I, Amy E. Reed, hereby submit this work as part of the requirements for the degree of:
Master of Science in Nutrition Sciences
in:
Department of Nutrition Sciences in the College of Allied Health Sciences
It is entitled:
The Relationship Between Different Types of Dietary Variety and Body Mass Index (BMI) at Different Time Intervals.

This work and its defense approved by:
Chair: Grace Falciglia
Sarah Couch
The Relationship Between Different Types of Dietary Variety and Body Mass Index (BMI) at Different Time Intervals

Amy E. Reed

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Previous Degrees Granted: Bachelor of Science in Health and Sport Studies, Miami University, 1997

Degree to be Conferred: Masters of Science in Nutrition Science, Department of Nutrition Sciences

College of Allied Health Sciences

Committee Members:
Grace Falciglia, RD, PhD
Sarah Couch, RD, PhD
Abstract

The purpose of this study was to examine the relationship between dietary variety and Body Mass Index (BMI) at different time intervals. Data was collected from 54, 4th and 5th graders. Subjects completed 15 consecutive 24-hour recalls and had their weight and height measured to calculate BMI and classify subjects as overweight or normal weight. The recalls were analyzed at 3, 7, and 15 days for 3 types of variety: 1) All sources variety (ASV), including the entire Food Guide Pyramid; 2) Grain, Fruit, Vegetable, Dairy, and Meat variety (GFVDM); and 3) Grain, Fruit, and Vegetable variety (GFV). The study findings suggest: 1) variety increased with time; 2) higher variety of ASV and GFVDM is associated with higher BMI; and 3) the positive relationship between ASV and GFVDM to BMI was seen at 3 days suggesting 15 days may not be necessary to see an association with a health outcome.
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The Relationship between different types of dietary variety and Body Mass Index (BMI) at different time intervals

The incidence of childhood obesity is increasing. The most recent National Health and Nutrition Examination Survey (NHANES) found that 16 percent of children and teens ages 6-19 are overweight, which is an increase from the previous survey where the rate was 11 percent (Prevalence, 2004). Diet quality is one environmental factor that contributes to obesity, especially consumption of excessive calories (Birch & Fisher, 1998). Dietary variety is one aspect of diet quality.

The Dietary Guidelines for Americans were designed to promote healthy food choices for Americans. Prior to the most recent revision of the Dietary Guidelines the recommendation was made for Americans to consume a variety of foods. Although the meaning of this recommendation was clear to trained professionals, the guidelines were confusing to the public (Keenan & Abusabha, 2001). The recommendation to consume a variety of foods was made to encourage people to eat from all food groups, but to some Americans, variety may mean different forms of the same food (Keenan & Abusabha, 2001). In today’s society this interpretation can lead to consumption of a variety of high calorie, commercial foods, which have led some researchers to hypothesize that greater dietary variety leads to increased body weight (McCrory et al., 1999). As more research surfaces concerning the types of foods that promote health, the 2000 Dietary Guidelines for Americans encourage the public to consume a variety of grains, with an emphasis on whole grains, and a variety of fruits and vegetables.

Definition of Dietary Variety

There are many ways to define and measure food variety. Overall dietary variety is the number of different foods consumed, regardless of food group (Krebs-Smith et. al.,
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1987; Smiciklas-Wright et al., 1986). When assessing overall variety, all foods are counted, including those containing little nutrient value (e.g. candy, soda pop, and cookies). Variety among food groups is defined as a representation of foods from the different major food groups within the diet (Krebs-Smith et al., 1987; Smiciklas-Wright et al., 1986). Some research has looked at variety in terms of satisfaction of the senses including the need to consume varying textures and consistencies (Rayno & Epstein, 2001). In addition, various methods of food preparation have been recommended to be included in the definition of dietary variety (Smiciklas-Wright et. al., 1986).

**How To Measure Dietary Variety**

Dietary variety can be calculated in many ways. Two variety measures were developed, using the general food groups, to assess the dietary variety of diet recalls of NHANES II participants. The first method was to compare variety to the food group recommendations by assigning 1 point for a 24-hour recall showing at least one serving from each food group, with a maximum score of 5, excluding the fats and sweets group. The five groups included in the scoring were dairy, meat, grain, fruit, and vegetable. This is also referred to as the Dietary Diversity (DD) Score (Kant et. al. 1993; Kant et. al., 1991). A second method was used to examine the diet recalls related to the recommendations for servings of the grain, fruit, vegetable, dairy, and meat groups. Two points were given for each food consumed in the fruit, vegetable, dairy, and meat group with a maximum of 4 points in each group. One point was granted for each grain serving with a maximum of 4 points from that group. There was a maximum of 20 points per diet recall (Kant et. al., 1991).
The Dietary Quality Index (DQI) by Patterson in 1994, and the Healthy Eating Index (HEI) by the United States Department of Agriculture in 1995 both include dietary variety as a component. The DQI was developed to evaluate usual dietary behaviors (Patterson et. al., 1994). The HEI was based on Diet and Health recommendations by the National Research Council, Committee on Diet and Health in 1989.

