Determining the associations between sibling relationships and their amount of physical activity, and the risk of childhood obesity

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Determining the associations between sibling relationships and their amount of physical activity, and the risk of childhood obesity

By

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Thesis

presented in partial fulfillment of the requirements for the degree of

Master of Science

in Health and Human Performance- Community Health and Prevention Sciences

The University of Montana

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Abstract

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Title: Determining the associations between sibling relationships and their amount of physical activity, and the risk of childhood obesity

Seventy percent of children who are obese will grow up to be an overweight or obese adult, increasing their risk for mental, physical and health conditions including heart disease, diabetes, and joint problems (CDC, 2012). The sibling relationship consists of four major domains: 1) warmth and affection, 2) hostility and conflict, 3) rivalry, and 4) relative status/power (Furman, Buhrmester, 1985). These domains may be associated with sibling levels of physical activity (PA) and risk for obesity. Very few studies have assessed how sibling relationships affect one another’s PA and how these variables are related to the risk of childhood obesity. Purpose: The purpose of this study was to assess associations between amounts of sibling PA, sibling relationship domains (affection, hostility, rivalry and relative power/status) and body mass index (BMI) in sibling dyads, age 8-12 years old. Methods: Sibling dyads between 8 to 12 years old responded to questions about their relationships with one another and their amount of PA. Height and weight measures were collected on each child. The parents/guardians of the siblings provided demographic information for their age, gender, income, race, education level, and number of people supported by their yearly income. Data Analysis: Statistical analyses generated participant descriptive data and mean scores for sibling relationship domains, levels of sibling PA and BMI z-scores. Multiple linear regression models determined 1) how well sibling relationship domain scores and sibling PA scores predict sibling BMI z-scores, and, 2) how well parent demographic variables predict sibling BMI z-scores. Results: Thirty-two sibling dyads completed the study (n=64). The BMI-for age percentile classifications showed 1% (n=1) of the siblings were underweight, 60.9% (n=39) were normal weight, 14.1% (n=9) were overweight, and 23.4% (n=15) were obese. The BMI z-score mean was 0.62. Younger sibling PA scores ($r^2=0.026$, $p=0.19$) were not significantly associated with older sibling BMI z-scores. Younger sibling affection ($r^2=0.026$, $p=0.88$), rivalry ($r^2=0.026$, $p=0.24$), hostility ($r^2=0.026$, $p=0.39$), or relative status/power ($r^2=0.026$, $p=0.19$) scores were not associated with older sibling BMI z-scores. Older sibling PA scores ($r^2=0.026$, $p=0.34$) were not significantly associated with younger sibling BMI z-scores. Older sibling affection ($r^2=0.026$, $p=0.96$), rivalry ($r^2=0.026$, $p=0.11$), hostility ($r^2=0.026$, $p=0.97$) or relative status/power ($r^2=0.026$, $p=0.42$) scores were not significantly associated with younger sibling BMI z-scores. Parent/guardian age ($r^2=-0.32$, $p=0.61$), race ($r^2=-0.32$, $p=0.16$), yearly income ($r^2=-0.32$, $p=0.89$), or education level ($r^2=-0.32$, $p=0.74$) were not significantly associated with child participants BMI z-scores. Discussion and Future Directions: Siblings play an important role in each other’s lives while growing up. While these relationships may impact their risk of obesity our study found that the amount of sibling PA, affection, rivalry, hostility or relative status/power were not significantly associated with the siblings BMI z-score. Although this study did not yield significant results connecting sibling PA and SRQ scores to BMI z-scores, this topic does stimulate interest in the connections between sibling relationships and risk of childhood obesity and may inform the design of future childhood obesity interventions that target siblings and their families.
Acknowledgements

I would like to thank the following individuals for their help and guidance during this project. To my chair Blakely Brown thank you for your support, guidance and constantly pushing me achieve more. Thank you to my committee members Laura Dybdal, Vernon Grant, and Kari Harris for your time and expertise. I would also like to thank each site that allowed me to work with it’s members or students; you all have been extremely welcoming and a joy to work with.

