EVALUATION OF DIETARY INTAKE OF
ADOLESCENT FEMALES WITH PHYSICAL DISABILITIES

A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Science in
Family and Consumer Sciences

by

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May 2002
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ABSTRACT

EVALUATION OF DIETARY INTAKE OF
ADOLESCENT FEMALES WITH DISABILITIES

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OBJECTIVE  To evaluate the dietary intake of adolescent females with disabilities using the Healthy Eating Index to identify problematic dietary habits. Thirty one 24-hour recalls were collected by an interviewer over the telephone. The data was analyzed using the Food Processor Nutrient Analysis Program and the Interactive Healthy Eating Index.

SUBJECTS  Thirteen adolescent females with physical disabilities between the ages of 12 and 19 years old participated.

DESIGN  Descriptive study to analyze and evaluate 5 components of the participants' diets. This study measured total Healthy Eating Index score, variety score, percent of calories from fat, servings of fruit and vegetables, and milligrams of calcium consumed. Three 24-hour recalls were collected for 12 participants with two 24-hour recall gathered for 1 participant. A total of thirty-one 24-hour recalls were obtained from telephone interviews.
ANALYSIS The 24-hour recalls were entered into the Food Processor Nutrient Analysis computer program and the Interactive Healthy Eating Index computer program available on the internet.

RESULTS Dietary intake as measured by 5 components scored in the “Needs Improvement category and was noted to be excessive in fat, deficient in number of servings of fruits and vegetables, and poor in calcium intake.

CONCLUSIONS/IMPLICATIONS The dietary habits of female adolescents with physical disabilities were comparable to non-disabled adolescents. Intake of fruit, vegetables, and calcium were below recommended intakes. The findings in this study are consistent with reported findings of similar studies. The HEI is a useful tool to generally measure quality of diet, but may not be a sensitive indicator of diet quality.
CHAPTER I
INTRODUCTION

The United States has the most sophisticated national nutrition monitoring system in the world (1). While a number of different groups are studied, adolescent females with physical disabilities are an under-served population with regards to inclusion in scientific research collecting and evaluating dietary intake (2). A review of current literature revealed that tools to assess diet and physical activity in disabled populations are lacking. Further research is needed to evaluate the quality of disabled female adolescents' diet in order to develop and administer appropriate interventions to improve dietary intake and overall health.

It is well documented that the dietary habits of adolescents are unhealthful and could benefit from interventions (3, 4). Adolescence is considered to be a nutritionally vulnerable period during which a teen experiences dramatic growth with changes in lifestyle and food habits. Adolescents with disabilities or chronic illness, those active in sports, or with imposed dieting restrictions may have special nutritional requirements that require intervention (5).

An ongoing pilot study funded by the California Breast Cancer Research Program (BCRP F60B- 0102) plans to develop appropriate and relevant tools to measure physical activity and diet in adolescent females with physical disabilities. The end goal of the study is to develop a research plan
about the etiology of breast cancer and the relationship to diet, physical activity, and serum hormone levels in adolescent females with physical disabilities. A total of 250 girls with disabilities will be recruited from two school districts in Southern California and then interviewed on three occasions using a 24-hour recall to assess dietary intake. The intake data will then be used to help develop methods of dietary intake in a population of adolescent females with disabilities (2).

The purpose of this thesis was to use the data collected thus far from 13 participants who completed between one and three 24-hour dietary recalls with a total of 31 dietary recalls for evaluation of the dietary intake. The 24-hour recalls were evaluated using two computer-based programs, the Food Processor Nutrient Analysis program (6) and the Interactive Healthy Eating Index (7). The intake data was then analyzed for percent of calories from fat, number of fruit and vegetable servings, total Healthy Eating Index score, variety, and calcium consumption as compared to current government recommendations.

The Healthy Eating Index (HEI) used is a 100-point analytic scoring tool used to measure conformity to the recommendations of the Dietary Guidelines for Americans and the Food Guide Pyramid (8). This tool, developed by the United States Department of Agriculture’s (USDA) Center for Nutrition Policy and Promotion, allows researchers to analyze the quality of dietary intake and provides a quantified score, which allows for comparison of HEI scores. The USDA plans to use the HEI to monitor dietary patterns among Americans over
time to be published periodically as data based on nationally representative samples becomes available (8). This study utilized the HEI to measure the diet quality and of adolescent females with physical disabilities, specifically calculating total HEI score and the variety component score from the 24-hour recall data. The results were then compared against similar data the government has published using the HEI to evaluate the diet of Americans.

**Statement of the Problem**

The purpose of this descriptive study was to measure and evaluate the dietary intake of an underserved population using the Healthy Eating Index in order to determine compliance with current dietary recommendations.

**Objective**

To evaluate the dietary intake of adolescent females with disabilities using the Healthy Eating Index.

**Definitions:**

- Disability: Anything that interferes with activities of daily living (2).
- Dietary Intake: solid and liquid food substances consumed in the course of normal living (10)
- Adolescents: individuals between twelve and twenty-one years of age (2).
Assumptions

• The dietary data collected from phone interviews was truthful and indicative of the subjects’ usual dietary intake.

• The Healthy Eating Index food portions and nutrient analysis correspond to that of the Food Processor program and are representative of typical foods consumed by study participants.

• The current government recommendations and guidelines for adolescent females are indeed the optimal diet for adolescent females with disabilities.

Limitations

• The 24-hour recalls were not collected by the author of this paper, therefore the food lists entered into the Healthy Eating Index Interactive website may have been misinterpreted.

