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Comparing healthy eating index scores to physical activity levels in adults using 20007–08 and 2009–10 NHANES data sets

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Comparing Healthy Eating Index Scores to Physical Activity Levels in Adults using 20007–08 and 2009–10 NHANES Data Sets

By

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Abstract

Research suggests diet intake among adults lacks in healthfulness, which contributes to poor quality of life and increased disease outcomes. This study assesses the relationship between diet quality, using the Healthy Eating Index (HEI), and presence of physical activity (PA). Participants included 11,167 adults ≥ 20yrs with valid NHANES 2007–08 and 2009–10 diet interviews and PA questionnaires. Subjects were divided into sedentary, 1–149 minutes per week of PA (moderate exercisers) and ≥150 minutes per week PA (meets or exceeds PA guidelines) groups based on guidelines set by the Department of Health and Human Services. Dietary interviews were scored for quality using the HEI. Those engaged in PA had higher total HEI scores (50.7 and 49.8) compared to sedentary adults (45.9). Individual dietary component scores showed mixed results, but indicated better diet quality in active individuals over sedentary individuals. These results can be used to improve diet quality in adults by providing insight into current practices.

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List of Abbreviations

Acronym	Meaning
ANOVA	Analysis of Variance
CDC	Centers for Disease Control and Prevention
DGA2010	Dietary Guidelines for Americans 2010
FP	Food Pattern
HDL	High Density Lipoprotein
HEI	Healthy Eating Index
MEC	Mobile Examination Center
MVPA	Moderate to Vigorous Physical Activity
NHANES	National Health and Nutrition Examination Survey
PA	Physical Activity
PAQ	Physical Activity Questionnaire
SD	Standard Deviation
SEM	Standard Error of the Mean
SoFAS	Sum of Calories from Solid Fats and Added Sugars
SPSS	Statistical Package for the Social Sciences
USDA	United States Department of Agriculture

Chapter 1: Background

Poor dietary and lifestyle behaviors add to negative health outcomes in the American population. Several chronic diseases including obesity (and all associated complications), diabetes, heart disease, coronary artery disease, some cancers, and osteoporosis are largely preventable through healthy eating habits. Over one-third of American adults are obese which equates to nearly 79 million individuals.[1] The effects of unhealthy eating are widespread and cost the US billions of dollars every year. Obese individuals incur medical costs that average almost $1,500 more than their normal weight peers and the total annual cost of obesity comes in at roughly $147 billion.[2] This number excludes costs of diet-related preventable diseases that are independent of obesity. Obesity and other diet-related chronic health conditions are ongoing issues that have yet to lose momentum. According to data gathered from the National Health and Nutrition Examination Survey (NHANES) by the National Center for Health Statistics, obesity rates among adults have more than doubled since 1960.[3] The benefits of healthful eating are known to have positive effects on the battle against obesity, yet the health industry has been unsuccessful at implementing these behavior changes in individuals.

Of the hundreds of health indicators assessed by the Institute of Medicine, nutrition ranks within the top twenty of importance.[4] Improving diet quality and healthful eating is a way to increase the health of our population and to begin to decrease the issues associated with overweight, obesity, and other chronic preventable diseases. A major deficit in the US is the lack of adherence to daily recommendations for food intake. The committee for Healthy People 2010 reviewed progress on their objectives to increase consumption of fruits, vegetables and grains and reported little to no improvements.[5] Fruit, vegetable, and whole grain consumption are key markers of a healthful diet, as are the control or decreased consumption of saturated fat, sodium,

and added sugars.[6] In the population of American adults, it is clear that mean/average dietary intake is far from meeting USDA dietary recommendations. This lack of dietary compliance leads to a multitude of poor health outcomes, which emphasizes the need to begin focusing more on nutrition and quality of diet. One strategy to close the gap between poor eating habits and a quality diet is to look at habits that already exist and expand upon them instead of constantly trying to develop new diet fads.

Statement of Problem

It is a common assumption that healthy eating patterns and exercise habits go together. Individuals who put an importance on healthy living through an active lifestyle and include moderate to vigorous exercise on a regular basis are assumed to be eating a more healthful and balanced diet than non-exercising individuals. By examining the reality behind this assumption, dietitians and healthcare professionals will be better able to counsel individuals and populations toward better eating habits by starting with the need to include regular exercise.

Currently, there are many studies researching restrictive diets combined with exercise to evaluate intervention of diet only vs. combined diet/exercise programs on weight change. Most research on exercise is in combination with weight loss efforts or to evaluate impact on a health condition. However, there is a lack of research that links regular exercise with choosing healthful eating habits. Having healthful eating habits and regular exercise is the basis for a strong quality of life that leads to a reduced risk of many chronic diseases.

Purpose Statement

The purpose of this study is to assess the relationship between time spent being physically active and diet quality. This study examined three groups of active adults: sedentary, moderately active, and meets and/or exceeds physical activity guidelines, against their diet quality based on the Healthy Eating Index scoring system using NHANES data sets from 2007–08 and 2009–10.

Research Objectives

1. Evaluate the diet quality of adults engaged in varying degrees of physical activity.
2. Determine the association between time spent being physically active and diet quality.

Hypotheses

1. We hypothesize that those engaged in any amount of physical activity will have a significantly higher total Healthy Eating Index and better overall diet quality than those engaged in no activity. We further hypothesize that those engaged in physical activity will have significantly better scores for specific diet components of the Healthy Eating Index; higher consumption of fruit, whole grains, green vegetables, and lower consumption of sodium, added sugars, and enhanced ratio of unsaturated to saturated fatty acids, than the sedentary group.
2. We hypothesize that there will be a positive correlation between time spent being physically active and diet quality, whereby as time spent being physically active increases, diet quality will also improve.

Chapter 2: Literature Review

Two major factors in health, wellness, and disease prevention are eating and exercise. No suspicion exists on whether improving these two factors results in better health outcomes. Many studies have evaluated the effectiveness of types of diet plans or exercise regimens on various health indicators (e.g., weight control, motivation, aging, disease prevention). Other studies seek to find the ideal way of enforcing these two tasks. Here, the recommendations for exercise and eating are reviewed along with the research that supports how these recommendations are being upheld. Literature evaluating the connection between food and health, exercise and health, and food and exercise will also be reviewed.

Components of a Healthy Diet and Consumption Reality

There are many ways to evaluate eating habits. Some standards have been defined as to what constitutes a healthful diet for American adults. The Dietary Guidelines for Americans are established by the United States Department of Agriculture (USDA) and put forth in a comprehensive document. These guidelines are revised every five years and a new edition was released in 2015. According to the 2010 guidelines, Americans should increase fruit and vegetable intake with particular attention to increasing variety of vegetables, consuming at least half of all grains as whole grains, and eating foods that increase nutrients of concern such as vitamin D, calcium, fiber and potassium.[6] Key recommendations on what to limit include keeping consumption low for sodium, saturated fats, refined grains, and added sugars.[6]

Current Dietary Guidelines for Americans set by the USDA recommend that adults consume two servings of fruit and three servings of vegetables a day at minimum.[6] Reports from the Centers for Disease Control and Prevention (CDC) show that only one-third of adults are

consuming fruit two or more times a day, ranging from 34.4% in 2000 to 32.5% in 2009 with lower percentages of adults who consume at least three vegetables per day.[7] Specifically, this 2007 report showed that only one quarter of the population (26.3%) consumed three or more vegetables daily.[7] King and colleagues[8] assessed the adherence to a healthy lifestyle using NHANES data. They looked at five trends of healthy living: produce intake, weight status, moderate drinking, regular physical activity, and smoking status. Using data from adults, the team looked at years 1988–1994 compared to 2001–2006 and found that among those over 18 years, adherence to a healthy lifestyle has worsened. The percentage of adults consuming five or more servings of fruits and vegetables a day dropped from 42% to 25% ($p<0.05$).[8] Consumption of vegetables in adults saw no improvement towards the Healthy People 2010 objective and has been made a leading health indicator, meaning it is a high priority health issue, in the Healthy People 2020 objectives.[9]

Yet another factor in a healthful diet is the consumption of whole grains. The Dietary Guidelines recommend that adults consume at least three servings per day.[6] Unfortunately, the American population is far from meeting this dietary goal. Reicks and colleagues[10] used NHANES data from 2009–2010 to assess fiber intake and found that 42% of adults consumed no whole grains at all. Although there has been recent debate about sodium intake, the current recommendations are set at 2300 mg for adults not at risk for cardiovascular health issues.[6] This is below the reality of what the average adult is consuming, which is at roughly 3500 mg per day.[11]

While the Dietary Guidelines for Americans is a very detailed document of what it takes to have a health promoting lifestyle, it may be complicated for the average person. MyPlate is a

useful tool for the general public looking for a balanced, non-therapeutic diet. This tool helps bridge the gap between the Dietary Guidelines and each real-world eating situation. Using this method helps to structure portion control and food group balance, two big factors in a healthful diet. The *Choose My Plate* website[12] is also a user-friendly way to get insight into healthful eating habits and practical nutrition recommendations. Even with accessible resources, there still exist large discrepancies between nutrition recommendations and the reality of what is consumed. For example, the MyPlate website resource advises that adults have a daily limit for empty calories based on daily calorie needs. However, empty calories are consumed in amounts that exceed these recommendations.[13] Empty calories are known to be those that lack nutritional properties while being calorically dense. These calories are also referred to as SoFAS, an acronym for the sum of calories from solid fats and added sugars.