The DQI weighted eight recommendations to create an evaluation tool for diet quality. The elements were ranked in the following order: total fat intake, saturated fat intake, cholesterol intake, fruit and vegetable intake, intake of grains, protein intake, sodium consumption, and calcium intake. Subjects received a score based on their ability to meet dietary recommendations for each of these nutrients and food groups (Patterson et. al., 1994). A modified version of the DQI was developed by Drewnowski et. al. in 1996, using only 5 criteria to evaluate diet. The modified DQI was developed to be used as a reference measure to evaluate dietary intake in relation to the Dietary Guidelines for Americans and the recommendations in Healthy People 2000. The criteria included, consuming diets with less than 30% of total calories as fat, 10% of energy as saturated fat, 300 mg cholesterol, 10% of energy from sucrose, and consuming a diet greater than 50% as carbohydrate. Each criteria met, received a point and each criteria not met received zero points.

The HEI is a 100-point tool that was devised to evaluate the adherence to recommended guidelines from both the Food Guide Pyramid and the Dietary Guidelines for Americans. There are 10 categories in the HEI and each worth a maximum of 10 points. The HEI measurements are based on dietary balance, moderation, and variety. The first five components evaluate the diet based on Food Guide Pyramid
recommendations, in which the number of servings consumed in each group is calculated (consuming half of a serving earns 1 point). Four of the components of the HEI are based on the Dietary Guidelines for Americans. The last component of the HEI measures dietary variety based on the number of different foods consumed. If a subject consumes greater than 16 items over a 3 day period they receive a full 10 points; if someone consumes less than 9 items over 3 days they receive zero points (Kennedy et. al., 1995).

**Time needed to assess dietary variety**

Research suggests that 15 consecutive days of food recalls are the most sensitive measure to capture variety over time (Drewnowski et. al., 1997; Falciglia et. al., 2004). Drewnowski et. al. asked subjects to record 15 consecutive days of food intake. These researchers observed an increase in the total number of foods consumed over time, which suggested that most individuals exhaust their food repertoire over a two week time period. Falciglia et al. (2004), examined the relationship between dietary variety and diet quality in children. Variety scores were calculated at 3, 7, and 14 days. Results from this study also demonstrated that variety increased as a function of time. The authors concluded that 14 days of food recalls were required to capture dietary variety in children. Research has previously determined that 15 consecutive days of food recalls are the most sensitive measure to capture variety, the time required to see a relationship between dietary variety and a health outcome, such as, Body Mass Index (BMI) has not been studied.

**The relation between variety and body weight**

Research has been completed on how dietary variety relates to body weight and health. McCrory et al. in 1999, studied healthy men and women by investigating dietary
variety within food groups and body composition. The subjects were asked to complete a food frequency questionnaire. Dietary variety was calculated as the percentage of different foods consumed from each group. The authors determined that an increased variety of vegetables was related to decreased body fatness whereas sweets, snacks, condiments, entrees, and carbohydrates were positively associated with body fatness. McCrory et. al. concluded that dietary variety and the type of food groups consumed was an important predictor of body fatness.

In 1993, Kant et. al. reported results from a study in which they used data from the First National Health and Nutrition Examination Survey (NHANES-I) to examine the relationship between dietary variety and all-cause mortality. BMI was one of the outcomes measured. A 24-hour diet recall was obtained for each participant and the DD score was determined based on foods consumed from each food group. The results showed that a higher DD score was associated with a lower BMI in women, but there was no clear relation among males.

