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Fruit and Vegetable Intake and Dietary Patterns of Preadolescents Attending Schools in the Midwest

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ABSTRACT

Objectives
The present study examined dietary intake of fruit and vegetables and dietary patterns of preadolescents attending schools in the Midwest.

Methods
A total of 506 students (11.2±1.3 years) from four public and private schools in Nebraska completed a validated 41-item Food Frequency Questionnaire to assess their dietary intake. Cluster analysis was used to cluster participants into low and high fruit and vegetable intake groups based on their responses to survey items associated with fruit and vegetable intake.

Results
The majority of the students (>50%) reported that their intake of each of the fruit and vegetable categories was less than three days a week. Males had significantly lower intake of most of the fruit and vegetable categories and whole grains compared to females ($p<0.05$). Students with higher fruit and vegetable intake also had higher intake of dairy, whole grains, and protein foods as well as higher intake of low nutritional quality foods compared to those with low fruit and vegetable intake ($p<0.05$). No significant difference was found in dietary intake of sugar sweetened foods between high and low fruit and vegetable intake groups ($p=0.50$).

Applications to Child Nutrition Professionals
Continued nutrition education and implementation of school nutrition policies to create a healthy food and nutrition environment in the school and at home are important for healthy eating among Midwestern children.

Keywords: preadolescents; fruit; vegetables; dietary patterns; healthy-eating; school nutrition

INTRODUCTION

The Dietary Guidelines for Americans 2010 recommend that children and adolescents consume more fruits, vegetables, whole grains, lean protein, and low-fat dairy products (U.S. Department of Agriculture [USDA] & U.S. Department of Health & Human Services [USDHHS], 2010). These foods, especially fruits and vegetables, are seen as important components of a healthy diet. However, today's youths do not meet these dietary recommendations (Kimmons, Gillespie, Seymour, Serdula, & Blanck, 2009). This raises serious public health concerns due to the evidence associating poor diet qualities with childhood and adolescent obesity and consequently increased risk of chronic diseases such as cardiovascular diseases and type 2 diabetes (Canete, Gil-Campos, Aguilera, & Gil, 2007). Despite many efforts made to reduce excessive energy intakes, particularly from foods and beverages that provide empty calories from fats and added sugars, research showed that approximately 40% of energy consumed by children and

adolescents are high fat and sugary foods, such as sugar sweetened beverages, fruit drinks, dairy and grain desserts, pizza, and whole milk (Reedy & Krebs-Smith, 2010).

Dietary habits, which affect food preference, energy consumption, and nutrient intake are generally developed in early childhood and particularly during adolescence (Savage, Mitchell, Smiciklas-Wright, Symons Downs, & Birch, 2008). Assessing current dietary intake among preadolescents is critical since this age group is starting to make their own food choices, as well as forming eating habits that may last through adolescence and into adulthood. Understanding the dietary intakes of preadolescents is necessary to identify problems and provide recommendations to school officials and local and federal policy makers to improve nutrition among students. A recent report stated that the majority of Nebraska students do not ingest the appropriate amount of fruits and vegetables on a daily basis (Nebraska Department of Education [NDE] & Nebraska Department of Health & Human Services [NDHHS], 2013). However, dietary patterns which take into account the overall diet, instead of individual nutrients, due to the complex effect of dietary intakes on the human body (Ambrosini et al., 2009; Hu, 2002; Newby, 2007; Schulze & Hoffmann, 2006) have not been assessed among the students attending public and private schools in the Midwest. Thus, the objectives of the current study were: 1) to assess dietary fruit and vegetable intakes and dietary patterns among preadolescents attending schools in the Midwest; and 2) to compare dietary intake between male and female preadolescent students.