Food Surveys Research Group, led by Sebastian and colleagues,[13] analyzed NHANES data and concluded that, on average, men consumed 934 calories and women consumed 624 calories per day from SoFAS. This is over one-third of daily calories coming from nutritionally lacking sources based on a 2,000 calorie diet. Malik and colleagues[14] reported the average daily intake of empty calories from added sugar alone was estimated to be 15.8% of daily calories, which equates to 318 calories per day based on a 2,000 calorie diet. Suggested intake of added sugar by the American Heart Association[15] is 100–150 calories per day, far below the previous finding of actual intake. Healthy People 2020[9] has recognized this over consumption of SoFAS and set an objective to lower the intake to 29.8% of added sugars, accounting for no more than 10.8% of daily calories.

Another method to quantify what a healthy diet amounts to is the Healthy Eating Index (HEI). This is a method established in 1995, and since updated, to score diets based on 24 hour recalls.[16] This score is reflective of diet quality and is an ideal method for evaluating groups or large populations based on a simple, straightforward set of parameters. Points are given for consuming enough of the positive diet influencers; produce, whole grains, dairy, proteins, and fatty acids and points are deducted for over-consuming negative diet influencers such as refined grains, sodium, and overall empty calorie sources.[17] Once the 12 dietary components are scored, a total closest to 100 reflects a healthful diet, while the lower the score, the further away one is from a healthful diet.[18] A total HEI score of 80 points or higher reflects a diet of high quality, between 50 and 80 points means the diet needs improvement, and a score less than 50 represents low diet quality.[17] This method is useful for associating overall diet quality with other lifestyle factors.

Guo and colleagues[19] found that lower HEI scores were more prevalent in overweight and obese individuals. HEI scores were also utilized by Drewnowski and Rehm[20] in their study on how low calorie sweetener use affects overall diet quality. They evaluated the HEI score against nine years of NHANES diet recalls (22,321 total diet surveys) for adults consuming low calorie sweeteners and found low calorie sweetener users consumed significantly more whole grains and vegetables, ($p<0.001$).[20] O'Neil and colleagues[21] looked at data from 8,861 adult diets from NHANES 2003–2006 for an association between consuming 100% orange juice and improved HEI scores. Results showed that those consuming 100% orange juice had HEI scores significantly higher in categories of whole grain consumption and whole fruit consumption along with significantly higher HEI scores for overall diet quality.

There are many studies that show that American adults are not consuming healthful diets. One example is the work done by McCullough and colleagues[22,23] in evaluating the adherence of diets to the Dietary Guidelines in two separate studies, one evaluating women and the other men. With a sample size of 67,272 US female nurses,[22] HEI total scores were determined from dietary recalls and averaged 64; 100 being the best diet quality and 0 being the lowest, meaning that this large population of women needed improvements in their diets. The 51,529 men sampled were found to have the same total HEI scores; averaging a score of 64.[23] HEI scores are beneficial in evaluating diet quality in accordance with the Dietary Guidelines. By evaluating the individual dietary component scores along with the total HEI score, a more detailed view of dietary compliance and shortfalls can be identified. McCullough and colleagues took this comprehensive approach and looked at numerous factors including, but not limited to physical activity, total HEI, vegetable servings, milk servings, alcohol intake, and multivitamin use.

Whether looking at preventable chronic disease rates, obesity statistics, or nutrition guidelines, there is a definite lack of emphasis on consuming a healthful diet. A factor in this is that doctor visits including nutrition counseling are on the decline, according to the Healthy People 2010 Final Review.[24] One key reason for this decline in nutrition counseling is that primary care physicians are not sufficiently trained to give dietary advice.[25] This is a large factor in continuing to close the gap between the dietary recommendations and reality of what is consumed.

Components of Regular Exercise and Reality of Compliance

There is no lack of evidence when associating exercise with positive health benefits. How exercise relates to disease outcome and quality of life has been extensively studied.

Physical activity works to strengthen the skeletal system, increase blood flow, lubricate joints, maintain joint stability, strengthen muscles, and reduce risk of injury. Exercise recommendations for the American population are set by the Office of Disease Prevention and Health Promotion.[26] For adults age 18–64, the guidelines are a mix of aerobic and strength activities with set intensities and durations. One doing moderately-intense activities should complete at least 2 ½ hours of aerobic activity along with strength training of all major muscle groups twice a week.[26] Aerobic activity should be at least 75 minutes per week for those choosing to do more intensity and still include muscle strengthening twice a week.

Warren and colleagues[27] conducted a 21-year longitudinal study in 7,744 adult men and found that a sedentary lifestyle was a strong predictor of cardiovascular disease and that high levels of physical activity were related to decreased incidence of such disease. A similar six year study on women's activity habits found that those who spent more time sitting were at higher risk for developing diabetes and obesity.[28] These conclusions are also supported by the work of Boothe and colleagues[29] who aimed to target how physical activity causes maladaptations of chronic disease. Their conclusion was that human systems are aerobic in nature and failing to engage in minimal daily physical activity is detrimental to overall health status. When looking at overall health status, Lee and colleagues[30] determined that inactivity leads to 9% of premature deaths worldwide. Unfortunately, little progress has been seen in physical activity compliance. Carlson and colleagues[31] analyzed activity trends from 1998–2008 NHANES data and found only 18% of adults met the physical activity guidelines for both strength and aerobic components.

Inactivity is a contributor to diseases that cost the US over $70 billion annually in related, preventable healthcare costs.[32] More physicians should be encouraging exercise as part of regular patient guidelines and recommendations since 8 in 10 adults see a physician annually.[33] Just 32.4% of adults were advised to exercise by their physician in 2010. Patients with a chronic disease such as diabetes or obesity are more likely to have their physicians recommend activity,[33] but recommendations to engage in physical activity are still far below an impactful percentage. An objective for Healthy People 2020 is to "Increase the proportion of physician office visits for chronic health diseases or conditions that include counseling or education related to exercise". The target is a 10% improvement from current standings of all adult and child physician visits that include education related to exercise.[34] Research shows the presence of physical activity can improve these chronic health conditions and can improve the quality of life associated with them.

Association of Eating and Exercise Behaviors

Just like healthy eating habits, physical activity provides a strong foundation for good quality of life with reduced risk of chronic disease. The two go hand in hand in promoting good health outcomes. Instead of viewing these as separate, independent health factors, they should be viewed as being dependent on each other for affecting health outcomes. Loprinzi and colleagues[35] have focused research on providing data on just this notion. In one of their cross-sectional studies, they looked at how moderate-to-vigorous physical activity affected health biomarkers compared to light physical activity. An interesting factor of this study was not only looking at time spent active, but also comparing the two groups of physically active individuals against how much time was also spent being sedentary. Those with more moderate-to-vigorous activity compared to sedentary time had more favorable health biomarkers: BMI, waist

circumference, C-reactive protein, HDL, triglycerides, fasting glucose, and insulin sensitivity. The authors[35] recommended more attention be paid to increasing physical activity at all levels while simultaneously decreasing sedentary behavior.

In a second study headed by Loprinzi along with a different set of colleagues,[36] the objective was to evaluate the combined effects of diet and exercise on overall health. Using activity and dietary data from NHANES 2003–2006, four groups were established for study: (1) healthy diet and active, (2) unhealthy diet and active, (3) healthy diet and inactive, and (4) unhealthy diet and inactive. Thirty-four percent of participants fell into the most undesirable category, unhealthy and inactive, while only 16.5% of participants fell into the healthiest group, healthy diet and active. These results showed a lack of healthy eating habits and active living. Researchers looked at whether participants met overall physical activity guidelines or not, but did not separate physical activity into subgroups: moderate or vigorous. Those meeting physical activity guidelines at any capacity were 32% more likely to practice healthier eating habits than those failing to meet the physical activity guidelines. This study shows that relationships between eating habits and physical activity exist. More research on this topic could lead to pinpointing how these two factors may affect each other and how to strengthen these relationships.

Buman and colleagues[37] researched how adults should spend their time in order to improve health biomarkers. With the help of NHANES data they were able to show that exercise may be the single best behavior to increase health. The research showed having thirty minutes used for moderate to vigorous physical activity (MVPA) instead of thirty minutes used being sedentary, was effective ($p<0.05$) in improving health standings versus those who allocated the same time block for light activity or sleep. Specifically the reallocation of 30 minutes/day of

from sleep to MVPA showed 2.5% smaller waist circumference, 25.3% lower C-Reactive protein, 4.4% higher HDL levels, 9.3% lower triglycerides, and 1.7% lower fasting glucose.