• The food lists offered by the Healthy Eating Index used by the author did not directly correlate with the food list in Food Processor program used by the interviewer.

• Small sample size (n=13) which limits generalizations of the results.

• All subjects were from Southern California and may not be representative of the national population.

• This study did not compare the dietary intake data to a control group of adolescent females without disabilities.
CHAPTER II
BACKGROUND AND SIGNIFICANCE

The association between dietary intake and health status has been and continues to be extensively researched. Adolescents are at a nutritionally vulnerable period when healthful eating habits are needed to attain optimal growth and development and to reduce the risk of chronic disease. In order to ensure healthful eating habits, adolescent food intake must be assessed to understand and quantify their dietary intake. A review of literature of nutrition-related studies revealed a lack of research including adolescent females with physical disabilities (3, 4, 5, 12, 14). Tools to assess dietary intake of adolescents with disabilities are not available and this group has not been studied to see if current methods of assessing diet are appropriate. Surveillance data suggest that the number of individuals with disabilities is increasing, especially among those younger than 18 years old (2). In order to design effective intervention programs to improve their diets, disabled adolescents need to be included in research to understand their particular dietary intake. Adolescent females with physical disabilities remain an underserved population in nutrition-based research with a limited number of tools available to assess dietary intake.

Including individuals under the age of 18 years represents a special challenge due to stringent guidelines. Guidelines for accessing minors include the need for parental consent and participant assent, which involves
contacting and educating the parents and participants about the proposed study. This additional effort often proves limiting when recruiting subjects. Another prohibitive factor is that young subjects are in school and are often without transportation, thereby making them less mobile and less available as they should not be removed from their schooling and planned activities. Furthermore, though most subjects have underreported intake, both adolescents and females consistently underreport dietary intake, often providing questionable accuracy of dietary recall data (11). Lastly, the recruitment pool for this type of study is much smaller than those studies that require a more general subject.

Despite the obstacles, young females with disabilities should be included in research in order to help prevent chronic disease, better address the obesity epidemic among children, and more accurately target nutrition education programs for adolescents. Recent reports from national nutrition surveillance data suggest that few adolescents are meeting dietary guidelines (12). The typical adolescent diet is high in saturated fat, total fat, sodium, and soft drink beverages and low in fruits, vegetables, fiber, and calcium-containing foods. Given these unhealthy tendencies the diet of adolescents may impede optimal growth and development and is increasing their risk for cardiovascular disease, cancer, and osteoporosis (13, 14).
Nutrition in Adolescence

The nutritional requirements of adolescents are influenced primarily by the normal occurrences of puberty and the simultaneous growth spurt. Puberty is an extremely anabolic period, with increases in height and weight, alterations in body composition from increased lean body mass, increased quantity of fat, and enlargement of many organ systems (10). Adolescents experience an increase in the velocity of physical growth thereby increasing nutritional requirements. Great variability in growth is found between adolescents during physiological maturity even among the same gender; therefore, age is a poor indicator of nutritional requirements. Weight, height, age, Body Mass Index (BMI), secondary sexual characteristics, and activity all need to be considered when estimating individual needs and assessing dietary intake (5). BMI is kilograms divided by meters squared and is used as a reference to compare a person's weight and height. Moreover, the lack of data on the nutrient needs of adolescents limits the ability to develop appropriate dietary recommendations (10). Current government guidelines generally recommend females ages 12-19 to consume 2,200 calories daily to ensure adequate intake during growth periods (5). Based upon the government's Food Guide Pyramid, adolescents are encouraged to consume 9 serving of grains, 4 servings of vegetables, 3 servings of fruits, 2 servings of milk, and 2.4 servings of meat daily to meet the increased needs for energy, vitamins, and minerals (8).
Additionally, the government dietary guidelines stress the importance of variety, moderation, and balance in food choices. Sampling different foods from all food groups allows for greater exposure to essential nutrients. Many adolescents tend to eat the same kinds of foods repeatedly, thereby resulting in intakes below the Recommended Dietary Allowances. The limited eating patterns exhibited by adolescents may have resulted from food neophobia during childhood, which prohibits trying new foods out of fear that the food would be unpalatable (13). This behavior contributes to poor dietary quality inasmuch as variety greatly enhances dietary quality.

**Dietary Intake of Adolescents**

The correlation between dietary intake and health is substantial. Two thirds of all deaths among adults in the United States resulted from cardiovascular disease and cancer (12). One third of those deaths can be attributed to dietary patterns (12). An increased risk of cardiovascular disease is attributed to diets high in saturated fat and total fat (10). Diets low in fruits and vegetables as seen in a typical teen diet, are often also low in fiber and high in fat and are associated with an increased cancer risk (12). The relationship between the adolescent diet and chronic diseases is based upon the assumption that eating behaviors are learned and solidified during childhood and adolescence and are sustained into adulthood, which emphasizes the importance of identifying and subsequently improving unhealthy dietary behaviors during adolescence (12).
For adolescents, the recommended intake of total fat is less than 30% of total caloric intake (17). Nutrition surveillance data revealed that only 36% of girls ages 12-19 years limit fat intake to 30% of total calories consumed (15). Excess fat intake contributes to heart disease and obesity occurs among all income groups and racial/ethnic groups of adolescents. The National Health and Nutrition Examination Survey (NHANES) data showed little change in the mean energy intake from 1970 to 1988-1994 except for an increase among adolescent females probably secondary to the increase of energy dense fat containing foods (15).

