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Breastfed infants have a reduced risk of becoming overweight or obese during childhood compared to formula fed infants. However, there is little evidence to assess whether this protective effect of breastfeeding persists into adolescence. As rates of obesity rise in adolescents, it is important to determine if breastfeeding in early infancy continues to have a protective effect on obesity, while also examining the health behaviors of diet and exercise to see if they are related to Body Mass Index (BMI). Therefore, the purpose of this study was to determine if there was a relationship between diet and BMI, physical activity and BMI, and breastfeeding and BMI during adolescence. All analyses were completed with waist circumference (WC) also. Participants were 163 16-year-olds. Dietary intake was determined from three, 24-hr dietary recalls which was used to calculate the Healthy Eating Index-2010 (HEI). Physical activity (PA) was determined using the Godin Leisure-Time Exercise Questionnaire, asking participants the number of times during the past week they completed strenuous, moderate, and mild exercise greater than 15 minutes and calculating a Total Exercise Score (TES). Mothers of participants were asked if they had breastfed their child, and if so, how many months and if supplemented with formula. This was used to calculate breastfeeding intensity.

In a multivariate regression analysis examining gender, race, SES, HEI, TES, and breastfeeding, significant predictors of BMI were race and breastfeeding (R^2=0.112, p=0.001). For every increase in breastfeeding intensity, BMI decreased by 0.22 units.

Non-whites had a 3.14-unit increase in BMI compared to whites. Non-whites had a significantly lower SES, HEI, PA, and breastfeeding intensity than whites.

In a multivariate regression analysis examining gender, race, SES, HEI, TES, and breastfeeding, significant predictors of WC were gender and breastfeeding (R^2=0.065, p=0.036). For every increase in breastfeeding intensity, WC decreased by 0.48 cm. Males had a 6.87cm increase in WC compared to females.

These results suggest that breastfeeding in early infancy may reduce the risk of obesity in adolescence. Race may be such a strong predictor of BMI because non-whites had a lower PA, diet quality, breastfeeding intensity, and SES.

ASSOCIATIONS OF BREASTFEEDING, DIET QUALITY AND PHYSICAL ACTIVITY WITH OBESITY IN ADOLESCENTS

by

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APPROVAL PAGE

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CHAPTER I

INTRODUCTION

Obesity has increased in both children and adolescents over the past 30 years. In fact, more than one-third of adults and 17% of youth in the United States are obese (1). Specifically, in 2011-2014, 8.9% of children age 2-5 years, 17.5% of children 6-11 years, 20.5% of adolescents age 12-19 years, and 36.5% of adults were obese (2). Obesity is not just a problem in the United States but is a global epidemic.

Obesity leads to an increased risk of cardiovascular disease, type 2 diabetes, stroke, cancer, and osteoarthritis in adults (3). In fact, adults who are obese as children have a much greater risk of these disorders compared to normal weight children who become obese adults (3). Even though obesity has a multifactorial etiology, consuming a healthy diet and engaging in physical activity can help lower the risk for obesity and the accompanying obesity-related morbidities (3).

The definition of obesity and overweight are different for children and adolescents than for adults. Based on the Centers for Disease Control and Prevention (CDC) growth charts, children and adolescents of the same age and sex with a BMI between the 85th and 95th percentiles are considered overweight, and those with a BMI at or above the sex- and age-specific 95th percentile of population are considered obese (4). No reference values have been established for waist circumference (WC) for children or adolescents; however, the most cited cutoffs were proposed by Cook et al. (5). They classified adolescents as having abdominal obesity if they had a WC at or above the 90th percentile value for age and sex.

Breastfed infants are less likely to become obese than formula-fed infants (6). One of the possible mechanisms is that human milk is involved in growth and appetite control during the neonatal period and infancy, affecting the programming of energy balance regulation in childhood as well as adulthood (7,8). It has also been hypothesized that breastfed infants develop a better self-regulation than bottle-fed infants because they stop nursing when they are full, compared to bottle-fed infants who are generally fed until the bottle is empty (9–11). Therefore, breastfeeding may have long-term beneficial health consequences by decreasing the risk of obesity later in life. However, some studies have not found a relationship between breastfeeding and obesity in adolescence or adulthood (12).

To date, there has been little research that has examined if breastfeeding may be associated with a future improved diet quality, and virtually no studies on breastfeeding and diet quality among adolescents. In a Dutch study that analyzed 2,043 children between 7 and 8 years of age, there was a significant relationship between breastfeeding and a healthier diet (13). In this sample, children who were breastfed more than 16 weeks had a healthier diet at 7 years compared to non-breastfed children. Also, in this study, the breastfed children consumed more fruit and vegetables and less meat, white bread, carbonated soft drinks, chocolate bars, and fried snacks than the non-breastfed children.

At 8 years of age the children had their BMI-for-age calculated and children breastfed for 1 to 16 weeks or for greater than 16 weeks were significantly less likely to be overweight compared to non-breastfed children. Dietary factors alone did not account for the differences in overweight incidence between breastfed and non-breastfed children at 8 years of age. While this study demonstrated that breastfeeding may be associated with a better diet quality, it also indicated some sort of protection against becoming overweight. Those infants who were breastfed showed a decreased risk of becoming overweight at 8 years of age, regardless of the duration of breastfeeding.

Physical activity (PA) is an important lifestyle behavior during youth because it can prevent and reduce the risk for obesity and cardiovascular disease (14). Physical activity can encompass many activities such as participating in sports, leisure activities such as dancing, cycling, running, or exercising with the goal of improving or maintaining one's level of cardiovascular fitness. This is in contrast to physical fitness which is comprised of many components including body composition, flexibility, muscular endurance and strength, as well as cardiovascular fitness (15). It has been shown in children and adolescents that physical activity is inversely related to BMI (16). According to *2008 Physical Activity Guidelines for Americans*, children and adolescents should participate in 60 minutes or more of physical activity daily (17). However, less than 3 in 10 high school students meet these recommendations (18).

It is also possible that there may be a relationship between breastfeeding and physical activity. One theory is that breastmilk contains hormones and nutrients that are not found in formula that promote healthy bone and muscle development, and therefore, theoretically, should improve cardiorespiratory fitness later in life (19). Also, breastfeeding mothers are more likely to be health conscious and subsequently more likely to promote healthy habits, which are likely to prevent becoming overweight and obesity later in childhood (6). Labayen et al. found that children and adolescents who were breastfed as infants were physically more fit, as measured by a maximal cycle ergometer test, than those children and adolescents who were exclusively formula fed as infants (20). They hypothesized that they found an association between breastfeeding and PA because there is evidence that nutritional factors including breastfeeding and formula feeding act in a critical time window in early life which may have long-term consequences for cardiovascular health and related morbidity later in life. Similarly, Zaqout found that exclusive breastfeeding appears to improve some physical fitness components in children (21). In contrast, Lawlor et al. failed to find an association between breastfeeding and cardiorespiratory fitness (22). Breastfeeding may be protective against CVD and obesity development but the studies are inconsistent.

There has been little research to date that has examined the relationship between diet quality, physical activity, and BMI-for-age in children and adolescents. Berkey et al. examined the role of PA, inactivity, and dietary patterns on annual weight changes among preadolescents and adolescents (23). The researchers found that the greater increases in BMI over one year were among girls who reported larger caloric intakes, lower physical activity, and increased time with TV/videos/games and among boys who reported greater time spent with TV/videos/games. For both genders, a greater increase in caloric intake from 1996 to 1997 predicted greater increases in BMI (23). Woon et al. examined behavioral factors and BMI-for-age in early adolescents and found that low energy intake and low energy expenditure were related to high BMI-for-age (24). Zalilah et al. researched the differences in energy intake, diet composition, time spent doing PA, and energy expenditure in underweight, normal weight, and at risk of overweight adolescents (25). Once body weight was adjusted for, overweight subjects had the lowest energy intake and energy expenditure. In other words, the subjects who expended the least amount of energy also had the lowest intake per kilogram of body weight compared to their normal-weight peers.

While there is little research on the relationship between diet quality, physical activity, and BMI in adolescents, these relationships have been examined in adults. Pate et al. reported that moderate-to-vigorous physical activity (MVPA) was inversely associated with BMI and waist circumference in almost all adult age groups (26). Furthermore, they reported an inverse relationship between diet quality and weight status in some age groups.

As rates of obesity have reached epidemic levels in children and adolescents in the United States and around the world, it is important to continue examining associations between diet and physical activity to see if they are related to obesity during adolescence. Therefore, the purpose of this study was to determine if there is a relationship between physical activity and BMI and WC, diet quality and BMI and WC, and if those relationships are moderated by breastfeeding. The specific aims and hypotheses are:

Aim 1. To determine if there is a relationship between breastfeeding and BMI and WC in adolescents.

Hypothesis 1a: Those who breastfed as infants will have a lower BMI and WC.

Aim 2: To determine if there is a relationship between diet quality and BMI and WC in adolescents and if this relationship is moderated by breastfeeding.

Hypothesis 2a: Adolescents that have a higher quality diet will have a lower BMI and WC.

Hypothesis 2b: Those who breastfed as infants will have a higher quality diet.

Hypothesis 2c: Breastfeeding will strengthen this relationship between diet quality and BMI and WC.

Aim 3: To determine if there is a relationship between physical activity and BMI and WC in adolescents and if this relationship is moderated by breastfeeding.

Hypothesis 3a: Adolescents who have a higher level of physical activity will have a lower BMI and WC.

Hypothesis 3b: Those who breastfed as infants will have a higher level of physical activity.

Hypothesis 3c: Breastfeeding will strengthen this relationship between physical activity and BMI and WC.

Aim 4. To determine if there is an interaction between diet quality and physical activity with BMI and WC and if breastfeeding moderates that relationship.

Hypothesis 4a: Adolescents who have better quality diet and are more physically active will have a lower BMI and WC.

Hypothesis 4b: Breastfeeding will strengthen this relationship between diet quality, physical activity, and BMI and WC.

CHAPTER II

LITERATURE REVIEW

Childhood obesity, defined as a body mass index (BMI) above the 95th percentile for age and sex, has dramatically increased in the United States, Europe, and Australia over the last four decades (27). In the United States in 2011-2014, 17% of 2- to 19-year-olds were obese (2). Both childhood and adolescent obesity are associated with an increased risk of hypertension, hypercholesterolemia, hypertriglyceridemia, and type 2 diabetes with its associated retinal and renal complications and subsequent increased cardiovascular disease, as well as other long-term negative health consequences (27). Obese children and adolescents are far more likely to become obese adults with greater risk of adverse health and psychological sequelae. In fact, obese adults who were also obese children have an even greater morbidity and mortality than adults with the same BMI but who were not obese children (3,27).

Diet Quality of Adolescents

Adolescents are eating a diet of poorer quality compared to the past, as measured by the Healthy Eating Index (HEI) (28). The HEI-2010 is an updated version of the original HEI-2005. It is used to measure diet quality based on the major dietary recommendations of the 2010 Dietary Guidelines for Americans (2010 DGA) (29). The HEI-2010 contains 12 components, including nine adequacy and three moderation components. For the adequacy components, intakes at the standard value or higher receive the maximum number of points and for the moderation components intakes at the standard or lower receive the maximum number of points, summing to a total of 100 points overall. Scores above 80 are considered to represent a "good diet," scores of 50 or below are considered "poor," and scores between 50 and 80 are considered "needing improvement." The HEI-2010 uses a density approach per 1,000 calories or as a percentage of calories to limit people who consume more food from having a higher score because of the quantity of food consumed rather than quality. Furthermore, it uses least restrictive standards, which means it uses the recommendations that vary by energy level, sex, and/or age that are the easiest to achieve. The DGA 2010 states that the type of fat is more important than the total amount of fat. Therefore, the ratio of unsaturated fatty acids (polyunsaturated plus monounsaturated) to saturated fatty acids is used. Refined grains, any non-whole grains, are under moderation components. The maximum score for sodium is less than 1,100 mg of sodium per 1,000 calories. Empty calories are accounted for as "solid fats and added sugars." Calories from alcohol are only empty calories, when alcohol is consumed above moderate amounts which is considered to be 2 drinks per day, or 13g of ethanol/1,000 calories (29). It is not just the calorie content of food that is important, but the nutritional quality of the food also matters. Both children and adolescents are consuming more calorie-dense, high-sugar, low-fiber foods (14). This is particularly true when it comes to the substantial amount of soda intake and other sugar-sweetened beverages consumed by youth today (30).

Diet quality begins to develop early in life and continues to evolve throughout childhood and adolescence into adulthood with many factors influencing it. Perry et al. examined 8,568 nine-year-old children's diets reported by their parents in a 20 item, 24-hour food frequency questionnaire in relation to children's BMI-for-age scores (31). The study found that childhood obesity as measured by BMI-for-age was significantly related to poor diet quality. The authors suggest that diet should be examined in its entirety and not based on individual foods or food groups, since many foods or nutrients are involved in the role of protecting or leading to obesity. The authors of the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) Committee on Nutrition recommend that whole dietary interventions should be used to help prevent obesity using a multidisciplinary approach that modifies both types of meals eaten, as well as where the meals are eaten (32). In other words, they recommend more whole foods be used to prepare meals consumed at home with the family. Another study by Jennings et al. also saw a relationship between diet and BMI (33). They reviewed 1,700 9- to 10-year-old British children's four-day food diaries. They discovered that children with high scores on the Diet Quality Index had significantly lower bodyweight, BMI, waist circumference, WHtR, and percentage body fat. Both of these studies suggest that overall diet quality is a substantial factor in child obesity.

Another study that looked at the association between diet quality in adolescents and weight gain over a ten-year period was done by Hu et al. (34). They evaluated the diets of 2,656 male and female participants with a mean age of 15. The participants had anthropometric measures and diet quality evaluated and scored at baseline and 5 and 10 years later. They demonstrated that higher diet quality in adolescence was associated with less weight gain during the transition into young adulthood. Furthermore, they found that this association was independent of energy intake, eating behaviors, physical activity, and cigarette smoking. They feel that it is important for children and adolescents to have a high-quality diet early in life in order to curtail some of the weight gain and associated comorbidities seen with increasing age in our society.

Further evidence for an association between diet quality and BMI in children and adolescents was demonstrated by Linardakis et al. in a study of 1,209 children and adolescents (35). They evaluated diet quality using the HEI and showed a correlation between higher diet quality and decreased mean BMI, waist/height ratio and systolic blood pressure, and total number of risk factors for metabolic syndrome. Similarly, the authors found an inverse relationship between physical fitness status and metabolic syndrome risk factors. The authors conclude that since chronic diseases are increasing in youth and subsequently in adults, more research needs to be done about the effects of obesity prevention through improved nutrition and physical fitness in children and young adults.

Contrary to the previous studies, Meyerkort et al. failed to find an association between early diet and BMI at age 3, 5, 8, 10, 14, or 17 years (36). They followed 2,563 participants from mid-gestation to 17 years of age. The diet quality of the participants as toddlers was evaluated using The Raine Eating Assessment in Toddlers (EAT). Diet quality was evaluated for the first 3 years at each visit and then again 14 years later. Adolescents' diet quality was evaluated using a semi-quantitative food frequency questionnaire. Infants' weight and lengths were recorded at birth and then BMI was calculated at 3, 5, 8, 10, 14, and 17 years of age. Although the researchers found no consistent associations between early diet quality and BMI at the above ages, they did find that birthweight and infant weight gain were significantly associated with BMI later in life. They recommend that further research be focused on optimizing infant nutrition to prevent excessive early weight gain and subsequent increased risk of obesity and agree with prior authors that obesity prevention is a complicated multifactorial problem.