The strength of exercise's impact on health was also researched by Maher and colleagues[38] in a cross sectional analysis of 5,083 adults. They were able to determine the relative risk of obesity based on time spent engaged in MVPA, television viewing, or being sedentary. While it should not come as a surprise, those with MVPA had the lowest relative risk of obesity. An important part of this study was its ability to show that small increases in time, 5–10 minutes, spent doing MVPA were associated with a significant decreased relative risk of obesity.

Two major factors contributing to activity levels are age and gender. These factors were considered in research done by Martin and colleagues[39] to observe the changes in non-sedentary activity as men and women age. After looking at a four day NHANES activity measurement of 5,788 adults, they found that men were slightly more active in younger years but had a more significant decline in activity while women's movement remained more consistent throughout the years.

Another factor thought to influence activity levels is location. Fan and colleagues[40] used NHANES activity data to test the theory of rural dwellers being less active than urban living peers. Results of 5,056 adults sampled revealed that while vigorous activity was higher in the rural population, and no difference was found in overall activity between rural and urban locations. Figuring out which factors influence physical activities is key to being able to increase physical activity levels in everyone.

There is plenty of literature to show how diet and exercise interact with weight management and disease outcomes. Unfortunately, however, there is not much documentation to support theories that those who exercise have healthier overall diets. A meta-analysis by Curioni and Lourenco[41] looked at interventions that included diet or exercise and compared the outcomes against programs that utilized both diet and exercise. The conclusion was that the combined efforts resulted in greater, long-term results for weight management.

Another study looking at long-term weight loss by Jakicic and colleagues[42] focused on the use of intermittent versus traditional continuous physical activity. They included 148 sedentary, overweight women over an 18-month behavioral intervention. Divided into three groups of long bout, short bout, and multiple short bouts of exercise, there was no significant improvement by using short bouts over long bouts of physical activity although all groups did increase fitness markers from baseline to the end of the study period. There was, however, a difference in the ability to lose weight and keep it off; those who maintained a higher volume of physical activity worked out the most time overall throughout the study saw the most weight loss. The researchers concluded that there is a dose dependent relationship between exercise and keeping weight off. This study reinforces why it is important to look at duration and intensity, as well as total volume, of physical activity when studying the relationship of physical activity to health and weight loss.

These data work to support the claim that diet and exercise could have an increased cumulative effectiveness on health outcomes than they would separately. Matta and colleagues[43] looked at motivational spillover between exercise habits and eating habits among 249 adults engaged in a weight reduction program and found increased improvements in exercise predicted

better eating self-regulation. This study provided evidence that diet and exercise work together during prescribed, intentional health programs. No research has been done to show that this spillover occurs at an intrinsic level, without any outside counseling or intentionally implemented health program. This strengthens the need to look at the underlying relationship between eating habits and exercise habits and be able to put data behind the assumptions that those who are concerned with having an active lifestyle are naturally inclined to eat a more healthful diet.

Chapter 3: Methods

Research Design

This is a cross sectional study that evaluates physical activity and healthy eating scores data from the 2007–08 and 2009–10 National Health and Nutrition Examination Surveys (NHANES). Public data sets from years 2007–2010 were accessed and information was extracted that is needed for this specific research question. Components of the Healthy Eating Index (HEI) were evaluated and an overall Healthy Index Score given. NHANES data was also used to create groups based on varying levels of physical activity engagement for American adults following physical activity guidelines for adults set by the Department of Health and Human Resources. These groups were non-exercisers, moderately physically active, and meets/exceeds guidelines.

Research Question

What is the relationship between diet quality and physical activity status: sedentary, engaged in moderate amounts of physical activity, and those meeting or exceeding physical activity guidelines for American adults 20 years and older?

Population

Adults age 20 years and over who participated in NHANES years 2007–08 and 2009–10 (n=11,167) with valid physical activity questionnaire and dietary intake data were eligible for inclusion in this study.

Data Collection

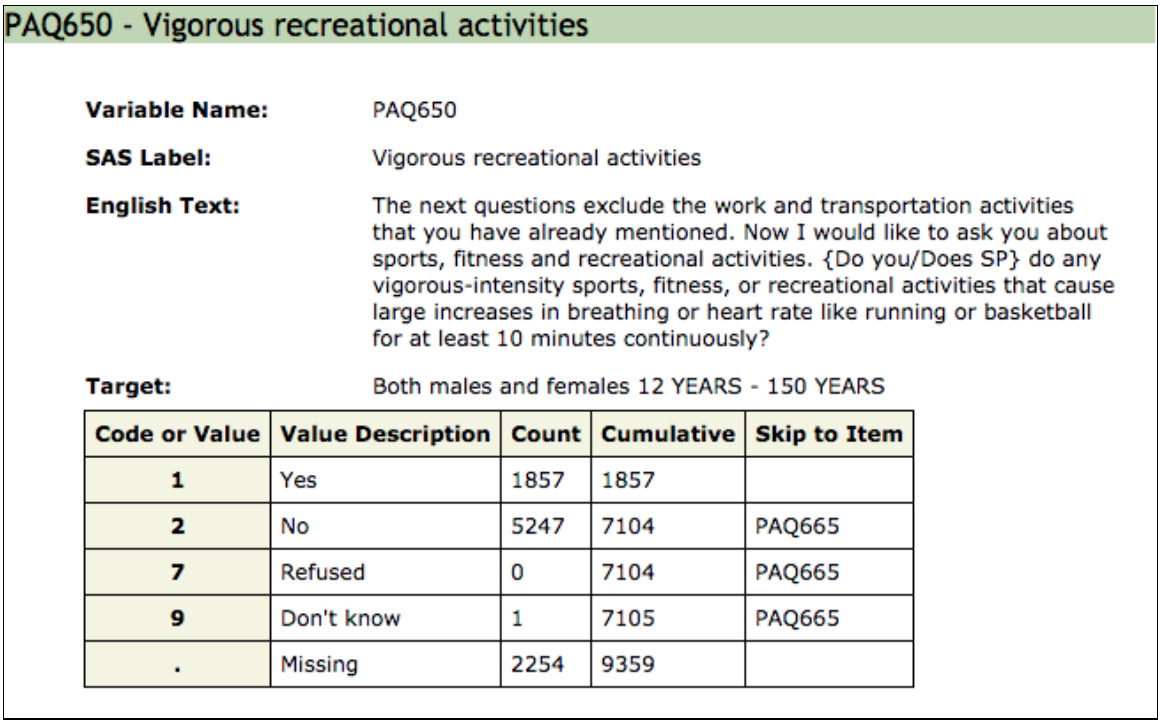
NHANES[44] is a nationwide program of health data collection that began in the early 1960s by the Centers for Disease Control and Prevention to assess the health and nutritional status of the American population. In 1999 the survey became an ongoing, continuous 2 year cycle in order to promote stability and consistency of the data collected. The program utilizes a three-step system of questionnaires, interviews, and a physical examination conducted at a mobile examination center (MEC). Roughly 5,000 individuals are surveyed each year on a plethora of health-related information. The sample population is intended to reflect the American population as a whole. For this reason, some populations such as minorities, low socioeconomic status, elderly, adolescents, and minority races are over sampled. The intent of NHANES is to examine the health of the nation, assist with predicting future health needs, and provide public data for research to be conducted. This study will take selected information from NHANES years 2007–08 and 2009–10 to evaluate the research question. The following details how the data are obtained and outlines selection criteria for use in this study.

Physical Activity Data

The physical activity questionnaire (PAQ)[45] includes questions relative to the population's age, daily activities, leisure time activities, and sedentary activities. Adults are questioned at home using Computer-Assisted Personal Interviewing-CAPI (interviewer administered) system (Figure 1 and 2). Completed PAQs with values of excessive activity time, such as activity for >24 hours per day, were excluded. Out of the 19 questions asked on the PAQ, it was determined that specific questions on moderate and vigorous activity would be used based

on the response of yes or no to completing each type of activity and the total minutes per week of each.

The Physical Activity Guidelines for Americans define adults as being physically active by completing 150 minutes of moderate physical activity per week or 75 minutes of vigorous physical activity per week. This definition of being physically active was used in this study by looking at total minutes of physical activity. Total minutes of physical activity per week were computed using the sum of moderate physical activity minutes per week and two times the vigorous physical activity minutes. Individuals with 0 minutes of activity were categorized into the sedentary group. Individuals reporting between 1 and 149 min/week were moderately physically active. Those who reported completing ≥150 min per week were meeting or exceeding the physical activity guidelines and were classified as meets/exceeds PA.



