THE EFFECTS OF SLEEP QUALITY ON DIET AND PHYSICAL ACTIVITY IN ADOLESCENTS FROM LOW-INCOME FAMILIES

By

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Abstract:

Objective: The purpose of this study was to evaluate the interaction of sleep quality on food energy intake, Healthy Eating Index (HEI) scores, physical activity, and screen time in low-income adolescents.
Methods: This study included 78 adolescents who completed the Tulsa 100 survey. The adolescents were randomly selected from the Kendall-Whittier or Eugene Fields neighborhoods of Tulsa, Oklahoma. Sleep quality was determined using the Pittsburgh Sleep Quality Index (PSQI), dietary intake was measured by the Automated Self-Administered 24-hour Recall (ASA24), diet quality was determined by HEI scores which were calculated from the ASA24 results, and self-reported physical activity and screen time were included in the Tulsa 100 questionnaire. Pearson's *r* correlations were used to determine if sleep quality was associated with food energy intake, HEI scores, physical activity, and screen time. A multiple linear regression was used to determine which food items had the greatest affect on the HEI scores. Frequencies, Independent *t*-tests and Chi Square were used as appropriate.
Results: Correlation between PSQI and HEI indicated that poor sleep quality was related to poor diet quality. PSQI was not significantly related to total food energy, physical activity or screen time. Total fruit, non-whole grain, and poly-unsaturated fatty acids were deemed the top 3 most important predictors of HEI scores in the multiple linear regression analysis of HEI.
Conclusions: Because better sleep quality was associated with a better diet quality as determined by HEI scores and lower BMI's, sleep is an important factor to consider when educating low-income adolescents on a healthy lifestyle. Additionally, to raise the HEI scores for this population, the focus should be on increasing total fruit and poly-unsaturated fatty acids while limiting non-whole grains.

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CHAPTER I

INTRODUCTION

The obesity epidemic is a growing concern for many health care professionals, political leaders, and individuals alike due to its health complications and economic burdens. Although in the past obesity was generally thought of as an adult disease, it has more recently become more common amongst children and adolescents. Further, children and adolescents from low-income families have a greater risk for obesity than children and adolescents from middle and upper class families.[1] Interestingly, sleep and the lack thereof has been linked to obesity along with cardiovascular disease (CVD) and diabetes.[2] However, adolescents do not always meet their sleep recommendations and socioeconomic status (SES) is considered a likely factor in sleep-related problems.[3-5]

The link between obesity and sleep duration, while complex, is likely due in part to sleep's effect on dietary intake and physical activity. Poor sleep is associated with greater food consumption.[6] As for physical activity, late bed times have been related to less physical activity compared to earlier bed times in adolescents.[7] Therefore, it appears that sleep may be a critical factor in maintaining a healthy diet and physical activity recommendations.

This research evaluates the relationship between sleep quality, diet, and physical activity in low-income adolescents from the Kendall-Whittier and Eugene Fields neighborhoods of Tulsa, Oklahoma. Low SES is believed to be a potential factor in sleeping problems and has also been linked to poor diet quality, and barriers to physical activity. Thus, adolescents from low-income families are a unique population from which to examine the possible correlations between sleep, diet quality, and physical activity.[5,8,9] This research is important in aiding healthcare professionals to more clearly understand how to reduce obesity and improve overall health in adolescents from the Kendall-Whittier and Eugene Fields neighborhoods and similar populations.

CHAPTER II

REVIEW OF LITERATURE

2.1 Obesity Epidemic

The obesity epidemic is both a growing problem and concern for health care professionals. According to the National Health and Nutrition Examination Survey (NHANES) survey from 2011 – 2012, over one third of adults in the United States are obese.[10] Obesity is a health concern due to its many negative possible outcomes such as type-2 diabetes, high blood pressure, high cholesterol, asthma, and arthritis.[11] In fact, it has been estimated that more than 300,000 deaths in the United States occur annually due to obesity related problems.[12] In addition, obesity is associated with a high economic burden due to the costs associated with its treatment and related diseases. By year 2030, costs associated with treating obesity related diseases are estimated to increase by $48-66 billon per year.[13] Because of the great health impact of the obesity epidemic, the causes of obesity need to be understood so that prevention strategies can effectively reduce obesity rates.

2.1.1 Obesity Epidemic Specific to Adolescents

While the obesity trends of adults are concerning, what is possibly even more concerning is how quickly the obesity epidemic is affecting children and adolescents. The NHANES survey from 2011 – 2012 reported 17 percent of youth aged 2- 19 years as obese.[2] The same diseases that

are associated with adult obesity are also related to childhood obesity. Therefore, it is likely that more and more children will be diagnosed with obesity related diseases such as heart disease and diabetes. In addition, it is common for obese children to have learning disabilities, developmental delays, depression, and joint problems.[14] Obesity is a serious concern for any age, but childhood onset is especially worrisome because the health consequences of obesity related diseases, such as diabetes, can begin at a young age and persist for the remainder of the child's life. Therefore, any factor possibly related to obesity should be evaluated to reduce this epidemic and its effect on the quality of life for our nation's next generation.

2.1.2 Obesity Epidemic Specific to Low-Income

While obesity is a growing problem for adolescents, it may be an even greater factor for adolescents from low-income families. Children and adolescents under 18 years comprise 23 percent of the population in the United States, and 45 percent of these individuals under 18 years live in low-income families.[15] The number of adolescents 12 – 17 years of age from low-income families was 41 percent in 2012, presenting a 5 percent increase from 2006. This fact is concerning because adolescents from low-income families are more vulnerable to substance abuse, sexual and reproductive health problems, violence, and obesity.[16] Adolescents of low socioeconomic status (SES) are limited in ways other adolescents are not. While this will be discussed in greater detail in other sections of this literature review, this ultimately limits the adolescents and their ability to lead a healthy lifestyle.

Because so many adolescents come from low-income families, low SES adolescents should be considered, apart from adolescents as a whole, to have a clear understanding of the unique problems these adolescents face in fighting the obesity epidemic. Low SES increases the risk of obesity in both children and adolescents.[1] Also, low SES is a significant risk factor for elevated BMI in adolescents aged 10-18 years. The trend between poverty status and being

overweight may be more significant with older adolescents than younger adolescents. According to Miech et al., there is significant correlation between poverty status and being overweight in 15-17 year old adolescents but no significant association in 12-14 year old adolescents.[17] This may be due to the greater amount of freedom older adolescents have in purchasing their own food and in making decisions on how to spend their time. While the trend between SES and increased BMI in adolescents is alarming, it is important to note that the trend has actually decreased over time.[18] In fact, according to Wang, less than 5% of the BMI variations found in the NHANES data from 1971 to 2002 could be explained by family income.[19] Nonetheless, when comparing the NHANES data from 1971 – 1980 with the data from 1999 – 2008, there has been a trend towards greater BMI gains in low-income children and adolescents compared to children and adolescents from higher-income households.[20] While the extent of the association between SES and BMI over time may be unclear, literature has shown that BMI and SES are related. The reasons for this relationship may in part be due to the differences found in sleep quality, diet, and physical activity of lower SES families compared to higher SES families. Therefore, it is important to evaluate each of these variables and analyze their implications on overall adolescent health.

Sleep is one factor to consider when researching obesity. In recent years, sleep has become of greater interest to healthcare professionals due to its relationship with obesity and increased BMI.[21,22] Sleep duration shorter or longer than a strict 7 to 9 hours a day has been positively associated with obesity, diabetes and cardiovascular disease (CVD). This suggests that sleep should be examined when studying ways to reduce obesity.

2.2 Sleep

Deficient amounts of sleep have been linked to a number of health concerns such as diabetes, CVD, increased BMI, and central obesity. Buxton and Marcelli used the US National Health Interview Survey data from 2004 – 2005 to determine the associations between sleep

duration and chronic disease risk.[2] After completing a logistic regression comparing the participants' hours slept each day compared with having had CVD, or having been diabetic or obese, the results showed that sleep durations of either more than 8 hours or less than 7 hours was related to greater risk for CVD, diabetes and obesity.

Similarly, Nishiura and Hashimoto conducted a 4-year study on low sleep duration related to BMI.[22] After analyzing the results of 3803 middle aged men, the researchers found that the men sleeping 5 hours or less had significantly greater BMI's at baseline compared to participants sleeping 7 hours. The participants only sleeping 5 hours also had greater BMI's at the study's 4-year follow-up. Although this study is limited in that it only included men, a cross-sectional Swedish study of women found similar results in regards to central obesity.[21] The results from the 400 participants showed a significant inverse correlation between total sleep time and sagittal abdominal diameter, a measure for central obesity.

Even with the relationship between low amounts of sleep duration and negative health consequences, sleep curtailment seems to be a common practice for many. The most recent recommendations for adults aged 18 – 64 years are 7 to 9 hours of sleep each night.[23] However, in the 2009 Behavioral Risk Factor Surveillance System survey more than 35% of adults reported sleeping less than 7 hours a day.[24] There are multiple reasons for sleep curtailment in adults such as work schedules, shift work, and easy access to technology at any time of the day or night.[24,25] Easy access to caffeine may also have a negative effect on sleep; it has been stated that nearly 90% of US adults consume caffeine.[26] Caffeine is readily available in numerous beverages, namely coffee, soft drinks, and tea. Although the reasons may vary, adults limiting sleep has become a common practice.

2.2.1 Sleep Specific Adolescents

While the lack of sleep is a concern during every period of life, adolescents are particularly vulnerable to short sleep durations due to the increased physical and social demands during this phase of life. While adolescents undergo many physical changes due to puberty, this is also the time when many will begin their first job which can add stress and time constraints. In addition, many adolescents use multiple technologies such a computer, television and a cell phone before going to bed which can result in later bedtimes.[27] The use of multiple technologies was also shown to be associated with greater caffeine consumption. With added stress of work and decreased sleep caused by technology use and caffeine consumption, it is no surprise that adolescents' sleep is of great concern.

According to the National Institutes of Health, it is recommended that teenagers get 9 to 10 hours of sleep each day.[3] Despite this, the average sleep reported by 245 high school students in Pittsburgh, PA was only 7.4 hours.[4] This is concerning because many of the same health concerns of reduced sleep durations associated with adults are also associated with adolescents. Gupta et al. conducted a cross-sectional study evaluating the sleep quality of obese adolescents compared to the sleep quality of non-obese adolescents.[28] The participants consisted of 383 adolescents aged 11-16 years from public schools in southeast Texas. Sleep quality was determined using a wrist actigraphy that was worn by each participant for one 24-hour period, and it reported both total sleep time and sleep disturbance. Although sleep disturbance was not found related to obesity, total sleep time was significantly correlated with obesity in that obese individuals experienced less sleep than non-obese individuals. In fact, the researchers found an 80% decrease in the odds of obesity for every hour of additional sleep. While this study does not establish sleep reduction as a cause for obesity, it does show a significantly greater likelihood of obesity with reduced sleep.

