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Exploration of the Impact of Childhood Obesity and the Correlation with Parents

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IMPACT OF CHILDHOOD OBESITY AND CORRELATION WITH PARENTS

Abstract:

Purpose: This review and analysis explored the prevalence of childhood obesity within the United States and other countries around the world, as well as the correlation between childhood obesity and parents. *Method:* I originally planned to conduct a survey study within the Muscogee-Columbus County School District (MCSD); however, I was unable to get the correct signatures in order to proceed with the Institutional Review Board (IRB) approval process. At that time I got approval from the Honors Dean and my Thesis Director to conduct an in-depth literature review and analysis on the impact of childhood obesity and the correlation with parents. *Results:* The results of the articles and journals indicated that childhood obesity can be linked to genetics, environmental factors, and lifestyle choices. Results were also in consensus with regards to childhood obesity having the ability to lead to early morbidity and mortality if it is not stopped. *Conclusion:* If not addressed in a timely manner, the resulting consequences of childhood obesity could be irreversible. Further research needs to be completed to specify just how much of obesity can be tied to genetics; currently there are only ranges. Further research would also be beneficial in order to learn which prevention methods work best in certain areas around the world to prevent the continuous rise of childhood obesity.

INDEX WORDS: Obesity, Childhood Obesity, Overweight

Table of Contents:

List of Appendices:

Introduction:

Obesity is one of the major health crises that is prevalent worldwide today. There are many reasons underlying the rise in the number of people who are considered either overweight or obese today such as genetic susceptibility, environmental stressors (work, finances, family, etc.), and lifestyle choices (consuming too much of the wrong foods and not exercising enough). With the current pace of day-to-day life, it is understandable why overweight and obesity numbers are steadily increasing. People today are constantly stressed and continually on the move. There is little time to exercise, prepare and eat healthy meals, and relax prior to the start of the next day. It is not only adults who are battling with overweight and obesity issues; children are also facing these challenges and consequences. There are more children today than ever before who are considered either overweight or obese. Therefore, as the overweight and obesity numbers steadily increase, health professionals are growing more and more concerned with the risk factors that are associated with a heightened Body Mass Index (BMI) measurement, especially among the younger population.

Impact Worldwide

Childhood obesity has been an increasing health issue since 1980, with it first becoming recognized as a major health problem by the World Health Organization (WHO) in 1998. By 2004, childhood obesity was prevalent worldwide, at which time the WHO found that 4.8% of children in developing countries, 17.1% of children in transitional countries, and 20.4% of children in developed countries were considered obese (Anuradha, Sathyavathi, Reddy, Hemalatha, Sudhakar, Geetha, and Reddy, 2015). In the United States alone in 2007-2008 it was estimated that nearly 19.6% of children (ages 6-19) were classified as being obese (Tate, 2015). According to the WHO, in 2014 there were roughly 1.9 billion adults and 41 million children

(under 5 years old) who were considered either overweight or obese worldwide. There was no information available regarding children ages 5-19. Since its recognition as a major health problem nineteen years ago, the prevalence of childhood obesity appears to only be increasing.

In the United States today, one in every five school children is considered to be obese (Weaver, Moore, Turner-Mcgrievy, Saunders, Beighly, Khan, and Beets, 2016). Similar childhood obesity trends have been reported in other countries, including England, Italy, Germany, India, and Australia (Role of genetic factors in childhood obesity and in susceptibility to dietary variations). Although the percent of children who are considered obese in the aforementioned countries is on the rise, those percentages are still lower than numbers recorded in the United States; yet, those countries are all experiencing a steady increase of childhood obesity within their population.

Definitions of Childhood Obesity

The definition of childhood obesity is differs slightly depending on the information source; however, the underlying theme remains the same: "excessive BMI-for-age compared to other children". For the purposes of this paper, a "child" refers to those ages 5-19 (in accordance with the WHO's definition). Before a person can be considered to be 'obese' they must surpass the classification of being 'overweight;' therefore, both definitions will be defined by two separate organizations for the purposes of this paper. The sources for the definitions were chosen due to previous studies utilizing these two organizations' definitions during their studies: the WHO, and the Centers for Disease Control and Prevention (CDC).

The WHO's definition of overweight for children is "BMI-for-age greater than one standard deviation above the WHO Growth Reference median." The definition for obesity for children is "greater than two standard deviations above the WHO Growth Reference median"

(Childhood overweight and obesity, n.d.). These definitions are the same as a BMI of 25 kg/m^2 and 30 kg/m^2 respectively, at 19 years old.

According to the CDC, the definitions of overweight and obesity for children are as follows: "Overweight is defined as a BMI at or above the 85th percentile and below the 95th percentile for children and teens of the same age and sex. Obesity is defined as a BMI at or above the 95th percentile for children and teens of the same age and sex" (Childhood Obesity Facts, 2016). These definitions of overweight and obesity in children are a close reflection of the adult definitions; however, with children, they are compared with their peers instead of being solely based on BMI percentage (i.e., BMI of 25% and 30% or greater).