A study by Lee et al (16) divided 192 girls into two groups based upon percent of calories from fat. A high fat (>30% calories from fat) group and a low fat (<30% calories from fat) group were designated based upon 3-day dietary recalls. The HEI, a tool to measure how well diets conform with national guidelines, was used in this study to assess the quality of the two diets. Girls in the high fat group consumed fewer fruits, more meat, fats, and sweets and also had lower HEI scores as compared to the low fat group. Girls in the high fat group also had lower intakes of fiber and vitamins A, C, B6, folate, and riboflavin (16).

Government surveillance data suggest that few adolescents meet the recommended number of servings of fruits and vegetables each day (17). Fruits and vegetables are important sources of phytochemicals, fiber, vitamins, and are low in fat and sodium. Studies have shown an inverse relationship between fruit and vegetable intake and breast cancer (18-22). Data collected
from the United States Department of Agriculture Continuing Survey of Food Intakes by Individuals (CSFII) show that only 23% of girls aged 12-19 years eat 2 or more servings of fruit daily, and only 38% of girls eat 3 servings of vegetables daily. The Youth Risk Behavior Surveillance Survey (YRBSS) for 1999 reported that fewer than 25% of students in grades 9-12 ate at least 5 servings of fruits and vegetables daily (12). Of all the food groups, adolescents are most deficient in number of servings of fruits and vegetables consumed (15).

Eating habits during adolescence may have long term effects on future risk for osteoporosis, especially for females. Women are at greater risk for developing osteoporosis than men; there are 25-30 million American adults afflicted with osteoporosis (12). In order to protect against osteoporosis, is it imperative to maximize peak bone mass by the second decade of life. Consequently, adequate calcium intake during adolescence is crucial to maximize bone density and the recommended daily intake of calcium for adolescent females is 1,300 mg (23). National Health and Nutrition Examination Survey (NHANES) III data showed the intake of calcium among adolescent females peaks at childhood and declines during adolescence (12). Only 19% of females aged 12-19 years from the NHANES III data consumed the daily calcium requirement of 1,300 mg per day (24). Decreasing calcium intake during adolescence is attributed to the increase in soft drink consumption (12). The replacement of milk with soft drinks not only reduces
calcium intake but also provides phosphoric acid, which is antagonistic to the calcification of bones (25).

Many factors shape adolescent eating behaviors. Teens are starting to buy and prepare their own foods, often eating rapidly and away from the home. Meal patterns are hectic, with meals skipped or missed and with extracurricular activities and school to interfere with set meal times. Females tend to miss more meals than males perhaps because of societal pressures to be thin or as to appear to not eat too much (14). The busy adolescent often relies upon fast foods for meals or snacks whether from vending machines, fast food outlets, or convenience groceries. These poor food choices are often low in iron, calcium, riboflavin, vitamin A, and folic acid and provide greater than 50% of calories from fat (10). Dietary intake may also suffer out of concern with physical appearance and body weight often leading to inadequate nutritional intake (5).

Brady et al (3) specifically compared children’s dietary intakes with national recommendations using the major components of the Food Guide Pyramid developed by the United States Department of Agriculture (USDA). Three 24-hour recalls were analyzed using the USDA Pyramid Servicing Database, which allows assessment of intake from the major components of the Food Guide Pyramid by putting data from a 24-hour recall into food groups. The study found that only 5% of 110 subjects consumed the recommended fruit servings per day while the tip of the Pyramid (discretionary fats and added sugars) accounted for nearly 50% of the dietary intake. The
females in the study consumed more energy per day from discretionary fat than males.

There is no dietary data available for adolescent females with physical disabilities to compare to the above data collected on adolescents.

In conclusion, concern for improving the dietary behaviors of adolescents is of paramount importance in the United States. Until data on dietary intake for adolescent females with disabilities is collected, specific interventions to improve their diets are misguided and gleaned from data using non-disabled adolescents. Reliable and usable dietary intake data from adolescents needs to be collected using the proper tool for the specific population. Proper diet assessment is the first step to address the underserved population.

Diet Assessment

The Guidelines for Adolescent Preventative Services (GAPS) and Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents recommend that adolescents receive annual health supervision and guidance to change dietary habits (26). In order to provide yearly health supervision, adolescents need to be screened for nutritional risk factors and a diet assessment performed to measure diet quality. Dietary assessment can identify problematic behaviors that require modification (26).

The initial dietary assessment of a subject includes collecting data on usual eating patterns to ascertain the presence of nutrition risk indicators. A
more detailed dietary assessment can then determine the overall quality of the diet and provide data about specific dietary components (26). Measuring dietary intake allows researchers to correlate between diet and the presence or risk of chronic diseases, serum lab values, and anthropometric measurements (5).

Over the past few decades, a variety of diet assessment tools have been developed to record dietary intake data (27). Four common dietary assessment methods are available, the 24-hour recall, food frequency questionnaire, food record, and diet history, each with particular strengths and limitations in use (28). All four methods ask subjects to describe foods eaten from one day up to years depending upon the method used (11). Prior to initiating diet assessment, available staffing, levels of motivation and literacy of the participant, resources to collect, analyze, and interpret data, and cost must be considered to ascertain the most appropriate tool to use (29).