Similarly, in a study by Cutler et al., they examined the relationship between dietary patterns and BMI in adolescents (37). This was a cross-sectional study that failed to find an association between a diet high in fruits and vegetables and thus presumably of higher quality, and a lower risk of being overweight or obese. Again, the authors comment that overweight status in adolescents cannot be attributed to factors other than dietary patterns alone and more research is needed.

Banfield et al. described the diet quality of children and adolescents by examining their adherence to the 2010 DGA by using the HEI-2010 (38). Furthermore, they wanted to see if any differences in diet quality occurred throughout childhood. The results showed that the youngest children were seen to have the highest overall diet quality due to significantly higher scores for total fruit, whole fruit, dairy, and whole grains. Also, the youngest group had the lowest sodium intake and children aged 4 to 8 also had the lowest intake of refined grains and empty calories. The total HEI-2010 scores were from 43.59 to 52.11, which is drastically lower than the minimum score of 80 that is recommended for a diet connected to good health. The authors found an inverse relationship between age and dietary quality. Another study by O'Neil et al. also examined the diet quality and nutrient intake of children and adolescents using the HEI-2005 (39). They focused on the consumption of whole grains and saw that the overall consumption of whole grains was low. Children and adolescents who consumed more whole grains had better diet quality and nutrient intake.

Researchers have reported that socioeconomic status (SES), gender, and race are related to rates of obesity. It has been shown that African Americans and Hispanics have higher rates of obesity than whites. In a study by Thompson et al., more African American girls were overweight than Caucasian girls (40). Using three NHANES surveys, Wang et al. reported that Hispanic boys age 6-11 and non-Hispanic black girls age 12-19 had the largest prevalence of severe obesity (41). In a meta-analysis by the World Health Organization, they state that a higher SES is associated with higher rates of breastfeeding and that breastfeeding mothers are much more likely to be health-conscious (6). This is important because these infants of high-income women are also more likely to be exposed to healthier lifestyles including obesity prevention and encouragement of physical activity.

Researchers have also shown associations between both gender and diet quality and SES and diet quality. Hiza et al. found that women have better diet quality than men and that adults' diets improve with increasing income level (42). Similarly, Darmon et al. found that diet quality decreased as SES decreased (43). Lalluka et al. found that healthy food habits were reported by 28% of women and 17% of men and a negative association was demonstrated between current economic difficulties and healthy food habits (44). Kirkpatrick et al. also found that higher income was associated with better adherence to recommendations of most food groups (45). In addition, it has been shown that diet quality varies among different ethnic groups. For example, whites typically have better diet quality than non-whites. Kirkpatrick found, with regard to race, that non-Hispanic blacks were the least likely group to meet food group recommendations. August et al. found that racial/ethnic minorities had less healthy dietary behaviors than whites (46).

Jackson et al. demonstrated some relationships between breastfeeding, diet quality, race, and SES (47). They found that longer breastfeeding durations were associated with lower levels of junk food consumption; however, this relationship was only consistent among low-SES blacks. In addition, this negative effect of breastfeeding on duration of the child's junk food consumption diminished among higher-SES individuals and was greater among lower-SES individuals. In other words, the effect of breastfeeding on decreasing the child's junk food consumption was greater in lower-SES individuals.

Another important contributor to childhood and adolescent diet quality is the type and frequency of snacks that they consume. This is particularly relevant as children spend more time in front of computers and televisions and spend less time being physically active than in the past (48). Ciccone et al. studied the associations among evening snacking, after school evening screen time, overall weight gain, and weight status (49). They reported that adolescents with greater than 6 hours of afterschool-evening screen time had a poorer quality of diet than those with less than one hour of afterschool-evening screen time. Also, the most common snack choices were calorie-dense, sugar-sweetened snacks. Since longer screen time is correlated with poorer diet quality, children and adolescents should be encouraged to spend more time being physically active and spend less time on computers, phones, and watching television in the evenings. This is another behavior change that could potentially improve their dietary habits.

However, the relationship between snack consumption such as sugar-sweetened beverage consumption and BMI in adolescents and adults is a complicated one. For example, a study by Johnson et al. failed to find an association between sugar-sweetened beverage (SSB) intake at 5 or 7 years of age and also failed to find an association with fatness at age 9 in both girls and boys (50). The authors state that their findings are contrary to prior studies and believe it can be explained by their specific measurement of fat mass and not just relying on BMI as most studies have. They believe this is a more accurate reflection of body composition. Their study was a large cohort study but they also contend that their results may not be significant because the amount of SSB consumed may not have been high enough to show an association. The authors state that in others studies that have shown an effect the subjects' average consumption of SSB is greater than in those studies not demonstrating an association. Another study by Laska et al. also demonstrated conflicting results (51). Their study demonstrated an association between SSB intake and increasing BMI in adolescent males but not in females. Although their sample size was large, the authors do comment that their participants were mainly upper middle class white students and therefore their findings could not be generalized. A recent meta-analysis by Kaiser et al. demonstrated that existing randomized evidence from studies on the effects of decreasing consumption of SSB on obesity was not statistically significant (52). No one would argue that SSB are a healthy addition to anyone's diet, but the researchers stated that larger, more long-term studies are needed to demonstrate a significant benefit of reduced consumption of SSB on obesity prevention.

Physical Activity of Adolescents

The WHO recommends that 5- to 17-year-olds exercise at a minimum 60 minutes per day at a moderate-to-vigorous intensity, and that most of the exercise should be an aerobic activity. As children have gotten heavier, their levels of physical activity (PA) are simultaneously declining. In fact, physical inactivity is fourth on the list of leading risk factors for global mortality, while being overweight and obesity are fifth (53). Researchers have demonstrated that physical activity declines from childhood to adolescence, which increases their risk of chronic diseases later in life (54). Furthermore, Chung et al. demonstrated that physical activity was inversely related to BMI in a sample of 3,147 American children and adolescents between the ages of 6 and 17 (16). This was true in both boys and girls, and this relationship persisted into adolescence. Their sample population was derived from the 4,718 children who completed the accelerometer arm of NHANES. The relationship was stronger in girls than boys and healthy weight girls were much more active, especially in moderate and vigorous activity than overweight or obese girls. They found that time spent in activity significantly decreased as the subjects got older and that girls were less active than boys across all ages, which further reinforces the importance of encouraging young girls to stay involved in athletics. These findings are alarming as exercise not only improves weight loss efforts and obesity prevention, but exercise also has been shown to improve adolescents' self-esteem and school performance (55).

Children and adolescents who are physically active are more likely to be active as adults (56). Unfortunately, despite the known advantages of PA, most adolescents do not meet the recommended levels for exercise. Also, if children are active, their levels of PA tend to decrease as they approach adolescence (54). Durant et al. conducted a study examining the relationship in youth 12-18 years of age between school environment and policy factors and youth PA, TV viewing, and weight status (57). Data were gathered using surveys completed by the adolescents. The researchers demonstrated that the frequency of physical education (PE) classes and access to school PA facilities after school were the school variables significantly associated with overall PA. This is significant, as only half of adolescents report attending PE class at least once per week.

Although a study by Kwon et al. demonstrated that time spent preforming moderate-to-vigorous physical activity is significantly associated with body fat mass in both boys and girls, they failed to find an association between either total sedentary time or between the number of breaks in sedentary time and obesity in children and adolescents (58). The authors do concede that the association of activity and obesity are multifaceted and their subjects were predominantly upper middle class white, so their findings could not be generalized. They do conclude that larger, more diverse studies are needed to further elucidate whether reducing sedentary behaviors will have an impact on reducing obesity rates in children and adolescents.

Interaction between Diet and Activity during Adolescence

In order to prevent obesity and long-term negative consequences, children and adolescents' PA and diet quality need to be improved. Although experts have recommended 60 minutes per day of moderate to vigorous activity for youth, data suggest that only 30% of adolescents meet this guideline for physical activity (53). Furthermore, the CDC estimates that less than 22% of high school students consume the recommended 5 or more servings of fruit and vegetables per day, only 15% meet the recommendation for total fat intake, and only 7% meet the saturated fat intake (59).

Sanchez et al. described the prevalence and clustering patterns of these four adolescent health behaviors (PA, TV, fruit and vegetable consumption, and dietary fat intake) (48). The researchers also examined the correlates of sociodemographic, behavioral, and parent health behavior of health risk behaviors. They demonstrated that almost 80% of the sampled adolescents had multiple physical and dietary risk behaviors and only 2% met all four of the health guidelines. Only 12% of adolescents consumed the recommended five servings a day of fruit and vegetables and only 45% met the PA guideline. More boys than girls met the recommended PA guideline. Unlike other studies, about two-thirds of the adolescents in this study met the recommended less than two hours of television per day. It is estimated that about 40% of adolescents watch television for greater than the recommended two hours per day (43).

Another study that looked at diet quality and physical activity in adolescents was the Web-SPAN project conducted by Storey et al. in Canada (60). Students in grade 7 to 10 were surveyed about their diet, physical activity, and related meal behaviors such as skipping meals and meals consumed away from home. A total of 4,981 students participated in the study. Diets were analyzed for both their macronutrient and micronutrient quality. Students were classified as having poor, average, or superior diet quality based on Canada's Food Guide to Healthy Eating (CFGHE). Diet quality was calculated by using the number of minimum food group recommendations that were met based on the 1992 CFGHE. Poor was classified as having met 0 or 1, average as having met 2 or 3, or superior as having met all 4. The results showed that 42% of students had poor diet quality, 50% had average diet quality, and only 8% had superior diet quality. They demonstrated an association between poor diet quality and greater number of meals consumed away from home compared to those with an average or superior quality diet. The researchers also demonstrated that students with poor quality diet had significantly lower levels of PA than students with average or superior diet quality. They also noted that students with average diet quality had significantly lower levels of PA than those students with superior diet quality, across both genders. This study further emphasized the need for improved diet quality and greater physical activity in adolescents.

Limited research exists on the relationship between diet and physical activity with BMI in adolescents. Berkey et al. researched the role of PA, inactivity, and dietary patterns on annual weight changes among preadolescents and adolescents while accounting for growth and development (23). The participants completed questionnaires in 1996 and again in 1997 and BMI was calculated at both times. The results showed that greater increases in BMI from 1996 to 1997 were among girls who reported larger caloric intakes, lower physical activity, and increased time with TV/videos/games. For boys, the results showed greater increases in BMI in those who reported greater time spent with TV/videos/games. For both boys and girls, a greater increase in caloric intake from 1996 to 1997 predicted greater increases in BMI.

Most of the studies examining diet, physical activity, and BMI in adolescents have reported energy intakes or food groups, but not diet quality. Monfort-Pires et al. looked at the relationship between diet quality and leisure-time physical activity (LTPA), as well as the relationship of these variables with cardiovascular risk factors such as BMI in prediabetic adults (61). They reported that the most physically active participants had better HEI scores and higher levels of dark green and orange vegetables, but not of whole grains. The active participants had lower BMI scores, while those who watched the most television had the highest BMI. This research demonstrates a relationship between diet quality, physical activity, and BMI in adults.

Another study by Pate et al. also examined the relationship between diet quality, moderate-to-vigorous physical activity (MVPA), and weight status within and across age groups in US adults by utilizing data from the National Health and Nutrition Examination Surveys from 2003-2004 and 2005-2006 (26). The authors found a consistent inverse relationship between participation in MVPA and weight status in both male and female US adults. However, the researchers failed to find a consistent relationship between diet quality and BMI or waist circumference in men and women aged 20 to 29.

In contrast to these aforementioned studies, Canadian researchers Woodruff et al. found conflicting results when they studied sixth-grade students to determine if there was an association between diet quality and physical activity levels (62). They used the Canadian version of the HEI (HEI-C) to determine diet quality. Their results showed that a majority (72%) of both boys and girls had poor diet quality and had scores that indicated the need for improvement. Their results contrasted earlier studies in that they found no difference in diet quality between males and females as well as no association with body weight status. In fact, overweight females consumed less of the unhealthy "other foods" category than the normal weight and obese female participants. Obese males, however, consumed more of the "other foods" category than either the normal or overweight male participants. The authors did find an association between activity one night per week and a higher diet quality. This association was not further increased by activity on more than one night per week. The authors hypothesize that perhaps there is not an increased effect on diet quality because if the participants are busy every night with activities this may preclude time to eat a healthy diet. In other words, they may be consuming fast food instead of eating a prepared meal at home, therefore lowering their diet scores. The authors attribute that the higher diet scores in the overweight females may have been caused by an underreporting of their intakes in order to provide “socially acceptable” portions consumed in the dietary recall. Underreporting is not uncommon among overweight-obese subjects compared to normal weight participants (63).

Energy Intake, Diet, and Energy Expenditure in Adolescents

One reason for weight gain relates to the homeostatic regulation of body weight (64). It is believed that low energy intake and low energy expenditure (low energy flux) is responsible for weight gain. High energy intake and high energy expenditure (high energy flux) is thought to prevent fat gain because it corresponds to a higher resting metabolic rate. Several studies have examined this relationship between energy expenditure and energy intake in adolescents.

Woon et al. examined the relationship between behavioral factors and BMI-for-age among early adolescents (24). Energy intake, energy expenditure, eating behaviors, physical activity, and screen time were evaluated using the Eating Behaviors Questionnaire and a 2-day dietary and PA recall. They found that low energy intake and low energy expenditure were associated with high BMI-for-age. However, they failed to find an association between macronutrient and micronutrient intakes with the BMI-for-age of the subjects. Zalilah et al. looked at dietary intake, physical activity, and energy expenditure of Malaysian adolescents (25). They found similar findings to Woon et al.

that the overweight adolescents had the largest overall energy intake and energy expenditure until they adjusted for body weight; then the overweight adolescents had the lowest energy intake and energy expenditure per kilogram of adjusted bodyweight. Similarly, Hassapidou et al. examined energy intake, body composition, diet composition and obesity in 502 adolescents aged 11 to 14 years in Greece (65). They included students from all socioeconomic levels and each underwent anthropometric measurements to calculate BMI as well as skinfold thicknesses to calculate percentage body fat. Their diets were analyzed for energy and macronutrient intake using 3-day diet recalls. Twenty-four-hour energy expenditure was calculated by adding RMR determined with the Schoffield equation for specific age and energy cost for activity from 3-day activity records. Each participant's RMR was multiplied by an average metabolic value depending on his or her activities using the tables by Ainsworth et al. (66). They found that both overweight boys and girls reported lower energy intake compared to the non-overweight groups. The researchers commented that this may be attributable to underreporting that is commonly observed in obese subjects. They also found no difference in the physical activity reported by overweight and non-overweight subjects which they attributed to overestimation of physical activity by the overweight subjects. Limitations of this include self-reporting of dietary intake as well as self-reporting of physical activity in order to calculate both energy intake and expenditure. They did report significant differences in diet composition between the two groups. Specifically, overweight subjects consumed less carbohydrates and less fiber than their normal weight counterparts. The overweight adolescents also consumed more snacks, sugar, jam, chocolate bars, and pizza and less legumes, vegetables, and fruits than the normal weight participants. The researchers conclude that poor diet composition is a significant contributor to obesity and more education is needed in schools to prevent the trend in excess weight gain in adolescents.