Furthermore, it has been suggested by Matthews et al. that insulin resistance in healthy adolescents is related to sleep duration.[4] In this study, 245 adolescents aged 14 – 19 years were

recruited from a high school in Pittsburgh, PA. The homeostatic model assessment of insulin resistance (HOMA-IR) was used to determine insulin resistance and sleep was reported both by the participants in a diary and by using an actigraphs worn at night. The results showed that the participants had significantly less sleep on weeknights, at self-reported 6.8 hours, compared to weekends at self-reported 8.7 hours. The actigraphy results were slightly less at 5.9 hours for weeknights and 7.4 hours for weekends. In addition, HOMA-IR results showed that lesser sleep durations by both self-report and actigraphy were associated with higher insulin resistance. Using a regression model, the researchers estimated that adolescents only receiving 6 hours of sleep could reduce their HOMA-IR from 3.179 to 2.896 by simply adding one hour of sleep per night. Because type-2 diabetes begins with insulin resistance, this study shows the importance of sleep, even at a young age, in reducing the risk for diabetes.

Additionally, in an experiment by Beebe et al., sleep has been shown to be crucial for adolescents' ability to learn in a classroom.[29] In this study, the sleep for 16 adolescents was tracked using both a sleep diary and actigraphy. Each participant experienced 5 days of sleep deprivation, where they were only permitted to be in their bed for 6.5 hours each night, and 5 days of a healthy sleep duration, where the adolescents were given earlier bedtimes to allow for 10 hours of time in bed each night. There was a 2-day washout period in between each 5-night section where bedtimes were chosen at will. Following each experimental 5-day period, learning and classroom attention were evaluated using a 30-minute educational film followed by a quiz. Participants in a sleep deprived state scored significantly lower on a quiz following the film presentation and were less attentive during the film than when in a healthful sleep state. Overall, these studies point to the importance of adequate sleep in adolescents to reduce obesity, promote overall health, and improve learning.

2.2.2 Sleep Specific to Low-Income

Adequate sleep is crucial to any adolescent's health, but sleep deprivation seems even more common for adolescents from low-income families. Gellis explains that sleep-related problems are due to a variety of factors, one likely being socioeconomic status.[5] In addition, research examining various SES indicators on children's sleep found that children from lower SES homes had overall worse sleep.[30] One of the specific SES indicators the researchers found linked to decreased sleep duration was "parental perceived economic well-being," meaning that children whose parents reported lower levels of being able to "make ends meet" were associated with lesser sleep durations.

In addition to even greater decreased sleep durations being linked to low-income children, the problems associated with sleep have also been studied in low-income children. A recent study by Miller et al., looked at the effect of sleep timing on BMI in 380 low-income preschoolers.[31] Interestingly, the researchers found that shorter nocturnal sleep durations were linked to greater BMIs, but this association was only significant in children going to bed later than 9:00 pm. While this study suggests that sleep durations and bedtimes may be related to higher BMI's and obesity, it is difficult to translate this to adolescents.

The above literature describes a potential link between sleep duration and obesity. While this link may not yet be fully understood, it is likely that it is related to how diet and sleep are correlated. Multiple studies have shown a relationship between sleep duration and diet such as greater carbohydrate intake and snacking among those who get less sleep.[32,33] In order to make the connection between sleep and obesity, sleep and its relationship with diet need to be explored.

2.3 Adolescent Diet

General diet recommendations for adolescents vary based on age and gender. For the 9-13 year age category, females need 1600 kcal/day while males need 1800 kcal/day.[34] For teenagers aged 14-18 years, females need 1800 kcal/day and males need 2200 kcal/day. In

addition, it is recommended that adolescents consume 3 cups of milk, 1.5 – 2 cups of fruit and 2 – 3 cups of vegetables per day as well as 5 – 7 ounces of grains and 5 – 6 ounces of either meat or beans per day.

The majority of adolescents do not meet the above recommendations. Analysis of the National Longitudinal Study of Adolescent Health found that of the 18,177 adolescents surveyed, over 70% did not consume the recommended amounts of vegetables and 55% did not meet the recommendations for fruit.[35] Even more concerning, the 2003-2004 NHANES study showed that fewer than 1 in 10 Americans (including both adolescents and adults) met the fruit and vegetable recommendations.[36] However, having a family meal with parental involvement is positively correlated with greater intakes of fruits, vegetables, and dairy products.[35]

Diet quality is important to maintaining overall health and well-being. Even at an adolescent's young age, benefits of a healthful diet are seen at the cellular level. One cross-sectional study compared inflammatory markers in 285 adolescents from Minneapolis, MN to their typical dietary intakes of fruits and vegetables.[37] The average intake of fruits and vegetables between all the participants was 2.75 cups, but with fruit juice and French fries excluded the average fruit and vegetable intake was close to only 2 cups per day. Fruit juice alone accounted for almost half of the total fruit consumption. While the average intake of fruit and vegetable consumption is about half of the dietary recommendations for this age group, there was a significant inverse correlation between fruit and vegetable consumption and C-reactive protein (CRP), tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), and F2-isoprostane (F2-iso). Because CRP, TNF-α, and IL-6 are markers of inflammation while F2-iso is a marker of oxidative stress, this study shows the importance of fruit and vegetable consumption to decrease inflammation and oxidative stress in adolescents.

Healthy dietary patterns are important for not only adolescents' current well-being but also their future health as an adult. Malik et al., examined the relationship between dietary patterns during adolescence and type 2 diabetes risk in adulthood.[38] Participants from the Nurses' Health Study II completed a number of food frequency questionnaires: one detailing their typical diet during high school and four (one every 4 years between 1991 and 2003) regarding their current adult dietary patterns. Two main dietary patterns were determined from the food frequency questionnaires, "Prudent" and "Western." The "Prudent" pattern consisted of high intakes of vegetables, fruit, legumes, and fish with limited snacks and soda while the "Western" pattern contained large amounts of desserts, snacks, processed meat, red meat, and French fries. Any new onset of diabetes was self-reported by the participants during the questionnaires. The results showed the "Western" dietary pattern in both high school and adulthood was associated with a greater risk for type 2 diabetes. This relationship existed even after controlling for other risk factors such as family history of diabetes, physical activity, and smoking.

Liu et al. conducted a similar study comparing adolescent dietary intake of fiber, vegetable fat, vegetable protein, and nuts with breast cancer risk in adulthood.[39] This was a case controlled study consisting of 2,865 women with breast cancer compared to 3,299 randomly selected controls. Each participant completed two food frequency questionnaires, one for adolescent dietary patterns and one for adulthood dietary patterns. After controlling for adult intakes, a significant inverse relationship was found between adolescent dietary intakes of fiber, vegetable fat, vegetable protein, and nuts and breast cancer risk. Both of these studies point to the importance of healthy dietary patterns during adolescents to protect health later in life.

2.3.1 Diet Specific to Low-Income

Similar to the role SES has on adolescents' sleep, being from a low-income family also effects adolescents' diet. Children from low-income families consume large amounts of added

sugars and discretionary fat.[40] In fact, their consumption of added sugars and discretionary fat is similar to that of adults. This is possibly because many foods high in added sugars and discretionary fats are both easy to prepare and low in cost. Therefore, these products seem like good choices for families with financial limitations. Further, SES accounts for 30% of the differences between white adults and black adults in regards to diet quality.[19] Although this statistic is referring to adults and not adolescents, there is likely lower diet quality for adolescents living in low-income families if parents have poor diet quality due to income constraints. Lastly, there are regional differences in food intake based on the lower SES states. For instance, the southern states of the US have generally a lower economic status compared to other states, meaning those from this area likely also have poorer diet quality.[41] While adolescents in general do not typically meet the recommendations for a healthful diet, low-income adolescents may be at an even greater risk for poor diet quality.

2.3.2 Diet and Sleep

Poor diet quality may be associated with sleep deprivation. Because of this, researchers have investigated both the effects of increased sleep on dietary habits along with the effects of decreased sleep on dietary habits. For example, Tasali et al. examined the effect of longer sleep durations on 10 overweight, young adult men.[42] To do this, the researchers followed the participants for one week before providing them with sleep hygiene counseling where the goal was to increase their bedtime by an additional 2 hours each night. After the 2-week intervention phase, the participants increased their sleep duration by 1.6 hours on average and an association was found between the longer sleep duration and a decreased desire for sweet and salty foods.

Similarly, poor sleep is associated with greater overall food consumption.[6] Not only are greater amounts of food likely to be consumed during times of sleep deprivation, but the quality of food is also more likely to be poor. In a cross-sectional study using data from the National

Longitudinal Study of Adolescent Health, greater fast food consumption was related to lesser sleep durations.[43] In addition, adolescents who self-reported sleeping less than 7 hours a night consumed fewer fruits and vegetables compared to the adolescents who reported sleeping greater than 8 hours a night. Eating greater amounts of food with lower diet quality are correlated in adults and adolescents alike who have lower sleep durations.

One possible explanation for this additional calorie consumption is the change in hormones related to appetite during sleep deprivation. Lack of sleep, particularly in young adult men, has been shown to increase ghrelin levels, hunger, and appetite while decreasing leptin levels.[44] Because ghrelin's role is to increase appetite while leptin decreases hunger, sleep appears to be a crucial aspect in maintaining proper appetite management. Therefore, sleep is important in regulating the body's "hungry" and "full" signals while also being related to more healthful food choices.

While sleep and diet show a relationship that may help in explaining the obesity epidemic, sleep and physical activity are related as well. Particularly, one notable way to decrease body fat is to increase physical activity. However, if the body is too sleep deprived to muster up the energy to be physically active, this part of weight management will be difficult to master.

2.4 Adolescent Physical Activity

According to the Centers for Disease Control and Prevention (CDC), children and adolescents aged 6 to 18 years should get 60 minutes of physical activity each day.[45] Unfortunately, the Youth Risk Surveillance Survey of 2013 found that only 27.1% of adolescents engaged in 60 minutes of physical activity for the 7 days prior to the survey.[46] In general, boys are more likely to engage in physical activity than girls.[47] According to the NHANES data from 2007-2010, 67% of males had ideal physical activity compared to only 44% of females. However, many adolescents, regardless of gender, do not meet physical activity recommendations.

Although there are multiple reasons adolescents are not meeting physical activity recommendations, one reason may be the availability of physical activity equipment. Sirard et al. investigated the possible correlations between the availability of media and physical activity equipment in the home and actual physical activity, sedentary time, and screen time in adolescents.[48] The 575 adolescents from Minnesota who participated wore accelerometers for one week to track physical activity and sedentary time. The adolescents self-reported their average screen time for both week days and weekend days. To determine the amount of physical activity and media equipment available in the home, the parents completed the Physical Activity and Media Inventory (PAMI) which is a detailed questionnaire assessing the amount and accessibility of media equipment in each room and the availability of 42 various items of physical activity equipment. The amount of physical activity equipment in the home was positively correlated with the amount of physical activity minutes participated in by both males and females while the amount of screen media equipment was associated with screen time in females. Thus, physical activity of adolescents is related to the amount and ease of access to physical activity equipment available in the home environment.