The 24-Hour Recall method was used for this study because it does not require literacy, has a low respondent burden, involves minimal memory recall, and is therefore appropriate for the adolescent population. The 24-hour recall is a method, which involves an interviewer probing a subject to recall all foods eaten in the past 24 hours. The tool is usually a single piece of paper with a list of meals and snack times to guide the interview. The 24-Hour Recall does not require literacy, can be administered in a timely fashion, the data collected can be immediately transferred to a dietary analysis program, and can be conducted in person or over the telephone. The 24-hour recall is inexpensive,
has a low respondent burden, and can be used in clinical settings. The limitations of use include the requirement of a skilled interviewer, the reliance upon memory and self-reported information, the lack of representation of usual intake with only one recall, and the difficulties with language barriers (26). Additionally, reported intake may reflect what the interviewer wants to hear, or does not reflect differences in days, seasons, or shifts, and low intakes may be over reported and high intakes underreported to impress the interviewer (10). A single recall is best used to provide information about a population, not an individual because it does not provide adequate quantitative data. Nevertheless, the 24-Hour Recall is applicable to most people and allows for assessment of variety of nutrients and food groups in addition to meal patterns.

The most widely used diet assessment method is the food frequency questionnaire (FFQ) because it is easy and cost effective to administer, assesses present and past dietary intake, and is useful as a screening tool (30). The FFQ is a list of usually 60–100 commonly consumed foods of which the participant is to designate how often they eat each food on a scale of never to six or more times per day. FFQs are useful in ranking individuals with regards to dietary intake, can be used in large population studies, and are free from observer bias (10, 27). Unfortunately FFQs do not assess meal patterning and may be difficult for adolescents with limited cognitive development in addition to being time consuming, with usually 100 or more items to rate. Furthermore, computers or special programs are needed to
analyze the data and each questionnaire needs validation. Also a self-administered questionnaire receives incomplete responses and lower response rates (10).

The food record is a tool in which the participant keeps a list of foods eaten throughout the day. It is to be used each time food is consumed to maximize accuracy. The food record is useful in that it does not rely on memory and food portions may be measured at time of consumption for greater accuracy of reporting. However, the recording of foods may influence intake thereby not reflecting actual intake and the food record requires literacy, time, and a trained staff to instruct the participant (26).

A diet history involves just one interview to assess diet and is appropriate for most people and is useful in longitudinal studies. By taking a general history of intake, individual day-to-day variations are eliminated, as are seasonal variations. The results provide a more complete and detailed description of both qualitative and quantitative information as compared to the other diet assessment methods (10). On the other hand, a diet history relies upon memory recall and requires highly motivated and literate subjects. A highly skilled interviewer is needed and a diet history usually takes 1-2 hours to administer along with high costs to check, code, enter, and analyze the data (26).

Despite the variety and constant improvement of available tools, accuracy remains a problem when assessing dietary intake (27). All dietary assessment methods are imperfect. Reliability and validity of diet assessment
tools are important to the significance of the data collection. Reliability addresses whether the tool is able to measure consistently over time, if the results are reproducible and validity addresses whether what is being measured is intended to be measured (11). Each diet assessment tool varies with respects to reliability and validity. All of the previously mentioned four methods for determining food intake are generally reliable and a biomarker was developed to test these methods for validity (11).

A biomarker is a variable measured in body fluids or tissues which independently reflects intake of food components (11). Doubly labeled water is an example of a biomarker that has been used to validate self-reported energy intakes and is considered the “gold standard” of diet assessment methods (11). Doubly labeled water is a technique that measures total daily energy expenditure in humans depending upon the principle of energy balance. Subjects drink stable isotopes of oxygen-18 and deuterium, and after a 12 to 14-day period, urine carbon dioxide production is measured (11). Studies using doubly labeled water have identified widespread underreporting of intake, especially among women, obese individuals, and children as they age (31). However, high cost, participant burden, and limited information restrict widespread use of doubly labeled water (30).

Reliability and validity of self reported food consumption is largely influenced by the way respondents interpret and respond to the dietary assessment instruments, especially when unhealthy foods are consumed (31). If assessment tools do not include snacks, simple meals, prepared foods, or
fast foods, the responses may be altered to fit within the questionnaire, thereby making the diet appear healthier (31). The FFQ avoids this by listing all foods whether snacks or meals. If a diet assessment tool lists snacks, fast foods, prepared, and packaged foods, respondents may view those choices as acceptable food choices and accurately report consumption of those foods. Studies have shown that snacks in particular tend to be underreported probably because subjects tend to recall or record the three traditional meals and do not remember to include foods and beverages eaten between meals (27). However, snacks are common in the adolescent diet and contribute greatly to total calorie intake, and if not reported, result in underreporting of dietary intake (14). Adolescents should be specifically instructed to recall all foods eaten and not just meals. Most dietary assessment methods were designed for and tested by white adults and necessitate modifications for other age and ethnic groups (31).

All methods of obtaining dietary intake information are subject to memory lapses, inability to judge portion sizes, failure to record foods faithfully, attempts to simplify recording, conscious altering of intake habits while recording, and failure to record foods eaten in excessive amounts (27). Characteristics like BMI, age, ethnicity, and weight history are associated with low-energy reporting during diet assessment and the subsequent reduction of reported intake (32). Dietary intake is least reliable from obese subjects, white non-Hispanic women, minimal formally educated subjects, lower socioeconomic groups, and from those who smoke (30, 31). One study
reported that percentage of body fat and the inability to read and spell were predictors of misreporting data (27). Another study found that biased over or underreporting of energy intake is characteristic of certain persons therefore repeat measurements do not increase validity of measurements because those subjects will continue to over or underreport (33).