To my parents and family thank you for always having faith in me and encouraging me to follow my dreams.

Larry, thank you for the constant support, guidance, and patience during this time.

Lastly, thank you to my fellow graduate students, who provided a laugh or distraction when it was most needed.

Dedication

I would like to dedicate this work to my brother, Kyle. Thank you for always being there, challenging me, providing a laugh and understanding my sisterly antics.
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Chapter One: Introduction

Seventy percent of children who are obese will grow up to be an overweight or obese adult, increasing their risk for mental, physical and health conditions including heart disease, diabetes, and joint problems (CDC, 2012).

The sibling relationship is made up of many different characteristics. Some of these characteristics include competitiveness, teasing, love, and pride (Senguttuvan, Whiteman, Jensen 2014). Older siblings are often a source of guidance and may act as caregivers towards their younger siblings (Feinberg, Solmeyer, 2011). The older sibling is able to comfort, support and help the younger sibling understand social situations (Kramer, Conger, 2009). Siblings who grow up in the same household can develop a feeling of stability, which may be challenging for young children to develop in other relationships outside of the household.

When siblings are affectionate towards each other or show support for one another they are more likely to express prosocial behaviors. Prosocial behaviors consist of sharing, helping and comforting others (Dunn, Munn, 1986). Investigators propose the sibling relationship consists of four domains; 1) warmth and affection, 2) hostility and conflict, and 3) rivalry 4) relative status/power (Furnman, Buhrmester, 1985).

There has been minimal research conducted on how sibling relationships affect weight status. Negative sibling relationships have been connected to depression, anxiety and poor self-esteem, which may increase a child’s risk for becoming overweight or obese.

Purpose of the Study

The purpose of this study was to assess associations between amounts of self-reported sibling physical activity (PA), self-reported sibling relationship domains (affection, hostility and rivalry) and body mass index (BMI) in sibling dyads, age 8-12 years old.
Statement of the Problem

In research exploring sibling relationships and risk for obesity, height and weight measures used to determine BMI have been self-reported, rather than objectively measured (Senguttuvan, et al 2014). Previous research did not report how the sibling relationship may predict BMI in children age 8-12 years old. Very little research has been conducted assessing the relationship between PA, sibling relationship domains and risk for obesity in this sibling age group. This study will add to the paucity of research in this area and may help guide future obesity prevention interventions that target siblings and their relationships with one another.

Research Questions

1. Are sibling relationship domains of warmth, hostility, rivalry, and the amount of reported sibling PA associated with sibling BMI-for-age percentiles and z-scores?
   a. Research Hypothesis: A higher amount of sibling warmth, and an increased amount of sibling physical activity will be negatively associated with BMI-for-age percentiles and z-scores.
   b. Research Hypothesis: A higher amount of sibling hostility and a decreased amount of sibling physical activity will be positively associated with BMI-for-age percentiles and z-scores.
   c. Research Hypothesis: A higher amount of sibling rivalry and a decreased amount of sibling physical activity will be positively associated with BMI-for-age percentiles and z-scores.
   d. Research Hypothesis: A higher amount of sibling relative status/power and a decreased amount of sibling physical activity will be positively associated with sibling’s BMI z-scores.
Delimitations

1. The study will be delimited to siblings who are enrolled in an after-school program within Missoula Boys and Girls Clubs of Missoula (Bonner and Lolo), Missoula Parks and Recreation after-school program, Boys and Girls Club of the Flathead Reservation (Ronan and Polson), and Target Range School District.

2. The data will be restricted to self-report responses from the questionnaires.

3. The study will be delimited by voluntary participation.

Limitations

1. The data will be limited to siblings from the target population who volunteered to participate in questionnaires and height and weight measures. These study participants may have different sibling relationships and physical activity levels than those who did not participate in the study.

