Non-Genetic Components of Childhood Obesity

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Abstract

Childhood obesity is causing rising concern for health officials throughout America as well as other developed countries. The rates of childhood obesity are leveling off or rising in many cases depending on the sample and subgroups of the samples such as gender and race. It is important to stop the rise of childhood obesity by finding possible causes and providing treatment. Obesity is linked to countless immediate and long term health problems including heart problems, sleep apnea, diabetes, and even certain cancers. Obesity is correlated not only to other health risks but also developmental problems such as low self-esteem and poor academic performance.

In this review, the links between obesity and stress, socio-economic status, diet, and physical activity were explored. Through this research it is more clear how stress, socio-economic status, diet and physical activity impact childhood obesity. It is important to note that the results of these studies find varying results. There are many other interactions and interplay between these factors that contribute to the causes of childhood obesity.
Non-Genetic Components of Childhood Obesity

Rates of childhood obesity have been leveling off or rising in many developed countries. In the United States the rates of childhood obesity has more than tripled since 1971. Childhood obesity is linked to countless immediate and long term health problems including heart problems, sleep apnea, diabetes, and even certain cancers. Obesity is correlated not only to other health risks but also developmental problems such as low self-esteem and poor academic performance. Now childhood obesity is the number one health concern according the parents and the American Heart Association (2016). This paper aims to explore the research on the possible non-genetic causes of childhood obesity such as stress, socio-economic status, diet, and physical activity.

If personal stress is found to increase the risk of obesity in children it is possible that parental stress would impact childhood obesity because of the integral role parents play in the life of their children. Things such as maternal depression, conflicts between parents, family disruption, and house moves can create a sizable amount of disruption and stress for a child (Giles et al, 2013). Parental stress could impact the baby through increasing their stress level or by altering the adults’ parenting style. In addition, non-secure parenting styles may create stressful home environments and interactions between the child and parents (Stenhammar et al, 2010). Non-secure attachments include avoidantly attached and ambivalent attached. Mothers with these attachments with their child seem to be less engaged and less responsive to the needs of their child (Larsen & Buss, 2014). The child can react by becoming upset or becoming emotionally distant. Research has also shown that sexually abused individual’s coping styles and eating behaviors may have changed to deal with their abuse. Some researchers have even found that children use overweight as a defense mechanism against abuse (Veldwijk, 2012).
Stress during childhood activates the HPA axis in children which releases cortisol and impacts both the stress system and eating behaviors (Koch et al, 2008). Cortisol is released in the presence of a stressor. Cortisol which is released when an individual is stressed has been correlated with obesity and an increase in visceral fat. The cortisol awakening response is defined as an increase of cortisol secretion within 60 minutes of waking up. This increase of cortisol is associated with chronic stress (Van Jaarsveld et al, 2009). Visceral fat has been shown in previous research to be associated with biological and behavioral responses to stress such as the activation of the HPA axis, high levels of cortisol, increased appetite and eating fatty sugary foods (Donoho et al 2011). There are also links with increased levels of cortisol and activity in the HPA axis with children who have been abused (Veldwijk, 2012).

In this review the links between obesity and stress, socio-economic status, diet, and physical activity will be explored. Through this it will give more insight into possible causes of the epidemic and possibly help guide treatments.

**Links between stress and childhood obesity**

In this section the correlations between stress and childhood obesity are explored. This is a complex area of research with conflicting results. Different researchers have found mixed results on the associations between perceived stress and childhood obesity. For example one study have shown that there were links between long term parenting stressors and not short term stressors (Kosh et al, 2008) and yet another study found that there was no association between parenting stressors and childhood obesity (Ohookana et al, 2016). Also, one study found increase in obesity only in girls in their study (Dockray et al, 2008). It is hypothesized that stress impacts obesity through behavioral mechanisms and eating unhealthy foods or not exercising, emotional mechanisms like comfort eating, and hormonal mechanisms such as the
HPA axis and cortisol (Van Jaarsveld et al, 2009). In addition, some researchers believe there are sex differences for how stress impacts the risk of obesity. They believe that stress is correlated with obesity because women seek fatty and sugary foods when stressed. However for males the increase of cortisol as a result causes an increase in food intake (Yin et al, 2005). Previous research has found links between traumatic experiences, psychological stress, family stress, cortisol levels, and abuse.