Obtaining dietary intake data from adolescents requires additional effort to ensure accuracy of reported intake because intake is sporadic and changes rapidly (10). The 24-hour recall is the most common tool used with adolescents, because they can easily recall the most recent foods and beverages working backwards in time (26). The interviewer can prompt the participant using daily routines such as school and after school activities to help recall recent items eaten. Pictures or lists of commonly consumed foods like snacks, beverages, and condiments can further improve the accuracy of the recall, especially if English is not the primary language (14). Accuracy also depends upon correctly estimated portion sizes in which pictures or comparisons to common objects may help. A visual depiction of foods has been shown to be effective with teenagers, yet has not been validated for use with children or adolescents (11). Lastly, the adolescent participant should be asked how typical the recall was compared to usual intake with exceptions noted and used in analysis (26).

In effort to obtain accurate data from child subjects, Johnson et al (11) tested a new method to estimate food intake on a sample of young children. The multiple-pass 24-hour recall method involved three passes designed to
limit underreporting. For the first pass, the participant created a quick list by recalling everything eaten on the previous day. The second pass then asked the respondent to clarify the foods recalled for the quick list. The interviewer prompted specific details of each food item listed. The third pass involved a review of the list of foods and additional probing for intake between meals and a final clarification of portion sizes. The multiple-pass 24-hour recalls were compared against total energy expenditure and no over or underreporting was noted (11).

**Healthy Eating Index**

The United States government monitors the dietary status and nutrition-related health status of the US population to make recommendations and interventions to improve Americans' health. Some programs instituted by the US government include the US Dietary Guidelines for Americans, the Food Guide Pyramid, and the National Cancer Institute 5 a Day for Better Health (1). The USDA developed the Healthy Eating Index (HEI) to provide a standard for assessing overall dietary quality. The HEI was developed to serve as a report card for the American diet and to monitor changes in food consumption patterns (8). Given the lack of standardized method to report changes in the American diet, the HEI is a single summary measure that allows for effective surveillance of changes in food consumption patterns (8). The HEI measures how well Americans' diets conform to the Dietary Guidelines for Americans and the Food Guide Pyramid (34).
The Dietary Guidelines for Americans and the Food Guide Pyramid suggest to select foods from a variety of food groups, to choose foods that are low in fat, saturated fat, cholesterol and moderate in salt and sodium (17). Ten dietary components are measured in the HEI reflecting the complexity of various dietary patterns. The HEI provides a score of diet quality, degree of variety in the diet and compliance to specific dietary guidelines and recommendations as developed by the USDA and Department of Health and Human Services (8).

The HEI is scored from zero to 100 with 10 dietary components evaluated worth 10 points each. For each component, a 10 would indicate the person consumed the recommended level of the specified food and a zero would indicate the person ate none of the recommended foods. Components 1-5 designate each section of the Food Guide Pyramid (excluding the tip section of discretionary fats and sugars) and sections 6-10 designate intake levels of total fat, saturated fat, cholesterol, sodium, and variety in a 3-day diet, respectively (8).

The average American diet is high in total fat and saturated fat and low in fiber and complex carbohydrates (8). To determine the HEI scores among Americans, the Agricultural Research Service of the USDA collected information from the Continuing Survey of Food Intakes by Individuals (CSFII). The CSFII provides data on the Nation's consumption of foods and nutrients in addition to the dietary status of individuals, with data being collected since 1936 (1, 35). Three days of dietary intake data were collected for 4,000
participants in 1989 and 3,400 participants in 1990 using face-to-face interviews. The sampling was weighted to be representative of the U.S. population. The average overall HEI scores from 1989 and 1990 were 63.8 and 63.9 respectively with a maximum possible score of 100. Most of the scores fell between 51 and 80, which is designated the “Needs Improvement” range. A mere 12 percent of Americans scored an 80 or above on the Index. Participants scored lowest in fruit and saturated fat intake among the component scores indicating a need for improvement to increase fruit consumption and decrease saturated fat intake. Dietary variety was the component score with the highest average, which indicates that most Americans choose from at least 16 different foods per day. Index scores revealed that females had higher average index scores than males and index scores increased with increasing levels of education and to a lesser degree, income. Individuals in the 15-39 year age category had lower average HEI scores. A higher index score is not only associated with a healthier diet but also an increased probability that at least 75 percent of the RDA for most nutrients will be met (34).

Another government-sponsored study utilized the data from the 1994-1996 CSFII study to compare prototype popular diets such as vegetarian, low carbohydrate, and high carbohydrate, using the HEI to measure the quality of each diet (36). A high carbohydrate diet with a Food Guide Pyramid pattern achieved the highest HEI total score of 82.9 and a low carbohydrate diet received the lowest score of 44.6. The results are expected given the HEI was
primarily based upon the principles of the Food Guide Pyramid and any diet following that pattern would score high. However, even though the pyramid recognizes meat alternates, the vegetarian diet scored significantly lower than the non-vegetarian diet because overall energy intake of the vegetarian group was low at 1,600 calories (36).

The HEI was validated using plasma biomarkers in a sample of women (37). The purpose of the study was to link HEI scores to plasma biomarkers of dietary exposure. The researchers collected measurements of plasma carotenoids, vitamin C, and folate, which did correlate strongly with four components of the HEI, dietary variety, fruit intake, low fat and saturated fat intake. The higher HEI scores also were associated with higher intakes of energy, carbohydrates, fiber, folate, and vitamin C (37). This study helped to validate the HEI as an indicator of a diet that follow the current guidelines.