2. The responses elicited will be limited to the accuracy of the participants during the completion of the questionnaires.

3. The generalizability of the results will be limited due to only sampling sibling pairs and their parents from the Missoula, Montana and Ronan, Montana.

4. The cross sectional study design limits the ability to capture change in the relationship, and BMI, that may occur over a longer period of time (i.e. longitudinal, prospective study design).
**Definition of Terms**
The following is a list of terms and their functional definitions for the purpose of this study.

*Sibling Dyad (or Pair):*

Children who are biologically related to each other and stem from the same parents/guardians (Merriam-Webster. n.d.). The sibling dyad (or pair) can be composed of older brother/younger brother, or older sister/younger sister, or older brother/younger sister or lastly, older sister/younger brother.

*Parent/Guardian*

The primary care giver of a child (Merriam-Webster. n.d.). The parent/guardian typically makes the household decisions.

*Childhood Obesity*

Body mass index (BMI)-for-age percentiles are used to determine if a child is overweight or obese (CDC, 2015). A child is considered underweight if their BMI-for-age is less than the 5th percentile; normal (or healthy weight) when they are in the 5th to less than the 85th percentile (CDC, 2015). A child is considered overweight if their BMI is at or between the 85th percentile to less than the 95th percentile and obese when their BMI is above the 95th percentile (CDC, 2015).

*BMI Z-Scores*

BMI standard deviation scores (i.e. BMI Z-Scores) are measures of weight that are adjusted for child age and sex (Must, Anderson, 2006). A BMI Z-score is determined from a child’s BMI-for-age percentile.
Sibling Relationship Domains

The sibling relationship is comprised of three different domains (Furnman, Buhrmester, 1985):

1. Warmth and affection relate to how much the sibling dyad supports, admires, shares, and helps one another.

2. Hostility and conflict are connected to the disagreements a sibling dyad will experience.

3. Rivalry is how each individual child perceives the differences in the way the parents treat the other sibling (i.e. the attention one sibling receives but the other sibling does not receive).

Physical Activity

Movement that requires energy and is produced by the body’s skeletal muscles (WHO, n.d).
Chapter Two: Review of Literature

Introduction

The increased amount of childhood obesity in the United States over the past decade has gained the attention of medical personnel, politicians, parents and academia. Childhood obesity can negatively affect every organ system in the human body (Han, 2010), as well as psychological wellbeing. Health care costs are increased for those who are obese (Reilly, Methven, McDowell, 2003). Children suffering from obesity are 70 percent more likely to be obese as adults (CDC, 2013). Childhood obesity has been linked to poor dietary habits and lack of physical activity (PA) (CDC, 2015).

Body mass index (BMI)-for-age percentiles are used to determine if a child is underweight, normal weight, overweight or obese (CDC, 2015). A child is considered underweight if their BMI-for-age is less than the 5th percentile, normal (or healthy weight) when they are in the 5th to less than the 85th percentile (CDC, 2015). A child is considered overweight if their BMI is at or above the 85th percentile and obese when their BMI is above the 95th percentile (CDC, 2015). BMI standard deviation scores (i.e. Z-Scores) are measures of weight that are adjusted for child age and sex (Must, Anderson, 2006). BMI z-score is useful when evaluating adiposity cross sectionally (Cole, Faith, Pietrobelli, Heo, 2005).

There is minimal research on how sibling relationships are related to risk of childhood obesity. Siblings have a powerful influence over one another; they may encourage or discourage physical activity. Conducting more research in this area may improve family-based obesity prevention interventions, especially those that focus on siblings.
Childhood Obesity

Short and long term medical problems, as well as, psychological disturbances are associated with childhood overweight and obesity (CDC, 2015). Childhood obesity increases health care costs and absenteeism from school (Geier, Foster, Womble, McLaughlin, & Borradale, 2007). Parent and guardian productivity in the workplace is also associated with childhood overweight and obesity. Socioeconomic status (SES) is associated with risk for childhood obesity (Fradkin, Wallander, Elliot, Tortolero, & Cuccaro, 2015). For example, families from a higher or lower SES are more likely to have overweight or obese children (Fradkin, et al., 2015).