Causes and Health Risks/Consequences

Obesity, in general, is a direct result of excessively consuming more calories than your body utilizes for daily activities. When assessing obesity in children, there are multiple factors that can lead to a child becoming overweight and potentially becoming obese. These causation factors include genetic susceptibility, surrounding environment (which may cause unnecessary stress), and lifestyle choices – including eating too much of the wrong foods and not getting enough exercise. There have been numerous studies conducted to attempt to pinpoint specific genes which may be indicators of a child's likelihood of becoming overweight or obese.

Regardless of one's age, there are additional social and health consequences associated with being overweight or obese. Childhood obesity not only impairs the child's ability to run and partake in sports or other activities with their peers, it may be an underlying cause of one's susceptibility of being bullied; therefore, having an impact on the child's overall emotional well-being. With regard to medical consequences, childhood obesity can lead to earlier diagnoses of non-communicable diseases such as the development of metabolic syndrome (MetS), diabetes

(Type II and possibly Type I), cardiovascular diseases, musculoskeletal disorders, hypertension, and even some cancers (Childhood overweight and obesity, n.d.).

MetS is a combination of metabolic signs that normally develop in an individual when they are overweight or obese. MetS may include excessive body fat percentage, high blood pressure, and impaired glucose metabolism, all of which can lead to an increased risk of Type II diabetes (and potentially Type I diabetes) as well as cardiovascular diseases (Monzani, Rapa, Fuiano, Diddi, Prodam, Bellone, and Bona, 2013). An elevated blood pressure increases the strain placed on your heart and organs due to being over-worked; therefore, putting an individual at higher risk of developing cardiovascular diseases. Impaired glucose metabolism can eventually lead to Type II diabetes, and possibly Type I diabetes, if not controlled with medication and changes made to the diet and exercise. In either case, the body does not process insulin correctly. Insulin is a hormone made in the pancreas and it is the way in which cells convert blood sugar (glucose) into energy for the body (How Insulin Works, n.d.). With Type II diabetes, the body loses the ability to use insulin correctly; therefore, becoming insulin resistant. With Type I diabetes, an individual's immune system kills the cells that are responsible for releasing insulin, making them insulin-dependent. Without insulin there is no way for cells to receive glucose, which is the body's main source of energy; therefore, when the cells become insulin-dependent, they rely on an outside insulin source. All of the aforementioned health risks and consequences of being considered overweight or obese can eventually, if not treated in a timely manner or correctly, can lead to a premature death.

There is a greater possibility of further complicating medical diagnoses in adulthood if obesity is not stopped during the younger years (i.e., more advanced stages of cancer, Type II diabetes can advance to Type I diabetes, joint replacements, etc.). Therefore, childhood obesity

can not only increase one's chances of life-long battles with disease(s), but it also increases the risk of premature death for individuals.

Original Thesis Proposal

When beginning my thesis, I originally planned to conduct a study within the Muscogee-Columbus County School District (MCSD). The purpose of conducting this original survey would have been to explore the correlation of habits between parents and their children, and to then compare the results to previous studies conducted in other areas of the country and world to assess where Columbus, Georgia falls in regards to childhood obesity habits (see appendix D for copy of original survey). The study was going to include a survey that would be disseminated to parents of students at three of the local schools (Clubview Elementary, Blackmon Road Middle, and Shaw High School). These three schools were chosen because of their location within Muscogee County, so that there would be less of a possibility of selection bias. However, upon sending the initial and follow-up email to the MSCD Chairperson and the three principals of the aforementioned schools on 02 February 2017 and 10 February 2017 respectively, I was unable to obtain the signatures required to proceed with the IRB approval process. At that time I received approval from the Honors Dean and Thesis Director to conduct and in-depth literature review and analysis on the impact of childhood obesity, the correlation with parents, and possible preventative measures.

Methods and Procedure:

Upon receiving confirmation to proceed in this new direction, I began the process of utilizing online databases (i.e. Galileo, iMedpub) to find scholarly articles and journals to conduct the research and analysis. I began research within Galileo in the Columbus State University's Library webpage. Within Galileo I narrowed the search to Scholarly (Peer

Reviewed) Journals and Academic Journals, with a publication date range between the years 2000 and 2017. With these parameters set, I searched using the following key words: "childhood obesity," "childhood obesity genetics," and "childhood obesity: causes and consequences." From these searches, there were a total of 200,433 results; 76,708 results; and 63,111 results respectively on Galileo. With these results I searched for those that appeared to contain relevant and valuable information that would help with the analysis on the impact of childhood obesity and the correlation with parents. After gathering articles from Galileo, I used Google to search for medical journals pertaining to Childhood Obesity. One of the results took me to the iMedpub website which is "an online access publisher" for medical and health care professionals with a database of approximately 130 different journals pertaining to a wide range of medical and health care field focuses. The top three journals that pertained to my research on this database included: the Journal of Childhood Obesity, the Journal of Obesity and Eating Disorders, and the International Journal of Obesity.

After finding the articles and journals pertaining to different aspects of childhood obesity, I had the opportunity to save them and organize them in a way that allowed me to more readily compare the findings within the numerous studies that had been conducted worldwide. I was able to gather the information needed in order to conduct my analysis on the impact of childhood obesity and the correlation with parents with the use of Galileo, iMedpub, the WHO webpage, and the CDC webpage.