McCullough et al (38) tested whether the HEI scores calculated from a FFQ would predict risk of major chronic disease in women. The HEI score was not associated with risk of overall major chronic disease in women, and the authors concluded that adherence to the Dietary Guidelines for Americans has limited benefit in preventing major chronic disease in women. The same researchers (39) tested whether a high HEI score could predict lower risk of chronic major disease in men using food frequency questionnaires from a cohort of American male health professionals. A weak, inverse association between HEI and risk of chronic disease was observed. The researchers suggest that improvements to the HEI may be warranted and further research
could have implications for refinements to the Dietary Guidelines for Americans and the Food Guide Pyramid (39).

A study of 70 fourth- and fifth-grade students used three days of dietary data to compute the HEI score, with one third of the children classified as neophobic (13). Neophobia is a personality trait, one who avoids novel foods out of the mistaken belief that they will be unpalatable, and because of this avoidance, never has this belief been corrected (13). The neophobic group scored a mean of 6.2 for the variety component score as compared to a 9.7 mean score for the average children. The neophobic children also had the lowest mean HEI score of 62.3 as compared to the average and neophillic group of 66.1 and 70.4, respectively. Lower saturated fat and variety component scores contributed most to the significant differences between the neophobic and average and neophillic groups. The results of this study illustrate the importance of variety of dietary intake and the impact on dietary quality as measured by the HEI (13).

The HEI has been shown to correlate with adherence to dietary recommendations and is somewhat useful to assess quality of diet. Though the HEI is unable to predict risk of major diseases, it can be helpful to identify dietary intake that does not conform to government guidelines.
The purpose of this study was to evaluate the dietary intake of adolescent females with disabilities. Research regarding dietary intake in adolescent females is scarce, therefore, additional research is needed to understand how young women eat and to measure the quality of their diet.

This thesis began by using data collected from an ongoing pilot study funded by the California Breast Cancer Research Program to develop appropriate and relevant tools to measure physical activity and diet in adolescent females with physical disabilities. The end goal of the study is to develop a research plan about the etiology of breast cancer and the relationship to diet, physical activity, and serum hormone levels. A total of 250 girls with disabilities will be recruited from two school districts in Southern California and then interviewed on three occasions using a 24-hour recall to assess dietary intake. The intake data will then be used to help develop methods of dietary intake in a population of adolescent females with disabilities (2).

The subjects used for this thesis included 13 girls aged 10 to 19 years old with physical disabilities who were interviewed via telephone to gather dietary intake data using the 24-hour recall method. Between one to three 24-hour recalls were obtained for each participant with 92 percent of the participants completing two or more recalls. The telephone interviewer was
previously trained to obtain dietary intake information using the telephone interview format. Parents for each participant provided informed consent and each girl volunteered and gave assent prior to being interviewed. The interviewer then proceeded to call the girls at their homes in the afternoons and evenings to gather intake data using the 24-hour recall.

The interviewer then entered each 24-hour recall into the Food Processor Nutrient Analysis Program for Windows version 7.70 (6). From the Food Processor program, the nutrients per serving, including the percent of calories from fat and number of fruit and vegetables servings per day was calculated as was the milligrams of calcium per day. Each participant was assigned an identification number for the computer program and a complete nutrient analysis and the current recommendations were created for each 24-hour recall entered. A total of 31 24-hour recalls were entered for analysis into the computer program.

The 31 itemized food lists that were entered into the Food Processor program were then entered into the United States Department of Agriculture Interactive Healthy Eating Index website program (7). The profile selected for each 24-hour recall was a teenage female with a recommended caloric intake of 2200 kcal per day as per government recommendations. Once the food lists were entered using the available food database, the interactive program calculated the total HEI score and variety component score for each subject.

With five components for each subject’s diet, an average score was calculated for each component including the percent of calories from fat,
number of fruit and vegetable servings, milligrams of calcium per day, total HEI score and variety score. Every participant had an average score for each component depending upon how many 24-hour recalls each subject had completed. The five averaged scores for each subject were then compared against each other using Microsoft Excel figures. The HEI scores for each participant was entered into an Excel table and then displayed as an Excel figure. Five figures were created for each of the 5 components. The results were also compared to data from the CSFII study in which the HEI was initially tested by the USDA (34). The HEI scores are categorized as “Poor” which is a score below 51, “Needs Improvement” which is a score between 51 and 80, and “Good” which is a score above 80, as defined by the HEI guidelines (8).
CHAPTER IV
RESULTS

Characteristics of the sample population, as shown in Table 1, had a mean age of 15.6 years with ages ranging between 10.25 and 19.5 years old. The subjects' BMI scores ranged from 15, which is considered underweight, and 50 which is designated as morbidly obese (10). The average BMI score was 25, which is considered appropriate. Average caloric intake per day was 1,234 calories which meets only 56% of the recommended 2,200 calories (8). The mean calorie intake ranged from 610 to 1782 calories per day. The component scores are listed in Figures 1 to 5.

Healthy Eating Index Total Score

As shown in Figure 1 the average total HEI score was 61. An overall HEI score of 61 rates in the “Needs Improvement” category of scores between 51 and 80. The HEI scores ranged from a low of 51 to a high of 72, with no scores in the “Poor” or “Good” categories (See Figure 1).

Average variety scores were also calculated from the HEI. I looked at variety to see to what degree a low variety score affects the HEI score, or if the HEI scores were higher because of high variety scores. The variety component comprises one-tenth of the total HEI score. Dietary quality is achieved in part by dietary variety, which increases exposure to nutrients. Other components evaluated from the Food Processor Nutrient Analysis
Program were percent of calories from fat, number of servings of fruits and vegetables, and calcium consumption. High fat diets, low fruit intake, and low calcium consumption have been identified as unhealthy practices exhibited by teenagers (5,10, 14, 26).