METHODOLOGY

Survey Instrument

The 41-item 2007 Block Food Screener (BFS) for ages 2-17 years (Choumenkovitch et al., 2013; NutritionQuest, 2013) and an additional demographic survey were used in the study. This validated screener (BFS) assesses the frequency of intake of the food items/groups over a 7-day time period (how many days last week) and portion sizes/servings in one day (how much in one day). It was developed and adapted from the validated Block Kids 2004 Food Frequency Questionnaire, an 80-item questionnaire designed to assess food and nutrient intake in children ages 2-17 years (Cullen, Watson, & Zakeri, 2008). The food groups that the screener captured were whole grains, fruits, vegetables, potatoes, dairy, protein foods (meat, poultry, fish and legumes), high fat foods, and sweetened foods with added sugar. The food list for this screener was created by identifying the most important sources of each of the aforementioned food groups in children aged 2-17 years, as determined by data from the National Health and Nutrition Examination Surveys 2001-2002 and 2003-2004 (Choumenkovitch et al., 2013; NutritionQuest, 2013). Food groups and portion sizes were selected for six age-and sex-specific categories. BFS has been used in studies to assess food group intake in children and adolescents with various ages (Choumenkovitch et al., 2013; Davis, Ventura, Cook, Gyllenhammer, & Gatto, 2011; Garcia-Dominic et al., 2012; Murashima, Hoerr, Hughes, & Kaplowitz, 2011).

For each item in the survey, participants chose how many days in the previous week they consumed the foods indicated in the item (e.g., none, 1 day, 2 days, 3-4 days, 5-6 days, or every day last week). The survey also included two questions of what types of cereal (e.g., name brands of sweetened and unsweetened cereal) or milk (e.g., skim, 1%, 2%, whole, chocolate, soy, etc.) that the children would consume the most. The responses to the items (except for the two questions asking for what type of cereal or what type of milk) were scored from 0-5, representing 0, 1, 2, 3-4, 5-6, and 7 days/week, respectively. Data regarding the frequency of intake was used

in the study since only approximately 20% of the participants completed the section regarding portion size/servings.

Participants and Data Collection

A total of 506 preadolescents aged 8 to 14 years from four public and private schools in Lincoln and Plattsmouth, Nebraska participated in the study. The schools were selected using convenience sampling. Schools in Lincoln and Plattsmouth were approached and four agreed to participate. Each participant completed the 41-item 2007 Block Food Screener (BFS) for ages 2-17 years (Choumenkovitch et al., 2013; NutritionQuest, 2013) and an additional demographic survey in their regular classroom settings from September to December 2014, with the assistance of the researchers. Parental consent was given before the data collection. The study was approved by the University of Nebraska-Lincoln Institutional Review Board.

Data Analyses

Food items in the survey were categorized into the following food groups and subgroups: Fruit (not including 100% fruit juice), 100% fruit juice, vegetables (including potatoes), dairy (milk, cheese), whole grain, enriched grain, protein foods (eggs, beef, chicken, pork, fish, legumes), high-fat foods (e.g., hot dogs, corn dogs or sausage, snack chips like potato chips, Doritos, Fritos, tortilla chips, and French fries), and sugar sweetened foods (e.g., candy, ice cream, cookies, sugar sweetened beverages) according to the Dietary Guidelines for Americans (USDA & USDHHS, 2010). Hot dogs, corn dogs, or sausages could be considered as protein foods; however, these items were characterized as high-fat foods due to their relatively high fat content. Scores for each food group and subgroup were summarized. Differences in scores of food items and summary scores of food groups and subgroups between male and female participants were assessed using t-tests. Differences between males and females in nominal variables such as race, type of milk or cereal consumed were compared using Chi-square tests.

Cluster analysis was used to categorize participants into groups in a way that participants in the same group were more similar to each other in certain characteristics (e.g., fruit and vegetable consumption) than those in the other group. The high and low fruit and vegetable intake (F&V) groups were defined based on participants' responses to the ten survey items related to fruit and vegetable consumption (not including dietary intake of 100% fruit juice). Participants who scored high on these items were clustered into the high F&V group. The low F&V group included participants with lower scores on the fruit and vegetable associated items. Mean scores on dietary intake of main food groups and subgroups between high and low F&V groups were compared using t-tests. The analyses were repeated after the adjustment for sex and age. SAS software version 9.3 (SAS Institute, Inc., Cary, NC) was used to perform all statistical analyses with a two-sided p value of <0.05 considered statistically significant.