PAQ650 - Vigorous recreational activities

Variable Name: PAQ650

SAS Label: Vigorous recreational activities

English Text: The next questions exclude the work and transportation activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities. {Do you/Does SP} do any vigorous-intensity sports, fitness, or recreational activities that cause large increases in breathing or heart rate like running or basketball for at least 10 minutes continuously?

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1	Yes	1857	1857	
2	No	5247	7104	PAQ665
7	Refused	0	7104	PAQ665
9	Don't know	1	7105	PAQ665
.	Missing	2254	9359	

Figure 1: Physical Activity Sample Question for Vigorous Activity
Source: http://wwwn.cdc.gov/nchs/nhanes/2007-2008/PAQ_E.htm

PAQ625 - Number of days moderate work

Variable Name: PAQ625

SAS Label: Number of days moderate work

English Text: In a typical week, on how many days {do you/does SP} do moderate-intensity activities as part of {your/his/her} work?

English Instructions: PROBE IF NEEDED: Moderate-intensity activity causes small increases in breathing or heart rate and is done for at least 10 minutes continuously. (SP interview version) HARD EDIT: 1-7. ENTER NUMBER OF DAYS. (MEC interview version) HARD EDIT: Less than 1 day or more than 7 days Error Message: The number of days should be between 1 and 7. ENTER NUMBER OF DAYS

Target: Both males and females 12 YEARS - 150 YEARS

Hard Edits: 1 to 7

Code or Value	Value Description	Count	Cumulative	Skip to Item
1 to 7	Range of Values	2644	2644	
77	Refused	0	2644	PAQ635
99	Don't know	2	2646	PAQ635
.	Missing	6713	9359	

Figure 2: Physical Activity Sample Question for Moderate Activity
Source: http://wwwn.cdc.gov/nchs/nhanes/2007-2008/PAQ_E.htm

Dietary Intake Data

Part of NHANES includes collecting dietary information by interview. The interview is an in-person 24-hour dietary recall taken in the MEC by a trained dietary interviewer.[46] The protocol for these interviews is detailed in the MEC In-Person Dietary Interviewers Procedure Manual[47] and includes questions, probing follow-ups, lists of foods, and measurement information (Figures 3 and 4). This recall is inclusive of all food and beverages consumed in the 24-hour range (midnight to midnight) of the day prior to the interview being conducted. After the interview is complete, participants are asked about salt consumption, whether their intake for the day in question was typical of other days, and if they follow a special diet. The database of information collected can be used in a variety of ways, such as this study, to look at dietary intakes of populations including eating patterns, nutrient breakdown, total energy consumption, and sources of food. Out of the vast amount of dietary data collected through NHANES, the MyPlate equivalents data were used for this research question. MyPlate equivalents are a way of assigning various serving sizes of commonly consumed foods to their ounce or cup equivalents in order to simplify the public's ability to eat as defined by the Dietary Guidelines. For example, adults are advised to consume 3 cups of dairy per day. One cup could come from 1 cup of milk or 1.5 ounce of cheese. [48]

- **MILK CARTONS:** There are 3 different shaped cartons that represent 2 different sizes: 8 FO and 16 FO. Use the milk cartons to estimate the amount of milk or juice consumed.

Exhibit 6-70. 3D cartons

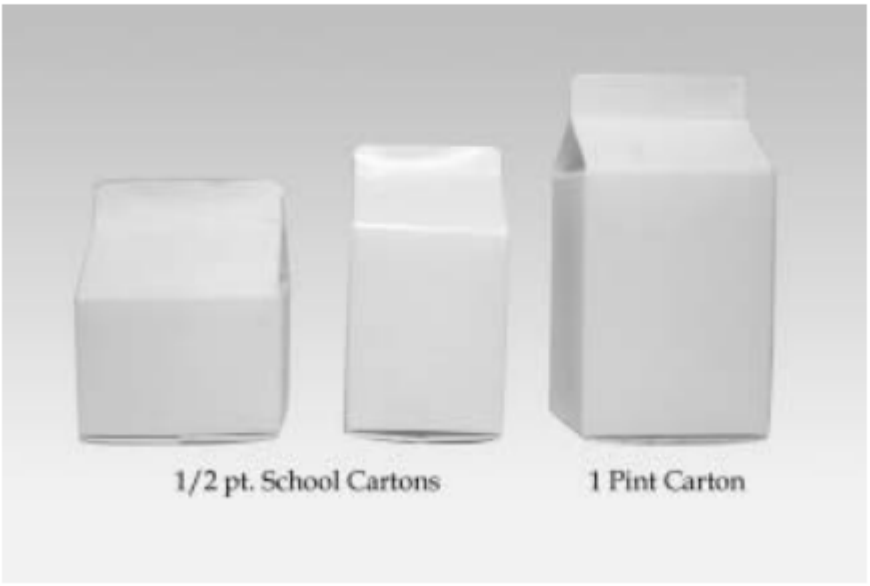


Figure 3: Models to Determine Food Quantities
Source: http://www.cdc.gov/nchs/data/nhanes/nhanes_01_02/dietary_year_3.pdf

If the occasion is made up of one single food, the prefilled text will be the name of the food rather than the occasion. For example, if the SP ate only a hamburger for lunch, then the probe would read:

"Did you eat/drink this 12:00PM hamburger at your home?"

It is possible that respondents may remember more foods as they think about the source of the food and where it was eaten. In this case, return to the RFL by pressing F10, and record the food in the next available RFL line.

Once you have asked the location for an occasion, you will ask the Between Interval Probe to determine if any food was eaten between the occasion you just collected and the next occasion reported.

Figure 4: Dietary Interview Sample Question
Source: http://www.cdc.gov/nchs/data/nhanes/nhanes_01_02/dietary_year_3.pdf

The reported intake of foods from the interview is converted to food pattern (FP) components. There are 37 FP which classify intake as cup equivalents of fruit, vegetable, dairy; ounce equivalents of grains, proteins; teaspoon equivalents of added sugars, gram equivalents of solid fats, oils; and number of alcoholic beverages.[49] This allows dietary intake to be simplified and comparable to the Dietary Guidelines for Americans 2010 (DGA2010) recommendations.

To answer the research question, Healthy Eating Index (HEI) diet quality scores were computed based on the updated HEI 2010 guidelines.[50] HEI was used to quantify diet healthfulness with a score for these groups. HEI is a method of scoring dietary intake to measure compliance to the USDA's dietary recommendations. Twelve diet components are assessed in the overall score (Table 1). A maximum score is 100. Higher scores indicate healthier overall eating and better compliance to Dietary Guidelines as compared to lower scores. This

straightforward approach to assess healthful eating and dietary habits will be utilized to quantify differences in eating quality for the groups of exercisers.

***Table 1*:** Healthy Eating Index 2010 Components and Scoring. *Source*: http://www.cnpp.usda.gov/sites/default/files/healthy_eating_index/CNPPFactSheetNo2.pdf

Dietary Component	Maximum Points	Standard for Maximum Score	Standard for Minimum Score
HEI 2010[1] **Adequacy**			
Total Fruit[2]	5	≥0.8 cup/1,000 kcal	No Fruit
Whole Fruit[3]	5	≥0.4 cup/1,000 kcal	No Whole Fruit
Total Vegetables[4]	5	≥1.1 cup/1,000 kcal	No Vegetables
Dark Green and Legumes[4]	5	≥0.2 cup/1,000 kcal	No Dark Green Vegetables or Legumes
Whole Grains	10	≥1.5 cup/1,000 kcal	No Whole Grains
Dairy[5]	10	≥1.3 cup/1,000 kcal	No Dairy
Total Protein Foods[6]	5	≥2.5 oz./1,000 kcal	No Protein Foods
Seafood and Plant Proteins[6,7]	5	≥0.8 oz./1,000 kcal	No Seafood or Plant Proteins
Fatty Acids[8]	10	(PUFAs + MUFAs)/SFAs >2.5	(PUFAs + MUFAs)/SFAs >1.2
Moderation			
Refined Grains	10	≤1.8 oz. equiv. per 1,000 kcal	≤4.3 oz. equiv. per 1,000 kcal
Sodium	10	≤1.1 gram/1,000 kcal	≥2.0 grams/1,000 kcal
Empty Calories[9]	20	≤20% of energy	≥50% of energy

1 Intakes between the minimum and maximum standards are scored proportionately.
2 Includes fruit juice.
3 Includes all forms except juice.
4 Includes any beans and peas (called legumes in HEI-2005) not counted as Total Protein Foods (called Meat and Beans in HEI-2005).
5 Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.
6 Beans and peas are included here (and not with vegetables) when the Total Protein Foods (called Meat and Beans in HEI- 2005) standard is otherwise not met.
7 Includes seafood, nuts, seeds, soy products (other than beverages) as well as beans and peas counted as Total Protein Foods.
8 Ratio of poly- and monounsaturated fatty acids to saturated fatty acids.
9 Calories from solid fats, alcohol, and added sugars; threshold for counting alcohol is >13 grams/1000 kcal

Total scores as well as scores for individual nutrition components were assessed. When computing the total protein and total vegetable scores, legumes were allocated to protein until protein needs were met and any remaining legume intake was allocated to the vegetable category.