Parental transportation to physical activity locations has also been associated with physical activity participation outside of school in adolescents.[49] This was reported in a study of 1678 middle school students from southern California. Through a survey, the students self-reported their physical activity outside of school during the previous 7 days as well as their participation in sports teams of special programs over the past year. The parents reported how many times per week the student was transported by a member of the household to a specific location to engage in physical activity. While males were transported more often than females, parental transportation significantly contributed to the females' physical activity. For the males, parental transportation was significantly related to their participation in sports and activity

lessons, but it was not significantly related to their totally physical activity. Thus, greater parental transportation is related to increased physical activity outside of school in females but not males.

While the amount of physical activity outside of school is important, physical activity during school is just as important due to the amount of time students spend at school each day. Haug et al. studied the potential correlations between physical environmental characteristics of schools and the amount of physical activity participated in by the students.[50] Each of the 16,471 students (grades 4-10) who participated completed a questionnaire assessing his/her amount of physical activity, the availability of facilities for physical activity at the schools, and duration of recess time. The results showed males participated in significantly more physical activity than females in all grades. Further, physical activity had the greatest prevalence for both genders during grade 6, but was significantly less in each consecutive grade beginning in grade 7 for females and grade 8 for males. Although there were no associations found between available facilities and prevalence of physical activity in grades 4-7, outdoor facilities in grades 8-10 were found to be significantly associated with daily physical activity during school breaks. Therefore, physical activity equipment in the home, parental transportation, and physical activity facilities at schools are factors that appear to affect the amount of physical activity engaged in by adolescents.

2.4.1 Physical Activity Specific to Low-Income

Interestingly, the SES of a neighborhood has a significant effect on its residents' level of physical activity. According to Boone-Heinonen et al., when analyzing data from the Coronary Artery Risk Development in Young Adults (CARDIA) study, there was a 16% difference in physical activity in African Americans from the most deprived neighborhoods compared to the most affluent neighborhoods.[51] Though the same results were not found in the white population and the reason for decreased physical activity in low-income black neighborhoods may not be

explicitly clear, this study suggests that physical activity can be affected by a person's neighborhood of residence.

In regards to children and adolescents, being from a lower SES home tends to show less physical activity engagement.[52] Children from lower SES families have several barriers and limitations for ease and ability to participate in physical activity. Safety is a primary barrier to physical activity for people from low-income neighborhoods; adolescents are less likely to frequent a facility offering physical activity if they do not think there will be a presence of safe adults.[53] Other barriers for adolescents participating in physical activity in low-income neighborhoods include the perception that the facilities offered in their neighborhoods are of lower quality than those offered in other neighborhoods and the perception that residents are unable to pay the fees associated with the facilities. In addition, children from low SES families do not perceive physical activity as fun or as important as children from either middle or high SES families.[54] Thus, many adolescents are not meeting physical activity recommendations and adolescents from low-income families are further limited in their access to physical activity opportunities. Further, reduced sleep quality may complicate the problem of limited physical activity even more.

2.4.2 Physical Activity and Sleep

Another potential health concern resulting from lack of sleep is its negative effect on physical activity. This is likely due to high levels of fatigue experienced during times of sleep deprivation resulting in a reduced desire for activities requiring high amounts of energy. After implementing a sleep intervention to improve sleep duration in young adults, one study discovered that increased sleep resulted in greater self-reported vigor.[42] In addition, an Australian study found interesting results regarding the relationship between bed timing behavior and physical activity.[7] In this study, 2200 adolescents aged 9 to 16 years were tracked in regards to

physical activity with self-reported activity minutes and screen time as well as steps tracked with a pedometer. The researchers clustered the adolescents into one of 4 groups: Early-bed/Early-rise (EE), Early-bed/Late-rise (EL), Late-bed/Early-rise (LE), or Late-bed/Late-rise (LL). Although the duration of the sleep time between the EE and LL groups was only minutes different (9 hours and 44 minutes compared to 9 hours and 36 minutes) the LL group participated in significantly less physical activity than the EE group. The EE group also had significantly greater screen time than the LL group. In addition, the researchers analyzed the different sociodemographic characteristics of each group and found that adolescents in the LL group were more likely to come from the low-income households than those in the EE group. This study shows that sleep duration may not be the only factor related to physical activity but sleep timing may also play a role.

In addition to longer sleep duration and early bed times being related to greater levels of physical activity, physical activity has also been shown to have a positive effect on sleep quality.[42,55,56] Brand et al. conducted a research study on adolescent sleep comparing athletes to non-athletes.[55] Sleep was tracked using the Pittsburgh Sleep Quality Index (PSQI), a questionnaire to rate various aspects related to sleep quality. The results showed that the adolescent athletes, who participated in an average of 17.69 hours of physical activity a week, reported better sleep quality than the non-athlete adolescents who participated in an average of 4.69 hours of physical activity a week. While adequate sleep encourages physical activity, physical activity in turn produces better sleep. The relationship between sleep and physical activity is intertwined, and therefore, very important.

2.5 Measurements

Pittsburgh Quality Sleep Index (PSQI)

The interest in sleep has resulted in a number of mechanisms to gauge sleep quality. One notable mechanism is the Pittsburgh Quality Sleep Index (PSQI) which is a questionnaire formulated to examine sleep status over the past month.[57] It consists of a number of open-ended and Likert type questions which are related to sleeping difficulties and overall sleep quality. The PSQI uses a 0-21 scoring system with greater numbers relating to poorer sleep quality. It is intended to be an easy to use instrument to measure "good" or "poor" sleepers. It can assess sleep disturbances and monitor sleep disorders.

Buysse et al. tested PSQI for validity and performance consistency by examining 3 different types of sleepers over an 18 month period.[57] First, the control group consisted of 52 healthy subjects without sleep complaints. The second group was comprised of 54 depressed patients from the Western Psychiatric Institute and Clinic who were considered "poor" sleepers. The third group included 62 patients with sleep disorders who were also patients of the Western Psychiatric Institute and Clinic. Each participant completed the PSQI questionnaire at least once, and 91 participants completed the PSQI a second time about 30 days after the first questionnaire. In general, the participants found the PSQI easy to use and understand. Because there were no significant differences found between the scores of the subjects who took the questionnaire twice, the PSQI was deemed to have performance consistency or test-retest reliability. Further, the validity of PSQI was supported because it accurately distinguished between the patients and controls. In other words, PSQI is able to differentiate from "poor" and "good" sleepers making it a good measure for sleep quality.

Automated Self-Administered 24-hour Recall (ASA24)

The ASA24 is a computer based 24-hour diet recall program. It is based on USDA's Automated Multiple Pass Methods (AMPM) which is an interview based 24-hour recall used by NHANES.[58,59] To test the validity of the ASA24, Kirkpatrick et al. compared the ASA24 to the

AMPM for known dietary intakes of 81 adults.[59] Actual food intake and plate waste for 3 meals was determined by weight and the participants were assigned to either the AMPM or the ASA24 recall group the next day. Each participant reported his or her 3 meals either through the interview based AMPM or the computer based ASA24. When the recalls were compared to the actual food intakes, both the ASA24 and the AMPM were roughly 80% accurate. Therefore, the ASA24 is compatible to the AMPM and while no recall method is perfect, the ASA24 performs notably well. Because the AMPM is expensive and requires time to conduct, the ASA24 has been recognized for its benefit to research by being comparable in quality to the AMPM but requiring less time and cost.

The process of the ASA24 involves completing seven steps as follows: meal-based quick list, meal gap review, detail pass, forgotten foods, final review, last chance, usual intake question, and supplement intake.[60] First, the meal-based quick list is the initial step where users list individual foods and drinks consumed during each meal and snack throughout the day. Users can either search for certain foods or browse foods in various categories listed. During this step, users also input where they ate the meal. Second, for the meal gap review, participants are asked if they consumed any additional foods or drinks during any 3-hour gap in their listed meals and snacks. If they respond yes to any 3-hour gap window, they then input that food or drink. Once that is complete, the users are taken through the "detail pass" for each food or drink item entered. During this step, the users enter how the food items were prepared, such as grilled or fried, and whether anything was added such as sugar or dressing. In addition, for each item the users are taken to a window to estimate the amount actually consumed. For this section, the program lists several pictures of various amounts for the users to choose from. After the detailed pass is complete for each food and drink listed, the users are asked if they consumed any commonly forgotten foods or drinks such as snacks or coffee. If the respondents answer yes to any of these, then they are taken to a window where they can enter the item(s). Following the forgotten foods

section, users are taken to the final review window where they are asked to review everything entered and edit or add anything they recognize that is missing. From the final review, a pop-up window appears to once again allow users to add any forgotten foods or drinks. Next, users are asked if the amount of foods and drinks entered are typical for a usual day. Finally, participants are asked if they consume any supplements and if so what type and the amount of each supplement listed. Completing an entry for the ASA24 can take approximately 20 – 30 minutes.[61]

Healthy Eating Index

ASA24 computes a Healthy Eating Index (HEI) score which relates to overall diet quality. HEI scores are based on the U.S. Department of Agriculture (USDA) food patterns.[62] To determine the HEI score, foods are divided into 12 components: Total Fruit, Whole Fruit, Total Vegetables, Greens and Beans, Whole Grains, Dairy, Total Protein Foods, Seafood and Plant Proteins, Fatty Acids, Refined Grains, Sodium, and Empty Calories. A score is determined for each of the 12 components based on actual intake compared to the Dietary Guidelines. The scores are then totaled for each component to formulate the HEI score. Greater scores indicate a higher diet quality while lower scores indicate a lower diet quality. The HEI-2010 been demonstrated to be valid and reliable in assessing diet quality.[63]

Physical Activity

While a commonly accepted, validated measure to test physical activity is the use of accelerometers, these are not always accurate due to user compliance issues. Therefore, other physical activity questionnaires have been evaluated for effectiveness. Ridgers et al. examined the validity of a questionnaire to determine older adolescents' compliance with physical activity recommendations.[64] Each of the 203 participants wore accelerometers for 8 days and self-reported the number of days they were physically active for at least 60 minutes over the past 7 days and in a typical week. Although most of the adolescents did not meet the physical activity

recommendations, the questionnaire results were found to be significantly correlated to the total physical activity recorded by the accelerometers. The researchers concluded that the self-reported questionnaire was valid in measuring non-compliance of physical activity recommendations. Therefore, this thesis will use self-reported physical activity durations provided by the Tulsa 100 survey.