Traumatic experiences such as sexual, emotional, and physical abuse can have lasting consequences on children. These traumatic experiences have mental and emotional consequences, increase stress levels, and alter coping mechanisms. Extreme levels of stress even just one occurrence has a correlation with obesity in children. Physical, sexual and emotional abuse are all significantly correlated with childhood obesity. The risk of obesity is increased as well in cases of more than one abuse. 51 percent of obese children were victims of multiple forms abuse compared to only 23 percent were normal weight with multiple forms of abuse. (Veldwijk et al, 2012). Isohookana et al (2016) found that traumatic experience such as sexual abuse can contribute to obesity in females. This study looked at 300 girls and 208 boys who were admitted for acute psychiatric hospitalization. It was found that girls who were sexually abused were 2.6 times more likely to be overweight compared to girls who did not experience a sexual abuse. While this was found for girls there was no correlation between obesity and traumatic childhood experiences.

Individual stressors and personal stress have been found to impact childhood obesity (Lohman et al, 2009 & Yin et al, 2005) Lohman et al (2009) suggest that the stressors may act on biology by activating the hypothalamus and increasing eating behavior or it may also be biological and stress makes it more likely for individuals to engage in unhealthy eating and
decreased physical activity. Yin et al (2005) was interested in how stress impacted obesity in children and looked not only at BMI but also sum of skin folds to measure general adiposity and waist circumference to measure central adiposity. It was hypothesized that stress would influence central adiposity more; however, it was found that stress predicted central and general adiposity. One interesting study measured stress of children by the number of house moves. It was found that house moves cause a prolonged physiological stress response that was found to be a statistically significant predictor to childhood obesity (Giles et al, 2013). In addition Donoho et al (2010) found that school stress in young girls was significantly correlated with visceral fat when examining what personal stressors impacted obesity in children. They measured school stress by arguing with a teacher, amount of big tests or projects, and fights in school. Conflicting results found that perceived stress was not correlated with increases in waist size or increases BMI; however, BMI and larger waist size were significantly higher for the adolescents that had higher stress. The fact that perceived stress was not correlated with increases in waist size and BMI suggest that stress does not impact the rate at which the adolescents are gaining weight. But the fact that BMI and waist size was significantly higher in adolescents that have higher stress suggests that ongoing chronic stress is related to childhood obesity (Van Jaarsveld et al, 2009).

Because parents and family are important in the lives of young children and adolescents many researchers expect to see correlations between parental stress and childhood obesity (Lohman et al, 2009) Parental divorce, unemployment, lack of social support, and serious life events have all been suggested to cause significant levels of stress in families and children making them points of interest when examining the links between family stress and childhood obesity(Watts et al, 2008, Stenhammar et al 2016, Koch et al, 2008). Serious life events such as
divorce, unemployment, death were assumed to cause stress and was found to increase the rate of childhood obesity (odds ratio of 1.42). The measure of parenting stress was not related to childhood obesity when the stress was short term but long term stress was positively correlated with obesity. Even when adjusted for parent obesity the relationship was still strong between parenting stress and child obesity. The more stressful situation that the family has the percentage of childhood obesity increases (Koch et al, 2008). Watts et al (2013) and Stenhammar et al (2016) found similar results linking perceived stress and lack of social support to childhood obesity. In addition non-secure attachment causing stress for the children was positively associated with obesity in children. Stehammar et al (2016) found that fearfully, preoccupied and dismissing attached children had odds ratios of 2.54, 2.9 and 1.93 prospectively. Ishookana et al (2016) however found no correlation between family stressors such as divorce or unemployment and childhood obesity. This could be because the sample of children was from a psychiatric hospital for trauma and not representative of a population impacted by stressors such as divorce and unemployment. In addition, Lohman et al (2009) found there was no direct correlation between family and maternal stressors or food insecurity with obesity. There was however an interaction between maternal stress and food insecurity that was significantly associated with obesity. One explanation for this could be because the participants were adolescents who were more independent than younger children. It is likely that if the children were younger parental stress would have a larger impact on obesity. Researchers note these findings are concerning because if stress impacts obesity these children may be at risk for starting a cycle and passing it on to their children as well. They stress the importance of helping families psychologically and with education on healthy eating (Koch et al, 2008).
Cortisol which is released when an individual is stressed has been correlated with obesity and an increase in visceral fat. Dockray et al (2009) examined the relationship between the amount of cortisol in children and obesity. They found that there was a significant association between cortisol release and childhood obesity. As cortisol release increased so did BMI but only in the girls in the study. Researchers have inferred that the significant relationship in cortisol release for girls not boys could be explained by a variety of factors. Boys and girls have different hormone secretion patterns which has an impact on what the children crave and how much they eat. Girls also release estrogen a different hormone than boys which influences the foods girls eat. Finally, girls are more likely to engage in stress eating than boys are statistically (Dockray et al, 2009). Results from the study by Donoho et al (2011) suggest that school stress is likely linked to chronic stress from the way the cortisol awakening response is the highest during the week when the children have school. This interaction between school stress and the cortisol awakening response is significantly associated with childhood obesity.