Results:

Impact Worldwide:

The results of the impact of childhood obesity worldwide are staggering. From a study conducted in Andhra Pradesh, India, a sample of 2,258 children ages 12 to 16 (1,097 boys and

1,161 girls), 11.2% of the boys and 10.3% of the girls were considered overweight and another 4.8% of boys and 4.8% of girls were considered obese (Anuradha et al., 2015). Although there were no significant differences across the different age groups within the study, there was a correlation reported with regard to the level of education the of mother. The Anuradha et al. study found, with a 95% CI of 1.048-2.354, that the higher the mother's education and the higher the family income, the more likely a child is to be overweight or obese. This may be due to the accessibility of a wider variety/range of food. This phenomenon (higher income equates to an increased accessibility to food) does not just occur in Andhra Pradesh, India, but throughout the world.

A study conducted testing for Metabolic Syndrome (MetS – a consequence of obesity) in the Puglia Region, San Marco in Lamis (southern Italy) included 489 school children (ages 6-13). Throughout the study, the researchers noted that the most prominent clinical characteristics included abdominal obesity and elevated blood pressure. Children involved in the study were tested for the five components of MetS and were considered to have MetS if they had at least three of the following components: "abdominal obesity, elevated blood pressure, high triglyceride levels, low HDL cholesterol level, and impaired fasting glucose" (Monzani, et al., 2013). Of the school children studied, 48 were identified as having MetS, with 38 children (79.2%) being categorized as having abdominal obesity and elevated blood pressure as two of their components of MetS (Monzani, et al., 2013). Out of the total sample population, 39.9% of children tested negative for all components of MetS while 0.2% of children tested positive for all five components of MetS. Of the remaining 59.9% of children included in the study, 32.5%, 17.8%, 9%, and 0.6% tested positive for a single component, two components, three components, or four components of MetS respectively (Monzani et al., 2013). With these

findings the researchers also noted that in younger children, that the only factor that was different between those with MetS and those without MetS, was the presence of a history of parental obesity (95% CI = 1.8-10.2; P = 0.002). With regard to the older children, it was a combination of factors: "presence of parental history of obesity, not walking/cycling to school, long screen time, and no breakfast," were all contributing factors to a child's susceptibility to becoming overweight or obese (Monzani et al., 2013).

Genetic Susceptibility:

Multiple studies agree on the fact that there is an obesity (obese) phenotype that is prevalent within families; however, most of the causative genes have not yet been discovered. In the study conducted by Herbert, Gerry, McQueen, Heid, Pfeufer, Illif, and Christman in 2006, results indicated that one of the common genetic variants associated with obesity appeared near the INSIG2 gene. This gene works with sterol regulatory element binding proteins (which are responsible for the synthesis of cholesterol and fatty acids), and is responsible for the reversed cholesterol transport within the liver (Heid, I. M., Huth, C., Loos, R. J., Kronenberg, F., Adamkova, V., Anand, S. S., Wichmann,H., 2009, October 23). The testing found that this INSIG2 gene is present in nearly 10% of individuals, based off of their test with those of differing ethnicities. Another study conducted in 2013 used a new method, the Genome-Wide Complex Trait Analysis (GCTA) to explore the heritability of body weight in children. The GCTA study conducted by Dr. Clare Llwewllyn involved 2,269 children (between eight and eleven years old). Dr. Clare Llwewllyn found that the overall effects of multiple genes were responsible for roughly 30% of individual differences experienced with childhood body weight (Study finds strong genetic component to childhood obesity, 2015).

Prior to the invention of the GCTA method, researchers could speed up the process of discovering the genetic loci and their correlation with obesity with invention of the Genome-Wide Association Studies (GWAS) in 2005. Researchers such as Aguilera, Olza, and Gil used the GWAS to provide evidence identifying the correlation of specific genes and their role in the development of obesity (the table can be found in Appendix C). The GWAS determined that there are 30 different genetic variants associated with obesity and an additional nine genetic variants associated with MetS from the Human Genome Project and the HapMap Project (Aguilera et al., 2013). Aguilera, Olza, and Gil noted that multiple studies confirmed that the genetic variant that appears to have the strongest correlation to genetic susceptibility to obesity is TMEM18; and those genetic variants that appear to effect children more than adults include TMEM18, SEC16, and KCTD15.

A study conducted by Willer et al.(Six new loci associated with body mass index highlight a neuronal influence on body weight regulation, n.d.), (N = 4,951; children 11years old) confirmed the significant correlation of variants in/near FTO, MC4R, TMEM18, KCT15, and GNPDA2 to obese BMI levels. Data was replicated in a study conducted in the United Kingdom (N = 1,038), confirming the significant correlation of two variants that Willer et al. previously confirmed: TMEM18 and GNPDA2, with a new additional possible significant gene variant – that being NEGR1. Data findings for a study conducted with the European Youth Heart Study (N = 2,042) confirmed the previous findings of Willer et al., and the United Kingdom study with finding the significant genetic variants of TMEM18, GNPDA2, and NEGR1; however, they also found association to obese BMI levels with ten other genetic variants: SEC16B, LYPLAL1, ETV5, TFAP2B, MSRA, BDNF, MTCH2, BCDIN3D, NRXN3, and SH2B1.