Variety Score

The tenth component of the HEI is based on the amount of variety in a person’s diet. The criteria for a perfect score of 10 are 16 different kinds of foods items consumed over a 3-day period. The criteria for a minimum score of zero are 6 or fewer food items consumed over a 3-day period. The participants had an average variety score of 7 with scores ranging from 3 to a perfect score of 10 (see Figure 2).

Percent of Calories from Fat

As shown in Figure 3, the participants consumed an average of 31 percent of calories from fat, slightly above recommended levels. The percent of calories from fat ranged from 23 percent to 40 percent.

Servings of Fruits and Vegetables

The adolescents in this study consumed on average a total of 2 serving of fruits and vegetables per day. One subject consumed no fruits nor vegetables while another subject consumed an average of 3.7 servings per day (see Figure 4).
Calcium Intake

Adolescents have a high requirement of 1300 milligrams of calcium per day for bone mineralization to help maximize peak bone mass at skeletal maturity (23). All subjects in this study fell short in consuming the recommended 1300 mg. of calcium per day with an average calcium intake was 524 mg and ranging from 259 to 827 mg calcium per day (see Figure 5).

Table 1. Characteristics of Study Population (n=13)

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<th>Age</th>
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<th>HEI</th>
<th>Variety</th>
<th>% fat calories</th>
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Figure 1. Total Healthy Eating Index Score
Figure 2. Variety Component Score

Variety Score

Subjects
Figure 3. Percent of Calories from Fat
Figure 4. Fruit and Vegetable Intake
Figure 5. Milligrams of Calcium per Day

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CHAPTER V
DISCUSSION

The purpose of this descriptive study was to measure and evaluate the dietary intake of an under-served population using the Healthy Eating Index. Thirteen adolescent females with disabilities were assessed using 24-hour recalls. The recall data was then analyzed using a computer database program to determine the percent of calories from fat, number of servings of fruits and vegetables per day, and consumption of calcium. The Healthy Eating Index was then used to measure the overall healthfulness of the diet and the variety of intake. A total of thirty-one 24-hour recalls were collected and used to evaluate dietary intake of the adolescent females.

Previous studies have documented the poor quality of the adolescent diet (5, 10, 12, 26). The results of this study disclose similar results for adolescent females with disabilities. The diets exhibit deficiencies of fruits, vegetables, and calcium and an excess intake of dietary fat. Their diets overall were rated to need improvement yet contained adequate variety in food choices. As a result, there was poor compliance with dietary guidelines and government recommendations.

Healthy Eating Index Total Score

One subject had only one day of dietary recall data available to tabulate the HEI score as opposed to the USDA study of the CSFII data to calculate
HEI that used three days of dietary recalls. When the USDA tested the use of HEI on only the first day of recall data, the results were similar to the three day results with the component scores somewhat lower and the average HEI score dropping 2 points. The lack of variety inevitable in only one day of intake may have contributed to the slight decrease in HEI score in their study and the results are likely transferable to this study (8).

The maximum overall score for the 10 components of the Index is 100 points. The USDA used data from the Continuing Survey of Food Intakes by Individuals (CSFII) in 1989 to initially test the HEI. The average overall HEI score was 63.8 for the 3,997 subjects tested. In 1990, 3,466 subjects’ diets were analyzed with an average score of 63.9 (34). Seventy-four percent of the scores ranged between 51 and 80 points, which is the “Needs Improvement” category. Results from this study’s 13 participants were similar with all scores in the “Needs Improvement” category. The average HEI score was 61, two points lower than the CSFII average. The scores ranged between 51 and 72. Of the 10 separate components, which comprise the HEI total score, the lowest scores came from the saturated fat, dairy, and fruit and vegetable components. Those low scores indicate that the participants consumed greater than 10 percent of calories from saturated fat, had fewer than three servings of dairy products, and ate less than 5 servings of fruits and vegetables. Those three components were responsible for lowering the total HEI score to the “Needs Improvement” category.
The overall results may have been even lower given that the HEI does not pick up on underreporting which was consistent among the 13 girls. As shown in Table 1, the average calorie intake was 1,234 calories per day, only 56 percent of the recommended 2,200 calorie diet (8). Only one 24-hour recall met the total calorie recommendation of 2200 calories per day. The range of calories was 610 to 1782 calories per day, with one 24-hour recall only reporting 217 calories per day. These calorie levels cannot be accurate considering basic energy expenditure principles. Possibly, the participant omitted poor food choices that would have adversely affected the HEI scores. The HEI scores would probably be lower if actual intake were reported.

On the other hand, perhaps the HEI scores would have been higher if intake was accurately reported. The underreporting, due to misunderstanding of portion sizes, or poor memory recall, may have prevented additional healthy food from influencing the HEI score. Since most components of the HEI had scores improve proportionately to increased intake, the HEI score could be higher with more reported foods.

The HEI does not appear to be sensitive enough to account for the effects of underreporting. Despite the low caloric intake, not one subject fell into the “Poor” category and participants’ scores were consistent with large studies’ scores (34). McCullough et al (38, 39) found the HEI to not be a predictor of chronic disease is males or females.
Variety Score

Component number ten of the HEI is based on the amount of variety in a person's diet. The 13 female subjects' scores ranged from 3 to 10 with an average score of 7 for the variety component indicating an overall varied diet. The results are comparable to the data presented by the USDA study including 7,000 subjects, also showing an average score of 7 (34). The results are higher than estimated from observing the food lists which appeared to contain similar foods eaten. Considering the prevalence of underreporting which would tend to limit variety in the diet, the results are better than anticipated. Overall, the average variety score indicates the subjects exhibited healthy food habits by choosing from a variety of foods.