**BMI used in children**

BMI correlates with measures of body fatness in children and adolescents (Barlow & Dietz, 1998). It is recommended that clinicians use BMI as the measurement to monitor risk of obesity and related complications in children (Barlow & Deitz, 1998; Himes & Dietz, 1994). BMI is the preferred method for assessing a child’s growth because it is easily obtained by measuring the weight and height of a child (Himes & Deitz, 1994). The measurement can also be tracked as it is now included on the National Center for Health Statistics (NCHS) growth chart for children 2-20 years of age (National Center for Health Statistics and the National Center for Chronic Disease Prevention and
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Health Promotion., 2001). Children with a BMI greater than or equal to the 95th percentile are considered to be overweight and those with a BMI greater than or equal to the 85th percentile, but less than the 95th percentile are considered to be at risk of being overweight (Barlow & Dietz, 1998; Himes & Dietz, 1994).

Purpose of the study

The purpose of this study was to evaluate the relationship between dietary variety and health status. In this study, BMI is used as the health status indicator. This study aims to compare the effects of three types of dietary variety on BMI and how dietary variety measured at different time intervals relates to BMI. The three types of dietary variety examined in this study were: all sources variety (ASV) including all groups in the Food Guide Pyramid, plus the fats and sweets group; grains, fruit, vegetable, dairy, and meat variety (GFVDM); and grains, fruit, and vegetable variety (GFV). Variety was assessed at three time intervals: 3 days, 7 days, and 15 days. The research questions were, “Does the type of dietary variety (ASV, GFVDM, or GFV) have an association with BMI?” and “How many days of dietary variety are needed to show this relationship?” The hypotheses were: 1) ASV and GFVDM variety will be positively associated with BMI and a high intake of GFV will be associated with a healthy BMI; 2) Fifteen days of food recalls are necessary to demonstrate a positive relationship between dietary variety and BMI; no relationship will be observed between variety and BMI based on 3 and 7 days. This study was undertaken because literature shows that there is a wide array of definitions of dietary diversity resulting in a need for more focused study on the effects of the specific recommendations made by the Dietary Guidelines for Americans
and additional agencies. Moreover, since most studies concerning the subject of dietary variety focus on adults, children have been chosen for this study.

**Research Design and Methods**

**Subjects**

The target population was children between the ages nine to eleven. Studies show that after age nine children are able to recall what they have eaten in a 24-hour period (Domel et. al, 1994; Emmons & Hayes, 1973). The study subjects were recruited from the 4th and 5th grade classes at an elementary school in Centerville, Ohio. The school was a public school in a middle to upper class suburban neighborhood. Students were invited to participate in the study via a letter and consent form sent to their parents explaining the purpose of the study and its procedures. The parents were instructed to send the signed consent form with their children to school. Students who did not have a signed consent form were excluded from participation in the study. The consent form outlined the purpose, procedures, risks, and benefits of the study, as well as described the right to refuse participation or withdrawal from the study. Students were also asked to sign an assent form, agreeing to participate in the study. This study was approved by the Institutional Review Board (IRB) at the University of Cincinnati.

A total number of 176 4th and 5th graders (103-4th graders and 73-5th graders) were eligible for the study. The ages of the students ranged from 9 to 11 years. There were 109 students with signed consent forms at the beginning of the study. The final number of students included in the study was 54. The reasons for excluded from the study included elective withdrawal, missing food records, inability to measure height and weight, inadequate recording of data, and outlying data when compared to the rest of the
sample. There were 24 males and 30 females in the final study sample. The race
distribution was 53 Caucasians and 1 African American. See Table I for the distribution
of reasons for removal or withdrawal from the study.

Table I: Description of Final Population Size

<table>
<thead>
<tr>
<th>Population</th>
<th>Number</th>
<th>4th grade</th>
<th>5th grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study Population</td>
<td>176</td>
<td>103</td>
<td>73</td>
</tr>
<tr>
<td># Consents Received</td>
<td>109</td>
<td>70</td>
<td>39</td>
</tr>
<tr>
<td>Withdrawals</td>
<td>7</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Missing Days of Records</td>
<td>30</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td>Incomplete Records</td>
<td>12</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Wt and Ht unavailable</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Outliers (^a)</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Final Sample (^b)</td>
<td>54 (50%)</td>
<td>28 (40%)</td>
<td>26 (67%)</td>
</tr>
</tbody>
</table>

\(^a\) Outliers included the subjects that had a BMI classifying them as underweight and a subjects with
outlying variety scores compared to the rest of the population.

\(^b\) Final Sample - The percentage of consented subjects included in the final sample.