Environmental Determinants:

Environmental determinants also play a role in the development of childhood obesity and studies have found that the literacy rates of parents, family income, sleep duration, screen time, and the amount of time exercising are all variables in regards to the outcome of childhood obesity. Anuradha et al., found through their study of 1,518 children in India that there was a "1.6 fold (95% CI: 1.048-2.354) when the mother attained higher education." The finding was correlated with the higher income of the family resulting in a higher probability that the child (children) would be overweight or obese. This study also found that children who slept fewer than seven hours at night were twice as likely to be overweight or obese compared to those children who received nine hours of sleep a night (Anuradha et al.).

Children are also at a heightened risk of becoming overweight or obese if their home environment is filled with stress. Shankardass, McConnell, Jerrett, Lam, Wolch, Milam, and Berhane, found that parents who responded to the survey scored an average a 4.0 on when using a "4-item version of the Perceived Stress Scale (PSS) rating of 0-16," and had a standard deviation of 2.9. Of those who responded in Shankardass et al's. study, many parents stated that to help manage their own stress and time, they would more often than not either prepare unhealthy meals or rely on a restaurant close by (most often a fast-food restaurant) for their evening nutrition more often than not. The stress that parents bring home may also be passed on to their children, which can lead to unhealthy eating habits, sedentary lifestyle, and the inability to sleep – all maladaptive coping behaviors that eventually lead to obesity (Vanaelst, 2013).

Discussion:

This in-depth literature review and analysis of previous studies was completed to explore the impact, correlation with parents, and possible preventative measures to combat the rise in childhood obesity.

Multifactorial Causes of Childhood Obesity:

This review and analysis confirmed the previous findings that childhood obesity cannot be tied to a single factor, but is considered the result of many different factors throughout a child's life. Those factors that contribute the most to a child's susceptibility of becoming overweight and/or obese include genetics, the surrounding environment, stress levels, and lifestyle choices. Genetic variants have been assessed to account for nearly 30% of a child's susceptibility of becoming either overweight or obese (Study finds strong genetic component to childhood obesity, 2015, June 26). The environment in which a child grows up in helps to shape their daily habits, which in turn will eventually lead to life-long, lifestyle choices. If the environment in which a child grows up in is constantly filled with unhealthy food choices and only the occasional healthy, well-balanced meal, the child will most likely begin to naturally select unhealthy choices throughout life. Stress levels have also been linked to obesity in adults; however, children can also experience stress. Stress can come from not getting the recommended amount of sleep, not giving one's self adequate time to get daily tasks accomplished, school, peers, sports, jobs, and other forms of constant bombardment of outside stimuli (television, radio, the internet, etc). If a child experiences stress in their surrounding environment every day, then they will most likely adopt maladaptive health behaviors, possibly leading to obesity and other health issues.

Confronting Childhood Obesity:

There are many different programs available for children afterschool or for families after the work day. However, some studies have found that adding yet another item to an already hectic schedule can cause additional stress for the parents and possibly the children. The United States adopted the Healthy Eating and Physical Activity (HEPA) Standards which were put into effect in November 2011 to begin the fight against childhood obesity (Weaver et al., 2016). The YMCA afterschool programs have implemented the HEPA Standards throughout their facilities nationwide and their goal is to positively influence the health of over nine million school children. These afterschool programs provide students with roughly 30 minutes of physical activity. In addition of providing school children with the opportunity to expend their energy through physical activity, the YMCA programs also serve fruit or vegetable snacks along with water to drink to help instill healthier habits (Weaver et al., 2016). The YMCA programs are doing what they can to educate the American youth about the benefits of living a healthy lifestyle and giving the students a means in which they can live a healthy lifestyle – at least while they are attending the program.

Another popular method in the promotion of childhood health and education is Family Based Treatment (FBT). This method includes active participation from the parents as well as the children. There have only been a couple of studies that have focused on the effects of parent involvement in childhood weight loss, but even so, it has been noted that "the most effective child weight loss interventions are characterized by a high level of parent participation, responsibility, and acceptance" (Braden, Strong, Crow, and Boutelle, 2015). The FBT programs that have been studied up to this point have also focused on families in which the child(ren) is/are in or above the 85th percentile for their weight compared to others of the same age and gender (O'Brien, McDonald, and Haines, 2013). This correlation of parent involvement and

childhood weight loss may be associated with children constantly seeking acceptance and approval from their parents; it may also just be correlated to the fact that children subconsciously follow their parents' habits, no matter what their habits may be (i.e., smoking when stressed, eating unhealthy foods, not exercising, etc.). Therefore, FBT programs have proven not only to help parents get involved in their child's (children's) health, but have also helped the parents lose weight and live healthier lives.