Statistical Analysis

To describe the diet quality of each activity group, means, standard deviations, and standard errors were generated for each of the 12 Healthy Eating Index dietary components as well as the overall HEI scores. Statistically significant differences between groups were determined using one-way ANOVA with $p<0.01$. Significance between groups of exercisers for each dietary component was calculated using post-hoc bonferroni correction. To analyze the NHANES data on the selected population, SPSS Complex Samples version 21.0 was used to account for complex sampling methods used in the sample selection. This version of SPSS Complex Samples conducts statistical testing based on the actual sample size; however, it also corrects for the oversampled NHANES populations to prepare nationally representative population estimates. The CDC generates weights to estimate the number of people each person represents in the US based on the demographic criteria used for sampling. Oversampled populations included minorities, low income, young children, older adults, and pregnant women, which factor into the weighting scheme. The weighted data represents the total US population (216,698,635). Analyses were conducted using Complex Samples that shift the means/percents to the population level by buffering the contribution of oversampled groups and increasing the contributions of under sampled groups based on the weights generated by the CDC. SPSS Complex Samples also computes p-values without using 216 million Americans as the sample

size. The standard error (standard deviation/sample size), using 216 million instead of 11,167 would artificially shrink the standard errors resulting in much smaller p-values, creating artificial significance where none exists. Complex Samples runs the statistics with the population mean, but computes the standard errors with a population standard deviation but the original sample size (11,167, not 216 million). This helps control that problem of a "population-based analysis." Correlation between HEI and minutes of physical activity was performed using linear regression analysis with $p<0.01$ and variance measured by R squared value.

Chapter 4: Results

After screening for minutes of time spent being physically active, the total sample was broken down into three groups: sedentary (n=6,240), moderately physically active (n=3,480), and meets or exceeds physical activity guidelines (n=1,447). Table 2 shows mean minutes of physical activity per day by group with standard deviations. While the total population sampled is 11,167, this is representative of a weighted US population size of 216,698,635. The sedentary group represented a weighed population of 103,683,030 individuals; the moderate PA group represented 78,112,223 individuals; and the meeting or exceeding PA group represented 34,903,382 individuals.

Table 1 and 4 and Figures 5 show that total fruit, seafood and plant proteins, and empty calories scores were significantly different between the sedentary group and both groups of physically active individuals ($p<0.01$); no difference was seen between the two physically active adult groups ($p>0.01$). For total vegetables, the moderately active adults had significantly higher HEI scores than the adults who were sedentary and meeting/exceeding PA guidelines; there was no significant difference between the sedentary group and meeting/exceeding PA guidelines group. There was no significant difference of HEI score between the three groups for intake of whole fruit, greens and beans, whole grain, dairy, fatty acids, refined grains, sodium, or total protein. For total HEI scores of diet quality, the sedentary group had significantly lower scores than both the PA groups; however, no difference existed between the PA groups.

Table 2: Mean and SD Minutes Spent Physically Active Per Exercise Category.
SD indicates standard deviation.

	Exercise category							
	No exercise		Moderate exercise		Meets or exceed PA guidelines		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Minutes moderate recreational activities	0.0	0.0	40.3	31.6	97.8	94.5	30.0	54.5
Minutes vigorous recreational activities	0.0	0.0	11.5	19.5	84.6	66.2	17.5	41.2
Total min physical activities (2x Vig min)	0.0	0.0	63.2	36.7	266.9	123.5	65.0	106.7

Table 3: Mean and SD HEI Component Scores Per Exercise Group.
Data presented as mean (Standard Deviation)

2010 Healthy Eating Index Scale Scores (range)	**Total**	**No Exercise N=6,420**	**Moderate Exercise N=3,480**	**Meets or exceeds guidelines N=1,447**	***p***
Total Fruit (0-5)	2.2 (2.1)	2.0 (2.1)	2.5 (2.1)*	2.4 (2.1)*	0.001
Whole Fruit (0-5)	2.2 (2.3)	1.9 (2.2)	2.4 (2.3)*	2.2 (2.3)	0.013
Total Vegetables (0-5)	3.1 (1.7)	3.0 (1.7)	3.2 (1.6)*	3.0 (1.6)**	0.001
Greens and Beans (0-5)	1.3 (2.1)	1.2 (2.1)	1.5 (2.2)	1.3 (2.1)	0.083
Whole Grains (0-10)	2.4 (3.2)	2.0 (3.0)	2.8 (3.3)	2.4 (3.2)	0.043
Dairy (0-10)	5.2 (3.4)	4.9 (3.5)	5.5 (3.4)	5.3 (3.4)	0.017
Total Protein Foods (0-5)	4.2 (1.3)	4.2 (1.3)	4.3 (1.3)	4.2 (1.4)	0.39
Seafood and Plant Proteins (0-5)	2.0 (2.2)	1.7 (2.1)	2.3 (2.3)*	2.1 (2.2)*	<0.001
Fatty Acids (0-10)	4.9 (3.6)	4.9 (3.7)	4.9 (3.6)	5.0 (3.7)	0.644
Refined Grains (0-10)	6.0 (3.7)	6.0 (3.7)	6.1 (3.6)	6.1 (3.6)	0.801
Sodium (0-10)	4.4 (3.6)	4.5 (3.6)	4.1 (3.5)	4.5 (3.5)	0.145
Empty Calories (0-20)	10.3 (6.9)	9.5 (6.9)	11.2 (6.7)*	10.9 (6.7)*	0.006
Total Mean 2010 HEI Score (0-100)	48.2 (15.1)	45.9 (14.4)	50.7 (15.5)*	49.4 (15.5)*	<0.001

*Significantly different from No Exercise group ($p<0.01$)
**Significantly different from Moderate Exercise group ($p<0.01$)

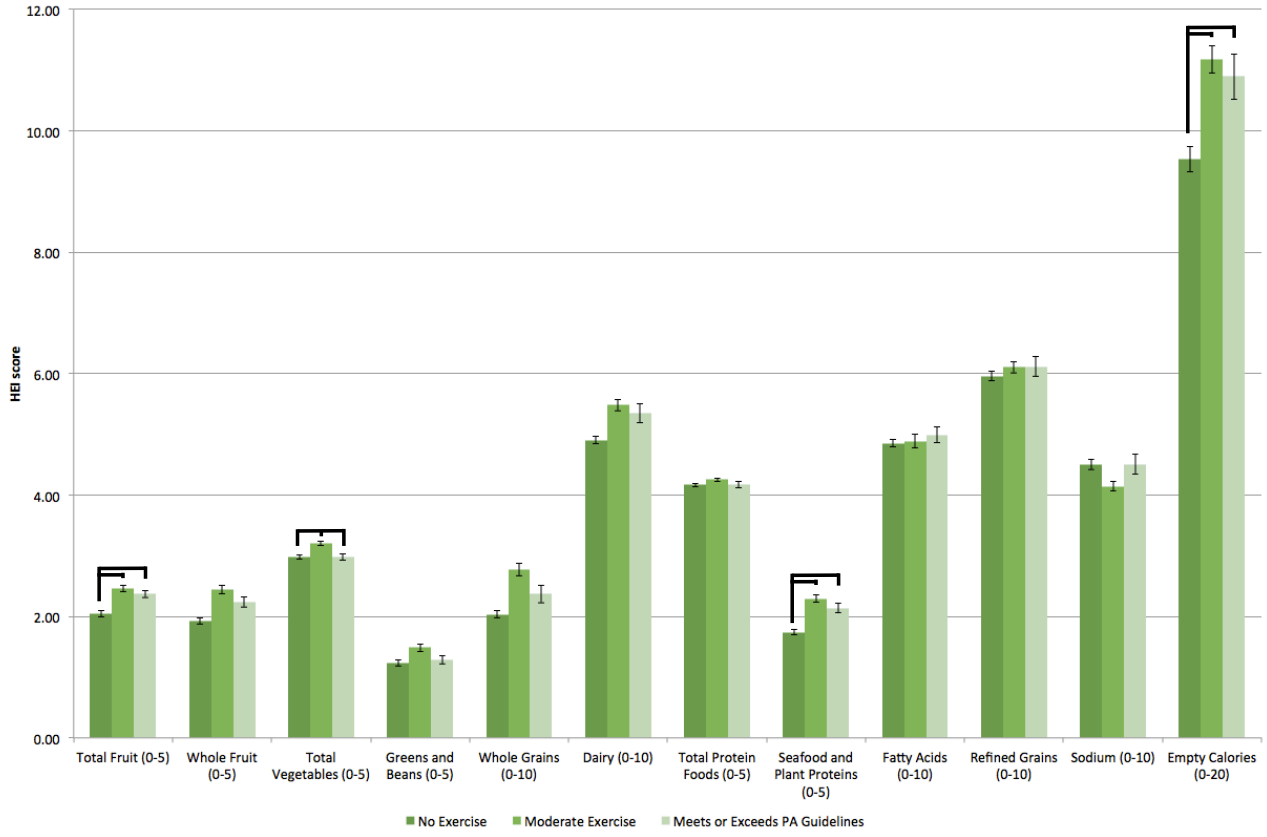


Figure 5: Mean HEI Scores by HEI Component +/- SEM
Error bars indicate standard error of the mean (SEM). Significance determined at $p<0.01$ as shown in Table 3 and 4.

