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EVALUATING NUTRITION KNOWLEDGE IN PARENTS  
AND ITS RELATION TO CHILDHOOD OBESITY

RACHAEL SHANGRAW

54 Pages

This study aims to evaluate the relationship between parental nutrition knowledge and their child's body mass index (BMI) to identify variables that are associated with increased obesity in American children. A cross-sectional study design was employed with a convenience sample of 464 parents of children between the ages of 2 and 12. Parents completed a GNKQ-R (General Nutrition Knowledge Questionnaire – Revised) survey to measure nutrition knowledge. Parents reported their child's height and weight which was later calculated and categorized according to the Center for Disease Control's BMI-for-age growth chart. The Kolmogorov-Smirnov Test for Normality was conducted to examine the distribution of both variables. The results showed the data for both variables were not normally distributed (BMI:  $p = <0.001$ , Score:  $p < 0.001$ ). This result led to the use of a non-parametric Spearman correlation to assess the association between parental nutrition knowledge and their child's BMI percentile. Parental nutrition knowledge scores and child BMI had a significant positive correlation ( $r=0.177$ ;  $p<0.001$ ). As the parental nutrition knowledge score went up, so did child's BMI percentile. This study highlights the relationship between nutrition education of parents and their child's BMI percentile. This study is one of the first to examine the relationship between parental nutrition knowledge and child BMI percentile indicating the need for further research to determine if parental nutritional knowledge could affect child BMI.

**KEYWORDS:** Obesity; body mass index; children; parent; nutrition knowledge

EVALUATING NUTRITION KNOWLEDGE IN PARENTS  
AND ITS RELATION TO CHILDHOOD OBESITY

RACHAEL SHANGRAW

A Thesis Submitted in Partial  
Fulfillment of the Requirements  
for the Degree of

MASTER OF SCIENCE

Department of Family and Consumer Sciences

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2022

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EVALUATING NUTRITION KNOWLEDGE IN PARENTS  
AND ITS RELATION TO CHILDHOOD OBESITY

RACHAEL SHANGRAW

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## ACKNOWLEDGMENTS

The basis for this research originally stemmed from my passion for finding better solutions in eradicating the obesity epidemic. Throughout my college career, I have learned the virtue of food and nutrition. I believe education can be a solution in precluding obesity. But first, I am to determine if education is an obstacle.

Throughout the research and writing of this thesis I have received a great deal of support and assistance. I would first like to thank those within my advisory committee. My supervisor, Dr. Jennifer Barnes; my Co-Chair, Dr. Julie Schumacher, and Dr. Chang Su-Russell whose expertise was invaluable in formulating my research question and methodology. Their insightful feedback propelled this thesis from the beginning.

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R.S.

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# CHAPTER I: EVALUATING NUTRITION KNOWLEDGE IN PARENTS AND ITS RELATIONSHIP TO CHILDHOOD OBESITY

## **Introduction**

According to the Center for Disease Control (CDC), 18.3% of children (ages 2-19) in the United States were considered obese in 2020. This is a 1.4% increase since 2010, where 16.9% of children and adolescents were obese. Obesity is defined as “weight that is higher than what is considered as a healthy weight for a given height.” As the obesity epidemic continues to increase in adults and children, the latest data from the CDC shows obesity prevalence increased from 30.5% in the year 2000 to 42.4% in the year 2018. During the same time frame, severe obesity increased from 4.7% to 9.2% (CDC, 2021).

The World Health Organization (WHO) conveys a large concern when it comes to the health risks associated with obesity. Children who are obese or overweight increase their risk for a multitude of diseases including heart disease, stroke, type 2 diabetes, hypertension, chronic obstructive pulmonary disease (COPD), certain mental illnesses and some cancers. Depending on the level of obesity, children can attain these diseases as early as two years old. High body mass index (BMI) continuing into adulthood increases the risk for developing diabetes, hypertension, and heart disease (Smith et al., 2014). WHO also states that heart disease, stroke, and COPD are among the top ten common preventable, premature deaths world-wide (WHO, 2019).

Obesity can be determined based on a person’s BMI. To calculate BMI, a person’s weight in kilograms is divided by the square of their height in meters. A high BMI is an indicator of obesity and weight related health conditions. Interpreting BMI for children is different than

for adults. For children, BMI is age- and sex-specific and expressed as a percentile obtained from a CDC growth chart. Adults who are 20 years of age or older are placed into categories based on their BMI. These categories are provided by WHO. BMI is an inexpensive and easy to perform method when determining weight categories that may lead to health problems. BMI is commonly done during a person's annual physical with a nurse or doctor as it has been shown to be a reliable indicator of one's overall health (CDC, 2020).

Those who received general education prior to the 1990's were not taught the extent of nutrition education that there is within the curriculum put into place after 1995 (Allenswroth, et al., 1997). Various studies have shown that parents lack the necessary nutrition information to provide their children with a healthful dietary pattern they can take into adulthood (Zhou, 2017). Due to the undesirable levels of obesity in children, parental education on healthy nutrition for their children is more necessary than ever. Parents seek education programs that address a comprehensive set of behavioral acts include healthy eating, nutrition literacy such as reading a nutrition label, and cooking skills (McManus et al., 2021).

The General Nutrition Knowledge Questionnaire (GNKQ) has been used to help identify strengths and weaknesses of the general population's understanding of healthy eating (Parmenter & Wardle, 2016). Originally developed in 1994, the GNKQ was revised in 2015 and is now titled GNKQ-R (General Nutrition Knowledge Questionnaire -Revised). This was revised to align with updated nutrition recommendations and was determined valid for use in 2016. Studies using the GNKQ-R have identified relationships between knowledge and demographic characteristics, knowledge and dietary habits, as well as knowledge and weight status (Kliemann et al, 2016).