This section looked at the correlations between stress and childhood obesity. This is a complex area of research with differing results. Different researchers have found mixed results on the associations between perceived stress and childhood obesity. The section specifically examined the relationships between traumatic experiences, psychological stress, family stress, cortisol levels, and abuse finding that stress is correlated with obesity in many cases.

**Links between socio-economic status and childhood obesity**

Research has shown that there are complex interactions that need to be studied and understood between the relationship of socio-economic status and childhood obesity. There has been a substantial amount of research done on this topic however the results vary. Some studies find no relationship or relationships only for certain sub-groups while others find positive
correlations and still others find negative correlations between socio-economic status and childhood obesity. This variety of outcomes highlight just how complex the relationship is.

Among the studies that found no correlation between socio-economic status and childhood obesity is a study by Brzozowski and Drews-Botsch (2015). They determined high versus low socio-economic status based on the hospital the child was born (private predominantly white middle class hospital vs public lower class hospital). In this sample there was no significant correlation between socio-economic status and obesity.

Other studies have found correlations between socio-economic status and childhood obesity. Researchers comment that it can be difficult to determine if socio-economic status or race is a better predictor of childhood obesity and many studies have explored this topic. Rogers et al (2015) were able to distinguish between race and ethnicity and socio-economic status to show their independent relationships with childhood obesity. Data shows that low socio-economic status ($p<.0001$) is a better predictor of obesity and overweight children than race/ethnicity ($p=.27$). Cook et al (2017) was interested in how socio-economic status and obesity interacted with a sub group of Asian Americans. The results showed adolescents with high or medium socio-economic status were significantly less likely to be overweight or obese (11.6% and 12.8%) than the adolescents in low socio-economic status. Proportion of overweight was higher in adolescents with low socio-economic status. Low socio-economic status specifically also was significantly correlated with obesity (odds ratio=2.24). Lower socio-economic status had higher rates of obesity.

Another study used Supplemental Nutrition Assistance Program (SNAP) receivers to identify low income households. A negative correlation between income and childhood obesity was found and children were 4.5 times more likely to raise an overweight child. This could be
contributed to the fact that mothers who received SNAP were more likely to not eat many fruits and vegetables, eat a lot of fast food, and drink a lot of sugary drinks (Watt et al, 2013). Eagle et al (2012) and Jackson et al (2012) found a negative correlation between family income and childhood obesity. They thought the discrepancies between the two different groups of socio-economic status can perhaps be explained by the built environment, activity space, access to healthy food, and safety of the community.

Negative correlations between socio-economic status and childhood obesity were found not only in America but in other countries such as Spain and England as well. The study by Navalpotro et al (2012) examined the link between neighborhood socio-economic status as well as family socio-economic status and found that the rates of obesity were 1.45 times higher in children who live in low neighborhood socio-economic areas. This suggests that it is not purely family income that impacts childhood obesity but it is complex and there are many factors that contribute to neighborhood socio-economic status. This study specifically looked at gross domestic product per capita, proportion of people who cannot read or write, number of sports facilities and the price of fruits and vegetables. In addition a study with a sample from England found the prevalence of obesity was two times higher for children in the low SES families than the high socio-economic families.