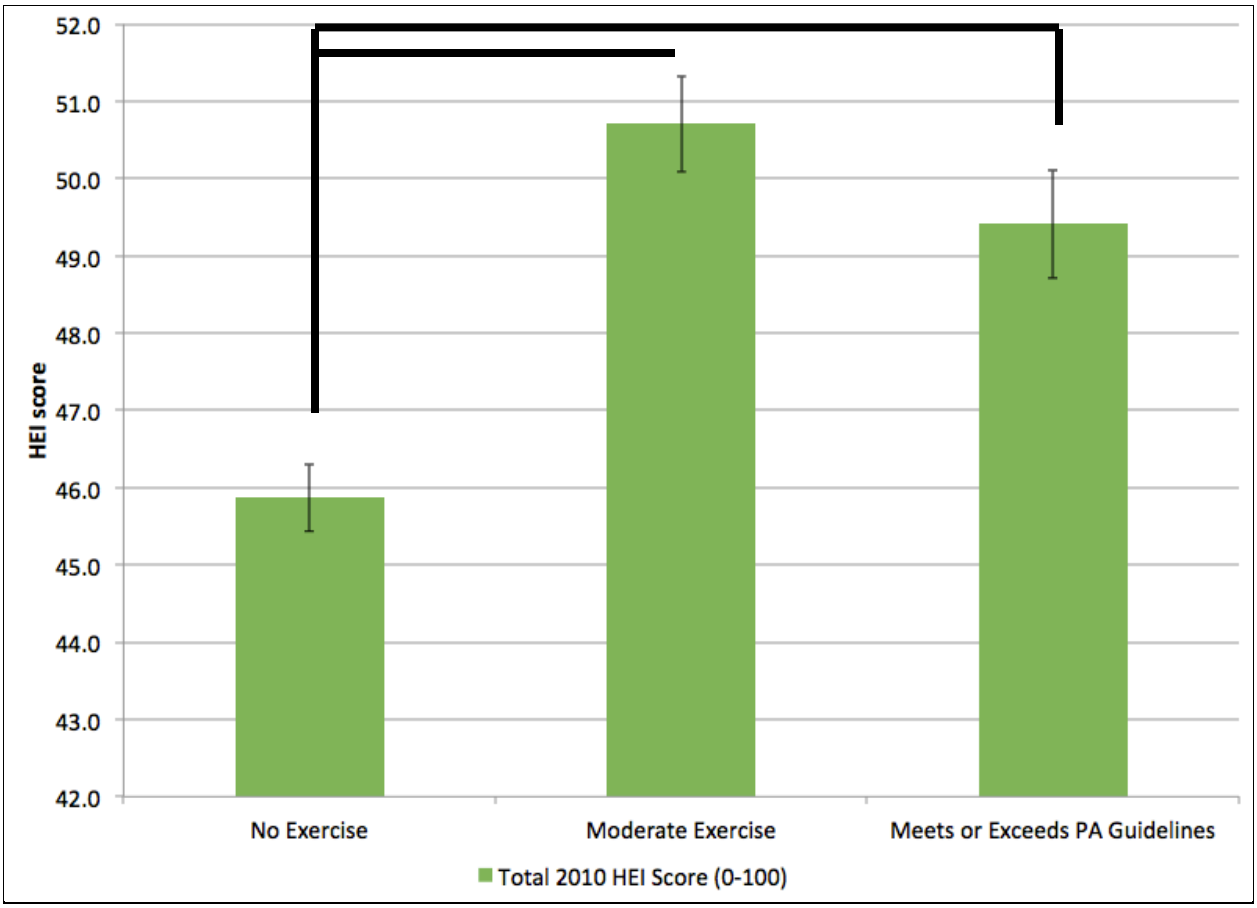


Figure 6: Total Mean HEI +/- SEM
Error bars indicate SEM. Significance determined at $p<0.01$ as shown in Table 3 and 4.

Table 4: P-values for HEI Component Scores
P-values calculated using one-way ANOVA. Post-hoc Bonferroni significance values are provided to compare between PA groups with overall ANOVA p-values <0.01.

	One-way ANOVA with multiple comparisons	Bonferroni significance		
2010 Healthy Eating Index Scale (range)	***p***	NE vs Moderate	NE vs Meets/Exceeds	Moderate vs Meets/Exceeds
Total Fruit (0-5)	0.001	<0.001	0.001	0.443
Whole Fruit (0-5)	0.013	-	-	-
Total Vegetables (0-5)	0.001	<0.001	1	0.001
Greens and Beans (0-5)	0.083	-	-	-
Whole Grains (0-10)	0.043	-	-	-
Dairy (0-10)	0.017	-	-	-
Total Protein Foods (0-5)	0.39	-	-	-
Seafood and Plant Proteins (0-5)	<0.001	<0.001	<0.001	0.158
Fatty Acids (0-10)	0.644	-	-	-
Refined Grains (0-10)	0.801	-	-	-
Sodium (0-10)	0.145	-	-	-
Empty Calories (0-20)	0.006	<0.001	0.006	0.91
Total 2010 HEI Score (0-100)	<0.001	<0.001	<0.001	0.202

Figure 7 depicts the relationship between total time spent being physically active and the total HEI scores. Blue points represent sedentary individuals, green are moderately active and gold meet or exceed PA guidelines. There is too much variability in HEI within groups to support a strong linear correlation analysis of the two variables: $p<0.01$ and $R^2=0.0025$, although a correlation exists. This shows a significant ($p<0.01$) correlation between the two variables, but also that they are not strong predictors of each other. The line of best fit poorly predicts HEI score based on time spent physically active. Physical activity time only explains 0.3% ($R^2=0.025$) of the variance in HEI.