## **This Study**

The purpose of this study was to examine how parental nutrition knowledge is associated with their child's BMI. This study aimed to address the following outcome:

**Specific Outcome: Evaluate parental nutrition education and assess the relationship with their child's weight status.**

**Hypothesis.** Higher parental nutrition knowledge will be associated with child BMI range of 5-85 percentile.

### **Methodology**

#### *Recruitment*

Participants from eight online parental support groups were used to gather data for this cross-sectional study. To be eligible for the study, parents had to be at least 18 years of age and have at least one or more children that reside within the same household between the age of 2-12 years. Participants were asked to choose one child to complete the survey for; specifically, the survey asked to choose the eldest child that resided in the household between the ages of 2-12.

Online parenting support groups were chosen through Facebook. Searches of groups discussing children were added. The names of the various groups included phrases such as "Smart Moms", "Mom Life", "Parent Talk", "Dad's that Cook", and "*name of city/town* Parents". A total of eight groups within the United States, containing at least 868 members and up to 314K members were chosen. The recruitment post was also posted on the researcher's personal page to reach the surrounding community.

At the end of the survey, participants were asked if they would like to enter their email for a chance to win one of six \$50 amazon gift cards. If the participants provided their email, it was not associated with their questionnaire to protect their privacy. The drawing was completed

following the closure of the online survey where six participants were randomly selected to receive the gift cards.

### *Procedure*

Participants interested in the study clicked the link provided in the recruitment post. This link took them to the informed consent page. Participants were required to agree to the informed consent prior to starting the survey. By agreeing, participants were directed to the self-administered survey using Qualtrics, LLC survey software. The survey was estimated to take 10 minutes to complete. If consent was not given, participants were directed to the end of the survey and not included in the study sample. Approval for the study was obtained from the Institutional Review Board.

### *Instrument*

The survey included a set of demographic and anthropometric questions followed by the nutrition knowledge questionnaire. The demographic section asked the number of children within the household, annual income, race, region, level of education, level of nutrition education, and source of diet information. Anthropometric data was self-reported by the participant on themselves and their child. Age, gender identity, height and weight were collected on the participant and their child. The height and weight provided by the participant was used to calculate BMI for their child by the researcher.

The nutrition knowledge questionnaire consisted of 21 questions each with up to five possible answers. An example includes “How many servings of fruits and vegetables per day do experts advise people to eat as a minimum? One serving could be, for example, an apple or handful of chopped carrots”. The option “not sure” was available for each question to avoid false data from guessing answers. Questions 1-7 assessed knowledge on general recommendations

from health experts. Questions 8-15 assessed knowledge on food groups and nutrients. Questions 16-22 assessed knowledge on nutrition related diseases and weight management.

### *Measures*

BMI for children was calculated by dividing the weight in kilograms by the square of height in meters.

$$\text{Formula: weight (kg) / [height (m)]}^2$$

BMI is age- and sex-specific for children. The age, sex, height, and weight for each child was used to determine the BMI percentile. Once the child's raw BMI was calculated, they were then placed into percentile groups based on their sex and age. The child's BMI percentile placed them into categories based on the CDC BMI-for-age growth chart. Categories include less than the 5<sup>th</sup> percentile=underweight, 5<sup>th</sup> percentile to 84<sup>th</sup> percentile=normal weight, 85<sup>th</sup> percentile to 94<sup>th</sup> percentile=overweight, and  $\geq$  to 95<sup>th</sup> percentile=obese.

Measure of nutrition knowledge was based on the number of points each participant received after taking the questionnaire portion of the survey. The scoring of the GNKQ-R was based on the grading system developed by the creator of the questionnaire. Each question was assigned 1 point if the answer was correct and 0 points if it was incorrect or the selection "not sure" was chosen. Thus, the final score ranged from 0 to 21 points. Participants were categorized into three equal groups depending on their final score from the nutrition knowledge questionnaire: low (0-7 points), medium (8-14 points), or high (15-21 points).

## **Data Analysis**

Data analysis was conducted using IBM SPSS 25. The analysis process began with elimination of inappropriate data collected. Surveys, including the questionnaire, that were incomplete or incorrectly reported before interpretation were not included within this study. To describe the characteristics of the participants within the study, proportions (%) were calculated for the categorical variables (gender, race, age, income, education, community in which one lives, number of children, degree of nutrition education).

BMI percentiles were calculated using the child's recorded height, weight, age, and gender. This placed them into their percentile category. Nutrition knowledge scores were calculated by the researcher. If the participant chose the correct answer, they were given one point. If the answer was incorrect or the option "not sure" was selected, there would be no points given from that question. Out of 21 possible points, the participants were placed into groups based on the amount of points given. The analysis technique used was a nonparametric Spearman correlation to evaluate the relationship between the child's BMI percentile and their parents' nutrition knowledge score.

## **Results**

Of the 464 participants who agreed to participate in the survey, 148 (31.9%) participants were excluded due to incomplete survey responses. The remaining 316 participants responded to all questions on nutrition knowledge and were included in this study. Demographic characteristics are shown in Table 1. Of the 316 participants, over half (67.7%) were female all between the age of 18 and 64. Participants were mostly concentrated in urban areas (50%) with an earned income between \$35,000 and \$44,999 (25%). For nutrition education, it was found that 23% had received no nutrition education (Table 1).



**Table 1** Demographics of Adult Study Sample

---

Factor	<i>N</i> =316	%
Gender		
Male	102	32.3
Female	214	67.7
Race		
White	244	77.2
Asian	28	8.9
Native Hawaiian	10	3.2
African American	23	7.3
Hispanic or Latino	10	3.2
Not sure	1	0.2
Age		
18-34	91	29
35-44	189	60
45-64	36	11
Income		
\$0 to \$9,999	9	3
\$10,000 to \$19,999	16	5
\$20,000 to \$34,999	60	19
\$35,000 to \$44,999	79	25

(Table Continues)

(Table Continued)

\$45,000 to \$54,999	29	9
\$55,000 to \$64,000	17	5
\$65,000 to \$79,000	16	5
\$80,000 to \$99,999	19	6
\$100,000 and Over	70	22

Education

Less than Highschool	8	3
Highschool/GED	36	12
Associates Degree	51	16
Batchelor Degree	112	36
Master's Degree	77	25
Doctorate Degree	29	9

Community

Rural Area	77	25
Urban Area	155	50
Metropolis Area	81	26

(Table Continues)

(Table Continued)

Number of Children

One Child	120	38
Two Children	140	44
Three Children	38	12
Four Children	17	5

Degree of Nutrition Education

None	72	23.1
Highschool Class	93	29.1
College Course	99	31.3
Certificate in Nutrition	34	10.8
Degree in Nutrition	18	5.7

All 316 children recorded within the study were between the ages of 2 and 12 years of age. Only information regarding anthropometric data, age, and gender was collected about the children. Over half (58.2%) were males. Over 37% of the children were between the ages of 6 and 9 (Table 2).