**Materials**

The researcher, a registered dietitian, educated the students on how to estimate
portion sizes with the assistance of food models, educational posters (Millen & Morgan,
Nutrition Consulting Enterprise, 1996), references to standard serving sizes (National
Dairy Council, 1996), label reading, and measuring utensils. The participants received
educational handouts on how to determine a portion size. The researcher also provided
the subjects with a blank food record every day to record the previous day’s intake.
Weights and heights were obtained on subjects away from the classroom in a specified
location with appropriate equipment (calibrated balance scale and stadiometer). The
weights and heights were used to calculate BMI. Weight, height, and BMI were
evaluated using the NCHS growth chart. Calculations of caloric and nutrient intake from
diet recalls were completed using the computer analysis program ESHA (ESHA
**Procedure**

Dietary variety was determined for 15 consecutive 24-hour diet recalls. All students were trained to complete a 24-hour diet recall on the first day of the study. The researcher trained the students on determination of serving size by using the handouts, models, posters and reference items previously described. All teaching aids remained in the classroom until the study was completed. Handouts were provided for children to use as a reference to help determine portion sizes on the weekend. The students received no nutrition education related to the reasons for the assignment to avoid bias when completing food records. It has been demonstrated that there is no difference between observed dietary intake and recalled dietary intake (Lytle et. al., 1993). As a result, 24-hour diet recalls were used in this study.

The 24-hour diet recalls were obtained in the classrooms during a 20 minute time period allotted by the teachers. The researcher asked a set of probing standardized questions about dietary intake to help students remember what they had to eat the previous day. The researcher was present to answer any questions and provide assistance to the students. Students were responsible for recording their own intake on the weekends and were provided with the researcher’s name and phone number to contact with questions, as well as a packet of dated food records. Students were asked to record their name on the 24-hour recall, as the researcher felt assigning numbers would have added complications. Once data was collected, each student was assigned a study number; therefore the students’ names were not utilized.

The researcher obtained weights and heights of students that had returned consent forms. The scale and stadiometer were kept outside of the classroom so the students
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could be measured in private. The procedure for obtaining weights and heights was to ask the children to remove shoes, belts, and other clothing items that would add significant weight (heavy sweaters, hair accessories, etc.) in order to obtain accurate measurements. BMI was calculated from the weights and heights and plotted on the gender and age appropriate NCHS growth chart. The subjects were classified into four categories based on BMI. The 4 categories were Category 1- <10th percentile, Category 2- 10th – 85th % percentile, Category 3- 85th -97th percentile, and Category 4- > 97th percentile.

Once all data was collected, the number of foods consumed was counted using guidelines from the Healthy Eating Index (HEI). Each food was only counted once if the subject consumed at least half of a portion. The following HEI rules were followed for counting variety in this study (USDA, 1995):

♦ Vegetables and fruits were all counted separately, but different forms of the same vegetable or fruit were not counted more than once. An example of this would be if a whole apple and applesauce were consumed in the same day they would not be counted separately, but once as an apple.

♦ Varying forms of the same meat were counted the same. Steak and a hamburger were both counted as beef. Ham was an exception and counted separate from other pork products.

♦ All types of fish were counted separately.

♦ Dairy products were all counted separately, but all cheeses were considered the same except for cottage cheese.
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- All white bread, was counted the same, but baked goods and pastas were counted separately. Whole grain breads were counted separately from breads made from enriched flour.
- Ready to eat cereals were counted according to the grain they were made of. Those made of the same grain were counted as one serving.
- Food mixtures, such as, casseroles and soups were broken down and the foods counted in the appropriate food groups.

Three types of variety were calculated: 1) all sources of variety (ASV), which included all groups in the food guide pyramid, plus the fats and sweets group; 2) grains, fruit, vegetable, dairy, and meat groups (GFVDM); and 3) grains, fruit, and vegetable groups (GFV). The variety score for each type of variety was determined at 3, 7, and 15 days. All variety scores were cumulative. If there were more than 2 days of food records missing or inadequate data was recorded, participants records were excluded from analysis. The usable records were entered into the ESHA computer analysis program to analyze intake of energy, protein, carbohydrates, fat, vitamin C, folate, iron, zinc, calcium, and fiber. In order to perform nutrient analysis, one day from each five day interval was chosen randomly for each subject in order to obtain a 3 day sample representative of the entire 15 days. All data was analyzed using the Statistical Analysis Systems (SAS) software (SAS Institute Inc, Cary NC). Results were reported to be significant at a P-value < .05.
Results

Table II shows the age, BMI, and general dietary characteristics of this study sample by gender. Race was not displayed in the table as the final study population was 53 Caucasians and 1 African American. An unpaired t-test assuming unequal variance was performed to determine significant differences in age, BMI and general dietary characteristics between males and females. There were no significant differences found between males and females for age, BMI, and general dietary characteristics. The nutrient intakes (Table III) for the subjects separated by gender were compared to the Dietary Reference Intakes (DRI) (Institute of Medicine, Food and Nutrition Board, 1997, 1998, 2000, 2001, 2002). The diets were adequate for protein, fat, vitamin C, and iron. Overall, the children consumed less than recommended of energy, folate, zinc, calcium, and fiber.