2.6 Summary

In summary, the obesity epidemic continues to be a major health concern; every aspect related to obesity must be addressed to better treat this epidemic. Sleep may play a critical role in maintaining healthy weight control through diet choices and physical activity. Because adolescents undergo many lifestyle changes that often result in decreased sleep, this age group is particularly vulnerable to the health consequences of decreased sleep. Individuals from low-income households are at an even greater risk for sleep reduction along with poorer diet quality and limited physical activity. While previous research has evaluated the effects of sleep on diet and physical activity in general populations, there is limited research examining sleep quality on diet and physical activity in low-income adolescents. This research adds to the current research by further supporting the limited information available on low-income adolescents regarding sleep's effect on diet and physical activity.

2.6.1 Purposes of this Research

The purpose of this project is to evaluate the possible associations between sleep quality and diet quality as measured by HEI, and between sleep quality and self-reported physical activity and screen time in adolescents from low-income families. The questions addressed in this research are as follows: 1) Are the diet quality and food energy intakes in low-income adolescents associated with sleep quality? 2) Are there associations in physical activity or screen time based on sleep quality in low-income adolescents?

2.6.2 Objectives

Objective: Evaluate the interaction of sleep on food energy intake and HEI score.

Objective: Evaluate the interaction of sleep on physical activity and screen time.

CHAPTER III

METHODOLOGY

The data for this study included survey items from the Pittsburgh Sleep Quality Index, physical activity assessed through surveys, and dietary intake as measured by the ASA24 which were all part of the Tulsa100 survey. The Tulsa100 survey also includes a number of other survey items requiring two day interviews that will not be reported in this thesis.

3.1 Sampling Population

The population for this study was all households with an adolescent child in either the Kendal-Whittier or Eugene Fields neighborhoods of Tulsa, Oklahoma. These communities were selected based on their high proportion of impoverished households: the focal population of interest in this study was impoverished adolescents who are believed to be more vulnerable to unhealthy physical activity, sleep and diet. Study participants were caregiver-adolescent dyads. Inclusion criteria for participating caregivers included: (1) being the parent or legal guardian of an age-eligible adolescent, (2) being the primary caregiver of an age-eligible adolescent, (3) willingness to participate, and (4) willingness to provide authorization for the minor child to participate in the study. Inclusion criteria for participating adolescents included: (1) being the individual for whom the random selection of the household was based (other age-eligible peers cannot be substituted); (2) age 12-17, (3) willingness to participate in the study. The exclusion

criteria eliminated: (1) anyone who lacked sufficient English to complete an interviewer-administered survey questionnaire and a videotaped interaction in English, (2) adolescents who had a known medical or developmental problems precluding regular physical activity, (3) any adolescent who was currently on a doctor-prescribed diet or had extensive food allergies, (5) and lastly, any adolescent with known (doctor-diagnosed) sleep problems.

3.1.2 Subject Selection Methodology

Research partners at Community Action Project (CAP) have an existing list of all households with either a middle- or high school aged child in the Kendal-Whittier and Eugene Fields neighborhoods. Their list was assembled by obtaining a list of households from the Tulsa Public School system, and CAP's mapping of these addresses to the known residences and dwellings in the neighborhoods. CAP's listing was used as the sample frame for this study with all households in the Kendal-Whittier and Eugene Fields neighborhoods including an age-eligible adolescent (based on TPS data embedded in the household roster) were enumerated. Following enumeration, a simple random subset of 100 households was selected. Each household was contacted by a trained data collector; once contact was made the household was screened for study eligibility, and caregiver-adolescent dyads were invited to participate if screened eligible. Recruitment continued until the desired sample was obtained.

3.1.3 Subject Recruitment

All participants were recruited by two trained, community-based interviewers. Six community members were hired and trained as data collectors for the study. As required by OSU Human Resources, the data collectors were hired as temporary university employees. Potential interviewers were referred by the leadership team of the PROMISE and CHOICE Neighborhood initiatives led by CAP. Individuals referred were recognized leaders of the community, many of whom have participated in neighborhood circle discussions of local community concerns and

solutions. Many also have been trained in the study circle model of facilitating group discussions that help community members develop innovative strategies to strengthen their neighborhood. Required attributes of selected data collectors included an outgoing and gregarious personality, the ability to work independently or with limited supervision, and English as a primary language.

All data collectors completed a two-day training session provided by the senior researchers. The training included a thorough review of the study purpose, participant selection and recruitment, data collection procedures, as well as tips for recognizing participant fatigue and potential child abuse or neglect. The training involved lecture, review of question-by-question specifications, instructor demonstrations, and group and paired practice with mock interviews. Interviewers were required to complete two practice interviews that were directly observed and evaluated in the Center for Family Resilience observational room. All data collectors completed the CITI program modules for training in protection of human subjects. These modules cover the historical origins of modern protection of human subjects' participation in research, and the rights of study participants including the right to confidentiality. Training also included material about the possibility of discovery of child abuse or neglect including signs and symptoms of psychological, physical, and sexual abuse, and the ethical responsibilities of any adult to report potential abuse or neglect along with a review of the reporting protocol in the event of suspected abuse or neglect. Data collectors were also provided guidelines for personal safety. Any data collector who did not demonstrate mastery of all procedures by the conclusion of the training session and the practice interviews received additional training or was released from the study.

Recruitment followed a two-step procedure. In the first step, simple random selection procedures were used to select households from the enumerated list of eligible households. In the second step, the Project Manager assigned up to 10 selected households to each data collector. The data collector made up to 10 attempts over a two-week period to make in-person contact with each individual at different times of the day and on different days of the week. Once contact was

made, the data collector explained the purpose of the visit, screened the individual for inclusion criteria, and invited individuals meeting inclusion criteria to participate in the study. Individuals who declined participation were thanked. Individuals who agreed to participate were scheduled for study enrollment and baseline data collection, although every attempt was made to enroll and collect baseline data immediately. Additional contact information (e.g., cell phone number, email address) were also obtained. A final disposition on all selected households was documented. Parents/caregivers who completed all aspects of the interviewer-administered survey received $50 for their participation. Adolescents could receive up to $80 for participating: $25 for completing the initial interview, $25 for completing the accelerometer data collection, and $30 for completing the two, 24-hour diet recalls.

3.1.4 Number of Subjects

In total, one hundred caregiver-adolescent dyads, equally stratified by adolescent age (50 adolescents aged 12-14, and 50 adolescents aged 15-17) were successfully recruited. The final sample included 200 individuals: 100 caregivers, and 100 adolescents. For the purpose of this study, only the adolescent responses were studied.

Written informed consent/assent was obtained from all study participants. The trained data collectors began by explaining the study to the potential parent/guardian. Once the parent/guardian expressed a willingness to participate in the study, the focal adolescent was asked into the conversation. The data collector explained all aspects of the study, emphasizing that participation is voluntary, that participants can stop participating at any time, and that all data will be kept completely confidential. A detailed description of each data collection component was provided to both the parent/guardian and the adolescent. All participants were provided the opportunity to ask questions about their involvement. After questions were answered, the data collector enrolled the parent/guardian, which included providing permission for the adolescent to

participate, by obtaining a signed informed consent. After obtaining permission from the parent/guardian, the adolescent was asked to enroll in the study by providing a signed assent form.

3.1.5 Duration of Subject's Participation

Participation duration differed for parents/guardians and adolescents. Parents' participation was less than 60 minutes. Adolescents' participation did not exceed 14 days. There were six components of data collection: (1) An interviewer-administered survey questionnaire with the parent/guardian (25 minutes), (2) an interviewer-administered survey questionnaire with the adolescent (25 minutes), (3) a video-taped parent/guardian-adolescent interaction (6 minute conflict task discussion + 2 minute set-up, for a total of 8 minutes), (4) anthropometrics of parent/guardian and adolescent (approximately 5 minutes for each member of the dyad), and (5) adolescent dietary assessment through 2, 24-hour diet recalls across a 7-day period.

3.2 Anthropometrics

Weight was measured to the nearest 0.1 kilogram using a professional grade digital scale (Tanita model BSB800). Adolescents wore lightweight clothing with shoes removed. Height was measured to the nearest 0.1 cm with a portable stadiometer (SECA Road Rod 214). Participants stood on the horizontal platform with heels together, stretching upward to the greatest extent. The data collector adjusted the head so that the Frankfort plane was horizontal to the ground. The horizontal arm of the stadiometer was brought down on the participant's head. The height measurement was taken twice and averaged, with the participant moving away from the stadiometer in between measurements. If the measurements differed by more than 5 mm, two additional measurements were taken and averaged. BMI was recorded using the BMI calculation: weight in kilograms divided by height in meters squared.

3.3 Dietary Assessment

Dietary data was collected using two 24-hour recalls during a 7-day period completed in person. One of the 24-hour recalls was obtained in person during the baseline interview with the adolescent, and it reflected foods consumed by the adolescent in the prior day. The second 24-hour diet recall was completed in person the day the data collector returned to retrieve the accelerometers, and it reflected food consumed the prior day. Dietary intake was assessed using the web-based ASA24 which is a self-administered 24-hour dietary recall using a multi-pass method. Upon initial recruitment into the study, the adolescents were asked to view the tutorial explaining how to complete the ASA24 on a laptop computer provided to the data collector, and then to complete the description of their previous day's food intake.

The ASA24 gathered all foods and beverages consumed by the adolescents in a 24-hour period. This included alcohol and vitamin supplement consumption. The nutrient reports showed macronutrient intakes as well as micronutrients such as vitamins and minerals. In addition, food groups were provided such as total fruit and total vegetables. These food groups were listed in units that could be easily translated to the number of servings achieved for a particular food group, and the food groups were used to calculate a Healthy Eating Index (HEI) score.

The results from the ASA24 were used to calculate a HEI score for each participant. For the individuals that had more than one ASA24 complete, an average of two recalls was used to calculate the HEI score. However, some participants only had one completed dietary recall. For these subjects, the one dietary recall provided was used to calculate the HEI score. In the case of more than two completed recalls, the two recalls most similar in total calorie intake were used to create an average. After the averages were determined, the individual scores for each of the 12 HEI components were calculated. Ratios were determined based on the maximum and minimum scores possible for each component, and the ratios were used to determine scores based on the participant's actual intake and the HEI scoring system for each component.[62] These scores were then totaled for each adolescent to determine his/her HEI score.

3.4 PSQI Assessment

The PSQI collected data on sleep difficulties and overall sleep quality. The questionnaire is divided into 7 subscales: 1) sleep duration, which is the actual time spent sleeping not the time spent in bed, 2) sleep disturbance, such as bad dreams, 3) sleep latency, which is the amount of time it takes to fall asleep, 4) daytime dysfunction due to sleepiness, 5) sleep efficiency, which shows the efficiency of an individual's sleep based on the amount of time spent in bed versus sleep duration, 6) overall sleep quality, a subjective measure on a scale rating from "very bad" to "very good," and 7) medications needed for sleep.[7,19] All subscales were scored in a range from 0=better to 3=worse. The total PSQI score was then calculated by adding each subscale score. The range for the total score was 0=better to 21=worse; scores of ≤5 indicated good sleep quality. Therefore, lower scores relate to better sleep quality, and a negative association between PSQI and HEI will demonstrate that poorer sleep quality is related to poorer diet quality.