Potential Additional Methods:

With childhood obesity now being classified as an epidemic and with the numbers of those battling it still on the rise, further action needs to be taken to stop the increase. The American school system should devote more time for student physical education and health-and-wellness education. The majority of high school students today must only complete one year of physical education within their four years of high school. Not only does this give students the time and opportunity to get into unhealthy habits (i.e., drugs, not exercising, etc), but it also sends the message that physical education and personal well-being are not essential in life. Therefore, if the schools, particularly high schools, mandate a physical education curriculum for every year that students are in school, then after twelve years of primary school the importance of personal health should be engrained into our younger population, preparing them to live healthier lives and to continue the healthy lifestyle trend.

Limitations:

This in-depth literature review and analysis does have limitations. There were over 340,000 peer reviewed academic journal articles available on the Galileo database alone. I, myself, would not have the time to read through all the information within the 340,000+ articles within a single semester. Each individual article in which I reviewed and analyzed to be included

in this process all have their individual limitations as well. The majority of the studies conducted had fairly large population sizes; however, they were still confined to a fairly small region geographically, making it difficult to rightfully generalize to the results to the worldwide population.

There were also limitations in regards to the original thesis proposal; my findings would have been a local finding. There was a strong possibility that there would not have been enough responses to the survey, which would have made it difficult to make a confident generalization for Muscogee County, let alone a confident generalization for the population within the Southeast region of the United States.

Conclusion:

Childhood obesity has been plaguing the United States and the rest of the world since 1980, and was coined as a major health issue by the WHO 18 years later in 1998. The number of those children classified as being overweight or obese is staggering (with one in every five American school children considered obese) and it continues to rise. Multiple studies have been conducted in order to find the link between childhood obesity, parents, and possible preventative measures, as well as the impact childhood obesity has on the individual, and the population, as a whole.

Great strides have been made in the last 19 years in regards to finding ways in which to reverse, or at least halt childhood obesity. There have been multiple studies conducted which confirm the original findings that genetic variants do in fact play a role in a child's susceptibility of becoming obese, with the largest study discovering 30 different genetic variants related to a greater susceptibility to an increased BMI, and an additional nine genetic variants related to a greater susceptibility in regards to the development of MetS. Still other studies confirm the

power that the surrounding environment has on children and their habits, while others found means in which to utilize their surroundings in order to combat and reverse childhood obesity (i.e., YMCA programs, FBT treatments). There have undoubtfully been great findings and exploratory studies in regards to childhood obesity since 1998; however, further studies still need to be conducted to solidify earlier findings and to potentially find better, more easily accessible, avenues of approach when targeting childhood obesity.

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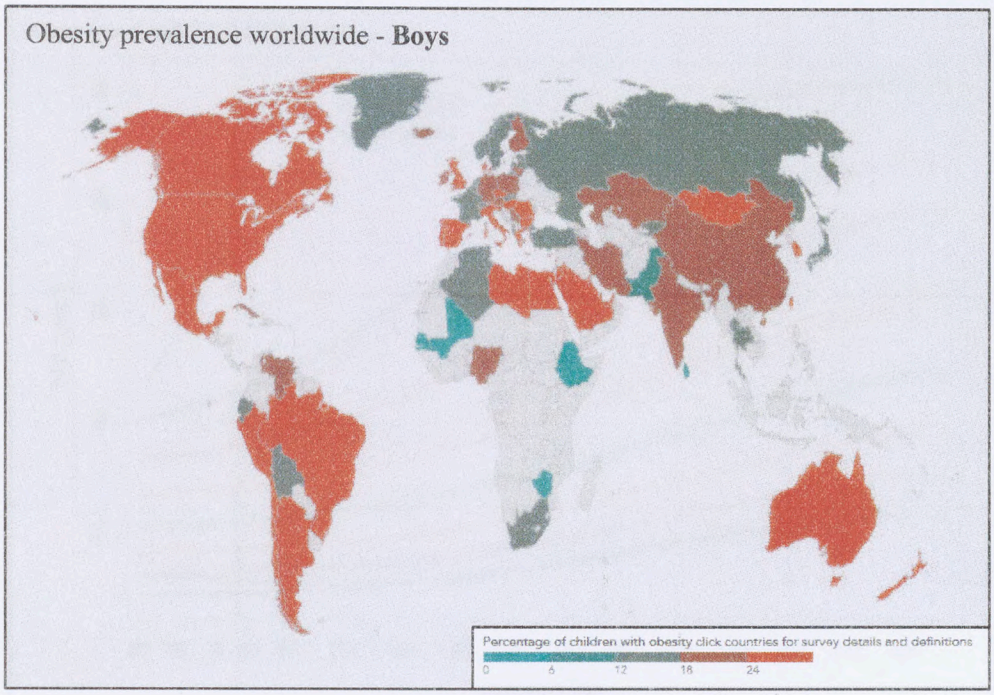
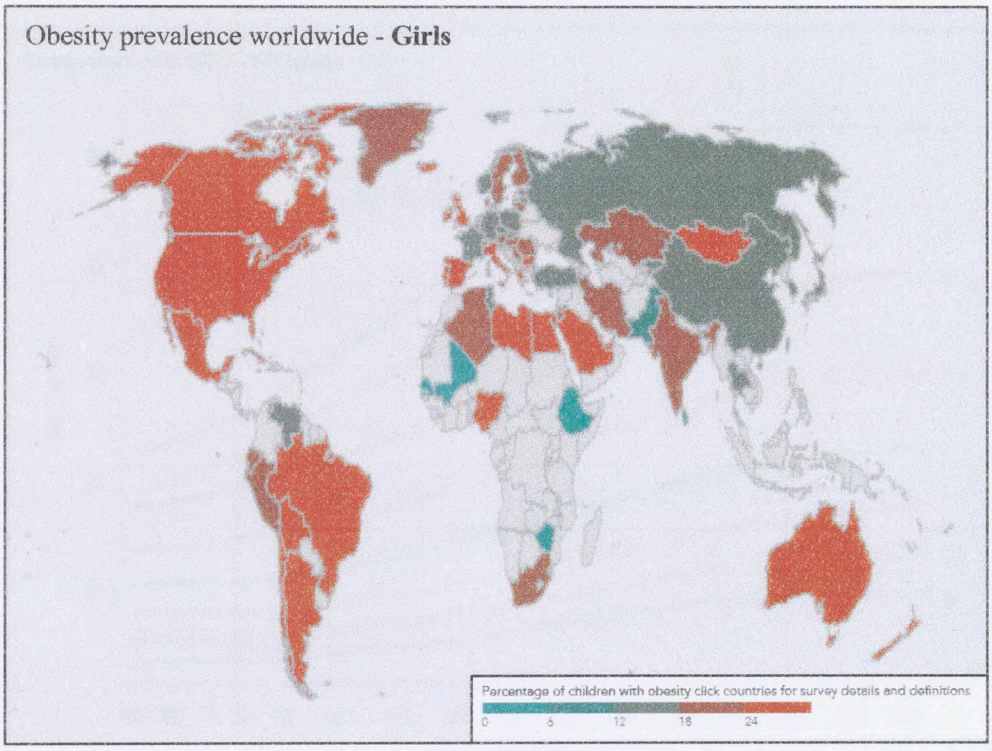
Appendix A