Approximately one-third of all school aged (kindergarten-12th grade) children in the United States are overweight or obese (Dixon, Pena, Taveras, 2012). Nearly 32% of students in the U.S. between the ages 2-19 are overweight or obese. Childhood obesity not only affects the child but also the child’s parents or guardians. Sepulveda and colleagues assessed how having a child that is overweight or obese affects the parents’ work productivity and absenteeism (Sepulveda, Tait, Zimmerman & Edington, 2010). Results showed that illness and psychological distress due to a child being overweight or obese may increase parental conflicts and caregiving (Sepulveda et al., 2010). Overweight or obese children are more likely to use surgical and laboratory services, behavior health visits, and outpatient facilities (Sepulveda et al., 2010). Investigators speculate that an increased use of these kinds of services could result in an increased rate of parent absenteeism from work (Sepulveda et al., 2010). If a child needs medical treatment then parent work attendance will decrease (Sepulveda et al., 2010). Future studies should be conducted to examine how one sibling that is overweight or obese impacts the parental role over the normal weight sibling. For example, does the normal weight child
have an increased rivalry with the overweight child because the parent takes more time off work to attend various doctor appointments with the overweight child instead of spending that time with the normal weight child?

Children who are obese are more likely to experience sleep apnea, psychosocial issues, increased risk of chronic disease and possibly, shortened lifespan (Dixon et al., 2012). The increased risk for chronic disease also affects healthcare resources and expenditures. Research shows children with a BMI in the 85 to less than the 95th percentile (i.e. overweight) had total annual health-care expenditure of $180 higher than children with a normal BMI (Finkelstein, E. A. & Trogdon, J. G. 2008). Children with a BMI ≥95th percentile (i.e. obese) had, on average, a $220 annual increase in healthcare expenditures (Finkelstein, E. A. & Trogdon, J. G. 2008). Increased expenditures in children with a higher BMI may be a result of additional outpatient visits or prescription medications (Trasande, L. & Chatterjee, S., 2009).

Causes of childhood obesity include poor dietary habits, both low and high socioeconomic status, genetics, lack of PA and environmental factors such as limited access to affordable healthy foods and increased advertising of unhealthy food and beverage products (CDC, 2015). Increased risk of childhood obesity is positively associated with lack of breastfeeding, introduction to solid foods too quickly and an adverse utero experience (i.e. Gestational Diabetes, extreme maternal stress, etc.)(CDC, 2013).

Socioeconomic status is measured in individuals and families by considering a combination of income, career, and education levels (American Psychological Association, n.d.). There is a connection between childhood obesity and SES; however, it may be influenced by gender, age, and country in which they are living (Wang, Lim, 2012). It has been shown that
children from high SES have higher rates of obesity as well as those from low SES (Wang, Lim, 2012) because dietary intake and PA levels vary across the various SES levels (Fradkin et al., 2015). For example, if a child comes from a family of low SES he or she may be more likely to eat foods high in fat and sugar (i.e. doughnut) and less likely to consume foods that are rich in nutrients (i.e. apple). The same child may be less likely participate in PA for various reason such as an unsafe neighborhood, lack of money for organized sport or he or she may have to care for a younger sibling.

A team of researchers looked at the correlation between weight and absenteeism from school (Geier et al., 2007). Fourth through sixth grade students (n=1126) participated in the study (Geier et al., 2007). The researchers grouped underweight and normal weight children into one category and overweight and obese children in a second category. Overall, overweight and obese children were absent significantly more (p< 0.05) than the underweight and normal weight children. On average, normal weight children were absent 10.1 ± 10.5 days (Geier et al., 2007). Overweight children were absent 10.9 ± 9.5 days and obese children were absent 12.2 ± 11.7 days (Geier et al., 2007). The researchers speculate the reason for the varying rates of absenteeism by weight status is because obese children are more likely to experience issues with their peers (i.e. excluded) and various medical conditions (i.e. asthma) when compared to normal weight children (Geier et al., 2007).