3.5 Physical Activity Assessment

Physical activity was measured through a subjective measurement taken based on the adolescents' answers to the questionnaire. The adolescents were first asked if they participated in any vigorous physical activity for at least 10 minutes during the previous week. For those who answered "yes," they were then directed to respond to a question asking how many days during the past week they participated in vigorous physical activity for the past week. Lastly, they were asked how long in minutes and hours they engaged in vigorous physical activity on the days they reported being vigorously active for at least 10 minutes. This serious of questions was then repeated for moderate physical activity. Additionally, adolescents were asked to report the hours per day they watched TV for both work days and non-work days.

3.6 Statistical Analysis

Before completing a statistical analysis, the participants' results for anthropometrics, sleep, and diet were matched since these were all stored in different data files. During this process, any individuals with incomplete data for sleep or diet were deleted. The data for individuals with identification numbers that could not be correctly matched with sleep and diet were deleted as well. This left a total of 78 participants. Additionally, any data points that were determined to have been entered incorrectly were adjusted. For example, one participant's physical activity was listed as 20 hours per day, and this was changed to 20 minutes per day. Any values that were clearly incorrect but for which we could not determine an obvious correction were deleted.

The Statistical Package for the Social Sciences (SPSS) was used to analyze the data. Frequencies were used to determine the distribution of the data. Chi Square tests were conducted on race, grade in school, and the household income ranges to determine if there were significant differences between genders. Independent *t*-tests were used to evaluate age in years, BMI, PSQI, total Kcal, HEI, physical activity minutes per week, and TV hours per week based on gender. Pearson's *r* correlation was performed to evaluate relationships between variables such as PSQI, HEI, physical activity, and TV time. A Stepwise Multiple Linear Regression was conducted to evaluate the variance explained in the total HEI scores by specific food items, in units related to the number of servings, percent kcals of macronutrients, and total kcals. A significance level of $p = 0.05$ was used as the threshold to determine statistical significance.

CHAPTER IV

FINDINGS

Of the 100 adolescents who participated in the study, 80 completed both the ASA24 and the PSQI. Further, participants with IDs that could not be matched were also dropped. This left a total of 78 participants who completed both the ASA24 and the PSQI surveys.

The general characteristics of the population are listed in Table 1. Of the 78 participants, there were 43 males and 34 females; one participant did not list a gender. There were two questions on the survey regarding race/ethnicity. First, the participants classified their race as either White, African American, Asian, Pacific Islander, multiracial, or other (because no participants reported a race of Asian or Pacific Islander, these categories were not included in Table 1). Then, the participants answered either "yes" or "no" to whether they were from a Hispanic/Latino descent. The majority of the adolescents classified themselves as both White and from a Hispanic/Latino descent, and while the participants grade in school ranged from 5^{th} to 12^{th} grade, the majority of the students were in high school (9^{th} – 12^{th}). Further, over 65% of the adolescents were from households with an annual income less than $30,000. When grouped based on gender, there were no major differences noted in sociodemographic characteristics.

The frequencies for the PSQI scores are listed in Table 2. The majority of the scores were between 2 and 6 with a mean of 5.1 ± 2.8. Over 62% of all the PSQI scores were less than or equal to 5.

Table 1 Sociodemographic Characteristics

	Total (n=78)		Boys* (n=43)		Girls* (n=34)	
	n	%	n	%	n	%
Race						
White (including Hispanic)	64	82.1	36	83.7	28	82.4
African American	9	11.5	6	14	3	8.8
Native American	2	2.6	1	2.3	1	2.9
Multiracial	1	1.3	0	0	1	2.9
Other	1	1.3	0	0	1	2.9
Latino/Hispanic						
Yes	61	78.2	36	83.7	25	73.5
No	15	19.2	6	14	9	26.5
Grade in School						
5th	2	2.6	1	2.3	1	2.9
6th	7	9.0	3	7	4	11.8
7th	13	16.7	11	25.6	2	5.9
8th	7	9.0	2	4.7	5	14.7
9th	16	20.5	10	23.3	6	17.6
10th	14	17.9	7	16.3	7	20.6
11th	6	7.7	3	7	3	8.8
12th	11	14.1	5	11.6	6	17.6
Household Income						
Less than $15,000	20	25.6	10	23.3	10	29.4
$15,000 - $29,999	32	41.0	16	37.2	15	44.1
$30,000 - $44,999	14	17.9	9	20.9	5	14.7
$45,000 - $59,999	6	7.7	5	11.6	1	2.9
$60,000 - $74,999	2	2.6	1	2.3	1	2.9
$75,000 - $99,999	2	2.6	1	2.3	1	2.9

*Chi Square showed no significant differences between genders for any of the variables listed in this table

Table 2 Frequency of PSQI Scores
(PSQI Mean: 5.1 ± 2.8)

PSQI Score	Frequency	Percent	Cumulative Percent
0	1	1.3	1.3
1	5	6.4	7.7
2	8	10.3	17.9
3	9	11.5	29.5
4	12	15.4	44.9
5	14	17.9	62.8
6	9	11.5	74.4
7	6	7.7	82.1
8	4	5.1	87.2
9	1	1.3	88.5
10	6	7.7	96.2
11	2	2.6	98.7
14	1	1.3	100.0

Table 3 denotes the number of participants who participated in at least 10 minutes of either moderate or vigorous physical activity over the week previous to being interviewed, and for those who did participate in physical activity, this table states the number of days per week participants engaged in either moderate or vigorous physical activity. Of the 54 adolescents (73%) who participated in moderate physical activity during the week, the most common responses for the number of days per week they engaged in moderate physical activity were 2, 3, and 5. Additionally, 56 adolescents (74.3%) reported engaging in vigorous physical activity for at least 10 minutes over the one-week period. The number of days per week of participation in vigorous physical activity was dispersed fairly evenly, but the most common response was 3 days per week.

Table 4 shows the mean, median and standard deviation for TV hours on work days and non-work days. Of the 74 adolescents who reported TV time, the average time spent watching TV

on work days was 2.9 hours while the average for non-work days was 2.6 hours. Both of the variables had a median of 3 hours.

Table 3 Physical Activity

	Moderate		Vigorous	
	n	%	n	%
***Physically Active in the Past Week**				
Yes	54	73.0	56	74.3
No	21	27.0	19	25.7
Number of Days Per Week				
1	5	6.4	10.0	12.8
2	16	20.5	8.0	10.3
3	14	17.9	12.0	15.4
4	2	2.6	9.0	11.5
5	11	14.1	8.0	10.3
7	6	7.7	9.0	11.5

*Participated in at least 10 minutes of physical activity in the past week.

Table 4 TV Hours (n=74)

	Mean	Median	SD
Work Days	2.9	3.0	1.7
Non-Work Days	2.6	3.0	1.6

Table 5 represents the mean, median, and standard deviation for age, BMI, PSQI, total Kcals, HEI, total physical activity minutes per week (moderate and vigorous combined), and total TV hours per week (work days and non-work days combined) for all the adolescents and grouped by gender. The average age was 14.4 years for all the adolescents and similar when grouped by gender. BMI and PSQI were also similar when grouped by gender and had a total mean of 25.4

(BMI) and 5.1 (PSQI). Kcals averaged at 1406.3 for the whole group, and the boys had a numerically greater kcal average than the girls with means of 1482.8 and 1307.6, respectively. However, this difference between the boys' and girls' kcals was not statistically significant. Additionally, the means for HEI, physical activity minutes per week and TV hours per week were 39.2, 342.3 minutes, and 19.7 hours, respectively. There were no statistically significant differences when grouped by gender for HEI, physical activity minutes per week, and TV hours per week.

Table 6 shows Pearson's *r* Correlation for BMI, age, income, PSQI, Kcal, HEI, physical activity minutes, and TV hours. Income was negatively correlated to BMI at a significance of $p = 0.01$, and PSQI was positively correlated to BMI at $p = 0.05$. Further, BMI and HEI showed a negative correlation at $p = 0.05$. Age was positively correlated to PSQI at $p = 0.01$. With $p = 0.05$, income was positively associated with TV hours and PSQI was negatively associated with HEI.

Table 7 shows the Pearson's *r* Correlation for PSQI, total physical activity minutes per week, total TV hours per week and the following food groups: Total Fruit, Whole Fruit, Total Vegetables, and Dark Green Vegetables. TV hours were negatively related to Dark Green Vegetables at $p = 0.05$. Additionally, Total Vegetables and Whole Fruit were significantly correlated also at $p = 0.05$.

Table 8 shows the results of a regression model for HEI scores. Total fruit is the most important predictor overall, accounting for 20.6% of the variance found in the HEI scores. In model 3, 50.1% of the variance in HEI is accounted for by total fruit, non-whole grains, and poly-unsaturated fatty acids. Model 10 consisted of Total Fruit, Non-Whole Grain, Poly-Unsaturated Fatty Acids (PUFA), Legumes, Discretionary Solid Fats (Disc. Fat), Sodium, Percent Kcals from Protein, Percent Kcals from Carbohydrate, Added Sugar, and Grams of Carbohydrates, explained 82.3% of the variance in HEI scores at $p < 0.001$.

Table 5 Mean and Medians for Age, BMI, PSQI, Total Kcal, HEI, PA minutes, and TV hours

	Total					Boys*			Girls*		
	Mean	Median	SD	Min.	Max	Mean	Median	SD	Mean	Median	SD
Age	14.4	15.0	2.0	11.0	18.0	14.3	14.0	2.0	14.6	15.0	2.0
BMI	25.4	23.3	6.7	14.0	44.3	24.3	22.7	5.8	26.3	24.6	7.3
PSQI	5.1	5.0	2.8	0.0	14.0	4.9	4.0	2.8	5.3	5.0	2.9
Total Kcal	1406.3	1282.5	737.2	149.0	4265.0	1482.8	1431.0	741.8	1307.6	1157.5	741.6
HEI	39.2	38.0	13.0	12.0	81.0	38.9	38.0	13.4	39.8	38.0	12.8
PA minutes	342.3	210.0	386.1	0.0	2130.0	341.2	200.0	349.4	351.2	270.0	441.5
TV hours	19.7	20.5	10.7	0.0	35.0	19.8	20.5	10.5	19.0	19.0	11.0

*Independent *t*-test showed no statistically significant differences between genders for any of the variables listed in this table.