Percent of Calories from Fat

National Guidelines recommend all Americans to consume a diet with less than 30 percent of calories from fat (40). The adolescent females in this study consumed, on average, 31 percent of calories from fat, slightly above recommended levels. Though 31 percent of calories from fat is close to the current recommendations, it still exceeds the upper limits of fat intake and therefore is too high. These results coincide with recent observations of the teenage diet exceeding fat intake recommendations (12, 14, 26).

The 24-hour recalls appeared to include many high fat foods reported including whole milk, sausage patties, and fried chicken. Yet the average percent of calories from fat was only 31 percent even with an overall low
calorie diet as the denominator. Soda consumption was prevalent with meals, possibly adding calories to the diet but diluting the percent of calories from fat because soda contains no fat. Juices and candies, also prevalent among the 24-hour recalls, would have the same effect of lowering the ratio of fat calories to total calories.

**Servings of Fruits and Vegetables**

Research indicates that diets containing at least 5 servings of fruits and vegetables may help prevent cancer, reduce the risk of obesity, heart disease, and hypertension. Perhaps the most disparaging results revealed by this study are the low intakes of fruits and vegetables among the disabled adolescents. The average intake was only 2 servings per day of both fruits and vegetables. One subject did not consume any fruits or vegetables. Sub-optimal servings of fruits and vegetables increase the risk for chronic disease later in life (12).

The number of servings of fruits and vegetables may have even been lower had they been averaged separately, and not combined into one group. By combining the fruits and vegetables, poor intake of fruits and vegetables could be masked. This is because fruit juice was counted in that category yet, fruit juice contains no fiber and is more calorie dense than a piece of fruit. A serving of fruit is considered healthier than an equivalent serving of juice. Additionally, 2 cups of sweetened cranberry juice is tallied equal to a serving of broccoli and spinach, two more nutritious choices. Yet, by combining fruits and vegetables, the component score may not reflect actual intake of fruits
and vegetables. The HEI separates fruits and vegetables into different components because the HEI is based upon the Food Guide Pyramid in which fruits and vegetables are independent sections.

**Calcium Intake**

Fifty percent of people, whose HEI scores are between 51 and 70 points, meet 75 percent of the RDA for calcium (8). The subjects in this study, with scores between 51 and 72, on average met only 40 percent of the 1300 mg RDA for calcium with an average consumption of 524 mg per day. Indicating that the subjects consumed nutrient-poor foods which did not contribute to calcium intake. Such foods include, soda, juices, and candies. Subjects consumed between 1 or 2 servings of dairy products per day, most of which were 2% or whole milk servings, both are sources of saturated fat. The low intake of calcium rich foods results in concern for the proper bone mineralization that should be taking place during adolescence.

The lack of dairy product consumption accurately reflects findings in other studies showing milk consumption decrease as soda consumption increases among adolescent females (12, 25). The majority of adolescent females are not consuming the recommended amount of calcium (25). The NHANES III (24) data found that only 19 percent of the adolescent females consumed the recommended 1,300 mg, whereas none of the subjects in this study met the RDA.
IMPLICATIONS

The preliminary data presented in this paper is consistent with current literature evaluating dietary intake of non-disabled adolescents. Educational programs to improve the diet of adolescents need to also consider females with disabilities, the health concerns are the same. Physical activity is limited in disabled teens, therefore emphasis should be placed on improving dietary habits, not physically demanding exercises.

The health implications of the poor dietary habits exhibited by 13 female adolescents are a cause for concern. The public health ramifications, assuming the dietary patterns are transferable to the larger adolescent population, are major. Health messages need to be communicated to children and adolescents to improve dietary habits in order to thwart the many chronic diseases that afflict adult Americans. The results of this study show that disabled female adolescents, similar to non-disabled adolescents, choose diets lacking in fruits, vegetables, and calcium, and supplement with fatty foods. Therefore, the health education curriculum and programs discussing diet could be the same. Though the materials should differ for the two groups when stressing the importance of physical activity.

The research implications of this study involve the usage of the Healthy Eating Index. The HEI is considered to be a global index to measure the quality of a diet. However, the tool, like most tools, has shortcomings. The HEI does not appear sensitive to underreporting or over-reporting, by not accounting for varied portion sizes or just needing to meet the minimum
servings to get a perfect score. In fact, the HEI seems to reward overeating of carbohydrate and protein based foods, only fats are given an upper limit. Grains, fruits, milk, meat, and variety are designated a daily upper limit of portions and a perfect score is given for consuming above the upper limit. Thus, anyone who ate excessive portions of grains, fruits, milks, and meats would receive a perfect score yet would suffer from over-nutrition. The HEI is a useful tool to measure relative quality of dietary intake for large populations, yet is limited in identifying specific dietary problems and should be used in conjunction with clinical judgment and expertise.

**Recommendations for Further Study**

1. Include a larger sample size of female adolescents with physical disabilities and then match to a control group of non-disabled adolescents.

2. Utilize in person interviewing with pictures of food portion sizes to compare to phone interviews to prevent underreporting.

3. Compare the 24-hour recalls to biomarkers, either a plasma carotenoid or doubly labeled water to validate findings.

4. Measure fruit and vegetable intake separately, giving less weight to fruit juice consumption.
REFERENCES


33. Black A, Cole T. Biased over- or under-reporting is characteristic of individuals whether over time or by different assessment methods. Journal of the American Dietetic Association 2001;101:70-80.