Waist Circumference

Many studies to date have evaluated adiposity using BMI, but waist circumference (WC) is also used. However, WC is considered as a valid tool to evaluate adiposity because it is positively associated with abdominal fat, which is a predictor of obesity-related diseases such as type 2 diabetes, hypertension, dyslipidemia, and cardiovascular diseases (67). WC is a simple measurement method that can quickly detect individuals at risk for obesity-related diseases. BMI is still a critical measurement because it does measure the severity of obesity, but WC measures body fat distribution (68). It is believed that excess body fat around the waist is more detrimental to health than body fat on the hips and thighs.

Breastfeeding and Obesity during Childhood and Adolescence

Since so many children are already obese, it is important to elucidate early modifiable factors that may predispose them to increased obesity risk later in life. For example, exclusive breastfeeding for the first six months of an infant's life has been shown to reduce the prevalence of obesity in infancy and the effect appears to be a dose-dependent relationship (69). In other words, the longer a woman breastfed her baby past six months of age, the less likely her infant would become obese. There is an inverse relationship between duration of breastfeeding and risk of overweight in infancy. In fact, a meta-analysis in 2015 also showed that breastfeeding decreased the odds of overweight/obesity by 13% that persisted until age 19 but then declined (70). However, the association was somewhat stronger in studies that reported exclusive breastfeeding compared to studies that compared ever breastfed with never breastfed subjects. A meta-analysis of 17 studies in 2014 demonstrated this dose-response between breastfeeding duration and decreased risk of childhood obesity (71). Children breastfed for greater than or equal to 7 months were less likely to be obese and children breastfed for less than 3 months had a 10% reduction in the risk of childhood obesity up to 19 years of age compared to never breastfed infants. In the WHO systematic review that included their updated meta-analysis, an association between breastfeeding and lower prevalence of overweight/obesity later in life was seen (6).

Research has demonstrated a protective effect of breastfeeding on obesity later in life in adolescents. In a study by Oddy et al., when formula was introduced at 4 months of age or earlier, this played a significant role in the trajectory of the BMI from birth to 14 years (72). They followed infants from birth until 20 years of age and found that infants who exclusively breastfed for less than or equal to 6 months were more likely to be overweight or obese (BMI>25) up to age 20. Formula feeding caused accelerated weight gain in infancy. In this study, infants who were exclusively breastfed had a leaner body mass than formula-fed infants, with this trend persisting to age 20, which may be protective against obesity in adulthood. The most critical time for breastfeeding's influence on future overweight or obesity risks may be in the first 6 months of life due to its potential effects on the infant's body composition.

In a study by Gillman et al., adolescents age 9 to 14 were less likely to be overweight if they were fed breast milk more than infant formula or if they were breastfed for longer durations (73). They found that adolescents who were breastfed for a minimum of 7 months were 20% less likely to be overweight than those adolescents who were not breastfed or were breastfed for less than 3 months. Another study by De Kroon et al. examined the relationship between breastfeeding and BMI in adolescents (74). They measured the BMI, WC, and waist-hip ratio (WHR) in 737 young adults who were part of the original Terneuzen Birth Cohort. The researchers demonstrated that exclusive breastfeeding duration had a significant inverse dose-response relationship with BMI, WC, and WHR. They also used questionnaires to determine if eating habits were healthy or non-healthy in the participants based on responses to dietary pattern, consumption of fruits and vegetables, snacks, sweetened beverages, and alcohol. Although the researchers found a positive relationship between breast feeding and healthy dietary habits in young adulthood, the results were not statistically significant.

In contrast to the previous studies, Michels et al. failed to identify a relationship between duration of breastfeeding and being overweight or obese as an adult (12). They questioned the mothers of 35,831 women who participated in the Nurses' Health Study II the United States on type of feeding, duration of breastfeeding, and exclusivity of breastfeeding among the participants. The participants provided information on their height and weight at age 5, 8, 10, 18, and at approximately age 40. The researchers did not find any association between either having been breastfed or duration of breastfeeding with a women's risk of being either overweight or obese during childhood up to age 40.

Potential Mechanisms of Protective Effects of Breastfeeding

The reasons for the protective effect of breastfeeding against obesity are still unclear although several theories abound. Since obesity is a result of an energy imbalance whereby energy intake exceeds output, then perhaps hormones in breast milk may modify the appetite center of the brain in infants (75). Appetite is controlled by the arcuate nucleus of the hypothalamus in the brain and it is affected by hormones such as leptin and ghrelin, which act as mediators between the adipose tissue, the gastrointestinal tract, and the brain. The pathways that are involved in appetite regulation do not mature until after birth and in early infancy. Additionally, hormones such as leptin, ghrelin, adiponectin, resistin, and obestatin have been identified in breast milk but are not found in infant formulas (75,76). This is important because these hormones may be crucial in early infancy in establishing the programming of normal energy balance that persists in childhood and adulthood. If programming does not occur early in the brain, then a person may be at increased risk for long-term obesity.

In addition to breast milk's hormone content, it has also been postulated that breastfeeding is protective against obesity because it allows infants to self-control their intake as opposed to bottle-fed infants who generally empty the bottle when feeding (11,76). This increased self-control over their intake presumably helps breast-fed infants learn to self-regulate their energy intake better than formula-fed infants. In other words, breastfed infants may be better at recognizing satiety signals and therefore they stop when they are full. Breastfeeding may exert both short- and long-term effects on the programming of normal growth and development. In other words, early infant nutrition could affect a person's long-term risk of being overweight or obese as an adult.

Breastfeeding and Dietary Intake during Childhood and Adolescence

As previously mentioned, in a study examining the differences in diet and lifestyle at age 7 between breastfed- and formula-fed children, Scholtens et al. found breastfed children were more likely to have a healthy diet (13). The researchers studied 2,043 Dutch children using questionnaires at age 7 to gather breastfeeding duration, diet, and lifestyle information. At 8 years they measured weight and height to calculate BMI. Children who were breastfed longer than 16 weeks had a healthier diet at 7 years compared to non-breastfed children. The breastfed children consumed more fruit and vegetables and less meat, white bread, carbonated soft drinks, chocolate bars, and fried snacks compared to those children who were not breastfed.

Another study by Skinner et al. examined if food-related experiences in the first two years of life predicted dietary variety in school-aged children (77). Dietary variety is associated with diet quality and the more variety in a diet the more likely that diet will meet nutrient recommendations versus diets restricted in variety and food groups.

Seventy child/mother pairs were interviewed 7 or 8 times when their child was between 2 to 24 months old and again when their child was 6, 7, and 8 years old. The results revealed that in the school-aged children vegetable variety was predicted by the mother's vegetable preferences. However, the fruit variety was predicted by breastfeeding duration and either early fruit variety or fruit exposure. The duration of breastfeeding was a positive predictor of fruit variety consumption in the school-aged children but this was not found for vegetable variety. The authors hypothesized that infants' experiences with breastmilk increased their acceptance of a greater number of flavors later in life but an unknown factor precluded this association with vegetable preference. The researchers admit that there must be other unidentified factors involved in food preference and recommend future longitudinal studies to elucidate them.

Another study by Grieger et al. examined the dietary patterns of 2,287 children in Australia between 2 and 8 years of age (78). This was a cross-sectional study in which children were classified as either breastfed or never breastfed and 24-hour dietary recalls were utilized to evaluate dietary variety. The researchers found a positive association between breastfeeding and an overall healthy dietary pattern that persisted up until the age of 8. Children who were breastfed tended to consume more fruits and vegetables, whole grains, and red meats than non-breastfed children. The researchers also demonstrated that this effect was independent of the mother's level of education.

Breastfeeding and Physical Fitness during Childhood and Adolescence

Since breastfeeding seems to confer a protective effect against obesity in childhood and potentially in adolescents, it is plausible that breastfed children may also be more physically fit than non-breastfed children. Labayen et al. hypothesized that exclusive breastfeeding was associated positively with physical fitness in children and adolescents (20). They looked at both the presence of exclusive breastfeeding as well as duration and categorized subjects into exclusively formula fed or breastfed less than 3 months, 3 to 6 months, and greater than 6 months. They tested the fitness levels in 1,025 children and 971 adolescents. They found that both children and adolescents who were breastfed as infants were physically fitter than those children and adolescents who were exclusively formula fed as infants. They also found that a longer duration of breastfeeding was associated with higher fitness levels, but there was no further increased fitness observed in infants exclusively breastfed for greater than 3 months versus those breastfed for greater than 6 months. This association was seen regardless of the socioeconomic status of the child or adolescent, the BMI of the mother, or the birthweight of the infant.

Zaqout et al. also examined the relationship between breastfeeding and physical fitness (21). They wanted to determine if there was a relationship between exclusive breastfeeding and physical fitness performance in children, and if this relationship was affected by breastfeeding duration. They examined 2,853 European children 6-11 years old who had exclusive breastfeeding duration and complete data on physical fitness.

Breastfeeding duration was categorized into never, 1-3, 4-6, and 7-12 months. Physical fitness included cardiorespiratory fitness, muscular strength, flexibility, balance, and speed. The researchers found a positive association between exclusive breastfeeding and lower-body explosive strength and also flexibility. Furthermore, they found a positive association between breastfeeding and balance in boys but this relationship was negative in girls. They also found that 1-3 months of exclusive breastfeeding was sufficient to improve lower-body explosive strength and any further duration did not increase the benefit. However, to have any benefit on flexibility or balance, 4-6 months of breastfeeding was needed, but this was not significant after adjustment for BMI and PA. They concluded that exclusive breastfeeding somewhat improves physical fitness components, mainly lower-body muscle strength, and therefore improves future health.

The aforementioned studies results are different than those found by Lawlor et al. in a study of 3,612 children in the Avon Longitudinal Study of Parents and Adolescents who were evaluated at age 9 for cardiorespiratory fitness, weight, and height (22). Medical records were examined for infant birthweight and information from mothers was obtained by mail at 4 weeks, 6 months, and 15 months about their infant's feeding practices. Categories were either ever breastfed versus never breastfed and then further divided by duration as never, less than 3 months, 3-6 months, and greater than 6 months. Although the investigators did find an association between birth weight and length with cardiorespiratory fitness, they failed to find an association between breastfeeding and later fitness. They believe that the intrauterine environment affects health later in life and that cardiorespiratory fitness is multifactorial in origin and larger long-term studies are warranted.

Physical Fitness and Physical Activity

Physical activity instead of physical fitness can be used as an accurate marker of health. A study by Schmidt et al. has demonstrated that both physical activity reporting and physical fitness testing offer useful information regarding subjects' cardiometabolic risk factors (79). They acknowledge that many studies rely on self-reported physical activity as they are much easier to conduct than objective fitness testing. In addition, they found an association between fitness level and risk factors as well as between reported physical activity and risk factors. Furthermore, Larsen et al. demonstrated a relationship between physical fitness and physical activity (80). They found that children who were physically active in sports clubs have better exercise capacity compared to children not active in sports clubs. Similarly, Blair et al. stated that physical activity and physical fitness are both important for health and they are unsure which is a better predictor of health (81).

In conclusion, an association has been demonstrated between breastfeeding and decreased risk of overweight and obesity later in childhood. However, this has been studied more in children than in adolescents and long-term prospective studies are needed to determine if the breastfeeding benefit extends into adolescence. It is still unclear how breastfeeding conveys long-term benefits such as lessening the risk of obesity in children, and researchers have yet to elucidate whether breastfeeding is associated with a better diet quality and higher physical activity in adolescents. It has been well documented that breastfeeding has several short-term benefits such as improving neonatal survival, improving infant and mother bonding, aiding in the achievement of optimum growth and development in infancy, providing natural immune benefits for the infant, and providing many maternal health benefits (82). It is possible that hormones contained in breastmilk may affect the development of the feeding and the satiety center in the central nervous system. Since these hormones are involved in energy balance regulation, their absence in non-breastfed children may cause changes in the programming of energy balance regulation that continue into adulthood (76). Thus, it could possibly lead to a lifelong higher risk of becoming overweight and obesity.

There have been no published studies examining the association between breastfeeding, overall diet quality, physical activity, and BMI-for-age in adolescents. Therefore, the purpose of this study was to determine if there is a relationship between physical activity and BMI, diet and BMI, and if those relationships are moderated by breastfeeding.

CHAPTER III

ASSOCIATIONS OF BREASTFEEDING, DIET QUALITY, AND PHYSICAL ACTIVITY WITH OBESITY IN ADOLESCENTS

Introduction

Obesity has increased exponentially in both children and adolescents in the past 30 years. In fact, more than one-third of adults and 17% of youth in the United States are obese (1). Based on the Centers for Disease Control and Prevention (CDC) growth charts, children and adolescents of the same age and sex with a body mass index (BMI) between the 85th and 95th percentiles are considered overweight, and those with a BMI at or above the sex- and age-specific 95th percentile of population are considered obese (4). Some researchers believe that waist circumference is a better measure of adiposity than BMI. However, no reference values have been established for waist circumference (WC) for children or adolescents. The most cited cut-offs were proposed by Cook et al. (5). They classified adolescents as having abdominal obesity if they had a WC at or above the 90th percentile value for age and sex.

Obesity is not just a problem in the United States but is a global epidemic. Obesity leads to an increased risk of cardiovascular disease, type 2 diabetes, stroke, cancer, and osteoarthritis in adults (6). In fact, adults who are obese as children have a much greater risk of these disorders compared to normal weight children who become obese adults. Even though obesity has a multifactorial etiology, consuming a healthy diet and engaging in physical activity can help lower the risk for obesity and the accompanying obesity-related morbidities.

Breastfed infants are less likely to become obese than formula-fed infants (70). And therefore, breastfeeding may have long-term beneficial health consequences by decreasing the risk of obesity later in life. However, some studies have not found a relationship between breastfeeding and obesity in adolescence or adulthood (12).

Previous research has shown an association between childhood and adolescent obesity and poor diet quality (31,33–35). However, there are conflicting results in the literature and other research has not found an association (36,37). To date, there has been little research that has examined if breastfeeding may be associated with a better diet quality and the studies report conflicting results. Scholtens et al. (13) found that breastfed children were more likely to have a healthy diet whereas Skinner et al. (77) found that the duration of breastfeeding was a positive predictor of fruit, but not vegetable variety consumption in children.

Physical activity (PA) is an important lifestyle behavior during youth because it can prevent and reduce the risk for obesity and cardiovascular disease (14). Physical activity has been shown to be inversely related to BMI in children and adolescents (16). According to 2008 Physical Activity Guidelines for Americans, children and adolescents should participate in 60 minutes or more of physical activity daily (17). However, less than 3 in 10 high school students meet these recommendations (18). Since breastfeeding may be associated with a healthier lifestyle and PA is part of a healthier lifestyle, it makes sense to evaluate the relationship between breastfeeding and physical activity. Unfortunately, most studies to date have had contradictory results. Labayen et al. found that fitness levels were higher in those children and adolescents who had been breastfed for 3 months or more compared with those who had been formula fed (20). However, Lawlor et al. found no association between breastfeeding and cardiorespiratory fitness in children (22).