**Table 2** Demographics of Child Study Sample

Factor	N=316	%
Gender		
Male	103	32.6
Female	211	66.8
Other	1	0.3
Age		
2-5	84	26.6
6-9	118	37.3
10-12	114	36.1

Only participants who answered all the questions within the nutrition knowledge questionnaire portion of the survey were included within this study. Those who did not answer all questions were removed. To help prevent guessing, skipped questions, or skewed data the option of “not sure” was a possible answer. Participants did take advantage of this option; however, it would lower the total score as this choice is not awarded a point. The mean nutrition knowledge score was 7.83. Over half of participants received a low score by answering a maximum seven questions correctly out of 21 (Table 2). The lowest score was 1 while the

highest score was 18. No one acquired all 21 points. The answer that was answered correctly by a majority of the participants (91.2%) asked, “how many times a week do expert recommend that people eat breakfast?” The questions that were answered least correct (29.11%) asked “which items are typically a good source of protein?” The type of questions that most participants failed to get correct were questions asking them to “select all that apply.” Only the participants that had selected all the correct answers received a point towards their nutrition knowledge score. Most children were placed into the 97<sup>th</sup> percentile categorizing showing that 34% of the participants children were overweight (34.8%).

**Table 3** Nutrition Scores and Child BMI Percentile

Factor	<i>N</i> =316	%
Parental nutrition Scores		
Low	172	54
Medium	125	40
High	19	6
Child’s BMI Percentile		
5 <sup>th</sup> percentile	58	18.04
10 <sup>th</sup> percentile	10	3.17
25 <sup>th</sup> percentile	14	4.43
50 <sup>th</sup> percentile	32	10.13
75 <sup>th</sup> percentile	9	2.85

(Table Continues)

(Table Continued)

85 <sup>th</sup> percentile	16	5.06
90 <sup>th</sup> percentile	34	10.76
95 <sup>th</sup> percentile	34	10.76
97 <sup>th</sup> percentile	109	34.80

*Inferential statistics*

The observed significance levels for both the Kolmogorov-Smirnov was conducted to examine the distribution of both variables. The results showed that the data for both variables was not normally distributed (BMI:  $p < 0.001$ , Score:  $p < 0.001$ ). There is strong evidence supporting a significant relationship between parental nutrition knowledge and child BMI. Because the data was not normally distributed, the non-parametric Spearman correlation was used to determine the relationship.

The non-parametric Spearman correlation test shows that there is a weak positive correlation between parental nutrition knowledge scores and the child's BMI percentile ( $r=0.188$ ). Parental nutritional knowledge scores and the child's BMI have a  $p$ -value  $< 0.001$  signifying that the correlation is highly significant and is not a function of random sampling error. Due to the amount of participants, the study had enough statistical power to identify even weak correlations. These results go against the null hypothesis and state that the nutrition knowledge score was significantly higher among parents with children who had a higher BMI percentile (Table 4).

**Table 4** Spearman’s Nonparametric Correlation ( $N=316$ )

---

Factor	
Correlation Coefficient	
Child’s BMI Percentile	0.188
<i>p</i> -value	0 .002

## **Discussion**

### **Major Findings**

With 316 participants, this study is one of the first to explore the relationship between parental nutrition knowledge and their child’s BMI percentile. Most of those who completed the survey had at least a bachelor’s degree or higher level of education. With many participants holding a respected degree, 23.1% had received no nutrition education courses, not even a highschool class. The potential cause of this could be that nutrition education was not required nor part of a structured academic plan in public schools until the mid-1990’s (USDA, 2020). With the average parental age group between 35 and 44 years of age (60%), many of these parents were not required to take a nutrition education course in highschool or college.

The GNKQ-R has been reported to be a valid tool in assessing the level of nutrition knowledge in adults (Gao, 2021;Matsumoto, 2017). Since its revisions, it has been kept up to date with recent and reliable information based on governmental guidelines and recommendations. Furthermore, this survey has also been revised and proven to be reliable when assessing the older population (Kliemann, 2016). These studies that had been done show that the questionnaire is measuring nutrition knowledge consistently.

No participant answered more than 18 of the 21 questions correctly. The answer that was answered correctly by most participants (91.2%) asked, “how many times a week do experts recommend that people eat breakfast?” This straightforward question could have been answered correctly by most participants due to the common phrase “breakfast is the most important meal of the day”. With this, a general rule of thumb is that every day should be started with breakfast. One study found that over 80% of adults over the age of 20 consume breakfast daily (CDC, 2021). Other questions that were generally answered correctly covered topics including dairy products, sugar, and fat. These questions all had one correct answer. True and false questions also had higher scores when compared to the “select all that apply” type of questions. These higher scores could be associated with the format of the question. Having one single answer reduces the chance of missing that question. Sugar and fat are also common topics presently discussed due to their contribution to the current obesity epidemic (CDC, 2021). Because these topics are currently talked about more, participants may have more up to date knowledge on sugar and fat.

Questions that were answered least correct (29.11%) asked “which items are typically a good source of protein?” The type of questions that most participants failed to get correct were questions asking them to “select all that apply.” Given that the question “which items are typically a good source of protein?” was a “select all that apply questions” participants who did not select all the correct answers were not awarded a point. A study assessing parents’ knowledge of protein found that only 40% had adequate knowledge of protein (Bharathi, 2020). Other questions that were like this format were also highly missed. These questions included “which items are typically high in sodium”, “which questions are typically higher in fiber”, and



“which items are considered starchy foods?” All these questions had the “select all that apply” format.