Studies interested in the interactions between socio-economic status, race, and gender have found a variety of conflicting results. Banks et al (2016) found that socio-economic status has different correlations with obesity depending on the race and sex of the children. There was a negative correlation for socio-economic status and obesity found in white children(Zscore= -0.09). While it had a positive correlation for the black boys (zscore=.11) but no correlation for black girls in the study. This supports the idea that the relationship between SES and obesity is
complex and not always the same for boys and girls or for all races. Similarly Singh et al found that there are inequalities in childhood obesity and rates are higher in children from families with low income but there were also other factors that influenced this relationship such as gender and race. There are several factors that may influence this finding including educational disparities, prevention efforts and poverty.

The relationship between socio-economic status and childhood obesity is complex. There has been an extensive amount of research done on this topic however the results are inconsistent. Research has shown that there are complex interactions between the relationship of socio-economic status and childhood obesity. Some studies in this review have found no relationship or relationships only for certain sub-groups while others find positive correlations and still others find negative correlations between socio-economic status and childhood obesity. This variability of results demonstrate just how complex the relationship between the causes of childhood obesity is.

**Links between diet and exercise and childhood obesity**

Childhood obesity and children who are overweight are thought to be impacted by the nutritional value of the food they eat and their physical activity levels (Snethen et al, 2007). The relationship between physical activity and diet to childhood obesity has been explored in several different ways. There are both correlational studies and treatment experiments that examine the relationship between obesity and nutritional value and physical activity.

Correlational studies interested in the relationship between childhood obesity and perceived health have mixed results. O’Neil et al (2010) found a relationship between BMI and the child's health perceptions. It is interpreted that as BMI increases the children rate themselves as less healthy. There was; however, not a significant relationship between the child's ratings of
overall health such as actual physical activity and foods consumed and BMI. This suggests that children only perceive themselves as less healthy as their BMI increases. Snethen et al (2007) found similar results when looking at what parents and children think contribute to good health. All of the parents communicated the importance of high caloric intake, sweet rewards, and a lack of time to prepare healthy meals and transport them to after school activities as factors that impacted the weight of their child. The children thought that eating unhealthy food made them more likely to be an unhealthy weight. They also stated that they did not engage in much physical activity and watched a lot of television and played a lot of video games. They agreed that if their parents engaged in physical activities with them more often they would be more likely to do it.

Correlational studies looking at actual levels of physical activity and diet in children provide important information as well. These studies all seem to have similar results regardless of how diet, physical activity, or obesity was measured. This is not the case; however, when different sub groups are looked at separately such as gender and race. An (2017) found a correlation between physical activity and diet in regards to childhood obesity it was concluded that healthy habits including eating good foods and being active is crucial for preventing obesity in children. Children who were not physically active and did not eat healthy foods were 19.3% more likely to be obese those who did exercise (16.2%) and those who did eat healthy (16.08%) or the other or both. In addition, Watt et al (2013) found that the consumption of sugary drinks was correlated to childhood obesity in their sample. Children were 4.7 times more likely to be obese if their mothers drank sugary beverages. Interestingly Gordon- Larsen et al (2002) found there are important race and gender interactions. The data indicates that treatment plans and interventions need to be mindful of these interactions of race and gender. Television and video
game playing was positively correlated to obesity in white boys (odds ratio = 1.52) and girls (odds ratio = 2.45) but not other races in fact it showed a decreased risk in Asians (odds ratio = 1.52). Risk of obesity decreased with physical activity in white boys (odds ratio = .81), black boys (odds ratio = .86), and Hispanic boys (odds ratio = .90) and girls (odds ratio = .91). This is interesting to note that these activities impact races in different ways. Similarly, another study found physical activity had a strong negative correlation with obesity in white but not black girls (White & Jago, 2012). This is extremely important information when thinking about treatment options for different races seeing as different races do not react the same to equivalent treatment plans.