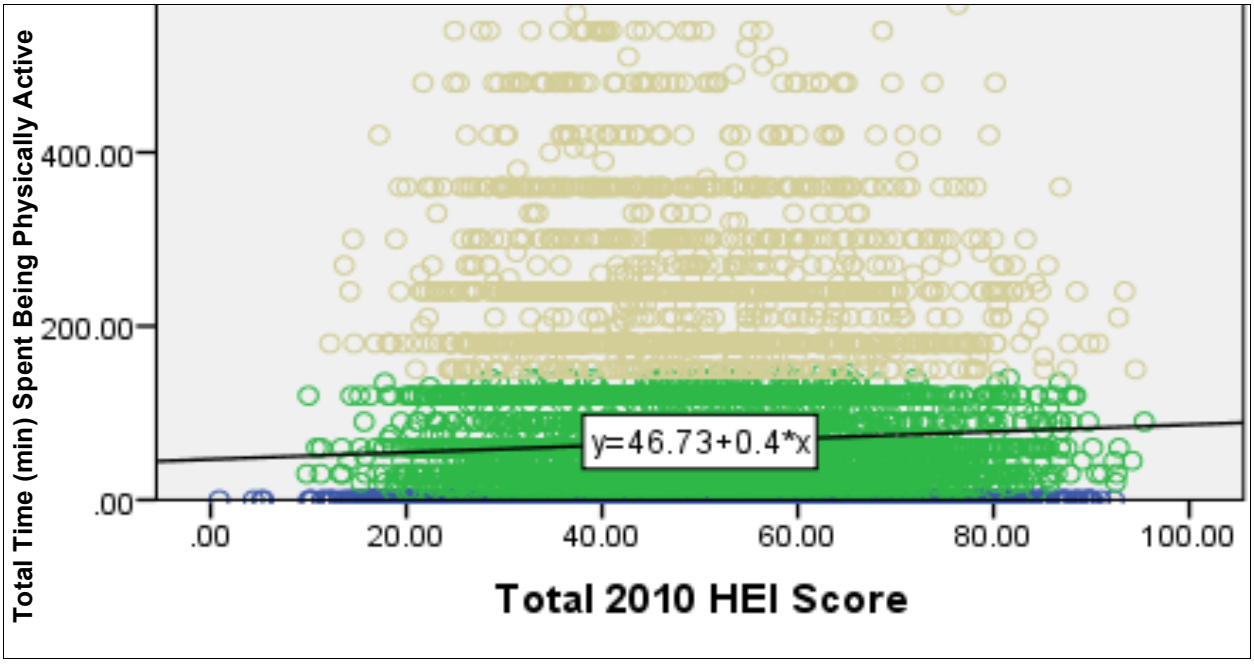


Figure 7: Scatterplot of Total Time Spent Physically Active vs. HEI

Chapter 5: Conclusions and Discussion

The results are consistent with hypothesis one: those engaged in any amount of physical activity (PA) will have a significantly higher total Healthy Eating Index (HEI) score and better overall diet quality than those engaged in no exercise. There was a significant difference in total HEI scores between those who engage in no PA and those engaged in at least some PA ($p<0.001$); meaning active adults consume a diet of slightly higher quality than their adult peers who are sedentary. There are many possible reasons for this significant difference. One reason may be that if a person is involved in their physical well-being, that person is likely to also be involved in their nutritional well-being. Focusing on being physically active is likely to lead to being more focused on overall improved health, including consuming a more healthful, high-quality diet. This could also be considered in the other direction: those who eat better in the first place might feel healthier, more energized, and more likely to engage in physical activity. Further research regarding the scenarios of which comes first, PA causing better eating or better eating causing increased PA could lead to a better understanding of healthy lifestyle predictors. This study saw a difference between no PA and PA which spurs the thought that if individuals engaged in some PA pay more attention to their diet quality, then those doing the most PA would logically be eating the most healthfully. This concept was predicted, however, when exploring data of individual HEI components that was found to not be the case.

Knowing that adults who are living a sedentary lifestyle have a poorer overall diet quality than their active peers means health professionals can target this group more effectively, possibly recommending small amounts of PA in addition to diet changes for these adults. This may in part promote better quality diet choices. Future research could be done to look at this relationship

more closely to see if minimal PA could be a predictor of better diet quality. A second, potential implication of this research is that adults involved in high amounts of PA do not eat better than their moderately active counterparts. It may be important for these adults to better understand the true effectiveness of how their PA affects overall health. Educating on types of PA (occupational, leisurely, work, play, sport, exercise), intensity, calorie burn, calorie intake, and nutrient density could be beneficial for this group to improve their understanding of intake vs. output.

Findings were only partially consistent with the second portion of hypothesis one: those engaged in moderate or vigorous PA will have significantly better scores for specific diet components of the Healthy Eating Index—higher consumption of fruit, whole grains, green vegetables, and lower consumption of sodium, added sugar, and fatty acids—than the no PA group. Once values for individual HEI score components were evaluated, the breakdown of individual diet component scores between the groups did not fit into a consistent pattern of diet quality and appeared random. This leads us to question whether there is a problem with the component breakdown itself and highlights the need to further investigate the eating habits of physically active people to distinguish why their eating habits do not match up with the notion that those who are more active do not appear to eat the healthiest diets in specific dietary components.

Specifically, the moderate PA group had higher mean scores for 4 of the 12 HEI dietary components compared to the sedentary group and had a higher mean score for consumption of total vegetables compared to the meets/exceeds PA group. The group meeting/exceeding PA guidelines had higher mean scores for only 3 of the 12 HEI dietary components as compared to

the sedentary group, and none of the 12 mean scores indicated better quality than the moderate activity group. Specifically, the moderate PA group showed significant difference ($p<0.001$) in better intake of vegetables as compared to the no PA and meets/exceeds PA groups. Non-exercisers may eat fewer vegetables due to less concern with overall health. On the flip side, it is a real possibility that those who engage in higher amounts of PA disregard vegetables as not being caloric enough to meet their activity needs. This could also be attributed to the notion that vegetables are fibrous foods and intake of such can create gastric distress such as bloating and gas. Symptoms such as these can make being physically active difficult and uncomfortable; therefore these foods may be avoided by individuals who are very physically active. When looking at the sodium component, hypothesis two predicted lower intake in the active individuals but no significant difference was found. This could be due to active individuals fueling and hydrating with sport specific nutrition that contains higher levels of sodium for electrolyte balance. Another component that merits further exploration is whole grain intake. Again, hypothesis two predicted that active individuals would consume significantly more whole grains than their sedentary peers; however, no significant difference was found. It is possible that there is a larger divide in carbohydrate intake in physically active individuals: more simple carbohydrates (milk, sport foods) to fuel energy levels and more complex carbohydrates from sources not falling into the grain category (legumes, starchy vegetables, pseudo-grains like quinoa) to balance out their overall diet.

A possible reason for the discrepancy between what was predicted in hypothesis two and the results found could be attributed to the categorization of foods into misleading categories. For example the recording of ketchup or French fries as vegetables could skew the results

regarding what is actually considered a healthful, high-quality diet. The categories of the HEI itself are therefore a limiting factor in looking at the healthfulness of diets. Because this information is obtained via diet recall by trained professionals, the questioned individual is not at risk for placing foods into incorrect categories (tomato as fruit or vegetable), and therefore, user error is not considered a factor that could influence results.

Those engaged in moderate PA ate a diet that is of better quality than the sedentary group. Although the moderate PA group also had a better score for total vegetables than the sedentary and meets/exceeds PA guidelines groups, this did not result in a higher overall diet quality for moderate exercisers over those meeting or exceeding PA guidelines. This indicates that while any PA is better than no PA when it comes to diet quality, more PA isn't necessarily better.

Although there was a small difference in the mean total HEI scores of the three groups, sedentary (45.9), versus moderate PA (50.7), and meets/exceeds PA guidelines (49.4), all three groups scored relatively poorly. On the HEI scoring system, a diet score of 80–100 indicates a quality diet, and no group scored in this range. A score between 50 and 80 points means the diet needs improvement, the moderately active individuals scored in this range. Scoring less than 50 represents low diet quality. The sedentary and most physically active groups scored in this range of low quality with the moderate group just barely meeting the needs improvement range. Although the moderate group appeared to fall into a better category of diet quality by this scoring system, it is not a significant separation from the highly physically active group. The low mean HEI totals for all three groups highlighted the poor diet quality American adults are known to have and the immense need to promote a more healthful intake over the population as a whole.

Using the dataset as a whole to find a correlation between total time spent engaged in PA and total mean HEI scores, although there is a high degree of variability presented, a significant correlation ($p<0.01$) between the two still exists. This significant positive relationship highlights the importance of being physically active and provides insight into how activity could potentially affect diet choices or vice versa. This study used pre-established Physical Activity Guidelines for American adults. It is possible that examining tighter groups of time spent being physically active, such as 30-minute increments, would result in more distinguished separation of eating habits. However, by looking at figure 7, we see that time spent being physically active only accounted for a fraction of overall factors that influence the total HEI score, and therefore, it cannot be used alone to predict better diet quality, but it has potential to be used along with other factors that may positively affect HEI scores. Research should be expanded to discover other factors that may be more influential on the total HEI score. By discovering the factors having the largest impact on total HEI, education can be targeted to have the greatest potential at increasing the overall quality of diet in adults.

A major limitation to this study was the inability to distinguish between physical activity and exercise. While exercise is generally referred to when discussing a healthy life, it is a term that differs from the data analyzed. Exercise is a subset of physical activity that is specifically done to maintain and/or improve health and fitness. For example, one who jogs daily to improve blood pressure would be engaged in exercise. The data taken from NHANES encompasses all physical activity including daily activities such as commuting to work and labor on the job. Movement like this is considered physical activity, but not specifically defined as exercise. Because of this, recommendations to exercise based on these findings are a specific

example of how the data can be applied. Advising people to move more in any capacity to increase overall physically activity is a more accurate, but extremely general way to apply the PA recommendations.

Continued follow-up research using the latest NHANES datasets can be used to highlight shifts in these trends over time, and would provide a useful tool for health professionals when making recommendations for American adults.

References

1. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011-2012. *JAMA*. 2014; 311(8):806-814.
2. Finkelstein E, Trogdon J, Cohen J, Dietz W. Annual medical spending attributable to obesity: Payer-and service-specific estimates. *Health Affairs*, 2009; 28(5):822-831.
3. Centers for Disease Control. Prevalence of overweight, obesity and extreme obesity among adults: United States, trends 1960-62 through 2005-2006. *National Center for Health Statistics*. Dec 23 2009. Web. Accessed October 10, 2014.
4. Isham G, Bialek R, Bradburn N, et al. State of the USA Health Indicators: Letter Report. *Institute of Medicine*. Dec. 2008.
5. Sondik E. Focus Area 19: Nutrition and overweight progress review. *National Center for Health Statistics*. April 2008.
6. US Department of Agriculture and US Department of Health and Human Services. Dietary Guidelines for Americans, 2010. 7th Edition, Washington, DC: U.S. *Government Printing Office*. December 2010.
7. *Centers for Disease Control and Prevention*. Morbidity and Mortality Weekly Report. Fruit and Vegetable Consumption Among Adults – United States 2005. March 2007.
8. King DE, Mainous AG, Carnemolla M, Everett CJ. Adherence to healthy lifestyle habits in US adults, 1988-2006. *Am J Med*. 2009; 122(6):528-534.
9. US Department of Health and Human Services. Healthy People 2020 Objectives: Nutrition and Weight Status. Web. https://www.healthypeople.gov/2020/topics-

objectives/topic/nutrition-and-weight-status/objectives. Last updated Oct 2014. Accessed October 27, 2014.