RESULTS AND DISCUSSION

All students (n=506) completed the BFS and demographic survey, which took about 20-30 minutes. The mean age of the participants was 11.21 ± 1.29 years. Approximately 53.8% were males, and 46.3% were females, with the majority being Caucasian (80.0%). Hispanic or Latino students made up 3.8% of the sample; however, about 17.1 % of students reported that they did not know whether they were Hispanic/Latino. Although the percentage of Caucasian students in the study was higher than the overall proportion of Caucasian students attending schools in Nebraska (68.9%) (NDE, 2015), the racial/ethnicity distribution in the current study still reflects

the overall distribution in the state where a majority of school-age children are Caucasian. The percentage of students receiving free and reduced price school meals for the four participating schools ranged from 7.0 % to 43.4% (NDE, 2015).

Dietary Intake Between Male and Female Students

Female students had significantly higher intake scores of whole grain (p = 0.008), vegetables (p =0.0004), and fruits (p = 0.0004) compared to male participants. Relative to male preadolescents, females also had significantly higher intake scores of all vegetable categories (p<0.05) except for green beans or peas and soup or stew with vegetables. Significant differences in type of milk consumed between male and female participants were also observed in the current study, with females consuming more non-fat or 1% fat milk and whole milk, while males consumed more 2% milk. In addition, greater than two-thirds (67.9%) of the participants reported that sugar sweetened cereals were the type that they ate the most with no significant differences (p = 0.11) observed between males and females. Furthermore, no differences were found in consumption of protein foods, high-fat foods, and sugar sweetened foods between male and female students in the study (Table 1). The results did not change materially after adjusting for age.

The current results indicated that females consumed more whole grains, non-fat or 1% milk, all types of vegetables and fruits and 100% fruit juice compared to males. A study by Ambrosini et al. (2009) also reported that a "healthy pattern" which was characterized by high intakes of fresh fruits, various vegetables, legumes and whole grain was positively associated with female gender. The underlying mechanism for the gender difference in fruit and vegetable intake has not yet been elucidated; however, research suggest that this gender difference may be explained by the fact that sociocultural pressures for thinness are greater for females than males (Stice, Shaw, & Marti, 2006). In support, Thompson, Heinberg, Altabe, and Tantleff-Dunn (1999) reported that more females than males were dissatisfied with their bodies and felt they were overweight. Additionally, there was no gender difference in intake of protein foods, although a previous study demonstrated that boys typically consumed more protein foods than girls (Hiza, Casavale, Guenther, & Davis, 2013).

Intake of Sugary Foods

Encouragingly, the current study observed that consumption of all categories of sugary foods including sugar sweetened beverages was on average less than 2 days a week (Table 1). The decrease in the consumption of sugary foods and beverages could be in part due to implementation of federal nutrition policies. For example, as part of the Child Nutrition and WIC Reauthorization Act of 2004, schools participating in federally reimbursable meal programs were required to develop school wellness policies (Fox, Dodd, Wilson, & Gleason, 2009). Most recently, the Healthy, Hunger Free Kids Act of 2010 mandated the "Nutrition Standards for All Foods Sold in Schools" that target food items sold outside of school meal programs, including ala carte, vending machines, or school snack bars. These guidelines increase whole-grain rich products, fruits, vegetables, dairy foods, and protein foods and limit the allowed number of calories, sodium, fat, and sugar in both snack and entrée items, resulting in elimination of items which contribute significantly to empty calories (USDA, 2014). However, nutrition educators and policy makers should also be aware that the majority of students in the current study (67.9%) reported that sugar sweetened cereals were the type that they ate the most.

Table 1. ***Student Demographic Characteristics and Dietary Intake Scores by Sex***