It was found that parents with higher nutrition knowledge scores had children with a higher BMI percentile. This goes against the hypothesis that stated parents with a higher nutrition knowledge score have children with a healthy range BMI percentiles. One study conducted in 2015 found that obese women had significantly higher levels of nutrition knowledge when compared to normal weight women. The researchers believe that those who were obese scored higher nutrition scores because obesity itself can be a motivational factor to seek out reliable information on weight control and healthy eating (Laz, 2015). Although this study was comparing adult BMI scales and not child BMI percentages, the case of having a family member in an “obese” category can become a stimulating factor to research and look for nutritional information from reliable resources including doctors, dietitians, or medical websites.

Another study done in 2021 had used the same nutrition knowledge questionnaire on young adults. It was found that young adults with a greater BMI (>30) had higher scores when compared to young adults who are underweight, normal, and overweight. This study suggested that even though obese individuals have higher nutritional knowledge, they simply may not have the inkling to apply that knowledge to their eating habits (Husain, 2021). Those who do not have a concern with their weight may not pursue this information from reliable resources, as they do not have that motivating factor. Most of their nutrition knowledge could be from their day-to-day activity such as the news, social media, or past knowledge (Gurajada, 2017; Zhou, 2017). Other possible factors of obese individuals scoring well on the nutrition knowledge questionnaire could include socioeconomic status, access to healthy food choices, or time to make healthy meals and exercise is limited. The results of this study are different to those of similar studies who found

that although there is a significant correlation between nutrition knowledge and obesity, participants who were obese had lower nutritional knowledge than those with a normal BMI (Akkartal, 2019; Keay, 2018).

Studies that did not look at BMI but instead compared nutritional knowledge to health risks associated with obesity showed that increased level of nutrition knowledge is associated with healthier eating habits and decreased cardiovascular risk (Hernandez, 2020; Yahia, 2016). What makes this study different from the previous studies listed is that this study reviewed parent nutrition knowledge scores and compared them to their child's BMI. All the other studies looked at adult or college student BMI levels.

### **Suggestions for Further Research**

Future studies may benefit from this study to investigate possible contributors to childhood obesity. Alterations to this study may also strengthen future studies with similar design and objectives. The strength of this study includes the investigation of nutrition knowledge in parents and its relation specifically to child BMI. Many previous studies have compared child BMI to parental BMI, low maternal education, food intake in children and parents, health behaviors in children and parents, and general education levels (Asakura, 2017; Fernandez-Alvira, 2015; Gurajada, 2017; Laz, 2015; Nanclares, 2018; Ruiz, 2016; Scaglioni, 2018; Wen, 2014; & Zhou, 2017).

There is minimal research specifically related to child BMI and parental nutrition knowledge. Future studies wanting to investigate possible contributors to the child obesity epidemic may benefit from this study as well as those wanting to implement parental education courses or programs. Questions branching off of this study can be investigated such as finding

possible reasons for obese individuals possessing more nutrition knowledge when compared to normal weight individuals

Future studies may benefit from having a revised survey so that there is only one possible response available. This study showed that questions with a single correct answer or true/false questions had a greater success rate. Questions asking the participants to select all answers that apply were commonly missed questions. Keeping the option of “not sure” is beneficial to avoid guessing and skewing the data.

### **Limitations**

Despite its strengths, this study has some limitations. First, the data gathered from the participants was self-reported and may be subject to recall bias. Anthropometric data would be highly dependable if this data came from a present collection of a nurse or doctor. The most reliable way to gather weight is by using a physician’s balance scale. The most reliable way to measure height is by measuring recumbent height using a physicians height rod (Mikula, et. al., 2016). It is possible that many participants used up to date data but may not have been as accurate if they did not go to a professional the day of filling out the survey. Other possible drawbacks could be that the participants did not have any up-to-date information on their child’s height and weight leading to guessing of their anthropometric data.

Additionally, the nutrition knowledge questionnaire had to be completed on their own devices at a location of their choice; hence, participants could look up the correct answer or ask those around them for assistance. Although it was stated at the beginning of the questionnaire that this was not the aim, the researchers have no proof of the avoidance of assistance. The

GNKQ-R is a publicly accessible survey with the questions and answers posted in an online PDF. Even though no participant received a perfect score, the looking up of answers is possible.

Lastly, the study population showed to be predominantly white females living in an urban area earning over \$35,000. This specific population could limit generalizability within other groups. Specific groups including teachers, policymakers, governmental officials, etc., were not identified and may not align with studies that had more focused participation groups. Furthermore, individuals without health problems or not having concerns about their children's health may have been less motivated to take part in such a study limiting the variety in participants.

### **Recommendations for Practice**

Based on the results of the survey, the public may benefit from education regarding sodium, fiber, protein, and carbohydrates. Implement strategies using brochures, media awareness, and education from health care providers are possible ways to improve nutrition awareness on these topics to the public. Other studies have also shown that parents are interested in learning about resources and skills related to healthy eating habits. Specific topics include cooking skills and ways to incorporate more fruits and vegetables into family meals (Gurajada, 2017).

Those who have positions within the educational system may find this study helpful when determining what to teach the public as well as why regarding nutrition. Using this study as a general outline, teachers, researchers, and administration can determine what nutrition skills their community is lacking. By determining what education is needed, steps can be taken to provide that education to the public. Researchers could further investigate the results from this

study and determine why parents with higher nutrition knowledge scores have children with greater BMI percentiles.

## **Conclusion**

In conclusion, this study highlights the relationship between nutrition education within parents and their child's BMI percentile. The findings showed that parents who have higher nutrition knowledge scores also have children with a greater BMI percentile. Future studies could further investigate the results of this study. Research can look at the cause of higher nutritional knowledge being associated with higher BMI percentages.

## CHAPTER II: EXTENDED REVIEW OF LITERATURE

### **Introduction**

According to the Center for Disease Control (CDC) 18.3% of children (ages 2-19) in the United States were considered obese in 2020. This is a 1.4% increase since 2010, where 16.9% of children and adolescents were obese. There are many factors that have been found to contribute to the obesity epidemic within children. Factors including genetics, the environment in which one lives, socio-economic status, level of education, and influence of the parents have been studied on their relationship with childhood obesity. Although some of these factors are non-modifiable, the knowledge and recommendations received from these studies show possible progress in understanding the components of obesity.