10. Reicks M, Albertson AM, Jonnagaladda S, Joshi N. Total dietary fiber intakes in the U.S. population are related to whole grain consumption: Results from the National Health and Nutrition Examination Survey (NHANES) 2009–10. *Nutr Res.* 2014; 34(3): 226-234.
11. Centers for Disease Control and Prevention. Morbidity and Mortality Weekly Report. Sodium intake among adults – United States 2005-2006. 2010; 59(24):10-13.
12. Choose My Plate. How Many Can I Have? US Department of Agriculture. http://www.choosemyplate.gov/weight-management-calories/calories/empty-calories-amount.html Accessed October 11, 2014.
13. Sebastian RS, Enns CW, Goldman JD. My pyramid intakes and snacking patterns of U.S. adults. What We Eat in America. *NHANES* 2007-2008. http://www.ars.usda.gov/SP2UserFiles/Place/80400530/pdf/DBrief/5_adult_snacking_mypyramid_0708.pdf Accessed February 25, 2016.
14. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: A systematic review. *Am J Clin Nutr*. 2006; 84(2):274-288.
15. American Heart Association. Guidelines: Sugars intake for adults and children. March 2014. https://www.heart.org/idc/groups/ahaecc-public/@wcm/@adv/documents/downloadable/ucm_463487.pdf Accessed October 13, 2015.
16. Center for Nutrition Policy and Promotion. Healthy Eating Index. USDA. http://www.cnpp.usda.gov/healthyeatingindex Accessed October 13, 2014.

17. Guenther PM, Reedy J, Krebs-Smith SM, Reeve BB, Basiotis PP. Development and evaluation of the Healthy Eating Index-2005: Technical Report. Center for Nutrition Policy and Promotion, *U.S. Department of Agriculture*. November, 2007. http://www.cnpp.usda.gov/sites/default/files/healthy_eating_index/HEI-2005TechnicalReport.pdf

18. National Center for Health Statistics. Healthy People 2010 Final Review. Nutrition and Overweight. 2012;357-371.

19. Guo X, Warden BA, Paeratakul S, Bray GA. Healthy Eating Index and obesity. *Euro J Clin Nutr*. 2004; 58:1580-1586.

20. Drewnowski A, Rehm CD. Consumption of low-calorie sweeteners among U.S. Adults is associated with higher Healthy Eating Index (HEI 2005) scores and more physical activity. *Nutrients*. 2014; 6(10):4389–4403.

21. O'Neil CE, Nicklas TA, Rampersaud GC, Fulgoni VL.100% Orange juice consumption is associated with better diet quality, improved nutrient adequacy, decreased risk for obesity, and improved biomarkers of health in adults: National Health and Nutrition Examination Survey, 2003-2006. *Nutr J* 2012; 11:107.

22. McCullough ML, Feskanich D, Stampfer MJ, et al. Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in women. *Am J Clin Nutr.* 2000; 72(5): 1214-1222.

23. McCullough ML, Feskanich D, Rimm EB, et al. Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in men. *Am J Clin Nutr* 2000; 72(5)1223–1231.

24. National Center for Health Statistics. Healthy People 2010 Final Review. Nutrition and Overweight. 2012;367.

25. Vetter ML, Herring SJ, Sood M, Shah NR, Kalet AL. What do resident physicians know about nutrition? An evaluation of attitudes, self-perceived proficiency and knowledge. *J Am Coll Nutr*. 2008; 27(2): 287-298.

26. US Department of Health and Human Services. 2008 Physical Activity Guidelines for Americans. Office of Disease Prevention and Health Promotion. 2006; Chapter 4.

27. Warren TY, Barry V, Blair SP. Sedentary behaviors increase risk of cardiovascular disease mortality in men. *Med Sci Sports Exerc.* 2010;42(5):879-885.

28. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA-J Am Med Assoc.* 2003;289(14):1785-1791

29. Boothe FW, Laye MJ, Lees SJ, Rector RS, Thyfault JP. Reduced physical activity and risk of chronic disease: The biology behind the consequences. *Eur J Appl Physiol.* 2008; 102:381-390.

30. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT. Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *Lancet*. 2012;380:219-229.

31. Carlson SA, Fulton JE, Schoenborn CA, Loustalot F. Trend and prevalence estimates based on the 2008 Physical Activity Guidelines for Americans. *Am J Prev Med.* 2010; 39(4):305-313.

32. Pratt M, Macera CA, Wang G. Higher direct medical costs associated with physical inactivity. *Phys Sports Med*. 2000; 28(10):63-70.

33. Barnes PM, Schoenborn CA. Trends in adults receiving a recommendation for exercise or other physical activity from a physician or other health professional. *National Center for Health Statistics*. 2012; 86:1-14.

34. US Department of Health and Human Services. Healthy People 2020 Objectives: Physical Activity. Web. https://www.healthypeople.gov/2020/topics-objectives/topic/physical-activity. Last updated Oct 2014. Accessed October 27, 2014.

35. Loprinzi PD, Lee H, Cardinal BJ. Daily movement patterns and biological markers among adults in the United States. *Prev Med*. 2014; 60:128-130.

36. Loprinzi PD, Smit E, Mahoney S. Physical activity and dietary behavior in US adults and their combined influence on health. *Mayo Clin Proc*. 2014; 89(2):190-198.

37. Buman MP, Winkler EA, Kurka JM, et al. Reallocating time to sleep, sedentary behaviors, or active behaviors: Associations with cardiovascular disease risk biomarkers, NHANES 2005-2006. *Am J Epidemiol.* 2014; 1;179(3):323-334.

38. Maher CA, Mire E, Harrington DM, Staiano AE, Katzmarzyk PT. The independent and combined associations of physical activity and sedentary behavior with obesity in adults: NHANES 2003-06. *Obesity*. 2013; 21(12):730-737.

39. Martin KR, Koster A, Murphy RA, et al. Changes in daily activity patterns with age in U.S. men and women: National Health and Nutrition Examination Survey 2003-04 and 2005-06. *J Am Geriatr Soc.* 2014; 62(7):1263-1271.

40. Fan JX, Wen M, Kowaleski-Jones L. Rural–-urban differences in objective and subjective measures of physical activity: Findings from the National Health and Nutrition Examination Survey (NHANES) 2003–2006. *Prev Chronic Dis.* 2014; 11:140-189.

41. Curioni CC, Lourenco PM. Long-term weight loss after diet and exercise: A systematic review. *Int J Obesity.* 2005; 29:1168–1174.

42. Jakicic JM, Lang W, Winters C, Wing RR. Effects of intermittent exercise and use of home exercise equipment on adherence, weight loss and fitness in overweight women. *JAMA*. 1999; 282(16):1554-1560.

43. Matta J, Silva MN, Sardinha LB, Vieira PN, Carraca EV, Andrade AM, et al. Motivational "Spill-Over" during Weight Control: Increased Self-Determination and Exercise Intrinsic Motivation Predict Eating Self Regulation. *Health Psychol*. Nov 2009; 28(6); 709-716.

44. Centers for Disease Control and Prevention. National Health And Nutrition Education Survey: About. http://www.cdc.gov/nchs/nhanes/about_nhanes.htm Last Updated February 3, 2015. Accessed April 20, 2015.

45. Centers for Disease Control and Prevention. National Health And Nutrition Education Survey: Physical Activity Questionnaire. http://wwwn.cdc.gov/nchs/nhanes/2007-2008/PAQ_E.htm#PAQ650 Published September 2009. Accessed April 19, 2015.

46. Centers for Disease Control and Prevention. National Health and Nutrition Education Survey: Dietary Interview. http://wwwn.cdc.gov/nchs/nhanes/2001-2002/DRXTOT_B.htm Last Updated July 2010. Accessed April 20, 2015.

47. National Health and Nutrition Education Survey. MEC in-person dietary interviewers procedures manual. http://www.cdc.gov/nchs/data/nhanes/nhanes_01_02/dietary_year_3.pdf Published Jan. 2002. Accessed April 21, 2015.

48. US Department of Agriculture. MyPlate: Dairy. http://www.choosemyplate.gov/food-groups/dairy-counts.html Accessed June 28, 2015.

49. US Department of Agriculture. Food Patterns Equivalents Database. http://www.ars.usda.gov/Services/docs.htm?docid=23871 Last Updated December 2014. Accessed April 21, 2015.

50. Guenther PM, Casavale KO, Reedy J, et al. Update of the Healthy Eating Index: HEI-2010. *J Acad Nutr Diet.* 2013; 113(4):569-580.