DIETARY FIBER INTAKE AND ITS RELATIONSHIP TO CHILDHOOD OBESITY

A Thesis Proposal

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Problem Statement

      Obesity, a condition of excess body fat, is classified by having a Body Mass Index (BMI) > 30 kg/m^2. In the late 1800s in the United States, only 3% of adults were considered overweight and obese, whereas approximately 34% of adults are obese today. However, obesity is also a common problem among children and adolescents. Within the past 20 years, the number of overweight children has doubled and the number of overweight adolescents has tripled (1). In the United States where childhood obesity is often referred to as an epidemic, approximately 2.5 million children and adolescents between 2-19 years of age are obese (2). Furthermore, the obesity epidemic is not limited to the United States as worldwide obesity has more than doubled since 1980 (3).

      The increasing incidence of obesity causes many individuals to be at a higher risk for developing other conditions. Overweight and obese individuals have higher BMI values which are strongly associated with weight-related morbidity and mortality rates (1). Obese children are at a higher risk of being obese adults which may lead to disability and premature death. They also suffer from breathing difficulties, increased risk of fractures, hypertension, early markers of cardiovascular disease (CVD), insulin resistance and psychological effects. Children who continue to be obese throughout adulthood are at an even higher risk for developing CVD, type 2 diabetes, musculoskeletal disorders, and even a few cancers. Deaths from malnutrition are often associated with complications from being underweight. However, malnutrition also refers to individuals who are over nourished, overweight and obese individuals. Currently in the United States, more individuals are dying from complications from obesity than from being underweight (4).

Obesity is a complex disorder caused by many different factors including genetics and lifestyle behaviors. In an environment where energy dense foods are abundant and physical activity is low, genetic factors causes some people to be more susceptible to weight gain than others. However, even individuals not predisposed to obesity are likely to gain weight over time if they are constantly consuming more energy than they are expending. As a result, the impact of lifestyle factors becomes very important regardless of whether an individual is predisposed to weight gain. The top two most common lifestyle factors causing obesity are poor dietary habits and low levels of physical activity. Dietary habits are comprised of a variety of elements expanding larger than the specific foods and beverages consumed. Dietary habits also include the nutrient profile of the foods, the frequency of consumption, portion size, and the amount of mineral and vitamins consumed(1).

Improving dietary habits and increasing levels of physical activity are two very important lifestyle changes obese individuals can make. Achieving and maintaining weight loss requires modifying current lifestyle behaviors including choosing what to eat and how much physical activity to engage in. According to the Dietary Guidelines for Americans, a healthy weight-maintenance program includes setting reasonable goals, choosing nutritious foods in moderation, and increasing energy expenditure through physical activity (1). Modifying lifestyle behaviors and decreasing body weight will eliminate the need for many medical expenses for obese individuals. The Center for Disease Control estimates $147 billion is spent annually to treat medical conditions associated with obesity (5).

Improving dietary habits includes consuming a balanced diet and meeting the recommended levels of nutrients. Currently, the average fiber intake for children and adults in the United States is less than half of the recommended levels. Fiber is a polysaccharide found in plants that is not digested or absorbed in the small intestine. Fiber has many health benefits including promoting the growth of beneficial intestinal bacteria and decreasing the risk of developing coronary heart disease, stroke, hypertension, diabetes, and certain gastrointestinal disorders. However, fiber also decreases the risk of developing obesity and has been used to aid in weight loss. Clinical trials tracing back to 50 years show the use of fiber supplements to aid in weight loss. Researchers noticed high-fiber foods were more filling than low-fiber foods. Consuming foods with soluble and viscous fiber delay gastric emptying which promote satiety. By promoting satiety, fiber is able to aid in regulating food intake (6).