### **Factors Influencing Obesity**

Many factors are to be taken into consideration when determining the cause of obesity. The CDC (Center for Disease Control [CDC], 2012) states that genetics, the environment in which one lives, and food choices all constitute the greatest proportion of the obesity epidemic within America. However, there are elements within each that should additionally be examined. It is important to determine all the causes of obesity as it can lead to specified solutions to this overall concern.

### **Genetics**

Genetics play an important role in determining a person's overall physiology. There is not a single gene variant that leads to obesity, yet it is understood that complex interactions between various genes within different environments can increase one's risk for becoming obese. Prader-Willi Syndrome (PWS), Proopiomelanocortin (POMC) deficiency, and Leptin Receptor (LEPR) deficiency are examples of diseases where altered genes have led to an increased risk in

obesity. Prader-Willi syndrome is a genetic disorder causing mental and physical growth dilemmas. Children with PWS show higher ghrelin levels, the hormone response to increase appetite, which then leads to obesity at a young age and most often type 2 diabetes (Butler, 2019). POMC deficiency and LEPR deficiency are disorders that effects the pathway used to signal when the body when it is full. Due to the disturbance of this pathway, distinct hormones are disturbed. This has shown to cause overeating, leading to obesity and sometimes type 2 diabetes at an early age (Kleinendorst, 2020).

Even without a particular genetic disorder, genes can alter human behavior and the way the body is responding to different environments. This includes the drive to eat when feeling hungry, desired activity level, and determinant of food choices based on cravings (CDC, 2012; Ozaki, 2020). Genetic exposure to some chemicals has also been found to alter the way the body stores nutrients, in result leading to obesity. Thiazolidinediones, a drug used to lower blood glucose, causes weight gain due to fluid retention, increased lipid storage, and adipogenesis (Vergaegen & Gaal, 2019). Steroids and antidepressants also have the side effect of weight gain. This is due to their nature of increasing appetite and disrupting metabolism (Kulkarni & Kaur, 2001). As research continues to explore the role genes play in obesity, other factors such as environment and conscious food choices have also been examined.

Almost all (98%) of gene expressions are based on your dietary intake. The primary genes effected are responsible for fat and carbohydrate metabolism as well as body temperature regulation, which can impact resting metabolic rate (Lin, et all, 2019). In similar studies, there have been findings that gene expression within adipose tissue is associated with weight loss (Campbell et al, 2013). Nutrition epigenetics is studying how food intake affects patterns of gene

regulation. In detail, it explores the science behind food molecules interacting with DNA within the metabolic system, eventually altering the level of gene expression in the body (Sedley, 2020).

## **Environment**

The environment in which one lives plays a large factor in their risk for obesity. When it comes to children, the environmental barriers occur primarily within the school setting, household, and surrounding community (Kim, et. al., 2019; CDC, 2012). The school environment constraints include food selection, time constraints, and peer pressure. Within the household, there are socio-economic constraints, structure and support components, time restrictions, and social pressure.

### *The School Setting*

Within the school environment the type of food available, swapping of school lunches, and peer pressure have an influence on a child's food intake (Adam, 2013). Since children are usually in school about two-thirds of the year, it is essential to look at intake during school hours. Children who are part of the National School Breakfast and Lunch Program are more likely to take the meals provided by the school. There are regulations on school meals, however, it has been shown that these meals contain more sodium than a packed lunch or breakfast from home (Farris, 2014). Government regulated serving sizes may not be enough to keep a child full throughout the day. Even though that child has had a substantial meal, they can be left feeling hungry. This increases their snacking of "quick grab" processed foods (Farris, 2014). The food served to the children is distinctive from what is consumed at the lunch table. In a food plate waste study, the United States Department of Agriculture (USDA) found that 60% of fruits and vegetables given to students in the lunch line are wasted and thrown in the trash (USDA, 2013).



Those who pack their lunch tend to have higher overall caloric intake, higher saturated fat intake, and lower vegetable intake compared to those who consume school lunches. They also tend to be more satisfied with their packed meal and less hungry after eating (Farris, 2014).

There is pressure to eat quickly before going to school and in the cafeteria. Time constraints can lead to a delay in the feeling of satiety and may cause overeating. Rushing to eat a substantial breakfast early in the morning before school can be difficult for children. Particularly when their parents are also rushing for work and unable to cook breakfast. They may eat a processed breakfast or skip this meal altogether. Mid-day lunch time at school is an average of 25-30 minutes. This includes getting to the cafeteria, standing in line, eating, and cleaning up. A short time frame rushes kids to eat fast or skip portions of their meal (Kim, et. al., 2019).

#### *At Home Setting*

Family structure and support is one of the most influential aspects of the social environment of children. Parents have influence over their child's food choices, food intake, and lifelong eating practices (Hebestreit, 2010; Lifshitz, 2008). Because of this, it has been found that children from families with obese parents are at a significantly higher risk for obesity in comparison to children with non-obese parents. If both parents are obese, there is an 80% chance of their children becoming obese; if one parent is obese, that decreases to 40%. If neither parent is obese, the chances of their child becoming obese is down to 10% (Bahretnian et al., 2017). Parental influence can be impacted based on the parents' education level, income, food insecurity, inadequate cooking skills, and limited time (Adam, 2013).

Socio-economic constraints on individuals and their household can lead to poor diet quality amongst the family (Beydoun, 2008). Socio-economic status, composed of education, income, and occupation, influence the family's eating pattern. Parents with a lower overall education level have been found to choose less healthful dietary choices when it comes to household meals. Further, less education can lead to a career of lower income. Lower income families lean towards low-cost food items which tend to contain higher amounts of sodium and fat. Possible food insecurity also limits food choices to what is affordable or available which are most commonly non-perishable foods high in sodium and total fat (French, 2019).