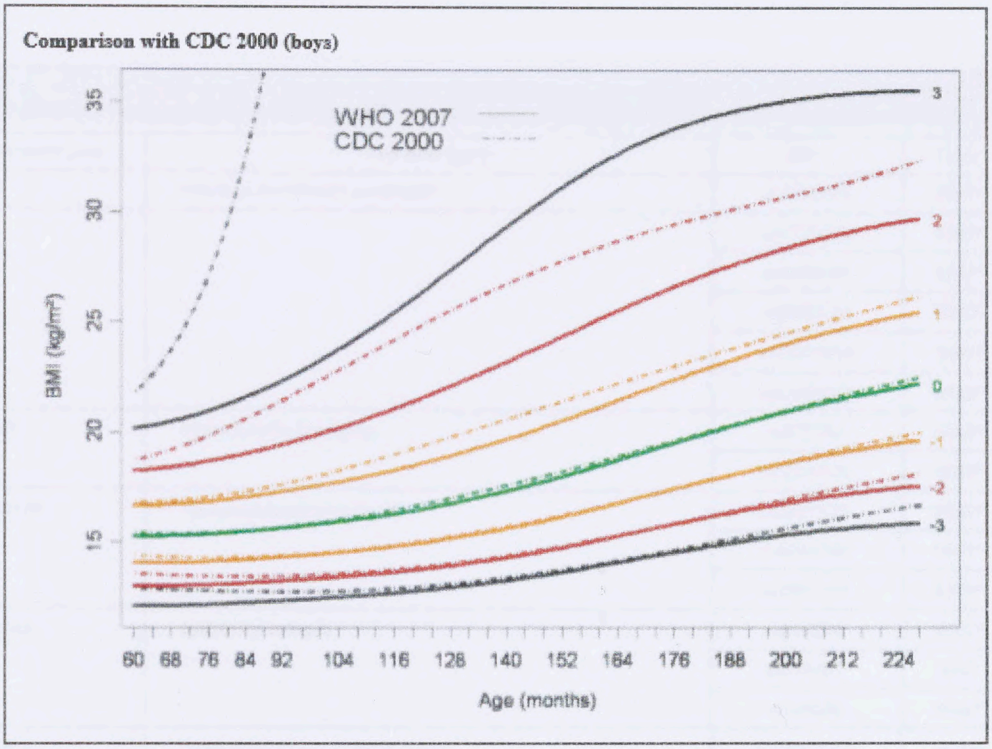
Graphs Depicting How Problematic Childhood Obesity is World-wide