The increasing incidence of obesity in the United States initiates a growing need for extensive research to discover ways to prevent and treat obesity. Studying the possible causes of childhood obesity is important in the dietetics field because of the increasing number of overweight and obese children. Discovering all the possible causes of childhood obesity will allow a dietitian to provide a comprehensive prevention or treatment plan for a specific child. As the obesity rates continue to increase, the levels of fiber intakes among children in the United States remains low. Consequently, studying the effects of fiber intakes and their correlation to children's BMI may reveal one the many ways to prevent and treat childhood obesity and save the lives of those suffering. If fiber intakes among children below the recommended Adequate Intake (AI) are

positively correlated with higher BMI values, then increasing fiber intakes among children may decrease the risk and incidence of obesity.

Related Research

Researchers have looked at a variety of possible causes of the obesity epidemic in the United States. To implement appropriate prevention programs for children, it is important to be knowledgeable of the many factors causing obesity Researchers have stated the best way to attempt to reverse the obesity epidemic is through prevention by improving lifestyle habits(4). A component of poor dietary habits among children is low fiber intake. Researchers have discovered the many gastrointestinal health benefits of consuming dietary fiber, especially in childhood. Foods high in fiber require more chewing which triggers satiety signals, slowing gastric emptying, and allowing the brain to realize when the stomach is full. An inverse relationship between dietary fiber and obesity rates are seen through observations of countries where individuals are consuming high amounts of fiber and have lower obesity rates than the United States. However, very little data has been collected in the United States associating low fiber diets and increased risk of childhood obesity (7).

Numerous research studies have shown the beneficial role fiber plays in satiety and weight management among adults. Data was collected from a RCT and cross sectional study funded by the National Institute of Health to examine self-reported dietary energy density among overweight, normal weight, and weight loss maintainers (10). Those maintaining weight loss self reported low dietary fat and higher dietary fiber intake than the overweight and normal weight groups. Therefore, increasing intakes of low energy density foods with fiber by consuming vegetables and whole grains promotes

satiety and seems to aid in maintaining weight loss. In a prospective cohort study of European adults, a statistically significant inverse relationship was determined between dietary fiber and weight/waist circumference. Those consuming high fiber diets had a lower weight and smaller waist circumference than those consuming low fiber diets. The results from the two studies support the beneficial role of fiber intake in maintaining a healthy body weight, promoting weight loss, and preventing weight gain (13).

While higher amounts of fiber intake promote weight loss and weight maintenance, consuming low amounts of fiber will lead to a higher risk of developing obesity. Data collected from adults in the Continuing Survey of Food Intakes by Individuals showed only 5% of participants were consuming the AI for fiber for their age group. In women, a low-fiber, high-fat diet was strongly associated with an increased risk of becoming overweight and obese compared to those consuming a high-fiber, low-fat diet (14). In a 12 year prospective study of middle-aged women, women who had low intakes of high fiber foods were 50% more likely to gain weight than women who high fiber intake over time. Women who consumed more whole grains consistently weighed less over the 12 year period than women who consumed less whole grains. Once again, weight gain was inversely associated with the intake of high fiber whole grain foods. The study also showed a positive relationship between the intake of refined grain foods and weight gain. Refined grain products do not contain the fiber found in whole grain foods, therefore consuming whole grain foods is important in weight maintenance (15).

While many studies have shown the benefits of fiber intake in weight maintenance among adults less studies have been conducted regarding fiber and weight maintenance among children. As the childhood obesity rates increase, the total

consumption of carbohydrates among children has increased. However most of the carbohydrates are in the form of low fiber refined grains. One common result among the data from the studies show the average fiber intake among children is significantly lower than the current Dietary Reference Intake (DRI) for their age group. Some studies show evidence of an inverse relationship between intakes of high fiber and fat intake, weight, adiposity, and waist circumference.

In the Feeding Toddlers and Infants Study of 2008, a cross-sectional study of a national random sample of United States children from birth through about age 4 years old measured nutrient intakes. The results showed dietary fiber was low in the majority of toddlers and preschoolers and saturated fat intakes exceeded the recommended amount. If the children from the study continue to consume low amounts of fiber and high amounts of saturated fat they will be at a higher risk of becoming overweight and obese during childhood (16). In a study of 109 overweight Latino children from ages 10-17 years old, the only dietary element associated with overall metabolic syndrome in the children was soluble fiber. Those who did not have metabolic syndrome consumed more grams of total fiber per 1,000 calories. The results suggest increasing soluble fiber could reduce central adiposity and improve over health of Hispanic children. Results also showed a significant inverse relationship between consumption of soluble fiber and waist circumference, suggesting higher amounts of fiber intakes may contribute to a smaller waist (17).