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Table 6 Pearson Correlation on Selected Variables

	BMI	Age in years	Income ranges	PSQI[1]	Kcal	HEI[2]	PA[3] min.	TV hrs.
BMI	1	0.326**	-0.287**	0.227*	0.034	-0.243*	0.050	-0.051
Age in years		1	-0.016	0.349**	0.187	0.066	0.148	0.110
Income ranges			1	0.076	-0.008	0.028	0.122	0.260*
PSQI[1]				1	0.044	-0.208*	0.157	-0.022
Kcal					1	-0.079	-0.079	-0.016
HEI[2]						1	0.027	-0.004
PA[3] min.							1	-0.020
TV hrs.								1

*Correlation is significant at the $p = 0.05$ level (1-tailed).

**Correlation is significant at the $p = 0.01$ level (1-tailed).

[1]Pittsburgh Sleep Quality Index (note: lower scores relate to better sleep quality)

[2]Healthy Eating Index

[3]Physical Activity

Table 7 Food Group Correlations

	PSQI	TV hrs.	PA min.	Total Fruit	Whole Fruit	Total Vegetables	Dark Green Vegetables
PSQI	1	-0.022	0.157	-0.067	-0.111	-0.005	0.018
TV hrs.		1	-0.020	0.067	-0.043	0.007	-.258*
PA min.			1	-0.025	-0.051	-0.119	0.143
Total Fruit				1	.641**	0.05	-0.012
Whole Fruit					1	.242*	0.081
Total Vegetable						1	0.029
Dark Green Vegetables							1

*Correlation is significant at the $p = 0.05$ level (2-tailed).

**Correlation is significant at the $p = 0.01$ level (2-tailed).

Table 8 Stepwise Multiple Linear Regression of Selected Food Items* on HEI Score

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.454[a]	.206	.195	11.68377	.206	19.711	1	76	.000
2	.611[b]	.373	.356	10.44988	.167	20.007	1	75	.000
3	.708[c]	.501	.481	9.38595	.128	18.967	1	74	.000
4	.765[d]	.585	.563	8.61395	.084	14.858	1	73	.000
5	.827[e]	.684	.662	7.57701	.098	22.348	1	72	.000
6	.842[f]	.708	.683	7.32877	.025	5.960	1	71	.017
7	.859[g]	.738	.712	6.98803	.030	8.093	1	70	.006
8	.869[h]	.755	.726	6.81646	.016	4.568	1	69	.036
9	.877[i]	.769	.738	6.66562	.014	4.158	1	68	.045
10	.907[j]	.823	.796	5.87934	.054	20.404	1	67	.000

a. Predictors: (Constant), Total Fruit

b. Predictors: (Constant), Total Fruit, Non-Whole Grain

c. Predictors: (Constant), Total Fruit, Non-Whole Grain , PUFA

d. Predictors: (Constant), Total Fruit, Non-Whole Grain , PUFA, Legumes

e. Predictors: (Constant), Total Fruit, Non-Whole Grain, PUFA, Legumes, Disc. Fat

f. Predictors: (Constant Total Fruit, Non-Whole Grain, PUFA, Legumes, Disc. Fat, Sodium

g. Predictors: (Constant), Total Fruit, Non-Whole Grain, PUFA, Legumes, Disc. Fat, Sodium, Percent Protein

h. Predictors: (Constant), Total Fruit, Non-Whole Grain, PUFA, Legumes, Disc. Fat, Sodium, Percent Protein, Percent Carb

i. Predictors: (Constant), Total Fruit, Non-Whole Grain, PUFA, Legumes, Disc. Fat, Sodium, Percent Protein, Percent Carb, Added Sugar

j. Predictors: (Constant), Total Fruit, Non-Whole Grain, PUFA, Legumes, Disc. Fat, Sodium, Percent Protein, Percent Carb, Added Sugar, Carbohydrates

*Total Fruit in cups, Non-Whole Grain in ounces, Poly-Unsaturated Fatty Acids (PUFA) in grams, Legumes in cups, Discretionary Solid Fats (Disc. Fat) in grams, Sodium in milligrams, Percent Kcals from Protein, Percent Kcals from Carbohydrate, Added Sugar in teaspoon equivalents, Carbohydrates in grams.

Table 9 shows the unstandardized coefficients for Model 10 from the multiple linear regression shown in Table 8. The standardized coefficients show the estimated effect to change the total HEI score for each of the HEI predictors. For example, the beta value of 2.545 for total fruit at $p < 0.05$ explains that the estimated effect of an additional cup of fruit results in an increase of 2.545 in the total HEI score. The significant beta values are as follows: Total Fruit at 02.545 ($p < 0.05$), Non-Whole Grain at -1.847 ($p < 0.001$), Poly-Unsaturated Fatty Acid at 0.924 ($p < 0.001$), Legumes at 10.161 ($p < 0.001$), Sodium at -0.006 ($p < 0.001$), Percent Kcals from Protein at 0.989 ($p < 0.001$), Added Sugar at -0.724 ($p < 0.001$), and Grams of Carbohydrates at 0.126 ($p < 0.001$).

Table 9 Effect Estimate for Change in HEI Score with Predictors* of HEI Score

Model		Unstandardized Coefficients		Sig.	95.0% Confidence Interval for B	
		B	Std. Error		Lower Bound	Upper Bound
10	(Constant)	12.940	9.278	.168	-5.579	31.459
	Total Fruit	2.545	1.006	.014	.538	4.552
	Non-Whole Grain	-1.847	.421	.000	-2.687	-1.007
	PUFA	.924	.157	.000	.611	1.237
	Legumes	10.161	2.724	.000	4.723	15.599
	Disc. Fat	-.083	.069	.234	-.221	.055
	Sodium	-.006	.001	.000	-.008	-.003
	Percent Protein	.989	.226	.000	.538	1.440
	Percent Carb	.174	.115	.136	-.056	.404
	Added Sugar	-.724	.148	.000	-1.019	-.430
	Carbohydrates	.126	.028	.000	.070	.182

Dependent Variable: HEI score

*Total Fruit in cups, Non-Whole Grain in ounces, Poly-Unsaturated Fatty Acids (PUFA) in grams, Legumes in cups, Discretionary Solid Fats (Disc. Fat) in grams, Sodium in milligrams, Percent Kcals from Protein, Percent Kcals from Carbohydrate, Added Sugar in teaspoon equivalents, Carbohydrates in grams

CHAPTER V

DISCUSSION

This study evaluated the relationships between sleep and diet and between sleep and physical activity in low-income adolescents from the Kendall-Whittier and Eugene Fields neighborhoods of Tulsa, OK. This population meets the criteria for low SES exhibited by over 89% of students at Kendall-Whittier and Eugene Fields Elementary Schools qualifying for free and reduced meals.[65] Further, over 65% of the adolescents in this study were from households with an annual income of less than $30,000.

Sleep, the main variable in this study, was measured using the PSQI questionnaire. The PSQI is used to determine sleep quality, and any score less than or equal to 5 is considered good sleep quality.[57] Because over 60% of the participants in this study scored a 5 or less on the PSQI, the majority are considered to have good sleep quality. The expectation was that fewer adolescents would have reported good sleep quality due to the previous mentioned literature by Gellis who links socioeconomic status as a likely factor explaining sleep-related problems and El-Sheikh et al. who found that children from lower SES homes had overall worse sleep. [5,30] Nonetheless, 37.2% were classified as having poor sleep quality showing some amount of sleep problems with this population.

As previously stated, diet was assessed using the HEI scoring system. The average HEI score was 39.2 for all participants. The ideal HEI score is 100 and according to the NHANES

report from 2011 – 2012, the average HEI score for children aged 2-17 was 55.07.[66,67]

Consequently, the average HEI score for the adolescents in this study was less than the national average by more than 15 points; indicating that adolescents from the Kendall-Whitter and Eugene Fields areas have less than ideal diet quality. Several studies reviewed previously also noted poor diet quality in low-income populations.[19,40] Additionally, the average for total kcal intake was on 1406.3. This is lower than the recommendation of 1600-2200 kcals for this age group.[34] Therefore, adolescents in this study do not have adequate diets either in food energy intake or diet quality.

Interestingly, the adolescents' mean for physical activity is closer to the recommendation of 60 minutes per day than expected.[45] The average reported time spent engaging in moderate and vigorous physical activity was 342 minutes per week, averaging out to 49 minutes per day. While this was a greater amount of physical activity than was expected for this population, 49 minutes per day does not meet the 60 minutes per day recommendation.[45] Therefore, this finding does align with the previously stated literature explaining that many adolescents and people from low SES neighborhoods do not meet their physical activity recommendations.[46,51,52]

The first research question for this study was to determine if diet quality and food energy intakes were associated to sleep quality. Diet quality was determined by HEI scores and total energy intake was obtained using the total Kcals provided for each participant by ASA24. Sleep was found to be associated to HEI (or diet quality) but not to total Kcals (or food energy). Further, while sleep was associated with the total HEI score, there was no association found between sleep and the fruit and vegetable food groups. Sleep's association to HEI is supported by the previously mentioned studies by Tasali et al. and Krguer et al. but the lack of relationship between sleep and fruit and vegetable intake differs from Kruger et al.'s study which found

longer sleep durations in adolescents to be associated with greater fruit and vegetable consumption.[42,43]

As mentioned, PSQI and total Kcal intake did not show a significant relationship. Therefore, even though diet quality was related to sleep, overall food energy consumption did not appear to be affected by sleep. This result differs from the previously mentioned research by Spiegel et al. who found that reduced sleep duration increased hunger and appetite.[44] This study may not have found a relationship between sleep quality and food energy intake due to a lack of food available to the adolescents. A lack of food availability may also explain why this group of adolescents only consumed an average of 1406.3 kcals per day compared to the recommendation of 1600-2200 kcals per day.[34] Also, lower levels of sleep may not affect adolescent appetite hormones like it does adults. While the cause may be unknown, lower sleep quality did not have an effect on total energy intake, but it was significantly related to diet quality which was considered poor with a mean HEI score of only 39.2.

The second research question asked whether there were associations in physical activity or screen time based on sleep quality in low-income adolescents. There were no significant associations between sleep and physical activity or TV hours. Therefore, sleep quality did not appear to have an effect on either the adolescents' participation in physical activity or the amount of time spent watching TV. A non-existent association between sleep and physical activity is contrary to the previously mentioned research by Tasali et al. and Brand et al.[42,55] Further, our result of TV hours not being related to sleep quality is also not what was expected based on the previously mentioned research. Calamaro et al. found that adolescents use multiple technologies, including TV, before going to bed.[27] Therefore, the expectation was that a significant association between TV hours and sleep quality would exist showing that as more TV was watched, sleep quality become poorer. However, the adolescents in this study could have been using technologies other than TV's such as cell phones or computers before going to bed. These were

not included in this study and could explain why TV hours did not show a significant relationship with PSQI.