Variables	**All** (N=506)	**Males** (n=272)	**Females** (n=234)	***p* value**[a]
Demographic Characteristics				
Age (*M* ± *SD*)	11.21±1.29	11.27 ± 1.55	11.07 ± 1.21	0.097
Race	**%**	**%**	**%**	0.775
Caucasian	79.96	78.60	81.55	
American Indian	2.18	1.85	2.58	
Asian	2.38	2.95	1.72	
African American	2.78	3.32	2.15	
Native Hawaiian/Pacific Islander	0.79	0.74	0.86	
Other, not listed	7.34	8.49	6.01	
I don't know	4.56	4.06	5.15	
Hispanic/Latino				0.908
Yes	3.78	3.70	3.86	
No	79.13	78.52	79.83	
I don't know	17.10	17.18	16.31	
Dietary Intake Scores				
Food Group	***M* ± *SD***	***M* ± *SD***	***M* ± *SD***	***M* ± *SD***
Whole grains[b]	2.87 ± 2.42	2.60 ± 2.39	3.18 ± 2.44	0.008
Dairy[b]	5.12 ± 2.48	5.11 ± 2.50	5.14 ± 2.48	0.922
Vegetables				
Corn, carrots, greens, and broccoli	2.31 ± 1.52	2.12 ± 1.59	2.55 ± 1.50	0.001
Tomatoes	0.65 ± 1.17	0.58 ± 1.14	0.72 ± 1.16	0.041
Potatoes (mashed or boiled)	1.00 ± 1.13	0.91 ± 1.09	1.13 ± 1.17	0.020
Lettuce salad	1.19 ± 1.47	1.00 ± 1.45	1.42 ± 1.46	<0.0001
Green beans or peas	1.04 ± 1.22	0.97 ± 1.17	1.13 ± 1.27	0.235
Soup or stew with vegetables	0.71 ± 1.11	0.69 ± 1.10	0.73 ± 1.12	0.685
Total vegetables[b]	6.92 ± 4.62	6.23 ± 4.64	7.74 ± 4.50	0.0004
Fruit				
Fruit[b]	5.69 ± 3.49	5.16 ± 3.47	6.27 ± 3.42	0.0004
100% fruit juice	1.90 ± 1.67	1.89 ± 1.69	1.91 ± 1.65	0.809
Total fruit and fruit juice[b]	7.59 ± 4.31	7.04 ± 4.31	8.24 ± 4.20	0.001

Protein foods				
Egg	1.17 ± 1.29	1.14 ± 1.30	1.21 ± 1.28	0.388
Beef[b]	2.45 ± 2.17	2.48 ± 2.23	2.40 ± 2.11	0.933
Chicken	1.53 ± 1.16	1.57 ± 1.22	1.49 ± 1.08	0.737
Pork	0.63 ± 0.98	0.65 ± 0.98	0.61 ± 0.98	0.636
Fish	0.46 ± 0.93	0.44 ± 0.89	0.50 ± 0.98	0.713
Beans	0.93 ± 1.44	0.95 ± 1.51	0.89 ± 1.37	0.920
Total protein[b]	7.11 ± 5.15	7.13 ± 5.30	7.08 ± 5.01	0.806
High-fat foods				
French fries, tater tots, etc.	1.29 ± 1.24	1.34 ± 1.34	1.23 ± 1.13	0.794
Hot dogs, corn dogs & sausage	0.99 ± 1.03	1.02 ± 1.01	0.95 ± 1.06	0.259
Snack chips	1.72 ± 1.38	1.70 ± 1.41	1.74 ± 1.32	0.513
Total high-fat foods[b]	5.25 ± 3.15	4.01 ± 2.61	3.54 ± 2.28	0.696
Sweetened foods				
Sugary beverage (soda, etc.)	1.66 ± 1.50	1.75 ± 1.56	1.53 ± 1.42	0.154
Ice cream	1.32 ± 1.30	1.29 ± 1.33	1.33 ± 1.27	0.492
Candy	1.21 ± 1.29	1.26 ± 1.36	1.17 ± 1.17	0.702
Cookies, cakes, brownies	1.15 ± 1.17	1.13 ± 1.17	1.17 ± 1.22	0.691
Total sweetened foods[b]	5.29 ± 3.45	5.41 ± 3.58	5.14 ± 3.28	0.471
Pizza or pizza pockets	1.26 ± 1.17	1.32 ± 1.24	1.20 ± 1.07	0.491
Type of milk drunk the most	**%**	**%**	**%**	0.019
Non-fat /1%	33.19	31.13	35.78	
2%	25.63	26.46	24.31	
Whole	11.76	10.89	12.84	
Other types	29.42	31.52	27.07	
Type of cereal eaten the most	**%**	**%**	**%**	0.112
Unsweetened	15.38	14.34	16.18	
Sweetened	67.88	71.73	63.73	
Other types	16.75	13.92	20.10	

Note: The items (except for the summary scores) were scored from 0 to 5, representing 0, 1, 2, 3-4, 5-6, and 7 days/week, respectively; data are presented as mean ± SD or otherwise indicated.
[a] P values for differences between male and female participants using t test or Chi-square test (for categorical variables).
[b] Summary scores were used.