Table IV shows the mean variety scores and standard errors (SE) for all types of variety at 3, 7, and 15 days. Variety increased with time for all types of variety. Analysis of variance was used to compare mean variety scores. There was a significant difference (P < .0001) between mean variety scores at 3, 7, and 15 days for each type of variety.

Table II: Characteristics of Population of the Study Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>Males (SD)(^a) (n= 24)</th>
<th>Females (SD) (n= 30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>9.7 (.7)</td>
<td>9.5 (.6)</td>
<td>.24</td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>18.0 (1.9)</td>
<td>18.5 (3.2)</td>
<td>.51</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>1706.9 (329.2)</td>
<td>1547.8 (366.4)</td>
<td>.10</td>
</tr>
<tr>
<td>% Protein(^b)</td>
<td>14.7 (3.5)</td>
<td>14.2 (2.3)</td>
<td>.52</td>
</tr>
<tr>
<td>% Fat(^c)</td>
<td>33.4 (4.1)</td>
<td>35.6 (7.6)</td>
<td>.18</td>
</tr>
<tr>
<td>% Carbohydrate(^d)</td>
<td>53.2 (5.6)</td>
<td>52.1 (7.8)</td>
<td>.54</td>
</tr>
<tr>
<td>Fiber (g)</td>
<td>11.8 (3.5)</td>
<td>12.3 (4.2)</td>
<td>.64</td>
</tr>
</tbody>
</table>

\(^a\) SD = standard deviation, \(^b\), \(^c\), \(^d\) The % of Protein, Fat, and Carbohydrate refers to the percent of energy from the stated nutrients
Table III: Nutrient Intakes of Males and Females

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Males = 24</th>
<th>Females = 30</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>References*</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>1706.9 (329.2)</td>
<td>2279 (EER)</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>61.8 (14.9)</td>
<td>34 (RDA)</td>
</tr>
<tr>
<td>% Protein</td>
<td>14.2 (3.5)</td>
<td>10-35% (AR)</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>63.6 (15.9)</td>
<td>61-85 (RDA)</td>
</tr>
<tr>
<td>% Fat</td>
<td>33.4 (4.1)</td>
<td>20-35% (AR)</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>227.8 (52.7)</td>
<td>130 (RDA)</td>
</tr>
<tr>
<td>% Carbohydrate</td>
<td>53.2 (5.6)</td>
<td>45-65% (AR)</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>60.9 (39.9)</td>
<td>45 (RDA)</td>
</tr>
<tr>
<td>Folate (mcg)</td>
<td>265.4 (124.3)</td>
<td>300 (RDA)</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>13.4 (3.7)</td>
<td>8 (RDA)</td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>7.4</td>
<td>8 (RDA)</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>847.5</td>
<td>1300 (AI)</td>
</tr>
<tr>
<td>Fiber (g)</td>
<td>11.8</td>
<td>31 (AI)</td>
</tr>
</tbody>
</table>

* References from the Dietary References Intakes: Estimated Energy Requirement (EER), Recommended Dietary Allowances (RDA), Adequate Intake (AI), and Acceptable Range (AR).

Table IV: Type of Variety for all subjects at 3, 7, and 15 days

<table>
<thead>
<tr>
<th>Variety Type</th>
<th>3 Days Mean</th>
<th>SE*</th>
<th>7 Days Mean</th>
<th>SE</th>
<th>15 Days Mean</th>
<th>SE</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASVb</td>
<td>18.9</td>
<td>0.8</td>
<td>30.1</td>
<td>1.0</td>
<td>40.8</td>
<td>1.5</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>GFVDMc</td>
<td>15.5</td>
<td>0.6</td>
<td>24.6</td>
<td>0.9</td>
<td>32.4</td>
<td>1.3</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>GFVa</td>
<td>9.4</td>
<td>0.5</td>
<td>15.5</td>
<td>0.8</td>
<td>21.2</td>
<td>1.1</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

* SE = Standard Error; b ASV = All Sources Variety; c GFVDM = Grains, Fruits, Vegetables, Dairy, and Meat; d GFV = Grains, Fruits, and Vegetables.
The mean values for each type of variety at 3, 7, and 15 days were analyzed using both absolute mean values and standardized mean values. For the two analyses the subjects were categorized into normal weight subjects (those with a BMI within normal limits, including those subjects in Category 2 for BMI) and overweight subjects (those with a BMI indicating they were overweight or at risk of being overweight, including those individuals in Categories 3 & 4 for BMI) for the mean values comparison. Mean variety scores of overweight and normal weight subjects were compared using analysis of variance; each time interval was analyzed separately and the three types of varieties were analyzed for each interval. In addition, the difference in mean variety scores for overweight and normal weight subjects within each variety group were compared across variety types to determine if significant differences existed.

