrelated and these factors significantly influence academic-behavioral problems at school. Older children were increasingly likely to be sedentary and to be unhealthy eater (Figures 2 and 3). This may simply be the result of greater autonomy in those choices, but it is an undesirable trend based on the analyses. Although age was a significant influence on increasing academic problems \( p = .012 \) this was not true for behavioral problems \( p = .101 \). The apparent parallelism between taking unhealthy meals and sedentary lifestyle suggests that unhealthy lifestyle behaviors were also significantly interrelated. Healthy/unhealthy meals were predictive of both academic \( p = .023 \) and behavioral \( p = .004 \) problems at school, whereas physical exercise levels were only statistically predictive of behavioral problems \( p < .004 \). Children classified as overweight-obese were more often sedentary and classified less healthy, which might be compounded further by taking unhealthy meals. Despite this presumption, the present analyses indicate that the children’s health status, not BMI PCTs, had the most significant contributory impact on their academic-behavioral problems at school.

Limitations

This cross-sectional study is based on statistical associations, which should not be interpreted as cause-effect relationships. Although the surveyed households were randomly selected, a respondent bias may have possibly existed that could have skewed the results. More affluent, better educated and health conscious parents may have been more likely to participate, and thus, bias the sample in favor of healthier, more academically successful children. There is always a potential for bias when the data are subjective estimates obtained from interested parties (ie, parents). Also, the study does not address the race/ethnicity and socioeconomic factors and all of them have been known to affect the children’s health, lifestyles, and academic problems.

Conclusions

Our analyses provide insights into the beneficial effects of healthy meals and physical activity on the children’s health and school success. Children who typically take healthy meals are more physically active, less sedentary, and not surprisingly in better health. These healthy lifestyle behaviors are also associated with better health status and fewer academic-behavioral problems at school. Despite the obvious benefits enumerated, more children tend to take unhealthy meals and adopt a sedentary lifestyle as they progress across age groups from 7 to 8 to 13 to 14 years and presumably have more say in those choices. Thus, health education and preventive interventions to encourage healthy lifestyle behaviors should begin early and be reinforced often.

Implications for School Health

Healthy lifestyle behaviors such as physical activities and healthy diets are significantly associated with reduced body weight and improved health status of children. Furthermore, children who are physically active and take healthy meals show reduced academic problems and behavioral problems at school. The implication derived from this observation strongly supports the notion that healthy children may be more positively and energetically involved in school participation and academic performance and less likely associated with behavioral problems. Health matters for children’s success at school. Healthy lifestyle behaviors, interacted with health status, are synergistically associated with a reduced risk of having academic-behavioral problems in children.

A majority of children in north Texas area are physically active (76%) and typically take healthy meals (81%), which seem to be consistent with the proportion of children in very good/excellent health (83%). Nonetheless, nearly 1 of 3 children is overweight-obese (30%). Healthy (or unhealthy) lifestyle behaviors, such as physical activities and dietary behaviors, are closely interrelated and reciprocally reinforced one another. Children who are physically active are more likely to take healthy meals and to have very good/excellent health, and vice versa. As a point of concern, children increasingly become sedentary and have unhealthy diets during the transition from childhood (7 to 8 years old) to young adolescence (13 years old).
to 14 years old). This trend is likely related to have increased autonomic or independent choices made by children themselves. This observation or implication appears to correlate with a national trend of childhood obesity pandemic. Thus, nurturing children with healthy lifestyle behaviors and stemming the vicious spirals between unhealthy habits and poor health status should start in early childhood before the advent of adolescent social and behavioral influences.

Human Subjects Approval Statement
This study was deemed exempt by the institutional review board at the University of North Texas Health Science Center.

REFERENCES