Intake of Fruit and Vegetables

Table 2 shows the dietary intake of fruit and vegetable items/groups among study participants. The frequency of participants' fruit and vegetable intake was categorized as "Never (0 day/week)", "Rare (1-2 days/week)", "Sometimes (3-4 days/week)", and "Frequently (≥5 days/week)". More than 50% of the participants reported that they had apples, bananas, oranges, or other fruits like strawberries and grapes less than 3 days in the previous week. For vegetables, the least consumed were tomatoes (8.9% had ≥ 3 days/last week), potatoes (mashed or boiled, not including French fries, 10.8% had ≥ 3 days/last week), and green beans or peas (12.9% had ≥ 3 days/last week). In addition 57.7% of the participants reported that they had corn, carrots, greens or broccoli no more than 2 days in the previous week.

Table 2. ***Frequency of Dietary Intake of Fruit and Vegetable Items/Groups among Student Participants (N=506)***

	Dietary Intake Frequency (Days/Week) Percent of Total Participants			
	Never (0 Days)	**Rare** (1-2 Days)	**Sometimes** (3-4 Days)	**Frequently** (≥ 5 Days)
Fruit				
Apple, Banana, Orange	15.23	38.08	19.24	27.45
Applesauce, Fruit Cocktail	54.28	30.54	6.79	8.38
Fruit like Strawberries, Grapes	21.77	34.68	17.34	26.23
100% Fruit Juice	28.20	37.40	15.60	18.80
Vegetables				
Corn, Carrots, Greens, Broccoli	12.90	44.75	20.16	22.18
Tomatoes	67.81	23.34	4.83	4.02
Potatoes (mashed or boiled)	43.09	46.10	7.82	3.00
Lettuce Salad	46.56	32.99	10.93	9.51
Green Beans or Peas	44.78	42.37	8.43	4.42

These results suggest that fruit and vegetable intake among the students was relatively low, with the majority reporting less than 3 days per week in terms of consuming each of the surveyed fruit and vegetable categories. The vegetables that participants most frequently consumed included corn, greens, carrots and broccoli; however, still only 42.3% (less than half) of the participants reported that they ate these vegetables greater than 2 days a week. The average intake of these vegetables (corn, greens, carrots, and broccoli) was 2.31±1.52 days during the previous week. Therefore, strategic interventions are needed to increase fruit and vegetable intake among preadolescents attending public or private schools in this region.

Dietary Patterns

To examine the dietary patterns, participants were clustered into high and low F&V groups based on their responses to the items regarding fruit and vegetable intake in the survey. Participants

who scored high on these items were clustered into the high F&V group, and those who scored low were placed in the low F&V group. The high F&V group had a significantly higher intake of protein foods (summary scores of beef, chicken, pork, fish, and beans), whole grains (summary scores of whole wheat bread or rolls and oatmeal), and dairy foods (summary scores of milk and cheese) relative to low F&V group (p <0.0001). On the other hand, greater consumption of high-fat foods (summary scores of hot dogs, corn dogs or sausages, snack chips, French fries) (p <0.0001) and some fast foods such as hamburgers/cheeseburgers (p <0.0001), and pizza/pizza pockets (p =0.009) were also observed in the high F&V group as compared to low F&V group.