As shown in Table V at 3 days, overweight individuals consumed a greater variety of ASV than the normal weight group. The overweight individuals also consumed greater variety of GFVDM at 3 days than the normal weight individuals, however neither difference was significant. There was little difference in mean variety scores of GFV variety between the overweight and the normal weight subjects at 3 days. At 7 and 15 days the normal weight subjects consumed more GFV variety, however the differences were nor significant.

Also shown in Table V are the results of the analysis of difference in mean variety scores for overweight and normal weight subjects within each variety group compared across variety types. When the difference in mean variety of ASV between overweight and normal weight subjects was compared to the difference in mean variety of GFV between overweight and normal weight subjects, the difference was significant.
difference between the overweight and normal weight subjects for ASV at 3 days is 2.0 and when that difference is compared to the difference between overweight and normal weight subjects for GFV at 3 days, which is 0.1, the ASV difference is significantly higher than the GFV difference (P-value = .03). Also, a significant difference was noted when comparing mean variety of GFVDM between overweight and normal weight subjects versus mean variety of GFV between overweight and normal weight subjects. The difference between the overweight and normal weight subjects for GFVDM at 3 days is 1.5 and that difference compared to the difference between overweight and normal weight subjects for GFV at 3 days, which is 0.1, is a significant difference (P-value = .002). The significance was only shown at the 3 day interval. No significant differences were observed between overweight and normal weight subjects for any source of variety at 7 and 15 days. These results are displayed in bar graph form for better visualization (Figures 1a-1c).

The absolute mean values of variety were standardized to facilitate comparison of data (Table VI). The differences in standardized mean variety scores for the overweight and normal weight groups were compared to each other across variety types. The standardized data analysis confirmed the findings of the analysis of the absolute data. Significant differences were observed when the differences between overweight and normal weight subjects for each variety type were compared to each other. The difference between the overweight and normal weight subjects for ASV at 3 days is 8.5 and when that difference is compared to the difference between overweight and normal weight subjects for GFV at 3 days, which is 0.7, the ASV difference is significantly higher than the GFV difference (P-value = 0.03). The difference between the overweight
and normal weight subjects for GFVDM at 3 days was 8.2, and when compared to the
difference between overweight and normal weight subjects for GFV of 0.7, GFVDM
difference was significantly higher (P value = <0.01). These results were not found at 7
and 15 days.

Table V: Type of Variety and BMI at 3, 7, and 15 days

<table>
<thead>
<tr>
<th>Type of Variety and BMI at 3 days</th>
<th>ASV Mean</th>
<th>ASV SE</th>
<th>GFVDM Mean</th>
<th>GFVDM SE</th>
<th>GFV Mean</th>
<th>GFV SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overweight (n= 12)</td>
<td>20.0</td>
<td>1.3</td>
<td>16.3</td>
<td>1.0</td>
<td>9.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Normal (n= 42)</td>
<td>18.0</td>
<td>0.7</td>
<td>14.8</td>
<td>0.5</td>
<td>9.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Difference</td>
<td>2.0</td>
<td>1.5</td>
<td></td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-Value</td>
<td>0.18</td>
<td>0.19</td>
<td>.91</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**P-Values of differences (Difference between BMI Categories within the same variety type vs. Difference between BMI Categories within a different variety type.)**

ASV vs. GFVDM = 0.44
ASV vs. GFV = 0.03 (ASV > GFV)*
GFVDM vs. GFV = 0.002 (GFVDM > GFV)*

<table>
<thead>
<tr>
<th>Type of Variety and BMI at 7 days</th>
<th>ASV Mean</th>
<th>ASV SE</th>
<th>GFVDM Mean</th>
<th>GFVDM SE</th>
<th>GFV Mean</th>
<th>GFV SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overweight (n= 12)</td>
<td>29.5</td>
<td>1.8</td>
<td>24.4</td>
<td>1.5</td>
<td>15.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Normal (n= 42)</td>
<td>30.8</td>
<td>1.0</td>
<td>24.8</td>
<td>0.8</td>
<td>16.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Overall Average</td>
<td>1.3</td>
<td>0.4</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-Value</td>
<td>0.54</td>
<td>0.81</td>
<td>0.52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**P-Values of differences (Difference between BMI Categories within the same variety type vs. Difference between BMI Categories within a different variety type.)**