There has been minimal research to date that has examined the relationship between diet quality, physical activity, and BMI-for-age in children and adolescents. However, as rates of obesity have reached epidemic levels in children and adolescents in the United States and around the world, it is important to continue examining associations between diet and physical activity to see if they are related to obesity during adolescence. Therefore, the purpose of this study was to determine if there is a relationship between physical activity and BMI and WC, diet quality and BMI and WC, and if those relationships are moderated by breastfeeding during infancy.

The specific aims and hypotheses are:

Aim 1. To determine if there is a relationship between breastfeeding and BMI and WC in adolescents.

Hypothesis 1a: Those who breastfed as infants will have a lower BMI and WC.

Aim 2: To determine if there is a relationship between diet quality and BMI and WC in adolescents and if this relationship is moderated by breastfeeding.

Hypothesis 2a: Adolescents who have a higher quality diet will have a lower BMI and WC.

Hypothesis 2b: Those who breastfed as infants will have a higher quality diet.

Hypothesis 2c: Breastfeeding will strengthen this relationship between diet quality and BMI and WC.

Aim 3: To determine if there is a relationship between physical activity and BMI and WC in adolescents and if this relationship is moderated by breastfeeding.

Hypothesis 3a: Adolescents who have a higher level of physical activity will have a lower BMI and WC.

Hypothesis 3b: Those who breastfed as infants will have a higher level of physical activity.

Hypothesis 3c: Breastfeeding will strengthen this relationship between physical activity and BMI and WC.

Aim 4. To determine if there is an interaction between diet quality and physical activity with BMI and WC and if breastfeeding moderates that relationship.

Hypothesis 4a: Adolescents who have better quality diet and are more physically active will have a lower BMI and WC.

Hypothesis 4b: Breastfeeding will strengthen this relationship between diet quality, physical activity, and BMI and WC.

Methods

Data from a sample of 16-year-olds participating in "The Right Track Health" study was used for this research project (83). "The Right Track Health" study examined childhood self-regulation and its role in the development of cardiovascular risk during adolescence. Self-regulation is used to refer to the specific set of processes or control mechanisms that function at the biological, emotional, and behavioral level and help individuals to manage arousal, attention, behavior, emotion, and cognition in adaptive ways (84–86). The overall purpose of RTH was to examine the relationships between childhood self-regulation and cardiovascular disease risk factors by analyzing physical fitness, nutrition, sleep quality, and biomarkers related to metabolic syndrome, inflammatory status, and several hormones and cytokines.

"The Right Track" study began in 1997 in Greensboro, NC and involved 450 families. Data collection occurred at ages 2, 4, 5, 7, and 10 years and is currently occurring at 16 and 18 years of age. The 2-year-olds for cohorts 1 and 2 were recruited from county health departments, daycare centers, and the Special Supplemental Nutrition Program for Women, Infants, and Children. In 1998, 6-month-olds were recruited for cohort 3. All three cohorts were convenience samples and were recruited with the goal of maintaining equivalent numbers of each sex. The cohorts were oversampled in order to obtain more children with externalizing behavior problems as reported by the caregiver. Approximately 70% were Caucasian and the remainder were African American. Children with chronic diseases or developmental abnormalities were excluded from the study.

Individuals from “the Right Track” study were contacted and invited to participate in this study, which involved data collection at age 16 to 17 (depending on when their birthday occurred and when they could come to the lab visit), health behavior evaluation including diet recall, and exercise logs. When the participants and their parent(s) arrived at the lab, a detailed explanation of all the testing was explained to both the parents and the participants. Consent was obtained from both the parent(s) and the adolescent participants. In addition, the parent(s) completed questionnaires that provided information regarding socioeconomic status, breastfeeding history, and recent general health of their adolescent including medications, surgeries, vaccinations, and any hospitalizations.

Human Subjects Protections

This study has been approved by the Institutional Review Board of the University of North Carolina at Greensboro. All of the participants gave assents to participate. All of the parents or guardians of the minor participants gave consent for the adolescents to participate.

Socioeconomic Status

The socioeconomic status of the sample was determined by using the Hollingshead Four Factor Index of Socioeconomic Status (87). It is a survey that measures the social status of an individual based on educational attainment and occupational prestige. The score is determined by multiplying educational attainment which ranges from 1 to 7 (1 being below high school and 7 being a graduate degree) by 3, multiplying occupation prestige which ranges from 1 to 9 (1 being unskilled labor and 9 being CEO, professor, or commissioned officer in the military) by 5, and then summing the two scores. The scores range from 8-66.

Obesity Indices

Participants were asked to refrain from any vigorous exercise and avoid alcohol for 24 hours prior to the scheduled visit. In addition, they were required to be fasting and to have not smoked cigarettes for two hours before their scheduled appointment in the lab. They were allowed to have water.

Before laboratory measurements, height and weight were reported by the participants on a questionnaire. In the lab, height was measured to the nearest 0.1cm with a wall mounted, calibrated stadiometer (SECA, Chino, CA) and weight was measured to the nearest 0.1kg with a balance-beam scale with the participants wearing no shoes and only light clothing. Body mass index (BMI) was calculated using the standard formula [weight (kg)/height (m^2)]. Lab-measured height and weight were used first to calculate BMI and then self-reported height and weight were used if they had not attended the lab visit. Waist circumference (WC) was measured to the nearest 0.1cm using a Gulick tension tape measure. This was performed by a sex-matched research assistant in a private location in the laboratory. WC was taken at the natural waist or smallest part of the abdominal area. Full details of these methods can be found in the Anthropometric Standardization Reference Manual (88).

Diet Recalls

While in the lab, a research assistant explained the diet recall process to the adolescents. The adolescents were provided with a booklet of common guides for portion sizes that were used during the diet recall interview conducted by trained and certified University of NC at Chapel Hill Nutrition Obesity Research Center staff. The booklet contains pictures of many common foods, food containers, food shapes, and food measurements. The adolescents were asked to keep the booklet near them during the day in a book bag or purse. The research assistants asked the adolescents the best days, times, and phone numbers (usually cell phones) at which they could be contacted to do the interviews. They were called on two weekdays and a weekend day within two weeks of the laboratory visit. If the participant had the booklet near them they used it to estimate amounts of foods and beverages consumed. If they did not have the booklet near them, they estimated as best as possible and the staff assisted them with portion sizes when appropriate. The booklets are appropriate for the University of Minnesota's Nutrition Data System for Research (NDSR), which is the diet recall software program that the staff used. They followed a standard script and multiple pass method, which allowed several chances to recall food, beverage, and dietary supplement intake over the previous day's 24-hour period. Participants were given a $10 gift card to Target after completing the first dietary recall interview, a $15 gift card after completing the second, and a $20 gift card after completing the third.

Overall Diet Quality

Diet quality was determined using the Healthy Eating Index (HEI). The HEI-2010 is an updated version of the HEI-2005. It is used to measure diet quality based on the major dietary recommendations of the 2010 Dietary Guidelines for Americans (2010 DGA) (29). The HEI-2010 contains 12 components, consisting of nine adequacy and three moderation components. For the adequacy components, intakes at the standard value or higher receive the maximum number of points and for the moderation components intakes at the standard or lower receive the maximum number of points, summing to a total of 100 points overall. Scores above 80 are considered to represent a “good diet,” scores of 50 or below are considered “poor,” and scores between 50 and 80 are considered “needing improvement.” The HEI-2010 uses a density approach per 1,000 calories or as a percentage of calories to limit people that consume more food from having a higher score because of the quantity of food consumed rather than quality. Furthermore, it uses least restrictive standards, which means it uses the recommendations that vary by energy level, sex and/ or age that are the easiest to achieve. The DGA 2010 states that the type of fat is more important than the total amount of fat. Therefore, the ratio of unsaturated fatty acids (polyunsaturated plus monounsaturated) to saturated fatty acids is used. Refined grains, any non-whole grains, are under moderation components. The maximum score for sodium is less than 1,100 mg of sodium per 1,000 calories. Empty calories are accounted for as “solid fats and added sugars.” Calories from alcohol are only empty calories, when alcohol is consumed above moderate amounts which is considered to be two drinks per day, or 13g of ethanol/1,000 calories (29).

Dietary Components

Output files 4 (nutrient data at the daily totals level) and 9 (food group serving counts at the daily totals level) were used from the NDSR 2013 software to obtain the data for certain dietary components and food groups.

Output file 4 was used to determine total energy, total fat, saturated fat, omega-3 fatty acid, fiber, sodium, potassium, calcium, and magnesium intake. The average of the three days of intake was taken for each category. Total and saturated fat (in grams) was combined and multiplied by 9 kcal per gram, then divided by 3 and multiplied by 100 to obtain an average daily percentage for energy consumed as fat. These average daily intakes were utilized in data analyses.

Output file 9 was used to determine refined grain, empty calorie, whole grain, fruit, vegetable, and legume intakes also by taking the average of the three days of intake for each category. The average cup equivalents consumed were used for each group. The legumes intake was calculated from the average of the three days of intake for the legumes group in NDSR output file 9. Full details of the scoring process are in Appendix A.

Physical Activity Questionnaire

Participants were asked to report their physical activity using the Godin Leisure-Time Exercise Questionnaire. Participants reported their exercise frequencies by answering how many times in the past week they participated in strenuous, moderate, or mild exercise for more than 15 minutes (19,89). Based on the participants answers to these questions, their Total Exercise Score (TES) was calculated from the following formula: TES = [(9 × Strenuous) + (5 × Moderate) + (3 × Light)]. The specific questions that were asked about physical activity were:

1. In the past 7 days (i.e., the past week), how many times did you do the following kinds of exercise for more than 15 minutes (write in each box the appropriate number)?
    a. Strenuous Exercise (heart beats rapidly). Please enter TIMES PER WEEK. (e.g., running, jogging, hockey, football, soccer, squash, basketball, martial arts, roller skating, vigorous swimming, vigorous long distance bicycling, cross country skiing)
    b. Moderate Exercise (not exhausting). Please enter TIMES PER WEEK. (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, dancing, skiing)
    c. Mild Exercise (minimal effort). Please enter TIMES PER WEEK. (e.g., yoga, archery, fishing, bowling, golf, easy walking, horseshoes, snowmobiling)

Breastfeeding Questionnaire

The participants' parents were asked to report breastfeeding information pertaining to their child. This breastfeeding information was used to calculate a breastfeeding intensity variable. Breastfeeding intensity was calculated from the number of months the child was breastfed and whether it was exclusive or mixed with formula. Values ranged from 0 (no breastfeeding) to 12 (6 months of exclusive breastfeeding). A value of 2 was given for exclusive breastfeeding, a value of 1 was given for breastfeeding supplemented with formula, and a value of 0 was given for formula feeding. The breastfeeding questions that were asked were:

1. When your adolescent was a baby, was she/he breastfed? Yes| No
2. If Yes: How many months was she/he breastfed?
3. If Yes: During the first few months of breastfeeding, was your child . . .

   Breastfed exclusively/Breastfed, and also received supplemental formula

Statistical Analysis

SPSS version 23 was used to complete all statistical analyses. Univariate analyses were performed including descriptive statistics, frequency analyses, and checks for normality. Descriptive statistics, including means and standard deviations, were performed for SES, race, BMI, PA, HEI-2010 score, and breastfeeding intensity for the total sample and by gender. Normality was checked for by looking at a q-q plot for BMI, WC, PA, HEI-2010 score, and breastfeeding intensity. Bivariate analyses, using Pearson correlations, Point-biserial correlations, or Chi-squared were performed on BMI, WC, SES, Gender, Race, PA, HEI-2010 score, and breastfeeding intensity. For Aim 1 the relationship between breastfeeding intensity and BMI was examined using a Pearson correlation analysis. For Aim 2 a Pearson correlation analysis was performed between diet quality and BMI. For Aim 3 a Pearson correlation analysis was also performed between PA and BMI, using the following variables for PA: the total frequency (number of times/week) of strenuous activity and TES. These analyses were done with WC as well.

A 5-step hierarchical linear regression analysis was performed by the researchers. The dependent variable was BMI or WC (two separate constructs for obesity). The independent variables were HEI-2010 score, PA, and breastfeeding intensity. The control variables were SES, gender, and race. The control variables were entered first. Then, the main effects (PA, HEI-2010 score, and breastfeeding intensity) were entered. The interaction between PA and diet was entered. Then the interaction of breastfeeding and diet was entered, followed by the interaction term of breastfeeding and PA. Finally, a 3-way interaction between HEI-2010 score, PA, and breastfeeding was entered in the last step.

As a post-hoc analysis, race was analyzed with BMI, WC, SES, HEI, PA, and breastfeeding intensity. Descriptive statistics, including means and standard deviations, were performed for SES, BMI, WC, PA, HEI-2010 score, and breastfeeding intensity for the total sample and by race (white and non-white).

Results

A total of 163 adolescents provided complete demographic and dietary information for the current study. Descriptive characteristics of the total sample and by gender are provided in Table 1 (tables are presented at the end of this chapter). There was a greater number of females in the study, 98 females compared to 65 males. Sixty-six percent were white, 28% African American, 5% mixed, and 1% "other" (for statistical analyses, the race variable was reduced to two groups: African American, mixed, and "other" were combined into a non-white group and compared with the white group).

Anthropometrics of the total sample by gender are also presented in Table 1. Height and weight were measured at the laboratory visit (n=133), but if that was missing, self-reported height and weight were used (n=30). Among those participants who had both self-reported and measured heights and weights, correlations were strong between both self-reported and laboratory-measured height (r=0.931, p=0.000) and weight (r=0.985, p=0.000). There were no significant differences in BMI between male and females. While there were 163 participants with anthropometric data, only 134 had WC measurements since it had to be measured in the lab and was not self-reported. As expected, males had a significantly greater WC (p=0.047), height (p=0.000), and weight (p=0.004) than females.

Of the 163 adolescents who completed diet recalls, 149 participants provided three days of recall, six provided two days of recall, and eight provided only one day of recall. For the participants who provided two days of diet recall the average of the two was used and for the participants who provided only one day that day was used and all of these were included with the participants who had three days of recall. Between these three groups there were not any significant differences in the average HEI scores. Overall, the diet quality of the adolescents as measured by the HEI-2010 was poor with the average HEI-2010 scores being 49.2 ± 12.0. Scores below 50 are considered “poor,” 50-80 “needing improvement,” and above 80 “good.” The HEI scores between genders were not significantly different, with the female mean score 50.1 ± 12.6 and the male mean score 47.8 ± 10.9.

The Physical Activity scores using the Godin Leisure-Time Exercise Questionnaire by gender are presented in Table 2 and was completed by 146 participants. The table contains the number of times of mild, moderate, or strenuous activity for more than 15 minutes per week and the total exercise score (TES) score for each participant. Males reported significantly greater frequency of physical activity than females for both strenuous exercise (p=0.004) and TES (p=0.008). For the breastfeeding information, 151 of the participants’ parents completed the breastfeeding questionnaire (see Table 3). There were no significant differences between females and males for the breastfeeding data.

The bivariate correlations in Table 4 show the numerous relationships between the continuous variables. Breastfeeding intensity, diet quality HEI score, and total exercise were negatively correlated to BMI (p<0.05). SES was significantly positively related to diet quality, physical activity (TES and strenuous exercise), and breastfeeding intensity, but negatively related to BMI.