Although not specifically related to the research questions, there were other significant findings in this study. First, BMI was found significantly related to income, PSQI, and HEI. The negative correlation found between BMI and income is supported by the previously stated research by Wang and Marask.[1,20] Also, poor sleep quality was related to higher BMI's in our study. This is similar to the study previously mentioned by Nishiura and Hashimoto who found that men sleeping 5 hours a night had significantly greater BMI's than men sleeping 7 hours a night.[22] It is notable that there were no associations found between PSQI and kcal or physical activity, but there was a relationship between PSQI and BMI. It may be that poorer sleep quality causes a slight decrease in physical activity and a slight increase in kcal consumption but not large enough to show a significant effect. BMI was also negatively correlated with HEI meaning that those who consumed a higher quality diet also had lower BMI's.

Second, age showed a significant positive relationship to PSQI and income was positively associated with TV hours. Because lower PSQI scores relate to better sleep quality, this shows that younger adolescents had better quality sleep or that older adolescents receive poorer quality sleep. This may be due to the likelihood that older adolescents have greater freedom in how they spend their time in the evenings or that their lives are busier with work and school related activities. The relationship between income and TV hours demonstrates that adolescents from higher income families tend to watch TV for longer durations than adolescents from lower income families.

Third, the food group correlations show dark green vegetable consumption was inversely and significantly related to TV hours. Therefore, adolescents who consumed greater amounts of dark green vegetables also spent less time watching TV. Additionally, whole fruit showed a

strong relationship to total vegetable intake – meaning that greater amounts of whole fruit intake was associated with greater amounts of total vegetable intake.

Stepwise multiple linear regression was used to determine the effect of various food items on the variance in the HEI score. Total Fruit was found to be the best predictor of HEI accounting for 20.6% of the total variance. Then, Total Fruit, Non-Whole Grain, and Poly-Unsaturated Fatty Acids, together accounted for 50.1% of the variance in the HEI scores. Total Fruit, Non-Whole Grain, Poly-Unsaturated Fatty Acids, Legumes, Discretionary Solid Fats, Sodium, Percent Kcals from Protein, Percent Kcals from Carbohydrates, Added Sugar, and Carbohydrates together accounted for 82.3% of the variance in HEI scores, meaning that these 10 food items predict the HEI score by 82.3%.

Further, the effect of each food item to change the HEI score was evaluated using the unstandardized coefficients from the linear multiple regression. The unit of each food item for the linear multiple regression model was kept in the original form as the ASA24 output which corresponds to number of servings. Total fruit (in cups) had a beta of 2.545 meaning that an additional cup of fruit would raise the HEI score by 2.545. Poly-unsaturated fatty acids (in grams), legumes (in cups), percent kcals from protein, and carbohydrates (in grams) also had positive beta values of 0.924, 10.161, 0.989, and 0.126, respectively. Therefore, these food items have a positive effect on the HEI score. However, non-whole grains (in ounces), sodium (in milligrams), and added sugar (in teaspoons) had a negative effect on the HEI score with beta values of -1.847, -0.006, and -0.724, respectively.

These results are important in understanding the best ways to improve the diet of this population. The variables listed above have a statistically significant effect on the HEI scores for adolescents in the Kendall-Whittier and Eugene Fields neighborhoods and are clearly available and consumed by these adolescents. To improve the HEI scores for this population, focus should

be placed on increasing the consumption of the variables with positive beta values, such as fruit, poly-unsaturated fatty acids, legumes, percent kcals from protein, and carbohydrates. Similarly, intake of those variables with negative beta values, such as non-whole grains, sodium, and added sugar, should be decreased. While other food components such as fish, nuts and seeds are apart of HEI, they are not consumed often enough in adolescents from this study to have a significant effect on HEI scores. Knowing this, it is questionable whether these foods could be implemented in their diets given that they aren't eating them currently.

5.1 Conclusions

Low-income families face many challenges in terms of leading a healthy lifestyle and mitigating against obesity. Past research of children and adolescents from low SES households have shown that this segment of the population has barriers to getting adequate sleep, eating healthy, and engaging in physical activity.[5,41,53] Our results showed that adolescents in the Kendall-Whitter and Eugene Fields neighborhoods of Tulsa, OK do not meet recommendations for a healthy diet based on an average HEI score of 39.2, do not consume enough food energy based on an average kcal of 1406, and 37% report poor sleep quality based on PSQI scores greater than 5. Additionally, this study showed a strong relationship between sleep quality and diet quality. BMI was strongly associated with income and sleep quality while a strong negative relationship between dark green vegetable consumption and time spent watching TV was also noted. This study is important because it adds to our understanding of low-income populations and the unique obstacles they face. In addition, this study provides specific diet components that should be targeted when trying to improve diets in adolescents from the Kendall-Whittier and Eugene Fields neighborhoods.

5.2 Strengths/Limitations

The strengths of this study are that it adds to the limited literature on sleep related to low-income adolescents and HEI scores related to low-income adolescents. Additionally, this study provides support for new guidelines that can be incorporated into new school lunch programs – specifically for the Kendall-Whittier and Eugene Fields schools or schools with similar demographics.

The limitations of this study are primarily related to the inaccuracy possible with self-reported data because the PSQI, ASA24, physical activity minutes and TV hours were based on questionnaires. As with any 24-hour recall, the ASA24 is largely based on one's ability to remember what was consumed during the past 24-hours. Similarly, the PSQI and questionnaire for physical activity and TV hours were also based on "typical" occurrences and activities from the previous week that had to be recalled. Inability to correctly remember could have resulted in inaccurate data. Also, adolescents in particular may become bored with the process and, trying to rush through the questions, may have possibly not answered the questions adequately.

Another limitation was the amount of missing responses and incomplete data in the sample. Several of the participants had only completed one ASA24 so an average of 2 recalls could not be completed. Additionally, there were missing pieces of the data such as incomplete height and weight variables or missing results for physical activity. Complete values for each participant may have increased the significance power of the results.

Lastly, the physical activity responses were limited in the way the physical activity questions were phrased. Adolescents were first asked if they participated in any moderate/vigorous physical activity within the past week. For those who did report engaging in at least some physical activity, they were then asked how many days during the past week they did these moderate/vigorous activities for at least 10 minutes. The third and fourth question asked the duration (in hours and minutes) of physical activity for the days the adolescents reported

moderate/vigorous activity. Therefore, it was assumed that physical activity duration was the same for each day moderate/vigorous activity was reported for at least 10 minutes. While this assumption may be correct most of the time, it is a limitation because adolescents were not asked to explain if their duration of physical activity differed between the days they were physically active. One time was given to account for every day that week of reported moderate/vigorous activity for at least 10 minutes. This could have caused an over estimation in physical activity. For instance, if an adolescent had basketball practice 3 days a week for 2 hours, and 2 days a week for 30 minutes, the adolescent may have described his physical activity as 2 hours for 5 days because there was no way to distinguish that 2 of the days were only for 30 minutes. Then, his total physical activity time per week would have been 10 hours (600 minutes) rather than the actual 7 hours (420 minutes).

5.3 Future Recommendations

In future studies, it would be useful to evaluate both low-income neighborhoods with middle to upper class neighborhoods for an income-based comparison. In the current study, it was determined that this low-income population was not consuming a healthy diet based on the national recommendations and national surveys. However, it would be interesting to compare the results presented in this study with higher income neighborhoods in Tulsa and determine if any significant differences exist regarding sleep quality, diet quality, and physical activity in adolescents from different SES backgrounds but within the same metropolitan area. This would help us better understand the specific role of SES on sleep, diet, and physical activity.

Additionally, a study should be done to analyze the effect of nutrition education on the specific diet changes found to have a significant effect on the HEI score. Either through neighborhood/community gatherings or school programs, education could be given on ways to increase the consumption of fruit, poly-unsaturated fatty acids, legumes, percent kcals from

protein, and carbohydrates while reducing the consumption of non-whole grains, sodium and added sugar. Specific and simple ways to follow these recommendations could be given such as replacing non-whole grain items with fruit, and limiting the consumption of processed foods which are high in sodium. Pre and post tests should be given to analyze the effect of the educational sessions on diet changes and total HEI scores.

Lastly, a similar study should be conducted using objective measurements such as accelerometers, to measure physical activity, and actigraphs, to measure sleep. These tools would provide a more specific understanding of the amount of physical activity and sleep that is being engaged in during the study. Therefore, the limitation of potential inaccuracy from self-reported data would be avoided.

5.4 Implications for the Field of Nutrition and Related Practitioners

This study is important to the field of nutrition because it further points to the importance of sleep quality even at the young age of adolescents. This study shows sleep quality as being significantly related to diet quality and BMI making sleep an important factor to consider when discussing dietary interventions for this age group. Discussing sleep hygiene needs to become an important part of healthcare. In addition, the poor diet quality seen in this low-income population points to the difficulties adolescents from low SES families may face. SES status needs to be taken into account when offering nutrition education/counseling because recommendations that are outside of someone's means cannot be followed. Low-income families are likely to have a more difficult time accessing healthy food choices. Therefore, when counseling low-income populations, this should be considered before giving suggestions or prescribing diets. Only after understanding what a patient or individual has access to or is able to afford can nutrition therapies and goals be effectively put into practice. Further, this study provides dietitians and practitioners with specific food items to consider when trying to improve the diet of this population. Therefore,

recommendations can be made specific to this population which can aid in improving HEI scores more rapidly and successfully.

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APPENDICES

Tulsa 100 (T1C) Family Study

Adolescent Interview

Thank you for your participation in our study and for your time today. As you know, our study focuses on adolescent sleep, physical activity, and diet. We are especially interested in the family-related and community factors that contribute to the development of healthy behaviors among adolescents.

SECTION 1. PERSONAL CHARACTERISTICS

1. How old are you?

_____ years

2. What is your birth month and year?

MONTH OF BIRTH: _____ YEAR OF BIRTH: _____ ○ DK ○ REF

3. Do you classify yourself as male or female?

O Male
O Female
O DK
O REF

4. Which racial group do you identify with? Would you say…

- O White
- O Black or African American
- O Native American or American Indian
- O Asian
- O Pacific Islander
- O Multi-racial→ SPECIFY_____
- O Other → SPECIFY_____
- O DK
- O REF

5. Are you of Latino or Hispanic descent?

- O No
- O Yes
- O DK
- O REF

6. What grade are you in school?

- O 4th Grade
- O 5th Grade
- O 6th Grade
- O 7th Grade
- O 8th Grade
- O 9th Grade
- O 10th Grade
- O 11th Grade
- O 12th Grade
- O DK
- O REF

Now I am going to ask you some questions about your recent physical activity and eating. Let's start with physical activity…

23. Are you limited in any way in any activities because of physical, mental, or emotional problems?

- O No
- O Yes
- O DK
- O REF

24. Do you currently have any health problem that requires you to use special equipment such as a cane, wheel chair, a special bed, or a special telephone?

O No
O Yes
O DK
O REF

We are interested in two types of physical activity – vigorous and moderate physical activity. Vigorous activities are characterized by large increases in breathing or heart rate, while moderate activities tend to be characterized by small increases in breathing or heart rate.