In a cross sectional survey, 24-hour dietary intake of five cohorts of 10 year olds and two cohorts of 13 year olds showed children who consumed more than 18 grams/day of fiber had a lower percentage of energy from fat and saturated fatty acid than children consuming less than 7 grams/day of fiber. Therefore, children who are consuming high

amounts of fiber are also consuming lower amounts of fats, decreasing their risk of developing obesity. The results show a relationship between increased high fiber intake and a more healthy diet. Children who had high fiber intakes consumed a more balanced diet comprised of fruits and fruit juices, vegetables and soups, and breads and grains than children who had lower fiber intakes. Children with low fiber intakes consumed foods that were higher in fat — such as fats and oils, eggs, cheese, pork and beef — than those with higher fiber intakes (8).

In preadolescent girls, an inverse relationship was reported between dietary fiber intake and adiposity. Girls consuming high amounts of fiber had less adipose tissue. Furthermore, an inverse correlation existed between dietary fiber and dietary fat intake. The study suggests girls consuming a high fiber diet had lower adiposity but also consumed lower amounts of fat, leading to a decreased risk of obesity (9).

In a study of 54 overweight Latino adolescents, sugar and fiber intake were measured after a 16 week nutrition education intervention. Results showed adolescents who increased fiber intake improved their BMI and decreased visceral adipose tissue. By decreasing BMI and adipose tissue, the adolescents decrease their risk for continuing to be overweight through adulthood (18).

Overall, the results from the data suggest correlations between dietary fiber intake and weight status exist. Children in the United States are consuming less than adequate amounts of fiber to promote health benefits to prevent obesity. Increasing children's fiber intake through consumption of fruits, vegetables, and complex carbohydrates will lead to a more balanced diet and even possibly prevent the incidence and risk of obesity.

Objectives of the Study

Childhood obesity rates have risen considerably in recent decades in the United States. Dietary intakes of children have also shown several areas for improvement. The purpose of this study is to examine the relationship between fiber intakes and obesity in US children. To assess this relationship, the following research questions will be explored:

- Is total fiber intake correlated with the BMI of children?

- Do age differences exist in the total fiber intakes among children by obesity status?

- Do differences exist in the adequacy of fiber intakes in children based on the current DRI's by obesity status?

Procedures

a. Design

Data from 1999-2008 National Health and Nutrition Examination Survey (NHANES) will be used to assess the relationship between total fiber intake among children and their BMI. NHANES is a program of studies used to evaluate nutritional and health status in the United States. The survey collects health and nutrition measurements of approximately 5,000 individuals a year in counties across the country. The survey includes interviews regarding demographics, socioeconomic, dietary, and health related questions. In addition to the interviews, highly trained professionals conduct medical and dental examinations, as well as collecting physiological measurements. Information from the survey is used to determine nutritional status and it's relation to health promotion and

disease prevention. The results from the NHANES surveys are used to set national standards for height and weight.

NHANES carefully oversamples specific populations to produce adequate sample sizes for reliable representation in statistical analyses. Over sampling of Hispanics, children, adolescents, elderly, and pregnant women ensure the sample is truly representative of the adults and children in the United States. Data from the NHANES surveys are used by agencies such as the Food and Drug Administration to assess program activities such as vitamin and mineral fortification regulations. As a result of the NHANES surveys many beneficial strides have been made in improving the knowledge and awareness of the trends of many health issues in the United States. The prevalence of overweight and obese individuals in the studies have led to the implementation of programs focusing on diet and exercise and have provided a way to evaluate trends in obesity (11).

b. Population and Sample

We will examine data from children by three different age groups: 2-5, 6-11, 12-18 years of age. Information including dietary intake and BMI status from 1999-2008 NHANES surveys will be used.

c. Data Collection and Preparation

The household interviews conducted of individuals 16 years of age and older were interviewed in person directly to collect demographic data. All survey partcipants who have a household interview record have a demographics file record providing family and individual level information. The file includes variables on gender, age, race/ethnicity, education level, marital status and household income. However, for those participating

under the age of 16 years had assistance from another individual in providing information for the survey.