Tables 5-42 show the results of the multiple regression analyses, examining the relationships of breastfeeding, diet quality, and physical activity to BMI and WC. In the first multiple regression model, only the control variables (SES, race, and gender) were entered to examine their relationships to BMI (Table 5). The R^2 was 0.082, with only race being a significant predictor of BMI. Non-whites had a 3.68-unit increase in BMI over whites. When breastfeeding intensity was added to the model, the R^2 increased by 3% to 0.110 (p=0.001) (see Table 6). For every unit increase in breastfeeding intensity, BMI decreased by 0.22 units. Non-whites had a 3.42-unit increase in BMI compared to whites.

Bivariate correlations were performed to see if there was a relationship between diet quality and BMI. They revealed that there was a significant negative correlation between diet quality HEI score and BMI (Table 4). Then, the control variables and diet quality HEI score were entered in a multiple regression model to examine their relationship to BMI. This revealed that only race, not diet quality HEI score, was significant (Table 7, R^2=0.088, p=0.001). A bivariate correlation was then performed to see if breastfeeding and diet quality were related (Table 4). A correlation was not seen between breastfeeding intensity and diet quality. Breastfeeding intensity was then added to the multiple regression model which strengthened the overall model and it was a significant main effect (Table 8, R^2 increased by 3% to 0.116, p=0.000). However, the interaction of diet quality HEI score and breastfeeding intensity was not significant (Table 9).

Next, bivariate correlations were utilized to see if there was a relationship between PA and BMI and PA and breastfeeding. Furthermore, multiple regression analyses were used to determine if there was a relationship between breastfeeding intensity and physical activity to BMI. Table 4 showed that TES and BMI were inversely related (p=0.11), but when strenuous exercise was examined by itself the relationship became stronger (p<0.05). After controlling for gender, race, and SES in a multiple regression analysis, neither TES (see Table 10, R^2=0.079, p=0.004) nor strenuous activity (see Table 13, R^2=0.087, p=0.002) remained significant. The bivariate correlations in Table 4 also showed that there was a significant correlation between breastfeeding intensity and both TES (p=0.05) and strenuous exercise (p=0.04). Adding breastfeeding intensity to the regression models strengthened the models (see Tables 11 and 14; for TES and strenuous exercise R^2 increased by 2%) and breastfeeding intensity was a significant main effect. Furthermore, breastfeeding intensity interacted with strenuous exercise to improve the model (see Table 15; R^2 increased by 6% to 0.146, p=0.000). However, the interaction of breastfeeding intensity and TES was not significant (Table 12).

Multiple regressions were then performed to see if there was an interaction between diet quality and physical activity with BMI and if breastfeeding moderates that relationship. No relationship was found when examining the interaction between diet quality and TES with BMI when controlling for gender, SES, and race (Table 17; R^2=0.082, p=0.006). Similarly, no relationship was found when examining the interaction between diet quality and strenuous exercise (Table 21, R^2=0.087, p=0.005). Adding breastfeeding intensity strengthened the models and R^2 increased by 3% and was a significant main effect (See Table 18 for TES, R^2=0.112, p=0.001 and see Table 22 for strenuous exercise, R^2=0.116, p=0.001). When adding the interaction of diet quality HEI score and TES and breastfeeding intensity to the model, diet quality HEI score and breastfeeding intensity were the significant main effects, but the interaction was not significant (Table 19). When adding the interaction of diet quality HEI and strenuous exercise and breastfeeding intensity to the model, diet quality HEI score, strenuous exercise, breastfeeding intensity, and their interaction were all significant and R^2 increased slightly by 2%.

The following are the significant results with WC. In Table 4, WC was significantly negatively related to breastfeeding intensity ($p<0.05$). Tables 24-42 show the results of the multiple regression analyses, examining the relationships of breastfeeding, diet quality, and physical activity to WC. However, only the significant results will be discussed.

In the first multiple regression model examining only the control variables (Table 25), R^2 was 0.064 but when breastfeeding intensity was added to the model R^2 increased by 1.5% to 0.080 ($p=0.008$). In all the multiple regression analyses with WC except for the one with diet quality HEI score, breastfeeding intensity remained significant the entire time. For every unit increase in breastfeeding intensity, WC decreased by 0.48 cm. In a multiple regression analysis to see if physical activity and breastfeeding intensity were related to WC, breastfeeding intensity interacted with strenuous exercise to improve the model and was a significant main effect (see Table 34, R^2 increased by 4% to 0.114, $p=0.004$). When using multiple regression analyses to examine the relationship between diet quality HEI score, PA, and breastfeeding with WC, strenuous exercise and breastfeeding intensity were the only significant main effects and R^2 increased slightly.

Since race was so significant in the multiple regression models of BMI, we compared the means and standard deviations of BMI, WC, SES, Breastfeeding Intensity, diet quality HEI score, strenuous exercise, and TES of the white and non-white groups (Table 43). These values were all significantly different except the 75th-90th WC percentile. Non-whites had a higher average BMI, higher percentage of people in the overweight and obese BMI percentiles, a larger average WC, and a higher percentage of people in the WC ≥ 90th percentile than whites. Non-whites had a lower percentage of people in the normal BMI percentile category, a lower average SES, Breastfeeding Intensity score, diet quality HEI score, strenuous exercise, and TES.

Discussion

The purpose of this study was to determine if there was a relationship between physical activity and BMI and WC, diet quality and BMI and WC, and if those relationships were moderated by breastfeeding. As obesity rates have reached epidemic levels in children and adolescents, it is important to examine associations between diet quality and physical activity to see if they are related to obesity during adolescence. Among this sample of 16- to 17-year-old adolescents, 19.0% were overweight and 16.6% were obese. This is very similar to the NHANES 2011-2012 report of 14.9% of US children and adolescents aged 2 to 19 who were overweight and 16.9% who were obese (90). Furthermore, the diet quality of the sample was relatively poor with the average

HEI-2010 scores being 49.2 ± 12.0, with only two participants scoring above 80, which is considered "good." These scores are lower than those reported for NHANES 2011-2012 children and adolescents age 2 to 17, with an average HEI score of 55 (91).

We did not find a relationship between diet quality and breastfeeding. Our results conflict with those of Scholtens et al. (13). The difference may be due to the method used to assess diet. We used a 24-hour dietary recall method whereas Scholtens et al. used a food frequency method. The food frequency questionnaire only asked the frequency of certain foods and did not ask about portion sizes. The Dutch children's parents were asked to report how many times in the previous month their child consumed a specific food or drink. Fruits and vegetables may have been remembered when asked about, but a junk food snack may have been forgotten if it did not fit exactly into one of the snack categories such as chocolate bars or fried snacks that were asked about. Also, other research conducted had many more dietary recalls performed, or the dietary recalls were reported by the parents, which may have increased the accuracy of the results as compared to the adolescents reporting in our study (13,77,78).

In this sample, physical activity as measured by the Godin Leisure Time Exercise Questionnaire was also relatively poor. Almost a third of the adolescents (30%) reported engaging in no strenuous exercise at all and 10% reported no physical activity in the form of mild, moderate, or strenuous. These alarming statistics are of importance since physical inactivity is fourth on the list of leading risk factors for global mortality (53). When examining only moderate and strenuous activities—since mild exercises are not strong contributors to health benefits—24 units or more is considered active with substantial health benefits, 14 to 23 units moderately active with some health benefits, and less than 14 units insufficiently active with less substantial or low health benefits (92). For this sample, 23% of participants had a strenuous/moderate score less than 14 units meaning they would be getting less substantial or low health benefits from their level of physical activity. Lack of physical activity is important in adolescents since researchers have demonstrated that physical activity declines from childhood to adolescence, which increases their risk of chronic diseases later in life (54).

Even though the amount of physical activity was poor, an inverse relationship was still found between TES and BMI that become even stronger when examining only strenuous exercise. This is thought to be due to the fact that strenuous exercise is a better indicator of physical fitness than moderate and mild exercise. Godin et al. found that the strongest correlation with VO_2 max percentile was with strenuous exercise (19). In addition, this correlation between strenuous exercise and BMI may have also been seen because people are generally better at remembering and reporting their strenuous PA (19). When using multiple regression analyses, the interaction of strenuous exercise and breastfeeding intensity was the only significant predictor of WC and BMI and not the interaction of TES and breastfeeding intensity. This may be because only a questionnaire was used to determine physical activity rather than using an exercise test to determine physical fitness. Physical activity can encompass many activities with a goal of improving or maintaining one's level of cardiovascular fitness, whereas physical fitness is actually a measure of cardiovascular fitness (15). Other studies that found a relationship between breastfeeding and physical fitness used measures of physical fitness such as cycle-ergometer tests, VO_2 max tests, and muscular strength tests, not questionnaires (20,21). If an exercise test had been used to measure physical fitness instead of asking about physical activity, more significant results may have been found between physical fitness and breastfeeding intensity.

One of the theories for the protective effect of breastfeeding against obesity is the belief that programming of the satiety center occurs during infancy. Since obesity is a result of an energy imbalance whereby energy intake exceeds output, then perhaps hormones in breast milk may modify the appetite center of the brain in infants (75). The pathways that are involved in appetite regulation do not mature until after birth and in early infancy. Additionally, hormones such as leptin, ghrelin, adiponectin, resistin, and obestatin have been identified in breast milk but are not found in infant formulas (75,76). This is important because these hormones may be crucial in early infancy in establishing the programming of normal energy balance that persists in childhood and adulthood. If programming does not occur early in the brain, then a person may be at increased risk for long-term obesity.

The sample in this study had a breastfeeding initiation rate of 82.8%, which is very similar to the 2016 Breastfeeding Report Card that stated that 4 out of 5 (81.1%) mothers in the US (75.3% in North Carolina) began to breastfeed in 2013 (93). Both of these numbers are considered high breastfeeding initiation rates with the Healthy People

2020 Objective to have 81.9% of mothers initiating breastfeeding by the year 2020. Also, it should be noted that our sample had already almost reached this rate for breastfeeding initiation, a notable point since this study began 20 years ago in 1997. Furthermore, the 2016 Breastfeeding Report Card reported that 51.8% of mothers in the US (47.5% in North Carolina) were still breastfeeding at 6 months in 2013. In this sample, 56.0% of mothers breastfed up until or greater than 6 months. However, neither of these rates meets the Healthy People 2020 Objectives of reaching a target of 60.0% of mothers breastfeeding at 6 months.

Additionally, in this sample parents were asked to report breastfeeding information about their adolescent when the adolescent was 16 years of age. Since breastfeeding is such a memorable experience, it has been shown that reporting breastfeeding information many years later is still valid. Kark et al. studied the validity of the breastfeeding information reported by mothers more than 20 years after birth (94). Mothers were interviewed about breastfeeding history with their child and this was compared to what had been recorded in the mother's and child's health clinic charts. What the mother reported was highly correlated with the information in the charts regardless of ethnicity, mother's education, family size, and the sex of the child. A review by Li et al. also examined the validity and reliability of maternal recall of breastfeeding history (95). Studies suggest that the accuracy of maternal recall of breastfeeding is high but diminishes further out from the breastfeeding event that they are recalling. In other words, breastfeeding recall is most accurate at 6 months of age and then gradually declines as the child gets older. While overall it seems mothers accurately seem to recall the initiation and duration of breastfeeding, there is a decrease in the accuracy of recall in most studies when they compared recall at a child's age of 3 compared to recall when the child was 14 to 15 years old. Specifically, the majority of mothers accurately recalled breastfeeding duration to within one month when the child was 3, which decreased to 37% accuracy when the child was 14 to 15 years old.

Among other breastfeeding questions, participants' parents were asked if they exclusively breastfed or if the child also received supplemental formula. In this sample, exclusive breastfeeding refers to the infant not receiving any formula but the infant may have been given food such as cereal. Mixed feeding means participants may have been breastfed but also received supplemental formula and does not refer to the addition of supplemental foods. Using this information, along with the number or months the child was breastfed as an infant, was used to calculate a breastfeeding intensity score. We attribute this as a reason why we found a relationship between breastfeeding and both BMI and WC in adolescents when other studies have been unsuccessful in finding a relationship. Several studies that did not find a relationship between breastfeeding and obesity in children or adolescents only used breastfeeding initiation but not intensity (96,97). Or they may have asked the duration of breastfeeding and if exclusive or mixed and used this information to categorize the participants into groups but did not calculate an intensity score (98,99).

In a meta-analysis by the World Health Organization, they state that a higher SES is associated with higher rates of breastfeeding and that breastfeeding mothers are much more likely to be health-conscious (6). This is important because these infants of high income women are also more likely to be exposed to healthier lifestyles including obesity prevention and encouragement of physical activity. Therefore, it is important to consider SES when evaluating the effects of breastfeeding on health parameters in the offspring and when conducting research on this relationship. When evaluating the general characteristics of this sample it was evident that a very diverse range of SES scores was present, with a mean of 43.8±14.0, and we did see a significant positive relationship between breastfeeding intensity and SES.

Our post hoc analyses showed that non-whites and whites had significantly different SES, diet quality HEI score, PA, and breastfeeding intensity, BMI, and WC. This is probably why race was stronger than each of these variables in the multiple regression models. This may also explain why certain variables were significantly correlated but not significant predictors in the regression analyses. Storey et al. found that race significantly predicted BMI in adolescents (100). We believe race significantly predicted BMI because non-whites had a lower diet quality HEI score, lower PA, lower SES, and lower breastfeeding intensity score.

More significant results were found with BMI even though similar trends were found with WC. We believe this is because we lost 18% of the participants who did not have WC data. This may have not been a large enough sample to see significant results.

This study had several strengths and limitations. At the time of the original enrollment of the participants the sample was considered representative of North Carolina (25). Now, in contrast, the sample is not representative of North Carolina, with most participants being either white or African American and very few from other ethnic groups. The sample has a low representation of Hispanics because the population of Hispanics in Greensboro was low at the beginning of the study in 1997 and has dramatically risen since then. However, we consider our large white and non-white groups a strength of this study because it allowed us to look at the effects of race and we also consider the diverse range of SES scores another strength of this study.

Another strength of this study was the method that was used to collect dietary information. The multiple pass method has been highly validated as an accurate measure of total energy and nutrient intake (101,102). Also, we consider it a strength that a majority of participants (91%) had three days of dietary recalls.

Completion of the dietary recalls in a timely manner after visiting the lab was a limitation. Ideally, the three dietary recalls would have been completed within two weeks of going to the lab. However, the first dietary recall was usually not completed until at least 6 weeks after the lab visit. Therefore, their dietary recalls may have been rather different when compared to their diet preceding the visit.

Another limitation is the participants may not have known exactly what was in a food prepared for them by a parent or purchased at a restaurant or school. Even with the food amounts booklet containing common portion sizes, it may have been difficult for them to estimate portion sizes in mixed casserole dishes that they were not involved in preparing. Another significant limitation is that memory was relied upon for physical activity recall and no physical fitness test was utilized.

We do consider it a remarkable strength that we had breastfeeding data for 151 participants in this study and that we used breastfeeding intensity as our breastfeeding variable so we were able to see a significant “dose effect” of breastfeeding. We also consider it a strength that we had a high percentage of participants who were exclusively breastfed. For example, of those who were breastfed, 68% were breastfed exclusively. However, a limitation of this study is that memory was relied upon for the breastfeeding information. Parents were asked breastfeeding information pertaining to their adolescent when the adolescent was 16 years old. However, it has been shown that breastfeeding history reported by mothers many years later is still highly valid (94).