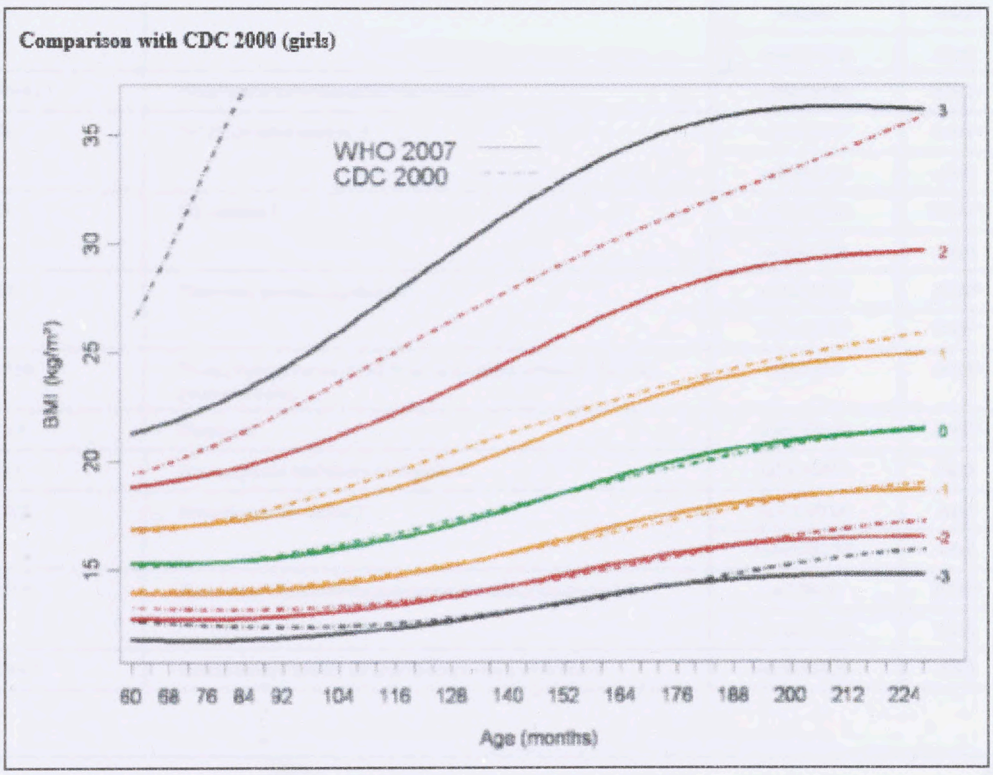




Appendix B

Graphs Depicting the Difference between the WHO and CDC Definitions





Appendix C

Table from **Genetic susceptibility to obesity and metabolic syndrome in childhood**

Table II

Genetic variants associated with obesity and metabolic syndrome through genome-wide association studies (GWAS)

Nearest gene	*Full gene name*	*SNP*	*Trait*
FTO	Fat mass and obesity associated	rs1558902	BMI*
		rs1121980	BMI*
		rs9939609	BMI*
		rs8050136	BMI*
		rs17817449	BMI*
		rs12149832	BMI*
MC4R	Melanocortin 4 receptor	rs571312	BMI*
		rs12970134	BMI*
TMEM18	Transmembrane protein 18	rs2867125	BMI*
		rs6548238	BMI*
		rs7561317	BMI*
SEC16B	SEC16 homolog B	rs543874	BMI*
		rs574367	BMI
		rs516636	BMI*
BDNF	Brain-derived neurotrophic factor	rs10767664	BMI*
		rs4923461	BMI
		rs6265	BMI*
		rs2030323	BMI
GNPDA2	Glucosamine-6-phosphate deaminase 2	rs10938397	BMI*
SH2B1	SH2B adaptor protein 1	rs7359397	BMI*
		rs7498665	BMI
ETV5	Ets variant 5	rs9816226	BMI*
		rs7647305	BMI
NEGR1	Neuronal growth regulator 1	rs2815752	BMI*
		rs2568958	BMI*
TFAP2B	Transcription factor AP-2 beta (activating enhancer binding protein 2 beta)	rs987237	BMI*
NRXN3	Neurexin	rs10150332	BMI*
FAIM2	Fas apoptotic inhibitory molecule 2	rs7138803	BMI
MTCH2	Mitochondrial carrier 2	rs3817334	BMI
		rs10838738	BMI
KCTD15	Potassium channel tetramerisation domain containing 15	rs29941	BMI*
		rs11084753	BMI
SLC39A8	Solute carrier family 39 (zinc transporter), member 8	rs13107325	BMI

Table II *(cont.)*
Genetic variants associated with obesity and metabolic syndrome through genome-wide association studies (GWAS)