As occupation often determines income, it also determines time available for shopping, cooking, ordering, and eating. Time has also been found to be a large constraint when it comes to healthy eating. As the workforce has increased, so has eating out at restaurants and consuming prepackaged snacks and meals. Eating out saves time by eliminating the shopping, preparation, cooking, and cleanup of eating. Some restaurants may be considered healthier than others yet, overall, many add extra sodium, sugars, fats, and preservatives to increase flavor and appeal. Packaged or premade meals tend to have a higher caloric and sodium count with less nutrition value than a homecooked meal (Horning, 2017).

Time constraints also limit family meals together. Families who eat together show an increase in fruit and vegetable intake as well as smaller portions per meal. Families who do not have time to eat together show an increased consumption of meals in front of the television. Further, families tend to eat from restaurants more often. Eating in front of the television and dining from restaurants have a negative influence on a child's diet quality (Lipsky, 2015). Other reasons parents may lean towards prepackaged meals include lower cooking self-efficacy and meal-planning ability (Horning, 2017; Kim, et. al., 2019).

People and families may make decisions based on their community. For example, a person may not walk or bike to the store due to a lack of sidewalks or bike trails. Relying on transportation of busses and cars can limit physical activity as well (CDC, 2021). Other aspects such as social pressure on portion sizes within restaurants and comparison to other people's food choices or feelings towards certain foods can lead to a misperception on nutrition intake. A USDA study found that individuals consume an extra 134 calories per meal when eating out. This is partially related to the portion sizes that are served when eating at a restaurant (USDA, 2018).

### **Food Choices**

Healthy eating is a critical factor influencing the weight of children. Many studies have shown controlling diet is more effective for managing childhood obesity over interventions that are designed to specifically increase level of physical activity (Dattilo et al., 2012). Healthy eating is generally defined by consuming the appropriate amounts of fruits, vegetables, whole grains, fat-free or low-fat milk and dairy products, lean meats, poultry, fish, beans, eggs, and nuts. Along with those choices, healthy eating includes avoidance or limitation of saturated fats, trans fats, cholesterol, salt (sodium), and added sugars (CDC, 2021).

One of the most common barriers to healthy eating is food cost. Fresh produce and meats tend to have a higher price tag. The low preservatives in these fresh foods also have a shorter shelf-life increasing food waste. Fast food, prepackaged meals, and canned goods tend to be cheap and convenient, yet they contain high amounts of fat and sodium (Marindale & Schiebel, 2017). A study conducted from 2003-2014 consistently showed that 25-35% of Americans consume fast-food (Lipsky, 2015). Further, data from a 2003-2018 study showed that 14.4% of children and adolescents consumed fast-food daily. During this same time frame, fruit intake

showed that 4 in 10 children consumed the recommended daily intake of fruit while only 1 in 10 children met the recommended intake of vegetables (CDC, 2018).

Studies have also shown that parents tend to be less confident in their cooking skills. Parents who do not understand the basics of cooking or are unable to find ways to make a variety of substantial meals, eat out more often and buy pre-made meals (Horning, 2017). Take out and pre-made meals contain high amounts of added sodium, saturated fat, and preservatives. With the nature of kids mimicking their parents' behavior, they may follow in their parents' footsteps and continue buying takeout meals and pre-made meals into adulthood (Scaglioni, 2018).

Media and marketing affects parent and child food choices. Marketing techniques through television, magazines, newspapers, the internet, and retailers can affect parental perception of certain foods (Adam, 2013, Gurajada, 2017; Zhou, 2017). Companies use marketing to advertise nutrient-poor and high sugar foods, which have been directed towards children for years. Approximately 98% of food-product advertisements that were viewed by children 2 to 17 were high in fat, sugar, and/or sodium (Powell, Szczpka, Chaloupka, & Brunschweig, 2007). Sugary breakfast cereals, potato chips, and soft drinks are the most common products advertised to children (Harrison, 2005). With use of fun and colorful characters, this allows the media to be a powerful force in a child's desire for certain foods (Adam, 2013).

Television, magazines, newspapers, internet, and retailers are also sources adults turn to when looking for information regarding nutrition (Elder, 2000). Many parents have some basic nutrition knowledge about what foods are considered "healthy" however, many receive most nutrition information to guide their nutritional choices through social media and the news which may not have accurate and scientific based information (Quaidoo et al., 2018). Individuals use

these sources in search for recipes, information, and food suggestions. Even though information gathered from media outlets may be diffused, short-term, or inaccurate, people still turn to these easily accessible resources (Zhou, 2017).

### **Parents' Nutrition Education Background**

There have not been studies relating parents' nutrition knowledge score to that of their child's BMI percentile, but various studies have shown that parent's knowledge of nutrition is lacking. In a specific focus group study completed in 2017, parents were asked questions on the importance of whole grains, fruits and vegetables, physical health, family meals, and the negative consequences related to high intake of sweetened beverages, inadequate sleep and exercise, and prolonged use of screen time. In addition, there was a lack of strategies for improving these behaviors in their children. Those who documented this study confirm that parents had numerous gaps in their knowledge related to healthy food choices, food preparations, and sleep guidelines (Gurajada, 2017; Zhou, 2017). A similar study showed that adults lack systematic dietary knowledge and guidance on obesity related behaviors (Zhou, 2017).

A potential factor of these findings could be due to the amount of nutrition education provided in public schools before the 1990's. Nutrition education in schools started as early as 1917 with basic nutrition recommendations. Many nutrition education programs were not implemented until 1980 with the release of The Dietary Guidelines. These guidelines provide evidence-based food and beverage recommendations for Americas to promote health and prevent chronic disease. Public health agencies and education institutions rely on these guidelines for education (USDA, 2020). The Nutrition Labeling and Education Act of 1990 required food to bear nutrition information, lead to the U.S. Nutrition Facts label making its first appearance in 1998. With various governmental guidelines put into place throughout the 90's, the National

Health Education Standards were first published in 1995. These standards provide the education, promotion, and support of healthy behaviors in students from pre-Kindergarten through grade 12. Various health-enhancing behaviors were provided through these standards that include nutrition education guidelines for schools to implement (CDC, 2019). Individuals who received education prior to the 1990's were not taught the extent of nutrition curriculum that was put into place since 1995 (Allenswroth, et. al., 1997).