Dietary intakes of the NHANES participants have been collected. The participants are eligible for two 24-hour dietary recall interviews. The first interview is conducted in person at the Mobile Examination Center and the second interview is conducted by telephone. For consistency in collection and the lower rates of completion of the telephone interview, only the first day of dietary recall will be used for these analyses. A 24-recall was used estimate the consumption of food and beverages, as well as intakes of energy, nutrients, and other food components. A proxy is used for young children who are unable to recall or answer specific dietary questions. A proxy will always respond for a child under the age of 6 years and the child does not need to be present for the interview. For children between the ages of 6-8 years, a proxy will be the primary responder but the interview will occur with the child will be present and may interject to provide further dietary information. The proxy for any child under 9 years old may be anyone who is knowledgeable about the child's dietary intake. For ages 9-11 years old the child will be the primary respondent but will be assisted by an adult. In some cases the proxy may not be able to provide information about food eaten at school or at daycare so information is dependent upon the child's response.

To determine if children are meeting the recommended intake of fiber, we must compute a percentage of their estimated intakes compared to the recommended levels. The percent of recommended intake will equal fiber intake (grams/day) divided by the Adequate Intake (AI) for the specific age group multiplied by 100. To classify adequacy of fiber intakes, if the percentage is below 100% of the AI, the child will be categorized

as not meeting the recommended intake of fiber using the current AI for total fiber

(grams/day) in the table below (12).

Age Group (years)	Male (grams/day)	Female (grams/day)
1-3	19	19
4-8	25	25
9-13	31	26
14-18	38	26

Age and Gender-based Adequate Intakes for Fiber (g)

To assess the weight status of children, NHANES collects body measurements

used to examine the associations between body weight and health and nutrition status and

to estimate the prevalence of overweight and obesity in the United States population. We

will use the body measurements of height and weight to compute BMI status. We will

generate BMI for age percentiles using EpiInfo and recode our results into obesity categories listed in the table.

BMI (kg/m^2)	Classification
< 5th	Underweight
5-85	Health Weight
85-95	Overweight
>95	Obese

Weight status classifications for children based on BMI-for-age-percentiles from the CDC growth charts

d. Instrumentation and data analysis

We will analyze data from

NHANES to determine if total fiber intake is correlated with the BMI of children. We

will generate the mean total of energy adjusted fiber (grams/1,000 kcals) intakes and

calculate the percent of AI for fiber by age group and weight status. These percentages

will determine if children are meeting their recommended dietary needs. We will use a

Pearson correlation to determine if a relationship exists between BMI-percentile and fiber

intake among children. The computed R value will signify the direction and strength of

the correlation between fiber intake and BMI status.

Analysis of variance (ANOVA) will be used to compare differences in mean fiber intakes and percent of AI by age and BMI status. Chi Square will be used to compare differences in the proportion of children meeting AI for fiber by age and BMI status. Results from ANOVA and Chi Square will determine if there are age differences in total fiber intakes among children by obesity status.

This data will be tabulated for analysis using SPSS (version 19.0). All analyses will be conducted using the SPSS Complex Samples (version 19.0) to account for the stratified, multi-staged sampling technique used in subject selection.

Facilities and/or Resources and Equipment Needed

The data analysis will be performed in Dr. Taylor's laboratory, which contains the software necessary to analyze the complex survey data.

Timetable for Data Collection:

Project Objectives and Tasks	Autumn	Winter	Spring
Data Preparation			
Access public use data files	░		
Training of software	░		
Data preparation	░		
Statistical Analysis			
Conduct analyses		▒	
Generate tables		▒	
Complete Thesis Document			
Develop results and discussion			▓
Present research at Ohio Dietetic Association and Denman			▓
Thesis defense			▓

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