Nearest gene	*Full gene name*	*SNP*	*Trait*
GPRC5B	G protein-coupled receptor, family C, group 5, member B	rs12444979	BMI
PRKD1	Protein kinase D1	rs11847697	BMI
QPCTL	Glutaminyl-peptide cyclotransferase-like	rs2287019	BMI
		rs11671664	BMI
MAP2K5	Mitogen-activated protein kinase 5	rs2241423	BMI
		rs4776970	BMI
LRRN6C	Leucine rich repeat neuronal 6C	rs10968576	BMI
FANCL	Fanconi anaemia, complementation group L	rs887912	BMI
CADM2	Cell adhesion molecule 2	rs13078807	BMI
TMEM160	Transmembrane protein 160	rs3810291	BMI
LRP1B	Low-density lipoprotein receptor-related protein 1B	rs2890652	BMI
MTIF3	Mitochondrial translational initiation factor 3	rs4771122	BMI
TNNI3K	TNNI3-interacting kinase	rs1514175	BMI
ZNF608	Zinc finger protein 608	rs4836133	BMI
PTBP2	Polypyrimidine tract-binding protein 2	rs1555543	BMI
RPL27A	Ribosomal protein L27a	rs4929949	BMI
NUDT3	Nudix (nucleoside diphosphate linked moiety X)-type motif 3	rs206936	BMI
LPL	Lipoprotein lipase	rs295	MetS
CETP	Cholesteryl ester transfer protein, plasma	rs173539	MetS
APOA5	Apolipoprotein A-V	rs2266788	MetS
ZNF259	Zinc finger protein 259	rs2075290	MetS
BUD13	BUD13 homolog (S. Cerevisiae)	rs10790162	MetS
APOC1	Apolipoprotein C-I	rs4420638	MetS
BRAP	BRCA1-associated protein	rs11065987	MetS
PLCG1	Phospholipase C, gamma 1	rs753381	MetS
APOA1/C3/A4/A5	Gene cluster region (SNP rs964184)	rs964184	MetS

* Association observed in children. BMI: body mass index. MetS: metabolic syndrome.

than for other traits. The most influential variants in the correlation among traits were in or near *LPL*, *CETP*, *APOA5*, *ZNF259*, *BUD13*, *TRIB1*, *LOC100129500*, and *LOC100128154*. The genes with variants that influence MetS *per se* included *LPL*, *CETP*, and the APOA-cluster (*APOA5*, *ZNF259*, and *BUD13*), which are known to play an important role in lipid metabolism.[26]

Another approach that combined several components of MetS in a GWAS was published by Avery et al,[27] who used data from 19,486 European Americans and 6,287 African Americans. Six phenotype domains (atherogenic dyslipidemia, vascular dysfunction, vascular inflammation, pro-thrombotic state, central obesity, and elevated plasma glucose), including 19 quantitative traits, were examined and analysed through a principal component analysis. These researchers then applied a multivariate approach that related eight principal components from the six domains. In European

Appendix D

Original Survey Questions

1.] Are you the parent or guardian of a child within the Muscogee-Columbus County School District?

Yes No

2.] Are you the mother, father, step-parent, or guardian?

Mother Father Step-Parent Guardian

3.] What is your current marital status?

Married Divorced Widowed Single

4.] How old are you?

< 20 20-25 25-30 > 30

5.] Do you experience stress from any of the following? (Check all that apply)

Work Relationships Finances Health Other

6.] How many children are you the primary caregiver for?

1 / 2 / 3 / 4 / More than 4

7.] What grade level are your children (is your child) in? (Check all that apply)

Kindergarten 1st Grade 2nd Grade 3rd Grade
4th Grade 5th Grade 6th Grade 7th Grade
8th Grade 9th Grade 10th Grade 11th Grade
12th Grade

8.] What physical activities do your children (does your child) participate in? (Check all that apply)

Team Sports
Individual Sports (gymnastics, dance, golf, etc…)
Neighborhood/Playground place
Other

9.] On average, how many hours a week do your children (does your child) participate in physical activity?

0-1 1-2 2-3 3-4
4-5 More than 5

10.] Do your children (does your child) readily want to be physically active?

Yes No Sometimes

11.] Do you encourage your children (child) to partake in physical activity by participating in physical activity with them?

Yes No Sometimes

12.] Roughly how many glasses of water do your children (does your child) consume daily?

0-2 Glasses 3-5 Glasses
6-8 Glasses More than 8 Glasses

13.] Roughly how many sugary/carbonated drinks do your children (does your child) consume daily?

0 1 2 3 or more

14.] On average, how many hours a week do you participate in physical activity? (Including adult league sport teams, running, biking, crossfit, etc…)

0-1 1-2 2-3 3-4
4-5 More than 5

15.] Roughly how many glasses of water do you consume on a daily basis?

0-2 Glasses 3-5 Glasses 6-8 Glasses Over 8 Glasses

16.] Roughly how many sugary/carbonated drinks do you consume on a daily basis?

0 1 2 3 or more

17.] On average, how many nights a week do you and your family eat out at restaurants?

0 1 2 3 nights or more

18.] On average, how many hours do your children (does your child) spend in front of a screen (i.e., computer screen, phone, and/or TV screen) per night?

30 minutes 1 hour 1 hour 30 minutes 2 hours or more

19.] On average, how many hours of sleep do your children (does your child) get per night?

Less than 6 hours 6-7 hours 7-8 hours 8-9 hours
9-10 hours More than 10 hours

20.] On average, how many hours of sleep per night do you get?

Less than 6 hours 6-7 hours 7-8 hours 8-9 hours
9-10 hours More than 10 hours

21.] Are you aware that there are different ways of measuring obesity in the following stages in life: infants and children under 5 years old, those 5-19 years old, and adults 19 years old and older?

Yes No

22.] Are you concerned about your children's (child's) weight?

Yes No

23.] Are you concerned about your weight?

Yes No

EXPLORATION OF THE IMPACT OF CHILDHOOD OBESITY AND THE CORRELATION WITH PARENTS

By

Emilee L. Leslie

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