According to Strauss, children ages 13 – 14 years, who were overweight or obese, had significantly lower self-esteem when compared to non-obese children (Strauss, 2000). During a longitudinal study, researchers administered a survey to children (n=970) when they were between 9 and 10 years old and again when they were between 13 and 14 years old. When the
children took the follow-up assessment at 13-14 years of age, 14% of boys who were obese had low self-esteem compared with 9% of boys who were not obese (Strauss, 2000). Thirty-four percent of Caucasian girls had low self-esteem levels compared to 8% of girls who were not obese (Strauss, 2000). Low levels of self-esteem were associated with sadness, loneliness, and nervousness. Strauss concluded that there is a significant relationship in adolescence between obesity and self-esteem levels (Strauss, 2000).

There are various long-term health risks associated with childhood obesity. These long-term effects include elevated risk for heart disease, diabetes, certain forms of cancer, and potential for a shortened lifespan (Basics About Childhood Obesity, 2012). These elevated health risks might be avoided if adequate PA levels are achieved (Taveras et al., 2013), which could reduce a child’s risk for becoming overweight or obese.

**Physical Activity**

According to the World Health Organization (WHO) children should participate in 60 minutes of PA seven days per week (WHO, n.d.). The 60 minutes can be comprised of aerobic (i.e. brisk walking), muscle strengthening (i.e. push-ups) and/or bone strengthening (i.e. jump roping) (How Much Exercise for Children Need, 2015).

High levels of PA are predicted by enjoyment of PA, positive parental and peer social support and influence, specific self-efficacy to exercise regularly, parental modeling, preference for PA behaviors and history of participation (Goran, Sothern, 2006). However, in children it is difficult to determine the effects of PA to energy expenditure (EE) because it is difficult to separate out the effects of the contribution of PA to EE from that of normal growth and maturation (Goran, Sothern, 2006). Energy balance is when the energy intake of food matches the EE (Goran, Sothern, 2006). It has been shown there is no relationship between EE and body
fat (Goran, Sothern, 2006). It is also difficult to understand the connection between sibling relationships, and their PA and weight status.

**Siblings**

Siblings spend a large portion of their time together which gives siblings ample opportunity to learn from one another (Kramer, Conger, 2009). Siblings have a detailed understanding of what it is like to mature and collectively be raised by their parent or guardian. This bond can lead to special forms of understanding and support between the dyad. This can be extremely important to the younger sibling when there are family stressors or transition. The older sibling may be able to comfort, support and help the younger sibling understand the situation (Kramer, Conger, 2009). Siblings who grow up in the same household can develop a feeling of stability, which may be challenging for children to develop in relationships outside of the home.

Children have a greater likelihood of growing up with a sibling than they do with their own father (Feinberg, Solmeyer, 2011). Siblings who are growing up without a father or a mother figure will develop a strong sense of companionship with each other. One sibling may look to the other as a replacement parental figure. For example, if the older sibling picks his or her younger sibling up from school the younger sibling may rely more on the older sibling in ways that are different from his or her father. This sibling reliance may help strengthen the relationship. The sibling relationship often involves competitiveness, teasing, pride, love, tears, and laughter among other traits (Senguttuvan, et al 2014). A study reported the most common positive qualities in a sibling relationship were companionship, admiration, pro-social behaviors and affection (Furman, Buhrmester, 1985). These results suggest that a sibling relationship with more positive qualities may result in the siblings participating in physical activities
together. These behaviors could decrease risk of the siblings becoming overweight or obese in childhood.