Experiments on physical activity have shown how exercise can be a preventative measure against childhood obesity. It is suggested that exercise can be used to mediate obesity in children. Through the interaction of stress and physical activity that physical activity can be used to buffer the effects of obesity in children (Yin et al, 2005). These studies are used to help reduce the rates of obesity while finding possible causes for childhood obesity. Lison et al (2017) found that there was a significant decrease in the percentage of body fat and BMI in individuals who created a workout plan and engaged in physical activity. Similar results were seen in a study of four schools in Bangkok. After intervention which included education of healthy foods and physical activity the students ate more healthy foods and ate unhealthy foods significantly less. Before there was a preference for sweetened milk and after it changed to natural or low fat milk. There was also an increase in exercise done by the children. Along with these changes made by the overweight and obese children the rate of obesity declined significantly from 19.3% to 16.8% (Sirikulchayanonta, 2011).
Breast milk has important nutrients, bioactive substances, and hormones not found in formulas. It has less calories, sugar, and fat. Formulas have an increased insulin which promotes the storage of fat cells while breast milk contains leptin which helps control hunger. Babies who were formula fed were found to have higher levels of insulin and a longer insulin response compared to breastfed babies. One study exploring the relationship between breast feeding and childhood obesity found babies who were breastfed were less likely to be overweight and obese. Children were least likely to be overweight and obese when breastfed for at least 6 months (Wang et al, 2017). This is an interesting finding; however it was not replicated in another study that found there was no significant correlation between breastfeeding and childhood obesity (Watt et al, 2013). This discrepancy could be due to the fact that Wang et al tried to limit other variables with her sample and only included non-smokers, above the poverty line, and were married and living together while Watt et al only used 152 Hispanic mothers and children from a predominately lower income community. Because their samples were so different the results may have turned out different.

The relationship between physical activity and diet to childhood obesity was explored in several different ways in this review. Correlational studies and treatment experiments were used to help determine the influence diet and physical activity had on childhood obesity. Through the research it is clear that diet and activity play a critical role in the childhood obesity epidemic seen today in developed countries. Although there were differences between race and gender there the research still supports a relationship between obesity and diet and physical activity.

**Discussion**
In this review the links between stress, socio-economic status, diet, and physical activity were explored. Through this research it is a little more clear what the impacts of stress, socio-economic status, diet and physical activity are on childhood obesity. It has also highlighted that the results often times conflict with each other. There are many other interactions and interplay between these factors that contribute to the causes of childhood obesity.

In regards to stress and its effects on childhood obesity the findings are concerning because if stress impacts obesity these children may be at risk for starting a cycle and passing it on to their children as well. They stress the importance of helping families psychologically and with advice and healthy decisions (Koch et al, 2008). Stressors such as house moves and other adjustable pressures should be limited or reduced during childhood to help reduce the prevalence of childhood obesity (Giles et al, 2013). Early treatment and intervention of physical, sexual, and emotional abuse could be critical in the prevention of obesity and other physical problems in children later in life (Veldwijk et al 2012).

Many researchers find differences in the correlations between stress and obesity for boys and girls or just look at girls. For example, researchers have inferred that the significant relationship in cortisol release for girls and no relationship for boys could be explained by a variety of factors. Boys and girls have different hormone secretion patterns which has an impact on what the children crave and how much they eat. Girls also release estrogen a different hormone than boys which influences the foods girls eat. Finally, girls are more likely to engage in stress eating than boys are statistically (Dockray et al, 2009).

This review supports the idea that there are many different types of stressors that can impact childhood obesity. The relationship between stress and obesity is still very unclear based on the variety of results found by different researchers. In addition, there are a variety of
different was to measure variables such as stress. For example in the study by Giles et al the number of house moves before age three was used to measure stress levels in children. While there is research that shows that house moves cause significant levels of stress in children there could be more. The idea that the authors use only house moves to measure stress levels in children may be a bit of a stretch and there may be other variables responsible for why there was a relationship between the number of house moves and obesity besides stress (2013). Some examples may be the family is eating more fast food because of a lack of time, they are unable to make home cooked meals because not having appliances yet, or they are unable to be physically active because of all the work that needs to be done around the house.