Conclusion

In conclusion, this study found that breastfeeding intensity was a significant predictor of both BMI and WC. Furthermore, a higher breastfeeding intensity score was significantly related to a higher TES, increased strenuous exercise, and an increased SES. This suggests breastfeeding may influence appetite or metabolic programming during infancy and/or breastfeeding may be a “proxy” for a healthy lifestyle. Furthermore, these results suggest that race may be such a strong predictor for BMI because non-whites had a lower breastfeeding exposure, poorer diet quality, lower PA, and lower SES.

Table 1

Characteristics of Sample

	Total *N*=163 (100%)	Female *n*=98 (60%)	Male *n*=65 (40%)
Race			
White	107 (66%)	63 (64%)	44 (68%)
African American	46 (28%)	30 (31%)	16 (25%)
Mixed	8 (5%)	4 (4%)	4 (6%)
Other	2 (1%)	1 (1%)	1 (2%)
Socioeconomic Status (SES)[1] X±SD	43.8 (14.0)	42.1 (14.7)	46.3 (12.8)
Anthropometrics			
Weight (kg) X±SD	71.0 (20.1)	**67.2 (17.8)**	**76.8 (22.1)**[2]
Height (cm) X±SD	170.4 (9.9)	**164.9 (6.4)**	**178.6 (8.5)**[2]
Body Mass Index (BMI) (kg/m^2)	24.4 (6.3)	24.7 (6.5)	24.0 (5.9)
BMI category	163 (100%)	98 (60%)	65 (40%)
Normal <85th percentile	105 (64%)	63 (64%)	42 (65%)
Overweight ≥85th-<95th percentile	31 (19%)	19 (19%)	12 (18%)
Obese ≥95th percentile	27 (17%)	16 (16%)	11 (17%)
Waist Circumference (cm) X±SD	78.6 (14.2)	**76.6 (13.4)**	**81.7 (15.0)**[2]
≥75th-<90th percentile	14 (10%)	10 (12%)	4 (8%)
abdominal obesity ≥90th percentile	7 (5%)	4 (5%)	3 (6%)

[1]This is defined from Hollingshead Four Factor of Socioeconomic Status (87). Possible scores range from 8 to 66.
[2]Significantly different than females, $p < 0.05$

Table 2

Self-Reported Physical Activity using Godin Leisure-Time Exercise Questionnaire ref. (19,89)

	Total	Female	Male
Mild[1]	3.3 (3.3)	3.2 (3.1)	3.4 (3.7)
Moderate[1]	3.0 (3.2)	2.6 (2.6)	3.6 (3.9)
Strenuous[1]	2.9 (3.0)	**2.3 (2.4)**	**3.8[3] (3.6)**
Total Exercise Score[2]	51.3 (41.2)	**43.0 (31.4)**	**62.5[3] (49.6)**

[1]Number of times (X±SD) of mild, moderate, or strenuous activity for more than 15 min per past week.
[2]Total Exercise Score (X±SD) = (9 × Strenuous) + (5 × Moderate) + (3 × Light)
[3]Significantly different than females, $p<0.01$

Table 3

Breastfeeding Information

	Total	Female	Male
Ever Breastfed Yes No	151 (100%) 125 (83%) 26 (17%)	88 (58%) 70 (80%) 18 (20%)	63 (42%) 55 (87%) 8 (13%)
Breastfed Exclusively	85 (68%)	46 (66%)	39 (71%)
Mixed Feeding	40 (32%)	24 (34%)	16 (29%)
Duration (# of months) X±SD	7.5 (7.5)	7.2 (7.5)	7.9 (7.5)
Intensity for 1st 6 months[1] X±SD	7.0 (4.8)	6.7 (5.0)	7.5 (4.6)

[1]Values range from 0 (no breastfeeding) to 12 (6 months of exclusive breastfeeding). A value of 2 given for exclusive breastfeeding, a value of 1 given for mixed feeding, and a value of 0 given for formula feeding

Table 4

Bivariate Correlations

	BMI	WC	Diet Quality HEI Score	TES	Strenuous Exercise	Breast-feeding Intensity	SES
BMI	1.0	**0.866** **0.000**	**-0.167** **0.033**	-0.134 0.107	**-0.164** **0.048**	**-0.251** **0.002**	**-0.161** **0.040**
WC	**0.866** **0.000**	1.0	-0.053 0.544	-0.102 0.266	-0.102 0.269	**-0.197** **0.029**	-0.129 0.136
Diet Quality HEI Score	**-0.167** **0.033**	-0.053 0.544	1.0	0.083 0.320	0.126 0.129	0.100 0.225	**0.171** **0.029**
TES	-0.134 0.107	-0.102 0.266	0.083 0.320	1.0	**0.844** **0.000**	**0.167** **0.047**	**0.178** **0.032**
Strenuous Exercise	**-0.164** **0.048**	-0.102 0.269	0.126 0.129	**0.844** **0.000**	1.0	**0.170** **0.043**	**0.197** **0.017**
Breast-feeding Intensity	**-0.251** **0.002**	**-0.197** **0.029**	0.100 0.225	**0.167** **0.047**	**0.170** **0.043**	1.0	**0.216** **0.008**
SES	**-0.161** **0.040**	-0.129 0.136	**0.171** **0.029**	**0.178** **0.032**	**0.197** **0.017**	**0.216** **0.008**	1.0

Note. Bold indicates significance; BMI= Body Mass Index; WC= Waist Circumference; HEI= Health Eating Index; TES= Total Exercise Score; SES= Socioeconomic Status

For the following regression Tables 5-42, Race is defined as white/non-white, Breastfeeding Intensity means the number of months the child was breastfed (stopping at 6 months) and whether it was exclusive or mixed with formula, SES scores can range from 8 to 66, and HEI scores can range from 0 to 100.

Table 5

Multiple Regression Model of Control Variables with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.454	0.973	(-2.375, 1.467)	0.642
Race	-3.683	1.035	(-5.727, -1.639)	0.000
SES	-0.034	0.035	(-0.104, 0.036)	0.339

Note. adj. R^2=0.082, *n*=163

Table 6

Multiple Regression Model of Control Variables and Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.409	1.011	(-2.408, 1.589)	0.686
Race	-3.421	1.134	(-5.662, -1.180)	0.003
SES	-0.022	0.039	(-0.098, 0.055)	0.572
Breastfeeding Intensity	-0.227	0.108	(-0.439, -0.014)	0.037

Note. adj. R^2=0.110, *n*=150

Table 7

Multiple Regression Model of Control Variables and Diet Quality HEI Score with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.627	0.977	(-2.557, 1.303)	0.522
Race	-3.458	1.044	(-5.519, -1.397)	0.001
SES	-0.027	0.036	(-0.097, 0.044)	0.454
Diet Quality HEI Score	-0.058	0.041	(-0.0139, 0.022)	0.155

Note. adj. R^2= 0.088, *n*=163

Table 8

Multiple Regression Model of Control Variables, HEI, and Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.577	1.014	(-2.582, 1.428)	0.570
Race	-3.166	1.144	(-5.427, -0.905)	0.006
SES	-0.017	0.039	(-0.093, 0.060)	0.670
Diet Quality HEI Score	-0.060	0.042	(-0.144, 0.023)	0.157
Breastfeeding Intensity	-0.220	0.107	(-0.432, -0.008)	0.042

Note. adj. R^2= 0.116, n=150

Table 9

Multiple Regression Model of Control Variables, Diet Quality HEI Score, Breastfeeding Intensity, and Diet Quality HEI Score X Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.573	1.018	(-2.585, 1.438)	0.574
Race	-3.127	1.157	(-5.415, -0.840)	0.008
SES	-0.016	0.039	(-0.093, 0.060)	0.675
Diet Quality HEI Score	-0.077	0.077	(-0.230, 0.076)	0.321
Breastfeeding Intensity	-0.332	0.442	(-1.206, 0.542)	0.454
Diet Quality HEI Score X Breastfeeding Intensity	0.002	0.009	(-0.015, 0.020)	0.794

Note. adj. R^2= 0.110, n=150

Table 10

Multiple Regression Model of Control Variables and TES with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.408	1.079	(-2.541, 1.725)	0.706
Race	-3.729	1.153	(-6.008, -1.450)	0.002
SES	-0.032	0.040	(-0.111, 0.047)	0.421
TES	-0.008	0.013	(-0.034, 0.018)	0.545

Note. adj. R^2= 0.079, n=146

Table 11

Multiple Regression Model of Control Variables, TES, and Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.330	1.092	(-2.490, 1.829)	0.763
Race	-3.436	1.195	(-5.799, -1.073)	0.005
SES	-0.022	0.041	(-0.103, 0.059)	0.590
TES	-0.005	0.013	(-0.032, 0.021)	0.690
Breastfeeding Intensity	-0.228	0.115	(-0.455, 0.000)	0.050

Note. adj. R^2= 0.103, n=142

Table 12

Multiple Regression Model of Control Variables, TES, Breastfeeding Intensity, and TES X Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.273	1.090	(-2.429, 1.883)	0.802
Race	-3.450	1.192	(-5.807, -1.093)	0.004
SES	-0.016	0.041	(-0.097, 0.065)	0.698
TES	-0.033	0.025	(-0.082, 0.016)	0.186
Breastfeeding Intensity	-0.408	0.178	(-0.760, -0.055)	0.024
TES X Breastfeeding Intensity	0.003	0.003	(-0.002, 0.009)	0.190

Note. adj. R^2= 0.108, n=142

Table 13

Multiple Regression Model of Control Variables and Strenuous Exercise with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.232	1.078	(-2.363, 1.899)	0.830
Race	-3.722	1.132	(-5.960, -1.484)	0.001
SES	-0.028	0.040	(-0.106, 0.051)	0.491
Strenuous Exercise	-0.228	0.178	(-0.579, 0.124)	0.203

Note. adj. R^2= 0.087, n=146

Table 14

Multiple Regression Model of Control Variables, Strenuous Exercise, and Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.166	1.090	(-2.332, 1.991)	0.879
Race	-3.413	1.177	(-5.740, -1.086)	0.004
SES	-0.019	0.041	(-0.099, 0.062)	0.650
Strenuous Exercise	-0.191	0.178	(-0.543, 0.162)	0.287
Breastfeeding Intensity	-0.220	0.115	(-0.447, 0.007)	0.057

Note. adj. R^2= 0.109, *n*=142

Table 15

Multiple Regression Model of Control Variables, Strenuous Exercise, Breastfeeding Intensity, and Strenuous Exercise X Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	0.117	1.073	(-2.004, 2.239)	0.913
Race	-3.595	1.154	(-5.878, -1.313)	0.002
SES	-0.009	0.040	(-0.088, 0.071)	0.826
Strenuous Exercise	-1.037	0.366	(-1.761, -0.312)	0.005
Breastfeeding Intensity	-0.509	0.157	(-0.820, -0.198)	0.002
Strenuous Exercise X Breastfeeding Intensity	0.098	0.037	(0.024, 0.172)	0.010

Note. adj. R^2= 0.146, *n*=142

Table 16

Multiple Regression Model of Control Variables, Diet Quality HEI Score, and TES with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.615	1.008	(-2.766, 1.535)	0.527
Race	-3.484	1.165	(-5.787, -1.181)	0.003
SES	-0.024	0.040	(-0.104, 0.055)	0.547
Diet Quality HEI Score	-0.058	0.044	(-0.145, 0.029)	0.191
TES	-0.007	0.013	(-0.033, 0.019)	0.589

Note. adj. R^2= 0.083, n=146

Table 17

Multiple Regression Model of Control Variables, Diet Quality HEI Score, TES and Diet Quality HEI Score X TES with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.669	1.091	(-2.825, 1.487)	0.541
Race	-3.506	1.166	(-5.812, -1.200)	0.003
SES	-0.027	0.040	(-0.107, 0.052)	0.498
Diet Quality HEI Score	-0.112	0.077	(-0.265, 0.041)	0.150
TES	-0.055	0.058	(-0.169, 0.059)	0.342
Diet Quality HEI Score X TES	0.001	0.001	(-0.001, 0.003)	0.396

Note. adj. R^2= 0.082, n=146

Table 18

Multiple Regression Model of Control Variables, Diet Quality HEI Score, TES, and Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.583	1.100	(-2.758, 1.591)	0.597
Race	-3.141	1.205	(-5.524, -0.758)	0.010
SES	-0.015	0.041	(-0.096, 0.067)	0.724
Diet Quality HEI Score	-0.068	0.045	(-0.156, 0.020)	0.130
TES	-0.004	0.013	(-0.031, 0.022)	0.749
Breastfeeding Intensity	-0.221	0.115	(-0.448, 0.005)	0.056

Note. adj. R^2= 0.112, n=142

Table 19

Multiple Regression Model of Control Variables, Diet Quality HEI Score, TES, Breastfeeding Intensity, and Diet Quality HEI Score X TES X Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.553	1.096	(-2.721, 1.614)	0.614
Race	-3.130	1.201	(-5.505, -0.756)	0.010
SES	-0.010	0.041	(-0.091, 0.071)	0.809
Diet Quality HEI Score	-0.094	0.048	(-0.189, 0.002)	0.054
TES	-0.029	0.022	(-0.072, 0.015)	0.196
Breastfeeding Intensity	-0.375	0.159	(-0.690, -0.060)	0.020
Diet Quality HEI Score X TES X Breastfeeding Intensity	0.00006070	0.000	(0.000, 0.000)	0.168

Note. adj. R^2= 0.118, n=142

Table 20

Multiple Regression Model of Control Variables, Diet Quality HEI Score, and Strenuous Exercise with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.443	1.090	(-2.559, 1.712)	0.685
Race	-3.497	1.145	(-5.762, -1.233)	0.003
SES	-0.021	0.040	(-0.100, 0.059)	0.606
Diet Quality HEI Score	-0.053	0.044	(-0.140, 0.034)	0.228
Strenuous Exercise	-0.203	0.179	(-0.557, 0.150)	0.258

Note. adj. R^2= 0.090, n=146

Table 21

Multiple Regression Model of Control Variables, Diet Quality HEI Score, Strenuous Exercise, and Diet Quality HEI Score X Strenuous Exercise with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.422	1.093	(-2.583, 1.738)	0.700
Race	-3.520	1.148	(-5.789, -1.251)	0.003
SES	-0.022	0.040	(-0.102, 0.057)	0.580
Diet Quality HEI Score	-0.085	0.062	(-0.208, 0.038)	0.175
Strenuous Exercise	-0.709	0.727	(-2.145, 0.728)	0.331
Diet Quality HEI Score X Strenuous Exercise	0.010	0.013	(-0.017, 0.036)	0.474

Note. adj. R^2= 0.087, n=146

Table 22

Multiple Regression Model of Control Variables, Diet Quality HEI Score, Strenuous Exercise, and Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.425	1.101	(-2.602, 1.752)	0.700
Race	-3.134	1.188	(-5.484, -0.784)	0.009
SES	-0.012	0.041	(-0.093, 0.069)	0.772
Diet Quality HEI Score	-0.064	0.045	(-0.152, 0.024)	0.153
Strenuous Exercise	-0.162	0.179	(-0.515, 0.191)	0.365
Breastfeeding Intensity	-0.215	0.114	(-0.441, 0.012)	0.063

Note. adj. R^2= 0.116, *n*=142

Table 23

Multiple Regression Model of Control Variables, Diet Quality HEI Score, Strenuous Exercise, Breastfeeding Intensity, and Diet Quality HEI Score X Strenuous Exercise X Breastfeeding Intensity with BMI