ASV vs. GFVDM = 0.31
ASV vs. GFV = 0.85
GFVDM vs. GFV = 0.31

<table>
<thead>
<tr>
<th>Type of Variety and BMI at 15 days</th>
<th>ASV Mean</th>
<th>ASV SE</th>
<th>GFVDM Mean</th>
<th>GFVDM SE</th>
<th>GFV Mean</th>
<th>GFV SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overweight (n= 12)</td>
<td>40.8</td>
<td>2.6</td>
<td>32.4</td>
<td>2.2</td>
<td>20.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Normal (n= 42)</td>
<td>40.9</td>
<td>1.4</td>
<td>32.4</td>
<td>1.2</td>
<td>21.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Overall Average</td>
<td>0.1</td>
<td>0.0</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-Value</td>
<td>0.95</td>
<td>0.99</td>
<td>0.74</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**P-Values of differences (Difference between BMI Categories within the same variety type vs. Difference between BMI Categories within a different variety type.)**

ASV vs. GFVDM = 0.87
ASV vs. GFV = 0.63
GFVDM vs. GFV = 0.24

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*SE= Standard Error; *ASV= All Sources Variety; *GFVDM = Grains, Fruits, Vegetables, Dairy, and Meat; *GFV= Grains, Fruits, and Vegetables; *Overweight = the subjects in Categories 3 & 4 for BMI; *Normal= the subjects in Category 2 for BMI
Figure Ia

Figure Ib

Figure Ic
Table VI: Standardized Mean Values of variety and BMI at 3, 7, and 15 days

<table>
<thead>
<tr>
<th>BMI Category</th>
<th>ASV(^a) (mean)</th>
<th>GFVDM(^b) (mean)</th>
<th>GFV(^c) (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overweight(^d) (n= 12)</td>
<td>45.8</td>
<td>45.8</td>
<td>38.2</td>
</tr>
<tr>
<td>Normal(^e) (n= 42)</td>
<td>37.3</td>
<td>37.6</td>
<td>37.5</td>
</tr>
<tr>
<td>Difference</td>
<td>8.5</td>
<td>8.2</td>
<td>0.7</td>
</tr>
</tbody>
</table>

P-Values (Difference between BMI Categories within the same variety type vs. Difference between BMI Categories within a different variety type.)

ASV vs. GFVDM = 0.93
ASV vs. GFV = 0.03 (ASV > GFV)
GFVDM vs. GFV = <0.01 (GFVDM > GFV)

Standardized mean values for all variety types of overweight vs. normal at 7 days

<table>
<thead>
<tr>
<th>BMI Category</th>
<th>ASV (mean)</th>
<th>GFVDM (mean)</th>
<th>GFV (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overweight (n= 12)</td>
<td>37.5</td>
<td>40.1</td>
<td>36.4</td>
</tr>
<tr>
<td>Normal (n= 42)</td>
<td>42.04</td>
<td>42.0</td>
<td>41.1</td>
</tr>
<tr>
<td>Difference</td>
<td>4.54</td>
<td>1.9</td>
<td>4.7</td>
</tr>
</tbody>
</table>

P-Values (Difference between BMI Categories within the same variety type vs. Difference between BMI Categories within a different variety type.)

ASV vs. GFVDM = 0.43
ASV vs. GFV = 0.95
GFVDM vs. GFV = 0.35

Standardized mean values for all variety types of overweight vs. normal at 15 days

<table>
<thead>
<tr>
<th>BMI Category</th>
<th>ASV (mean)</th>
<th>GFVDM (mean)</th>
<th>GFV (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overweight (n= 12)</td>
<td>62.3</td>
<td>59.6</td>
<td>54.0</td>
</tr>
<tr>
<td>Normal (n= 42)</td>
<td>62.6</td>
<td>59.5</td>
<td>56.3</td>
</tr>
<tr>
<td>Difference</td>
<td>0.3</td>
<td>0.1</td>
<td>2.3</td>
</tr>
</tbody>
</table>

P-Values (Difference between BMI Categories within the same variety type vs. Difference between BMI Categories within a different variety type.)