Older siblings are more likely to be models, sources of guidance, and caregivers to their younger siblings (Feinberg et. al., 2011). Sibling units that involve a brother have a greater amount of conflict. Kim and colleagues found second born children report higher levels of conflict between siblings until the age of 12 compared to first-born children (Kim, McHale, Osgood, Crouter, 2006). Sister dyads have a greater level of intimacy between them (Feinberg et. al., 2011). When sibling conflict was evaluated, 70% of families (n=2,143) reported physical violence such as biting, kicking, punching between the sibling dyad (Steinmetz, S. K., Strauss, M. A., Gelles, R. J., 1981). These findings suggest further investigating if younger siblings do in fact report higher levels of conflict when compared to older siblings.

Siblings learn from each other in a variety of ways: observational learning, interactions with each other, identity formation and de-identification in regards to the sibling, shared experiences, and separate experiences that may lead to resentment within the unit (Kramer, 2009). Observational learning consists of formal or informal instruction that occurs between siblings. One theory that describes the way siblings learn from each other is Social Learning Theory (Bandura, 1977). Social Learning Theory proposes that individuals will learn new behaviors and develop beliefs through reinforcement. For example, older siblings have the ability to teach their younger sibling various tasks such as brushing teeth (Kramer, 2009). Younger siblings frequently mimic their older brother or sister. The older sibling can learn from the younger one as well. Relationships may play a part in how siblings influence each other; if the relationship is positive there will be more opportunities to learn and observe one another
Leeuw, Harriette, Leeuw, Strien & Engels, 2006). For example, a younger sibling will observe how the older sibling acts around his or her peers and then may mimic that behavior.

The general interactions between siblings’ can demonstrate sibling support or neglect. Sibling support has been linked to social aptitude and academic engagement (Feinberg et. al., 2011). When siblings are young, hostility is a predicting factor of hostility towards a friend or another family member later in life (Kramer, 2009). Identity formation or de-identification takes place when the older sibling begins to “set the bar” (Kramer, 2009). This may help the younger sibling look to their older sibling as a role model and strive to achieve more, or make the younger sibling resentful of the older sibling. De-identification also takes place when siblings develop their own interests and passions that are separate from one another (Kramer, 2009). As siblings who are close in age grow up together they share many experiences, which may produce a feeling of solidarity between them (Kramer, 2009). Sibling support is believed to be extremely important, especially when there are difficult events happening within the family unit, such as divorce or when a family pet dies. The sibling interactions may develop more feelings of warmth or hostility between the dyad, which may be a predictor for a child being overweight or obese.

Pachucki and colleagues conducted a study to determine risk of obesity within siblings. The researchers recruited families who had one or two children aged <18 years currently living at home (Pachicki, 2014). Results showed that in households with two children, the older sibling had a 5.4 times greater chance of being overweight or obese if the younger sibling was overweight or obese while the younger sibling had a 5.6 times greater risk of being overweight or obese if the older sibling was obese (Pachucki, 2014). The study also explored the
relationship between sibling gender and risk of childhood obesity. When a boy had an older brother, the younger brother was 11 times more likely to experience obesity. However, if the older sibling was female, the younger brother was only 6.6 times more likely to experience obesity. When a sister had an older obese sister, the younger sister was 8.6 times more likely to be obese or overweight. These results suggest that having an obese, same gender sibling, increases the likelihood that the younger sibling will be overweight or obese (Pachucki, 2014).

The study also assessed the relationship between sibling obesity and levels of physical activity (Pachucki, 2014). Results showed that younger siblings with more vigorous PA were significantly less likely to be obese, although having an extremely active older sibling was associated with a higher risk of obesity in the younger sibling (Pachucki, 2014).

The studies described above suggest that sibling relationships, birth order and gender, may be associated with risk of obesity in siblings. The relationship siblings share or do not share is thought to influence healthy and unhealthy coping behaviors. Future research should explore how the siblings relationship influences coping behaviors.