There are many interactions that stress has with other factors that make it unclear how stress is related to obesity. Some researchers suggest that there are two probable interactions with personal stressors that can contribute to the complex causes of childhood obesity. Biological responses may be responsible. The HPA axis may contribute to obesity or it may be behavioral responses mainly responsible. Poor eating habits and lower physical activity being two examples (Lohman et al 2009). In addition, lower SES has been associated with high stress because of having to live with limited resources, economic burdens, and more negative life events in general (Yin et al, 2005). Finally, there has been research to show that physical activity can decrease the responses of stress that are associated with obesity. It is suggested that exercise can be used to mediate obesity in children. Through the interaction of stress and physical activity that physical activity can be used to buffer the effects of obesity in children (Yin et al, 2005). It would be interesting to examine the specific relationship between physical activity and stress for children and see if exercise decreases stress levels resulting in a decrease in obesity rates or if physical activity only results in a decrease in the rates of childhood obesity
In relation to socio-economic status and the studies done discrepancies upper and lower class may be due to the fact that lower income households may have less physical activity, less healthy food, more unhealthy food, and more time watching tv or playing video games (Rogers et al, 2015). It is unclear if socio-economic status has a direct relationship with childhood obesity because most of the literature is correlational studies. There very well may be third variables or inverse relationships.

There are studies done on children in England and Spain highlighted in this review. There may be different cultures, habits, and foods that may interact with the findings. However I think it still provides important insight on the relationship between socio-economic status and childhood obesity that cannot be discarded just because it was found in a different country. These countries are also all developed and industrialized therefore it is safe to assume that there are more similarities than differences when looking at the samples but it is none the less important to note. It would be interesting to do a study on undeveloped countries and the relationship between socio-economic status and childhood obesity. I would predict that the relationship between the two would be very different in developing countries compared to developed countries. I would predict that there would be a positive relationship between socio-economic status and childhood obesity. When families have more money and more resources they are able to buy more food which would likely increase their BMI. While individuals with low socio-economic status in undeveloped countries don’t have programs like SNAP to provide them food and they are more likely to be malnourished.

When talking about diet and physical activity and looking at the research in this review it is clear to see that there are undoubtedly interactions. This is important to note for treatments
and planning early on in a child’s life. For example some research on breast feeding support that nutrition even very early on in life is critical in the battle against childhood obesity.

This research shows that there are interactions between race and gender that challenges the association between physical activity and obesity demonstrating that it is not the same for boys and girls or for every race. These ethnic and gender difference may be due to a combination of socioeconomic, environmental, and cultural differences. Many times different cultures tend to live in one area and this shapes the community they live in and influences their environment. If their culture is less focused on eating healthy and exercise that would be reflected in their community and effect everyone who lives there. Also if there are some communities with high amounts of crime with a large population of a single race they might be less likely to engage in physical activity in fear of crime. This is important information to know when trying to come up with interventions and treatments for obesity and noting that it perhaps should be different for different races and or genders.

This review of the literature shows how many different factors such as stress, socioeconomic status, diet, and activity level all play a part in childhood obesity. The causes of this epidemic are complex and it is unclear in many of the results how they are all related because much of the research is correlational. For example in the experiment by Watts et al (2013) it is unclear if the obesity risk increases because of stress or because of increase in sugary drinks and sweets. The same is true for the relationship with SES and obesity it is unclear if it is because they need food stamps that obesity risk increases or if it’s because they eat more sweets and sugary drinks while on food stamps or there could be an interaction with education level as well. Another example is in the study by Magnusson et al. the results do not show clearly if the main relationship with obesity is SES or if it has to do with diet or activity level. It shows that in
higher SES communities they eat healthier, exercise more, watch less television, and play less video games. It is unclear if these are the reasons a correlation is found between low socio-economic status and childhood obesity.

This research is important because rates of childhood obesity have been leveling off or rising in many developed countries. Childhood obesity is linked to countless immediate and long term health problems including heart problems, sleep apnea, diabetes, and even certain cancers. Obesity is correlated not only to other health risks but also developmental problems such as low self-esteem and poor academic performance. In the future this research can help guide treatments and help target communities in need of intervention.
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