Studies have shown the impact of education and its relation to healthy eating patterns. Increased education (not specifically parents) showed higher odds of increasing fruits and vegetables, proper portions for meals, foods of fewer calories, more whole grains, breakfast daily, and consuming foods with less sugar (Asakura, 2017; Fernandez-Alvira, 2015; Gurajada, 2017; Laz, 2015; Nanclares, 2018; Ruiz, 2016; Scaglioni, 2018; Wen, 2014; & Zhou, 2017). Conversely, those with lower education showed higher frequency of consuming fried meats, fish, and potatoes; sugared beverages and desserts, and fatty foods (Fernandez-Alvira, 2015; Vercchen, 2010). In relation to obesity, previous studies across 11 European countries indicated that low maternal education could yield to substantial risk of early childhood obesity (Ruiz, 2016; Scaglioni, 2018). Higher nutrition knowledge in children has also been associated with children increasing consumption of fruits and vegetables and decreasing intake of high sugar foods (Asakura, 2017). These habits showed stronger implementation in schools where teachers reinforce nutrition education within their classroom (Leines et al., 2014).

A study added that nutrition knowledge is not only associated with healthy intake of foods, but also with other healthy behaviors such as beginning to exercise and exercising more often (Laz, 2015). An interactive healthy lifestyle intervention focused on low socio-economic families that significantly improved parental knowledge of pediatric healthy lifestyle. Changes in

parental knowledge is a key preliminary step in behavior change to ultimately effect behavior. Informing and encouraging parents of toddlers to develop a healthy lifestyle at an early age remains a promising intervention for prevention of childhood obesity (LoRe, 2019).

Women who have received less than a highschool diploma have the lowest nutrition knowledge scores compared to those who have some form of collegiate education. This study also found that obese women had higher nutrition education scores verses normal weight women. This finding is thought to be from obesity itself being a motivational factor to seek reliable information and advice on weight control and healthy eating (Laz, 2015).

Parents have expressed a desire for more reliable access to nutrition education and healthy behaviors. One study found that 22 parents were interested in community-based programs that would provide education on healthy eating, nutrition literacy such as reading a nutrition label and cooking skills (McManus et al., 2021). Parents need access to information to create healthy home environments for obesity prevention, yet participation for in-person education programs is challenging. Web-based interventions are promising educational tools due to convenient availability. However, information is limited in their development and evaluation (Gurajada, 2017).

### **Paternal Influence on Children's Nutrition Habits**

Increasing nutrition education in parents allows them to provide their children with healthier meals and become positive dietary role models within the household. At home, the food preferences of parents affect the eating habits of their children (Adam, 2013; Kim, 2019). Parents are their child's first and most important dietary role models holding the greatest responsibility when it comes to establishing good diet quality and overall shaping their child's eating behaviors (Adam, 2013).

In a previous study, most children reported their mom or dad having the most influence on their eating habits as 95% of children said they like eating what their parent(s) eat (Keys, 2010). Parents are important agents in the promotion of health, behavior, and education of their children. They create the food environment that structures their children's first experiences with food through various tastes and quality of foods. The parents' belief in food practices, perspective on food, eating attitudes, knowledge, and understanding of the benefits of proper nutrients are passed down to their children. For example, when parents prefer high-fat, high-caloric food, children lose the chance to eat a variety of dishes and lean towards consuming high-fat, high-caloric foods (Adam 2013; Scaglioni et. al., 2018; Zarnowiecki, 2012).

Parental food habits and feeding strategies are dominant determinants of a child's eating behavior and food choices overtime (Savage et al, 2007). One study of 2-5-year-old children in the United Kingdom found that eating the same food as their parents was the best predictor of preschooler's vegetable consumption (Lipsky, 2015). Conversely, multiple studies have found that children repeat their parents' actions of not wanting to eat healthy foods and tend to choose foods higher in sugar and fat over fruits and vegetables (Slusser 2011; Scaglioni, 2018).

Due to the nature of the family environment being replicated by their children, creating a healthy environment for children is what creates healthy eating habits within the whole family. Findings of scheduled meals within the home and at school prevents overeating as well as healthier meal and snack options at appropriate times. Mealtimes that are shared with family such as family dinners, show positive nutrition health within children and adolescents. Meals eaten together contain healthier options with less fat, sodium, and sugar (Glanz et al, 2021).

Studies indicated that a positive family system may be part of a process that establishes and promotes beneficial healthy eating behaviors (Vandeweghe et. al., 2016). Early



establishments of health-promoting eating behaviors in U.S. adolescents have positive health benefits into adulthood (Lipsky, 2015). With this, it is necessary to educate parents continuously about this aspect of their role and about the importance of managing their own eating habits to manage the eating habits of their overweight or obese children. Helping parents improve their diet may promote improvements in their adolescent's diet and is a potential target for interventions designated to increase healthy eating among adolescents (Watts, 2014).

### **Summary**

There are many factors that have been found to contribute to the obesity epidemic within children. Although some of these factors are non-modifiable, the knowledge and recommendations received from previous research show possible progress in understanding the components of obesity. Encouraging positive changes when possible can lower a child's risk for obesity and lead to improved overall health for generations to come. It is important to create and support a healthy environment that makes it easy to engage in physical activity and choose healthy foods within the school, household, and community setting (CDC, 2021). Factors including genetics, the environment in which one lives, socio-economic status, level of education, and influence of the parents, have been studied for their relationship with childhood obesity. Studies have shown the relationship between parental nutrition education knowledge and parental BMI but have not investigated the relationship between parental nutrition education and childhood obesity.

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APPENDIX A: SURVEY TO ESTABLISH LEVEL OF GENERAL NUTRITION  
KNOWLEDGE IN PARENTS

This is a survey, not a test. It is important that you complete it by yourself. Your answers will remain anonymous. If you do not know the answer, please mark “not sure” rather than guess.

How many children are in your household?

- 1
- 2
- 3
- 4
- 5
- 6
- 7 or more

What is your annual household income?