Table 3. ***Dietary Intake Scores of Student Participants with High and Low Fruit and Vegetable Intake (N=506)***

Variables	**High F&V**[a] (n = 233)	**Low F&V**[a] (n = 236)	***p* value**[b]
Age (*M + SD*)	11.16 ± 1.20	11.18 ± 1.58	0.90
Sex	**%**	**%**	<0.0001
Male	44.59	63.24	
Female	55.41	36.75	
Dietary Intake Scores	***M* ± *SD***	***M* ± *SD***	
Total fruit[c]	8.07 ± 2.61	3.33 ± 2.49	<0.0001
100% fruit juice	2.55 ± 1.61	1.21 ± 1.40	<0.0001
Total vegetables[c]	9.44 ± 4.78	4.42 ± 2.68	<0.0001
Total whole grain foods[c]	3.41 ± 2.17	2.31 ± 2.17	<0.0001
Total enriched grain foods[c]	2.81 ± 1.98	2.31 ± 1.94	0.004
Total dairy foods[c]	5.64 ± 2.48	4.66 ± 2.42	<0.0001
Total protein foods[c]	8.79 ± 6.00	5.56 ± 3.69	<0.0001
Total high-fat foods[c]	4.50 ± 2.61	3.54 ± 2.28	<0.0001
Total sugar sweetened foods[c]	5.34 ± 3.45	5.12 ± 3.29	0.504
Sugary beverage (soda, etc.)	1.70 ± 1.48	1.57 ± 1.49	0.252
Fast foods			
Hamburgers, cheese burgers	1.17 ± 1.14	0.80 ± 0.91	<0.0001
Hot dogs, corn dogs, sausages	1.14 ± 1.31	0.86 ± 0.95	0.004
Pizza or pizza pocket	1.38 ± 1.16	1.15 ± 1.17	0.009

Note: The survey items (except for the summary scores) were scored from 0 to 5, representing 0, 1, 2, 3-4, 5-6, and 7 days/week, respectively; data are presented as mean ± SD or otherwise indicated.

[a] Cluster analysis was used to cluster participants into groups based on their responses to the items related to fruit and vegetable consumption. Participants who scored high on the fruit and vegetable related items were clustered into the high fruit and vegetable intake (F&V) group. The low F&V group included participants with low scores on fruit and vegetable intake related items.

[b] P values for differences between high and low F & V groups using t test or Chi-square test (for sex).

[c] Summary scores were used.

No significant differences in intake of sugar sweetened foods (p =0.50) and sugary beverages (p =0.25) were observed between the two groups. The intake of 100% fruit juice ($p < 0.0001$) was higher in the high F&V group compared to low F&V group (Table 3). Although there were more females in the high F&V group than males, results remained statistically significant after the adjustment for sex and age.

Examining dietary patterns of preadolescents attending public and private schools is important for developing nutrition interventions targeting the improvement of quality of dietary intake in this population. A healthy food pattern is characterized by high intake of fruits, vegetables, low-fat dairy, whole grains and a low intake of sugar sweetened foods (Ambrosini et al., 2009; Ritchie et al., 2007). As expected, in the current study students who consumed more fruit and vegetables also ate more foods with higher nutritional qualities, such as whole grains, dairy, and protein foods.

Similar findings were reported previously. For example, Grieger, Scott, and Cobiac (2012) examined food consumption and dietary patterns in 1,114 Australian girls aged 9-16 years and reported that girls identified in the meat and vegetable cluster, on average, consumed more lean red meat, vegetables, fruits, and low-fat dairy products and had a higher intake of many nutrients. Interestingly, the current results also suggest that intakes of high-fat foods such as snack chips, hot dogs, corn dogs, sausages, and French fries and fast foods like hamburgers, cheeseburgers, pizza, or pizza pockets were also higher among those with higher fruit and vegetable consumption, and no differences were observed in sugar sweetened food intake between the two groups. These findings suggest that predicting whether preadolescents have a healthy dietary pattern may not be solely based upon their fruit and vegetable intake levels since the current results indicate that higher fruit and vegetable consumption was also associated with increased intake of high-fat foods and the consumption of sugar sweetened foods was independent of the levels of fruit and vegetable ingestion.

The daily or weekly total caloric intake was not assessed in the study since there was a limited number of participants (20%) who completed the portion size/servings section of the survey. It is possible that the current results may be confounded by the total caloric intake, that is individuals with higher daily or weekly caloric intake may have consumed more fruit and vegetables, whole grains, protein foods, dairy products, as well as high-fat foods and some fast foods compared to those with lower total daily or weekly energy consumption. However, the influence of total caloric intake may not be relevant due to the following facts: 1) More females in the high F&V group than males (55.4% vs. 44.6%) and in general males consume higher amount of total daily energy than females; and 2) Sugar sweetened food intake was not different between high and low F&V groups.