25. Thinking about vigorous activities you did in the past week ***when you were not working***, did you do any vigorous activities for at least 10 minutes at a time, such as running, aerobics, heavy yard work, or anything else that causes large increases in breathing or heart rate?

O No
O Yes
O DK
O REF

IF ANSWER IS NO GO TO QUESTION 26

25a. How many days this week did you do these vigorous activities for at least 10 minutes?

_____ days
O DK
O REF

25b. On days you did vigorous activities for at least 10 minutes at a time, how much total time per day did you spend doing these activities?

_____ : Hours and minutes per day
O DK
O REF

26. Thinking about the moderate activities you did in the past week ***when you were not working***, did you do any moderate activities for at least 10 minutes at a time, such as brisk walking, bicycling, vacuuming, gardening, or anything else that causes some increase in breathing or heart rate?

O No
O Yes
O DK
O REF

IF ANSWER IS NO GO TO QUESTION 27

26a. How many days this week did you do these moderate activities for at least 10 minutes?

_____ days
O DK
O REF

26b. On days you did moderate activities for at least 10 minutes at a time, how much total time per day did you spend doing these activities?

: Hours and minutes per day
O DK
O REF

27. During the past week, how many hours a day did you watch TV on work days?

0 hrs	<1 hr	1 hr	2 hrs	3 hrs	4 hrs	5+ hrs	DK	REF
O	O	O	O	O	O	O	O	O

28. During the past week, how many hours a day did you watch TV on non-work days?

0 hrs	<1 hr	1 hr	2 hrs	3 hrs	4 hrs	5+ hrs	DK	REF
O	O	O	O	O	O	O	O	O

Now I am going to ask you some questions about your sleep habits.

31. During the past month, what time have you usually gone to bed?

____:____ AM/PM CIRCLE AM OR PM

888 ____ DK

999 __ REF

32. During the past month, how long (in minutes) has it usually taken you to fall asleep?

_____ minutes

888 ____ DK

999 __ REF

33. During the past month, what time have you usually gotten up?

____:____ AM/PM CIRCLE AM OR PM

888 ____ DK

999 __ REF

34. During the past month, how many hours of actual sleep did you get during your primary sleep time? (This may be different than the number of hours you spent in bed)

____ . ____ hours

888 ____ DK

999 __ REF

35. During the past month, how many times during your primary sleep time have you been awakened?

_____ times

888 ____ DK

999 ____ REF

For this next set of questions, please choose one of these responses [REFER TO RESPONSE CARD #5]: not during the past month, less than weekly, once or twice weekly, or three or more times weekly. During the past month, how often have you had trouble sleeping because you…

	Not during the past month	**Less than weekly**	**Once or twice weekly**	**Three or more times weekly**	**DK**	**REF**
36…Cannot get to sleep within 30 minutes?	O	O	O	O	O	O
37… Wake up in the middle of the night or early morning?	O	O	O	O	O	O
38…. Have to get up to use the bathroom?	O	O	O	O	O	O
39… Cannot breathe comfortably?	O	O	O	O	O	O
40… Cough or snore loudly?	O	O	O	O	O	O
41… Feel too cold?	O	O	O	O	O	O
42… Feel too hot?	O	O	O	O	O	O
43… Have bad dreams?	O	O	O	O	O	O
44… Have pain?	O	O	O	O	O	O
45… Other reason(s), please describe:_____ _____ _____ _____	O	O	O	O	O	O

REMOVE RESPONSE CARD

46. During the past month, how would you rate your sleep quality overall? Would you say…

1 ____ Very good

2 ____ Fairly good

3 ____ Fairly bad

4 ____ Very bad

888 ____ DK

999 __ REF

47. During the past month, how often have you taken prescription or nonprescription medicine to help you sleep? Would you say…

1 ____ Not during the past month

2 ____ Less than weekly

3 ____ Once or twice weekly

4 ____ Three or more times weekly

888 ____ DK

999 __ REF

48. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity? Would you say…

1 ____ Not during the past month

2 ____ Less than weekly

3 ____ Once or twice weekly

4 ____ Three or more times weekly

888 ____ DK

999 __ REF

49. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done? Would you say…

1 ____ Not a problem

2 ____ Only a very slight problem

3 ____ Somewhat of a problem

4 ____ A very big problem

888 ____ DK

999 __ REF

50. How would you describe your current sleep situation? Would you say…

1 ____ No bed partner or roommate SKIP TO Q174

2 ____ Partner or roommate in another room

3 ____ In the same room, but different bed

4 ____ Partner or roommate in the same bed

888 ____ DK

999 ____ REF

Please use one of these responses to answer the following questions [REFER TO RESPONSE CARD #5]: not during the past month, less than weekly, once or twice weekly, or three or more times weekly.

In the past month, has your roommate or bed partner told you that you had…	**Not during the past month**	**Less than weekly**	**Once or twice weekly**	**Three or more times weekly**	**N/A**	**DK**	**REF**
51…loud snoring?	O	O	O	O	O	O	O
52… long pauses between breaths while asleep?	O	O	O	O	O	O	O
53… legs twitching or jerking while you sleep?	O	O	O	O	O	O	O
54… episodes of disorientation or confusion during sleep?	O	O	O	O	O	O	O
55… other restlessness while you sleep? Please describe: _____ _____	O	O	O	O	O	O	O

REMOVE RESPONSE CARD

56. What is the chance of your dozing or falling asleep while …		Never	Slight chance	Moderate chance	High chance
a.	…sitting and reading? Would you say…	O	O	O	O
b.	…watching TV? Would you say…	O	O	O	O
c.	…sitting inactive in a public place	O	O	O	O
d.	…lying down in the afternoon? Would you say	O	O	O	O
e.	…sitting and talking to someone	O	O	O	O
f.	…sitting quietly after lunch	O	O	O	O
g.	…being a passenger in a motor vehicle for an hour or more? Would you say…	O	O	O	O
h.	…stopped in traffic	O	O	O	O

57. Have you ever nodded off or fallen asleep while driving a vehicle?

O No → SKIP TO 58
O Yes

57a. How often have you fallen asleep while driving a vehicle?

O Once or twice a year, or less
O 1 to 2 times a month
O 1 to 2 times a week
O 3 – 4 times a week
O Everyday

58. Has anyone ever told you that you quit breathing during your sleep?

O No
O Yes

Center for Nutrition Policy and Promotion's HEI Fact Sheet[66]

CNPP Fact Sheet No. 2 February 2013

HEI- 2010[1] component	Maximum	Standard for maximum score	Standard for minimum score of zero
▲ Adequacy *(higher score indicates higher consumption)*			
Total Fruit[2]	5	≥ 0.8 cup equiv. / 1,000 kcal[10]	No fruit
Whole Fruit[3]	5	≥ 0.4 cup equiv. / 1,000 kcal	No whole fruit
Total Vegetables[4]	5	≥ 1.1 cup equiv. / 1,000 kcal	No vegetables
Greens and Beans[4]	5	≥ 0.2 cup equiv. / 1,000 kcal	No dark-green vegetables, beans, or peas
Whole Grains	10	≥ 1.5 ounce equiv. / 1,000 kcal	No whole grains
Dairy[5]	10	≥ 1.3 cup equiv. / 1,000 kcal	No dairy
Total Protein Foods[6]	5	≥ 2.5 ounce equiv. / 1,000 kcal	No protein foods
Seafood and Plant Proteins[6,7]	5	≥ 0.8 ounce equiv. / 1,000 kcal	No seafood or plant proteins
Fatty Acids[8]	10	(PUFAs + MUFAs) / SFAs ≥ 2.5	(PUFAs + MUFAs) / SFAs ≤ 1.2
▼ Moderation *(higher score indicates lower consumption)*			
Refined Grains	10	≤ 1.8 ounce equiv. / 1,000 kcal	≥ 4.3 ounce equiv. / 1,000 kcal
Sodium	10	≤ 1.1 gram / 1,000 kcal	≥ 2.0 grams / 1,000 kcal
Empty Calories[9]	20	≤ 19% of energy	≥ 50% of energy

[1] Intakes between the minimum and maximum standards are scored proportionately.
[2] Includes 100% fruit juice.
[3] Includes all forms except juice.
[4] Includes any beans and peas not counted as Total Protein Foods.
[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 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 (PUFAs and MUFAs) to saturated fatty acids (SFAs).
[9] Calories from solid fats, alcohol, and added sugars; threshold for counting alcohol is > 13 grams/1,000 kcal.
[10] Equiv. = equivalent, kcal = kilocalories.

Score Equivalents for Adequacy HEI Components

Total Fruit Score	5	4	3	2	1	0					
(cups/1000kcals)	≥0.8	0.64	0.48	0.32	0.16	0					
Whole Fruit Score	5	4	3	2	1	0					
(cups/1000kcals)	≥0.4	0.32	0.24	0.16	0.08	0					
Total Vegetable Score	5	4	3	2	1	0					
(cups/1000kcals)	≥1.1	0.88	0.66	0.44	0.22	0					
Greens and Beans Score	5	4	3	2	1	0					
(cups/1000kcals)	≥0.2	0.16	0.12	0.08	0.04	0					
Whole Grains Score	10	9	8	7	6	5	4	3	2	1	0
(cups/1000kcals)	≥1.5	1.35	1.2	1.05	0.9	0.75	0.6	0.45	0.3	0.15	0
Dairy Score	10	9	8	7	6	5	4	3	2	1	0
(cups/1000kcals)	≥1.3	1.17	1.04	0.91	0.78	0.65	0.52	0.39	0.26	0.13	0
Total Protein Score	5	4	3	2	1	0					
(oz./1000kcals)	≥2.5	2	1.5	1	0.5	0					
Seafood and Plant Proteins Score	5	4	3	2	1	0					
(oz./1000kcals)	≥0.8	0.64	0.48	0.32	0.16	0					
Fatty Acids Score	10	9	8	7	6	5	4	3	2	1	0
(MUFA+PUFA)/SFAs)	≥2.5	2.37	2.24	2.11	1.98	1.85	1.72	1.59	1.46	1.33	≤1.2

Score Equivalents for Moderation HEI Components

Refined Grains Score	10	9	8	7	6	5	4	3	2	1	0
(oz./1000kcals)	≤1.8	2.05	2.3	2.55	2.8	3.05	3.3	3.55	3.8	4.05	≥4.3
Sodium Score	10	9	8	7	6	5	4	3	2	1	0
(grams/1000kcals)	≤1.1	1.19	1.28	1.37	1.46	1.55	1.64	1.73	1.82	1.91	≥2

Empty Calories Score	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(% total kcals)	≤19	20.6	22.1	23.7	25.2	26.8	28.3	29.9	31.4	33	34.5	36.1	37.6	39.2	40.7	42.3	43.8	45.4	46.9	48.5	≥50

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