- \$0 to \$9,999
- \$10,000 to \$19,999
- \$20,000 to \$34,999
- \$35,000 to \$44,999
- \$45,000 to \$54,999
- \$55,000 to \$64,000
- \$65,000 to \$79,000
- \$80,000 to \$99,999
- \$100,000 and Over

What is your race?

- Asian
- Native Hawaiian or other Pacific Islander
- Black or African American
- Hispanic or Latino
- White
- Not Sure
- Prefer not to answer

What type of community do you live in?

- Rural Area (Less than 2,500 people)
- Urban Area (2,500 to 49,000 people)
- Metropolitan Area (50,000 or more people)

What is your highest level of education?

- Less than highschool (no diploma)
- Highschool graduate/GED or equivalent
- Some college or Associate degree
- College graduate and Bachelor degree
- College graduate and Master's degree
- College graduate and Doctoral degree

What is your highest level of nutrition education (when did you last take a nutrition course)?

- None
- Highschool class
- College course
- Certificate in nutrition
- Degree in nutrition/dietetics

Where do you first look when you have questions regarding food or diet information?

- Family
- Friends/Coworkers
- Internet (social media, news)
- Healthcare Professional (doctor, practitioner)
- Registered Dietitian
- Books / Brochures / Magazines

In years, how old are you?

- 18-34
- 35-44
- 45-64
- 65+

What is your current gender identity?

- Male
- Female
- Trans male/Trans man
- Trans female/Trans woman
- Genderqueer/Gender non-conforming
- Different Identity (Please Specify)\_\_\_\_\_

How tall are you without shoes?

\_\_\_\_\_Feet

\_\_\_\_\_Inches

How much do you weigh?

\_\_\_\_\_lbs.

Complete this portion for only one of your children, the oldest between the ages of 2 and 12 who reside in the same household.

In years, how old is your child?

- 2-5
- 6-9
- 10-12

What is your current gender identity of your child?

- Male
- Female
- Trans male/Trans man
- Trans female/Trans woman
- Genderqueer/Gender non-conforming
- Different Identity (Please Specify)\_\_\_\_\_

How tall is your child without shoes?

\_\_\_\_\_Feet

\_\_\_\_\_Inches

How much does your child weigh?

\_\_\_\_\_lbs.

How do you consider your child' weight? Please select the most appropriate answer.

- Overweight
- Underweight
- About the right weight
- Not sure

Over the past 30 days, on average how many hours per day did your child sit and watch TV, videos, or play on a screen device (ex. phone, television, tablet, computer, or laptop)?

- Less than 1 hour
- 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours or more

During the past 7 days, on how many days was your child physically active for a total of at least 60 minutes?

- 0 days
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days



Select the item(s) health experts recommend that people should be eating more of. Select all that apply.

- Fruit
- Food and drinks with added sugar
- Vegetables
- Fatty foods
- Processed red meats
- Whole grains
- Salty foods
- Water
- Not sure

Select the item(s) health experts recommend that people should be eating less of. Select all that apply.

- Fruit
- Food and drinks with added sugar
- Vegetables
- Fatty foods
- Processed red meats
- Whole grains
- Salty foods
- Water
- Not sure

How many servings of fruit and vegetables per day do experts advise people to eat as a minimum? (Once serving could be, for example, an apple or a handful of chopped carrots).

- 2
- 3
- 4
- 5 or more
- Not sure

Which type(s) of fats do experts recommend people should eat less of? Select all that apply.

- Unsaturated fats
- Trans fats
- Saturated fats
- Not sure

Which type of dairy products do experts say people should drink more often?

- Full Fat (e.g., full fat milk)
- Reduced fat (e.g., skimmed and semi-skimmed milk)
- Mixture of full fat and reduced fat
- Neither – dairy products should be avoided
- Not sure

How many times per week do experts recommend that people eat oily fish (e.g. salmon and mackerel)?

- 1x per week
- 2x per week
- 3x per week
- Every day
- Not sure

How many times per week do experts recommend that people eat breakfast?

- 3x per week
- 4x per week
- Everyday
- Not sure

If a person has two glasses (8oz) of 100% fruit juice (no added sugar) in a day, how many of their daily fruit and vegetable servings would this count as?

- None
- One serving
- Two servings
- Three servings
- Not sure

According to “MyPlate” (a guideline showing the proportion of food types of people should eat to have a balanced and health diet), how much of a person’s diet should be made up of starchy foods?

- Quarter
- Third
- Half
- Not sure

How many food groups are there according to the USDA (United States Department of Agriculture)?

- 2
- 4
- 5
- 7
- Not sure

Which item(s) are typically high in added sugar? Select all that apply.

- Diet soda drinks
- Natural yogurt
- Ice cream
- Tomato Ketchup
- Watermelon
- Not sure

Which item(s) are typically high in sodium (salt)? Select all that apply.

- Breakfast cereals
- Frozen vegetables
- Baked beans
- Bread
- Red meat
- Canned soup
- Not sure

Which item(s) are typically high in fiber? Select all that apply.

- Oats
- Bananas
- White rice
- Eggs
- Potatoes with skin
- Pasta
- Not sure

Which item(s) are typically a good source of protein? Select all that apply.

- Chicken
- Cheese
- Strawberries
- Baked beans
- Butter
- Nuts
- Not sure

Which item(s) are considered starchy foods? Select all that apply.

- Cheese
- Pasta
- Potatoes
- Nuts
- Bananas
- Not sure

Which of these diseases is related to a low intake of fiber?

- Bowel disorders
- Anemia
- Tooth decay
- Not sure

Which of these diseases is related to how much sugar people eat?

- High blood pressure
- Tooth decay
- Anemia
- Not sure

Which of the following do health experts recommend to reduce the chances of getting certain cancers?

- Drink alcohol regularly
- Eat less red meat
- Avoid additives in foods
- Not sure

To maintain a healthy weight, it is recommended that people cut out fat completely.

- True
- False
- Not sure

To maintain a healthy weight, it is recommended that people should eat a high protein diet?

- True
- False
- Not sure

Research shows that bread always causes weight gain.

- True
- False
- Not sure