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	-0.215	1.093	(-2.376, 1.947)	0.845
Race	-3.198	1.175	(-5.521, -0.875)	0.007
SES	-0.006	0.041	(-0.087, 0.074)	0.879
Diet Quality HEI Score	-0.097	0.047	(-0.190, -0.004)	0.040
Strenuous Exercise	-0.719	0.323	(-1.357, -0.081)	0.027
Breastfeeding Intensity	-0.386	0.140	(-0.664, -0.108)	0.007
Diet Quality HEI Score X Strenuous Exercise X Breastfeeding Intensity	0.001	0.001	(0.000, 0.002)	0.041

Note. adj. R^2= 0.137, *n*=142

Table 24

Multiple Regression Model of Control Variables with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	5.973	2.504	(1.019, 10.928)	0.019
Race	-4.798	2.597	(-9.936, 0.340)	0.067
SES	-0.131	0.091	(-0.310, 0.049)	0.153

Note. adj. R^2= 0.064, n=134

Table 25

Multiple Regression Model of Control Variables and Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.186	2.632	(0.973, 11.399)	0.020
Race	-3.804	2.887	(-9.521, 1.914)	0.190
SES	-0.118	0.102	(-0.319, 0.084)	0.250
Breastfeeding Intensity	-0.480	0.276	(-1.026, 0.066)	0.084

Note. adj. R^2= 0.080, n=122

Table 26

Multiple Regression Model of Control Variables and Diet Quality HEI Score with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.017	2.523	(1.025, 11.008)	0.019
Race	-4.897	2.654	(-10.148, 0.353)	0.067
SES	-0.133	0.092	(-0.314, 0.049)	0.151
Diet Quality HEI Score	0.021	0.104	(-0.184, 0.226)	0.842

Note. adj. R^2= 0.057, n=134

Table 27

Multiple Regression Model of Control Variables, HEI, and Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.198	2.649	(0.951, 11.444)	0.021
Race	-3.849	2.968	(-9.727, 2.030)	0.197
SES	-0.118	0.102	(-0.321, 0.084)	0.251
Diet Quality HEI Score	0.008	0.109	(-0.209, 0.224)	0.944
Breastfeeding Intensity	-0.480	0.277	(-1.028, 0.068)	0.086

Note. adj. R^2= 0.073, n=122

Table 28

Multiple Regression Model of Control Variables, Diet Quality HEI Score, Breastfeeding Intensity, and Diet Quality HEI Score X Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.111	2.642	(0.877, 11.344)	0.023
Race	-4.658	3.025	(-10.650, 1.334)	0.126
SES	-0.118	0.102	(-0.320, 0.084)	0.251
Diet Quality HEI Score	0.257	0.222	(-0.182, 0.696)	0.249
Breastfeeding Intensity	1.064	1.227	(-1.366, 3.494)	0.388
Diet Quality HEI Score X Breastfeeding Intensity	-0.031	0.024	(-0.079, 0.017)	0.199

Note. adj. R^2= 0.078, n=122

Table 29

Multiple Regression Model of Control Variables and TES with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.865	2.754	(1.410, 12.320)	0.014
Race	-3.762	2.909	(-9.524, 2.000)	0.199
SES	-0.131	0.100	(-0.330, 0.068)	0.194
TES	-0.040	0.036	(-0.111, 0.031)	0.266

Note. adj. R^2= 0.060, n=120

Table 30

Multiple Regression Model of Control Variables, TES, and Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.883	2.817	(1.300, 12.466)	0.016
Race	-3.197	3.040	(-9.221, 2.828)	0.295
SES	-0.110	0.105	(-0.318, 0.098)	0.296
TES	-0.034	0.036	(-0.105, 0.038)	0.351
Breastfeeding Intensity	-0.483	0.289	(-1.055, 0.090)	0.097

Note. adj. R^2= 0.074, n=116

Table 31

Multiple Regression Model of Control Variables, TES, Breastfeeding Intensity, TES X Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	7.205	2.813	(1.631, 12.780)	0.012
Race	-3.287	3.026	(-9.285, 2.710)	0.280
SES	-0.095	0.105	(-0.303, 0.113)	0.366
TES	-0.104	0.061	(-0.225, 0.016)	0.089
Breastfeeding Intensity	-0.996	0.459	(-1.905, 0.086)	0.032
TES X Breastfeeding Intensity	0.010	0.007	(-0.004, 0.024)	0.154

Note. adj. R^2= 0.083, *n*=116

Table 32

Multiple Regression Model of Control Variables and Strenuous Exercise with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.906	2.744	(1.469, 12.342)	0.013
Race	-4.147	2.849	(-9.791, 1.497)	0.148
SES	-0.121	0.101	(-0.321, 0.080)	0.235
Strenuous Exercise	-0.556	0.449	(-1.446, 0.334)	0.219

Note. adj. R^2= 0.062, *n*=120

Table 33

Multiple Regression Model of Control Variables, Strenuous Exercise, and Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.963	2.801	(1.412, 12.513)	0.014
Race	-3.480	2.982	(-9.389, 2.429)	0.246
SES	-0.100	0.105	(-0.309, 0.108)	0.343
Strenuous Exercise	-0.515	0.450	(-1.406, 0.377)	0.255
Breastfeeding Intensity	-0.483	0.288	(-1.054, 0.088)	0.096

Note. adj. R^2= 0.078, n=116

Table 34

Multiple Regression Model of Control Variables, Strenuous Exercise, Breastfeeding Intensity, Strenuous Exercise X Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	7.803	2.768	(2.317, 13.289)	0.006
Race	-4.033	2.932	(-9.844, 1.777)	0.172
SES	-0.077	0.104	(-0.282, 0.128)	0.459
Strenuous Exercise	-2.390	0.912	(-4.198, -0.582)	0.010
Breastfeeding Intensity	-1.150	0.400	(-1.944, -0.356)	0.005
Strenuous Exercise X Breastfeeding Intensity	0.220	0.094	(0.034, 0.407)	0.021

Note. adj. R^2= 0.114, n=116

Table 35

Multiple Regression Model of Control Variables, Diet Quality HEI Score, and TES with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.931	2.778	(1.428, 12.434)	0.014
Race	-3.915	2.984	(-9.825, 1.996)	0.192
SES	-0.134	0.101	(-0.335, 0.067)	0.190
Diet Quality HEI Score	0.028	0.112	(-0.193, 0.249)	0.802
TES	-0.040	0.036	(-0.111, 0.031)	0.267

Note. adj. R^2= 0.052, n=120

Table 36

Multiple Regression Model of Control Variables, Diet Quality HEI Score, TES, and Diet Quality HEI Score X TES with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.936	2.790	(1.408, 12.463)	0.014
Race	-3.916	2.996	(-9.852, 2.021)	0.194
SES	-0.133	0.102	(-0.335, 0.069)	0.196
Diet Quality HEI Score	0.057	0.206	(-0.352, 0.466)	0.784
TES	-0.016	0.150	(-0.312, 0.280)	0.914
Diet Quality HEI Score X TES	0.000	0.003	(-0.006, 0.005)	0.869

Note. adj. R^2= 0.044, n=120

Table 37

Multiple Regression Model of Control Variables, Diet Quality HEI Score, TES, and Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.873	2.842	(1.240, 12.507)	0.017
Race	-3.172	3.130	(-9.375, 3.031)	0.313
SES	-0.110	0.106	(-0.319, 0.100)	0.301
Diet Quality HEI Score	-0.004	0.115	(-0.231, 0.223)	0.971
TES	-0.034	0.036	(-0.106, 0.038)	0.353
Breastfeeding Intensity	-0.483	0.290	(-1.058, 0.092)	0.099

Note. adj. R^2= 0.065, n=116

Table 38

Multiple Regression Model of Control Variables, Diet Quality HEI Score, TES, Breastfeeding Intensity, and Diet Quality HEI Score X TES X Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	7.038	2.855	(1.378, 12.697)	0.015
Race	-3.073	3.138	(-9.293, 3.146)	0.330
SES	-0.104	0.106	(-0.314, 0.106)	0.328
Diet Quality HEI Score	-0.052	0.130	(-0.310, 0.206)	0.689
TES	-0.067	0.056	(-0.178, 0.043)	0.231
Breastfeeding Intensity	-0.714	0.413	(-1.532, 0.105)	0.087
Diet Quality HEI Score X TES X Breastfeeding Intensity	0.00008889	0.000	(0.000, 0.000)	0.433

Note. adj. R^2= 0.062, n=116

Table 39

Multiple Regression Model of Control Variables, Diet Quality HEI Score, and Strenuous Exercise with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	7.017	2.773	(1.524, 12.509)	0.013
Race	-4.356	2.921	(-10.142, 1.431)	0.139
SES	-0.124	0.102	(-0.326, 0.078)	0.226
Diet Quality HEI Score	0.039	0.112	(-0.182, 0.261)	0.725
Strenuous Exercise	-0.570	0.453	(-1.467, 0.327)	0.211

Note. adj. R^2= 0.055, n=120

Table 40

Multiple Regression Model of Control Variables, Diet Quality HEI Score, Strenuous Exercise, and Diet Quality HEI Score X Strenuous Exercise with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.883	2.795	(1.346, 12.420)	0.015
Race	-4.338	2.931	(-10.144, 1.469)	0.142
SES	-0.121	0.102	(-0.324, 0.083)	0.242
Diet Quality HEI Score	0.103	0.170	(-0.233, 0.439)	0.544
Strenuous Exercise	0.368	1.927	(-3.449, 4.185)	0.849
Diet Quality HEI Score X Strenuous Exercise	-0.017	0.034	(-0.085, 0.051)	0.617

Note. adj. R^2= 0.049, n=120

Table 41

Multiple Regression Model of Control Variables, Diet Quality HEI Score, Strenuous Exercise, and Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	6.979	2.830	(1.369, 12.589)	0.015
Race	-3.515	3.070	(-9.599, 2.569)	0.255
SES	-0.101	0.106	(-0.311, 0.109)	0.344
Diet Quality HEI Score	0.006	0.115	(-0.222, 0.234)	0.959
Strenuous Exercise	-0.517	0.454	(-1.416, 0.382)	0.257
Breastfeeding Intensity	-0.483	0.289	(-1.057, 0.090)	0.098

Note. adj. R^2= 0.069, *n*=116

Table 42

Multiple Regression Model of Control Variables, Diet Quality HEI Score, Strenuous Exercise, Breastfeeding Intensity, and Diet Quality HEI Score X Strenuous Exercise X Breastfeeding Intensity with WC

	β	Standard Error	95% Confidence Interval	*p*-value
Gender	7.505	2.850	(1.855, 13.155)	0.010
Race	-3.535	3.060	(-9.601, 2.531)	0.251
SES	-0.090	0.106	(-0.300, 0.120)	0.396
Diet Quality HEI Score	-0.064	0.127	(-0.315, 0.187)	0.613
Strenuous Exercise	-1.435	0.838	(-3.097, 0.226)	0.090
Breastfeeding Intensity	-0.778	0.367	(-1.506, -0.051)	0.036
Diet Quality HEI Score X Strenuous Exercise X Breastfeeding Intensity	0.002	0.001	(-0.001, 0.005)	0.196

Note. adj. R^2= 0.075, *n*=116

Table 43

Characteristics of Sample by Race

	White *n*=107	Nonwhite *n*=56
Body Mass Index (BMI) (kg/m^2)	**23.0 (4.8)**	**27.0 (7.8)**
BMI category	107 (66%)	56 (34%)
Normal <85th percentile	**79 (74%)**	**26 (46%)**
Overweight ≥85th-<95th percentile	**16 (15%)**	**15 (27%)**
Obese ≥95th percentile	**12 (11%)**	**15 (27%)**
Waist Circumference (cm) X±SD	**76.5 (10.7)**	**82.4 (18.5)**
≥75th-<90th percentile	8 (9%)	6 (13%)
abdominal obesity ≥90th percentile	**2 (2%)**	**5 (10%)**
Socioeconomic Status (SES) (X±SD)	**46.7 (13.1)**	**38.3 (14.3)**
Breastfeeding Intensity for 1st 6 months (X±SD)	**7.9 (4.7)**	**5.2 (4.7)**
Diet Quality HEI Score (X±SD)	**50.8 (12.6)**	**46.0 (10.1)**
Strenuous Exercise (X±SD)	**3.3 (3.4)**	**2.3 (2.2)**
Total Exercise Score (X±SD)	**58.1 (44.4)**	**38.2 (30.4)**

Bolded items are significantly different, $p<0.05$

CHAPTER IV

EPILOGUE

This study found a protective effect of breastfeeding on obesity in adolescents, which has previously been observed more often in children. Furthermore, even though a relationship was not found between breastfeeding and diet quality, this research revealed an association between breastfeeding and physical activity suggesting that some programming may be happening during infancy. While a relationship was not found between breastfeeding, diet quality, physical activity, and BMI, the results show that the effects of breastfeeding persist into adolescence through its association with physical activity.

I have learned a great deal and gained many valuable skills by completing this research under the mentorship of Dr. Lovelady. For instance, this includes a much better knowledge of statistical analyses and data analysis, a better understanding of the various measures of diet quality and physical activity, how breastfeeding data are collected and reported in the literature, and a greater appreciation for the vast amount of data that were collected over the duration of the original prospective longitudinal study. With this study being my first research study, I have learned so much about research in general including the importance of improving my writing skills, checking data for errors, and constantly reviewing the current literature to check for updates.

For future research, I believe it would be interesting to perform a similar study with a cohort of young adults for several reasons. The BODPOD, which is an air displacement plethysmography device that has been demonstrated to be a valid and reliable tool for measuring a range of individuals' body density, including overweight or obese individuals, was used to measure the body density of the young adult cohort (71, 72). I think this would have provided a more accurate BMI and other variables such as lean body mass, fat mass, and percent body fat could be examined. Furthermore, the young adults complete a Peak Exercise Test to measure cardiovascular fitness and to examine the heart rate and autonomic response to exercise. During this test, the goal is to reach peak oxygen consumption, which is a good indicator of overall health status. A test of physical activity would be more reliable than an exercise questionnaire. While we still found a relationship between breastfeeding and physical activity, I think it would be useful to perform a similar study using the BODPOD measurements and the Peak Exercise Test. It would be interesting to see if the relationship between breastfeeding and physical activity became even stronger and if a relationship was found with diet quality. In addition, maybe exercise would become a significant predictor of BMI in a multiple regression analysis.

This study had challenges in its data collection, particularly since it was a longitudinal study. As is true for many studies, visit no-shows seemed to be a problem for follow-up visits. I am not sure how to remedy this, but larger monetary incentives such as gift cards to restaurants and perhaps more flexible hours for appointments may help to offset the inconvenience to participants and parents and prevent missed work and school. This study also followed participants for several years but still managed to collect data for many of the participants. The investigators were fortunate that more subjects were not lost due to issues such as leaving the area or moving and being lost to contact. I am impressed by the enormous undertaking and how complicated it is to perform a long-term study such as this one.

During the completion of this research, I have learned a great deal and have acquired invaluable skills that will serve me well in any field that I enter in the future. This research project has opened my eyes to the world of research and the many paths that I could take in the future with both nutrition and as a dietitian. After completing the dietetic internship, I may continue on and pursue a PhD and continue research. However, even if I do not, this experience has been a very important contribution to my education. It has allowed me to develop skills as a researcher, which will help prepare me for a career as a dietitian. I believe that these skills will have a positive impact on my practice as a clinician and help me to better interpret the literature objectively to better help my clients.