CONCLUSIONS AND APPLICATION

In conclusion, the current results indicate that preadolescents attending public and private schools in the Midwestern area who had higher fruit and vegetable consumption also had higher intake of not only foods with better nutritional qualities but also unhealthy foods such as foods with high fat content, as well as fast foods like hamburgers, cheeseburgers, pizza, and pizza pockets. They also had similar intake of sugar sweetened foods compared to those with low fruit

and vegetable intake. Despite the decreased intake of sugar sweetened foods, low intake of various fruit and vegetables was also observed in the current study. In addition, this study is the first study which examined dietary patterns of Midwestern preadolescents attending public and private schools. The current findings are valuable for direct interventions to improve diet quality of students in the area.

Limitations of the Study

There are several limitations of the current study. Since the sample was drawn from public and private schools in Lincoln (Nebraska) and surrounding areas, the current findings may not completely represent the entire preadolescent population attending schools in Nebraska and the Midwestern region. However, the majority of the participants were Caucasian, and the current study population varied in socio-economic status with a range of 7.0% to 43.4% of the students receiving free or reduced price school meals among the four participating schools. Therefore, demographics would be similar between the current study participants and the preadolescents attending schools in the region. Dietary intake was assessed using a food screener in the current study, and a more detailed food frequency questionnaire may help to understand participants' dietary habits in greater depth. However, this screener has been used in various studies in younger children and in youth of similar age to the participants in the current study (Choumenkovitch et al., 2013; Davis et al., 2011; Garcia-Dominic et al., 2012).

School Environment

One main area for intervention to improve children's dietary habits is the school environment. With children spending approximately one-third of their day in school, there is great potential for either the prevention or development of childhood obesity. Considerable efforts have been made to improve the nutrition environment of the schools recently. The U.S. Department of Agriculture's Fresh Fruit and Vegetable Program provides fruits and vegetables during the school through a yearly benefit of $50-$75 per student for qualifying schools based on income (USDA, 2015). Additionally, the Healthy, Hunger-Free Kids Act mandates that schools implement guidelines aimed at increasing the amount of dietary fruits, vegetables, dairy, protein, and nutrients of health benefits in school meals, while also decreasing the overall calories, total fat, saturated fat, sugar, and sodium in those meals (USDA, 2010). Furthermore, the National School Lunch and School Breakfast Programs increase access to dairy by offering milk at both meals and provide an opportunity for students to have daily breakfast (USDA, 2014).

While the current study observed decreased intake of sugar sweetened foods and beverages, the results also suggest that dietary intake of various fruit and vegetables were low among students attending schools in this region. Although the federal and local nutrition policies which mandate schools to limit students' access to unhealthy foods such as sugary snacks and beverages appear effective, the question remains: How to motivate students to increase their fruit and vegetable intake and eat a wide variety of these foods? Strategic changes of the school dining environment could be a possible solution. For example, the Smarter Lunchroom Movement, which uses strategies including moving and highlighting nutritious food groups, naming and displaying vegetables with catchy titles, highlighting healthy entrées on the lunch line, and implementing lines of healthy choices, has been documented as a best practice for increasing student consumption of healthy foods and promoting healthy eating behaviors via changes in the lunchroom environment (Smarter Lunchrooms Movement, 2015).

Engaging Family and Peer Network

Another important finding in the study is that even students with higher fruit and vegetable intake also consumed more foods with low nutritional qualities such as high-fat foods and fast foods, suggesting healthy and unhealthy dietary patterns coexisted among preadolescent students in this area. This also suggests that in addition to improving the school nutrition environment, creating a healthy food environment outside schools by educating parents to increase the choices of home healthy foods, limit the access to unhealthy foods, increase the frequency and quality of family meals and change the habits of eating fast foods regularly is equally important. Additionally, the involvement of preadolescents' peer networks in prevention and intervention efforts is also critical for promoting and maintaining positive eating behaviors among the youth.

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