ASV vs. GFVDM = 0.87
ASV vs. GFV = 0.44
GFVDM vs. GFV = 0.16

\(^a\) ASV= All Sources Variety; \(^b\) GFVDM = Grains, Fruits, Vegetables, Dairy, and Meat; \(^c\) GFV= Grains, Fruits, and Vegetables; \(^d\) Overweight = the subjects in Categories 3 & 4 for BMI; \(^e\) Normal= the subjects in Category 2 for BMI

Discussion

This study found that variety increases with time, which agrees with previous research (Drewnowski et al., 1997; Falciglia et al., 2004). It was observed that overweight children consumed a greater amount of ASV and GFVDM variety at 3 days when compared to normal weight subjects, but the difference was not significant.
However, when the differences in variety between overweight and normal weight subjects for ASV and GFVDM at 3 days were compared to the difference in variety between overweight and normal weight subjects for GFV at 3 days, it was found that the overweight subjects consumed greater amounts of ASV and GFVDM than GFV. This finding supports the hypothesis that ASV and GFVDM variety would be more likely to be associated with a higher BMI. The relationship was only found at 3 days, therefore, this study did not support the second hypothesis that the association between variety and BMI would most likely be seen at 15 days.

The variety scores increased as a function of time for all three types of variety. For the three types of variety in this study the scores increased as follows: 1) ASV, 18.9, 30.1, and 40.8; 2) GFVDM, 15.5, 24.6, and 32.4; 3) GFV, 9.4, 15.5, and 21.2. Falciglia et. al., 2004 also found variety increased as a function of time in children. In that study there were 33 subjects and two types of variety were examined, GFVDM and GFV. Variety scores were recorded at 3, 7, and 14 days. The GFVDM scores in that study increased in the following manner at 3, 7, and 14 days, 12.2, 17.9, and 22.6. The GFV variety scores were 7.0, 10.2, and 12.9, respectively. When comparing the variety scores for these two studies the current study shows higher variety scores at the same time intervals.

The comparison of the difference between the variety scores for overweight and normal weight subjects for ASV and GFVDM to the difference in variety scores between overweight and normal weight subjects for GFV showed the overweight group consumed more ASV and GFVDM. This agrees with the findings of another study. McCrory et. al., 1999, concluded that a high variety of sweets, snacks, condiments, entrees, and
carbohydrates lead to increased body fatness. However, McCrory et. al. also concluded that a low variety of vegetables led to increased body fatness and this study did not show a significant difference in GFV variety scores between overweight and normal weight subjects.

In this study the only significant results showing an association to BMI were seen at 3 days of intake. Previous research demonstrated that 15 days of diet recalls are needed to fully assess the variety in an individual’s diet. Three days of dietary variety showed an association with BMI and no association was seen at the 7 and 15 day intervals. This finding could mean that 15 days is the most sensitive measure of dietary variety, but when a researcher is attempting to show association between dietary variety and a health outcome, such as BMI, the number of days of dietary variety needed to show that association could be less than 15 days.

A limitation of this study was the study was performed early in the school year. This likely affected the final sample size, as some of the 4th graders may not have been developmentally ready to record data, which could be why the completion rate of the 4th graders was lower than that of the 5th graders. In the future, studies in this age group may work better at the end of the school year as children will be used to school work and have improved skills to complete the procedures.

The overall conclusions of this study are: 1) variety increases as a function of time as seen by previous research; 2) children who are overweight eat a larger variety of ASV and GFVDM compared to normal weight children at 3 days variety; 3) there were no significant differences in GFV intake between overweight and normal weight subjects at 3 days variety, however it was observed at 7 and 15 days that the normal weight subjects
consumed more GFV variety, but the difference was not significant; and 4) the association between ASV and GFVDM and BMI may require less than 15 days of 24-hour recalls to find a relationship, but to find an association between all types of variety and BMI, 15 days of variety may need to be obtained. Since the results demonstrated that variety has an association to BMI at 3 days and traditionally 15 days of diet recalls have been needed to assess variety, the study of dietary variety and the amount of time needed to show a relationship to a health outcome is an area of further research. Due to the small size of the sample and lack of demographic diversity, further studies should include a larger, more diverse population in order to arrive at conclusions that could be extrapolated to the general population.
References


National Center for Health Statistics and the National Center for Chronic Disease Prevention and Health Promotion. (March 1, 2001). *NCHS Growth Chart*. Form No. 207.