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APPENDIX A

HEI-2010 SCORE CALCULATION METHODOLOGY

The following protocol is what our lab group uses to calculate HEI-2010 scores from the data from the Nutrition Data System for Research (NDSR). It is originally from (Mellendick, K., 2016, Embargoed dissertation, UNCG) but has been updated for this research.

HEI-2010 Score Calculation Methodology

Diet quality is representative of an average of the participant's intake over 3 days of diet recall data which is expressed as an HEI-2010 score. These HEI-2010 scores are calculated by using output files 1 (nutrient data at the component/ingredient level), 4 (nutrient data at the daily totals level), and 9 (food group serving counts at the daily totals level) from the NDSR 2013 software.

HEI-2010 component scores for total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and refined grains were calculated from food group serving counts from output file 9. Whole grains, total protein foods, seafood and plant proteins, and refined grains serving counts were converted to ounces. Total fruit, whole fruit, total vegetables, greens and beans, and dairy serving counts were converted to cups.

The total fruit component of the HEI-2010 is comprised of all fruit listed in the MyPyramid Equivalents Database. A total fruit amount was produced by the summation of all fruit groups from NDSR output file 9. The whole fruit component of the HEI-2010 contains all fruits from the total fruit component, except for 100% fruit juice. In NDSR, all fruit groups, except juices, were summed to produce a whole fruit amount. The total vegetables component of the HEI-2010 also is comprised of all vegetables listed in the MyPyramid Equivalents database. A total vegetables amount was produced by the summation of all vegetable groups from the NDSR output file 9. The summation of all dark green vegetables, dried beans, and peas is considered the greens and beans component which is procured from the summation of the dark green vegetables group and legumes groups from the NDSR output.

The whole grains component of the HEI-2010 is comprised of all grains containing the entire grain kernel. This is applicable to whole wheat flour products, brown rice, and several unrefined grains, for example, quinoa, barley, etc. There are three groups for grains in the NDSR output file 9 which are whole grains, some whole grains, and refined grains. To determine the whole grain portion of the some whole grains group, we approximated that all some whole grains are about 50% whole grain (103). In order to calculate the whole grains amount, we totaled the whole grains group with half the some whole grains group. From the NDSR output the some whole grain group was determined in the same way for the HEI-2010 refined grains component. The HEI-2010 describes refined grains as grains that include less than the whole kernel. This refined grains amount is determined by adding the refined grains group with half the some whole grains group.

The dairy component is described by the HEI-2010 as products created from cow's milk, goat's milk, and fortified soy beverages. Foods produced mainly from milk fat like butter, cream, ice cream, and sour cream are left out from this component and only whole fat and reduced fat milk products are included. Milk, yogurt, and cheese groups were totaled from NDSR output file 9 to produce a dairy amount but dairy-based desserts, creams and dairy-based supplements were left out.

The total protein foods component of the HEI-2010 is comprised of all meat, poultry, fish, eggs, nuts, legumes, and soy-based meat substitutes like tofu. These groups were totaled from the NDSR output file 9 to create a total protein foods amount. HEI-2010 describes seafood and plant proteins as any seafood, nuts and seeds, and soy products, except soy beverages. Therefore, a seafood and plant proteins amount was created from the summation of all fish, shellfish, nuts and seeds, and meat alternatives groups from the NDSR output. If the maximum (2.5 oz. equivalents per 1,000 kcal) score for total proteins foods components is not reached from other protein foods this is the only time beans and peas are counted towards this component; however, they are only counted up to the threshold for the maximum score. Beans and peas that are counted in the total protein foods component are also counted toward the seafood and plant proteins component but are not counted toward the total vegetables or greens and beans component. After the maximum score for the total proteins foods component is met, then any bean and peas intake left over will count toward the total vegetables and greens and bean component.

Scores for the sodium and fatty acids components were generated from nutrient data at the daily totals level from NDSR output file 4. The sodium component of the HEI-2010 is just the daily intake of sodium which is provided by NDSR output file 4 directly. The fatty acids component of the HEI-2010 is described as the sum of dietary polyunsaturated fatty acids and monounsaturated fatty acids, which is then divided by saturated fatty acids. The fatty acids component was calculated from the total daily intake of the polyunsaturated, monounsaturated, and saturated fatty acids produced from the NDSR output file 4.

The empty calories component score was generated from the nutrient data at the daily totals level from NDSR output file 4 and at the component/ingredient level from NDSR output file 1. The HEI-2010 describes empty calories as calories from solid fats, alcohol, and added sugars. NDSR output file 4 provides a total for solid fats in grams and contains an added sugars group which is described as sugar used in prepared foods, processed foods, and added separately to foods. The grams of ethanol from NDSR output file 4 was used first in order to calculate the alcohol part of the empty calories component. Calories from alcohol are only included in the empty calories component as grams ethanol if intake is greater than 13 grams per 1,000 kcal. The other energy-containing macronutrients contained in alcoholic beverages were identified from NDSR output file 1. From all alcoholic beverages, each of the following was totaled in grams: carbohydrates except for sugars, fat except for trans and saturated fats, and protein. The macronutrients were then summed to get the total energy gained from alcoholic beverages. Sugar was not included since it was contained in the added sugars amount. Trans and saturated fats were not included since they were contained in the solid fats amount.

All data in grams must be converted to energy in order to generate a score for the empty calories component. Carbohydrates form alcoholic beverages, proteins from alcoholic beverages, and added sugars were multiplied by 4 kcal/gram. Fats from alcoholic beverages and solid fats were multiplied by 9 kcal/gram. Ethanol was multiplied by 7 kcal/gram. The above six were then totaled, divided by total energy, and multiplied by 100 percent. This percentage was used to score the HEI-2010 empty calories component as below. Total energy consumed from NDSR output file 4 was used for total energy.

[(50% - average 3 day %energy from empty calories)/ 31] x 20 =

Participant Empty Calories Component Score

50% represents the standard for a minimum score in this category, while 31 is the difference between the standard for a minimum and maximum score.

All adequacy components of the HEI-2010 that are converted to cup equivalents (total fruit, whole fruit, total vegetables, greens and beans, dairy) were scored as below:

(3 day average cup equivalents consumed/ 3 day average for energy) x 1000 = Participant Standard

(Participant Standard/ Component Standard for Maximum Score) x maximum points possible = Component score

All adequacy components of the HEI-2010 that are converted to ounce equivalents (whole grains, total protein foods, seafood and plant proteins) were scored in the same manner as above, replacing cup equivalents for ounce equivalents.

The refined grains component of the HEI-2010 was scored as below:

(3-day average ounce equivalents consumed/ 3 day average for energy) x 1000 = Participant Refined Grain Standard

[(4.3 – Participant Refined Grain Standard)/ 2.5] x 10 = Refined Grains Component Score

4.3 represents the standard for a minimum score in this category, while 2.5 is the difference between the standard for a minimum and maximum score.

The HEI-2010 sodium component was scored similarly:

(3-day average gram sodium consumed/3-day average for energy) x 1000 = Participant Sodium Standard

[(2 – Participant Sodium Standard)/ 0.9] x 10 = Sodium Component Score

2 represents the standard for a minimum score in this category, while 0.9 is the difference between the standard for a minimum and maximum score.

Finally, the HEI-2010 fatty acids component was scored as below:

(3 day average grams polyunsaturated fatty acids + 3 day average grams monounsaturated fatty acids)/ 3 day average grams saturated fatty acids = Participant Fatty Acids Standard

[(Participant Fatty Acids Standard – 1.2)/ 1.3] x 10 = Fatty Acids Component Score

1.3 represents the standard for a minimum score in this category, while 1.2 is the difference between the standard for a minimum and maximum score.

In each case above, if the calculated score exceeds the maximum points for the component, the maximum points for that component replaced the score.

Dietary Components

Output files 4 (nutrient data at the daily totals level) and 9 (food group serving counts at the daily totals level) will be used from the NDSR 2013 software to obtain the data for certain dietary components and food groups.

Output file 4 will be used to determine total energy, total fat, saturated fat, omega-3 fatty acid, fiber, sodium, potassium, calcium, and magnesium intake. The average of the three days of intake will be taken for each category. Total and saturated fat will be combined and multiplied by 9 kcal per gram, then divided by 3 and multiplied by 100 to obtain an average daily percentage for energy consumed as fat. These average daily intakes will be utilized in data analyses.

Output file 9 will be used to determine refined grain, empty calorie, whole grain, fruit, vegetable, and legume intakes also by taking the average of the three days of intake for each category. Instead of converting to an HEI component score, the average cup equivalents consumed for each will be used for each category. However, the legumes intake will be calculated from the average of the three days of intake instead of using cup equivalents for the legumes group in NDSR output file 9.

APPENDIX B

ADOLESCENT ASSENT FORM

UNIVERSITY OF NORTH CAROLINA AT GREENSBORO

RIGHT TRACK

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Health Visit: Adolescent Assent Form

Title of Study: Pathways from Childhood Self-Regulation to Cardiovascular Risk in Adolescence
Project Investigators: Laurie Wideman, Susan Calkins, Lilly Shanahan, Susan Keane, and Cheryl Lovelady

<u>What are some general things you should know about research studies?</u>

You are being asked to take part in a research study. Your parent, or guardian, needs to give permission for you to be in this study. You do not have to be in this study if you don't want to, even if your parent has already given permission. To join the study is voluntary. You may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty.

Research studies are designed to obtain new knowledge. This new information may help people in the future. You may not receive any direct benefit from being in the research study. There also may be risks to being in research studies. Deciding not to be in the study or leaving the study before it is done will not affect your relationship with the researcher or the University of North Carolina at Greensboro.

Details about this study are discussed below. It is important that you understand this information so that you can make an informed choice about being in this research study. You will be given a copy of this assent form. You should ask the researchers named above, or staff members who may assist them, any questions you have about this study at any time.

<u>What is the purpose of this study?</u>

People's ability to fight disease (their immune system) and factors related to their metabolism play an important part in people's health. The purpose of this study is to collect information on the immune system and metabolism of Right Track Project participants.

<u>How many people will take part in this study?</u>

There are approximately 400 other people in this research study.

How long will your part in this study last?

Today's visit should last no more than 1 hour.

What will happen if you take part in the study?

You will complete a medical history form and the experimenter will document all medications you have brought to the lab for visit purposes. You complete some basic questionnaires on health, exercise and nutrition. Your height, weight, waist circumference, and blood pressure will be taken by the experimenter. Next, you will rest for 5 minutes, and then we will take a small amount of blood (15-20 ml or 3-4 teaspoons) from your arm. The blood sample will be stored in a secure lab facility. In a few months from now, the blood samples will be tested for immune function (e.g., proteins related to inflammation and cytokines), and metabolic factors (e.g., cholesterol, glucose, and insulin). Please note that we cannot perform medical diagnostic tests from the blood samples. Thus, the information from the blood samples will be used for research purposes only.

What are the possible benefits from being in this study?

There are no direct benefits to you for your participation in this study. In a scientific sense, this research study may give scientists more information about how the development of social, academic, and emotional development may lead to physical health outcomes for teens.

What are the possible risks or discomforts involved from being in this study?

There are no extraordinary risks to you from participating in the study. Infection is possible when blood samples are taken, but this risk will be minimized through the use of sterile techniques by a trained technician. Only slight discomfort should occur during the blood draw. You should feel slightly more pain than a mosquito bite when the blood sample is taken. Bruising may occur following a blood draw and may result in mild-to-moderate soreness to the touch for several days.

The Institutional Review Board at the University of North Carolina at Greensboro has determined that participation in this study poses minimal risk to participants. If at any time you feel uncomfortable answering a question, that question may be skipped. Similarly, if at any time you are uncomfortable participating in any of the assessments, that may be skipped. There may be uncommon or previously unknown risks. You should report any problems to the researcher.

If you have questions, want more information or have suggestions, please contact Laurie Wideman at (336) 334-3234 or Susan D. Calkins at (336) 334-9836. If you have any concerns about your rights, how you are being treated, concerns or complaints about this project or benefits or risks associated with being in this study please contact the Office of Research Integrity at UNCG toll-free at (855)-251-2351.

How will your privacy be protected?

Data collected from you will remain confidential. All data will be identified by participant ID# only and your data will not be stored together with any other other identifying information. Hard copies of questionnaire data will be kept in locked cabinets in the Right Track laboratory in Eberhart building at UNCG. Questionnaire data collected online will use an online survey-collection program called Qualtrics, which uses a "Secure Socket Layer". This is the equivalent to the industry standard for securely transmitting credit card information over the Internet. In addition, Qualtrics is a secure site with SAS 70 certification for rigorous privacy standards. Absolute confidentiality of data provided through the Internet cannot be guaranteed due to the limited protections of Internet access. Please be sure to close the browser when finished so no one will be able to see what you have been doing. Blood samples will be de-identified (code number & date only) and stored in the secure Exercise Physiology lab at UNCG. Data can be stored infedinitely, but will be destroyed when no longer needed for research.

Participants *will not* be identified in any report or publication about this study. Although every effort will be made to keep research records private, there may be times when federal or state law requires the disclosure of such records, including personal information. This is very unlikely, but if disclosure is ever required, UNC-Greensboro will take steps allowable by law to protect the privacy of personal information. In some cases, your information in this research study could be reviewed by representatives of the University, research sponsors, or government agencies (for example, the FDA) for purposes such as quality control or safety.

To further help us protect your privacy, we have obtained a Certificate of Confidentiality from the United States Department of Health and Human Services (DHHS). We can use this certificate to refuse to disclose information (for example if there were a court subpoena) that may identify you in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. Disclosure will be necessary, however, upon request of DHHS for the purpose of audit or evaluation.

What we find out about you will be private. That means we don't tell anyone anything about you—including your parent, your teacher, or anyone else that is not connected to our study. However, there are two situations where we would have to tell someone about your answers. First, we have to report any child abuse or neglect that we see or that you might tell us about. Second, if you give us information that makes us think that you are serious about hurting yourself or someone else then we will talk with your parent about that so that you can get the help you need to stay safe.

What if you want to stop before your part in the study is complete?

You can withdraw from this study at any time, without penalty. You will receive your $50 gift card regardless of whether you complete the entire study. The investigators also have the right to stop your participation at any time. This would only happen if there was reason to be concerned for your well-being as a result of participating in this study.

Will you receive anything for being in this study?

You will be receiving $50 gift card for taking part in this study. You will also be entered into a raffle for winning an iPad mini. There will be a random drawing for an iPad mini two times within the next year.

What if you have questions about this study?

You have the right to ask, and have answered, any questions you may have about this research. If you have questions about the study (including payments), complaints, concerns, or if a research-related injury occurs, you should contact the researchers listed on the first page of this form.

What if you have questions about your rights as a research participant?

All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns about your rights as a research subject, or if you would like to obtain information or offer input, you may contact the Institutional Review Board at (855) 251-2351.

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Participant's Agreement:

I have read the information provided above. I have asked all the questions I have at this time. I voluntarily agree to participate in this research study.

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Your signature if you agree to be in the study Date

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Printed name if you agree to be in the study

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Signature of Research Team Member Obtaining Assent Date

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Printed Name of Research Team Member Obtaining Assent