**Sibling Relationship Measurements**

Sibling relationships are measured in multiple ways. The three most common ways of assessing sibling relationships are interviews, questionnaires and direct observation (Conger, Lorenz, Wickrama, 2004). Direct observation is most commonly used in young siblings (Schicke, 1995). The researcher will typically observe the sibling dyad by themselves, or with only the mother or father present, or with both parents present (Schicke, 1995). This provides the researcher with an understanding of how the sibling interactions change with other family members around (Schicke, 1995). The most common places for observations include the children’s home, a laboratory or the classroom (Schicke, 1995). There have been differing
results when siblings are studied in various settings. For example, there are typically lower rates of interaction when a sibling dyad is being observed in a laboratory setting when compared to being observed at home or school. This may because the laboratory is an unfamiliar setting (Schicke, 1995). Within sibling research it may be beneficial to observe sibling dyads without the mother present, as prosocial behaviors are more likely to be displayed when the mother is absent (Schicke, 1995). Prosocial behaviors include any behaviors that are intended to benefit someone else (Eisenberg, 2006). Future studies in this area should take this into consideration if the research is exploring how the sibling relationship impacts prosocial behaviors, and if these behaviors are related to risk of obesity in the sibling pairs.

Interviews are commonly used to assess a sibling relationship. The interviews can be conducted with both the parents and children (Schicke, 1995). Interviews with the parents provide information from more than one source and assist the researcher in gaining more insight than what he or she has observed (Schicke, 1995). Parental interviews also provide the parent’s perception of the sibling relationship (Schicke, 1995). Parental interviews are primarily used in research focusing on young children. Edwards and colleagues interviewed parents (n=53) of children age 5 and 6 years old to determine how siblings and friends influence PA and screen time (Edwards, Jago, Sebire, Kesten, Pool, & Thempsom, 2015). From the interviews researchers concluded that sibling PA is influenced in the form of impromptu play rather than structured play time (Edwards, Sebire, Kesten, 2015). Quantitative approaches might be helpful in determining if siblings do impact one another’s PA. To quantify PA researchers could use self-report surveys in children six years and older and activity monitoring. The self-report surveys could consist of questions that address what type of PA the sibling dyad participates in
together. The activity monitoring data could help researchers objectively determine when siblings are most active together. This kind of mixed methods approach (self-report surveys and activity monitoring) could create a strong picture of the PA sibling pairs participate in and how they influence one another.

Self-report measures have been the preferred method of research when the participants are in middle childhood and adolescence, between the ages of 6 and 11 years old (Conger, Lorenz, Wickrama, 2004) (CDC, 2015). Children age six and older have been shown to add to the researcher’s image of the sibling relationship (Schicke, 1995). Children age six and older are able to participate in interviews and provide the researcher with valuable information (Schicke, 1995). For example, Stillwell and colleagues conducted interviews with 6-year old participants \( n=25 \) asking them to describe themselves, family and friends (Stillwell, Dunn, 1985). The researchers then compared the children’s answers to the mother’s. Results showed a high correlation between what the child reported on their relationship with his/her sibling and what the mother reported (Stillwell, Dunn, 1985). The study did confirm that children are able to provide accurate information to researchers in regards to their sibling relationship.

The Social Relations Model (SRM) was originally developed to study shared realities and the perceived similarities in relationships (Conger, Lorenz, Wichrama, 2004). Researchers have used the SRM and its three components of perceived similarity to study sibling relationships (Conger, Lorenz, Wickrama, 2004). The components of perceived similarity are as follows: 1) Perceived similarity is one sibling’s view of how similar he or she is to their sibling; 2) Actual similarity is the level of agreement between what the siblings state on his or her self-report measures in regards to their own behavior; 3) Understanding similarity is the degree to which a
child’s perception of his or her sibling’s behavior corresponds with the siblings’ self-perception (Conger, Lorenz, Wickrama, 2004). There are also various domains (i.e. warmth, hostility, rivalry) within sibling relationships that may be perceived the same or differently within each individual sibling. These domains, and their potential relationship to risk of childhood obesity, are described in the following section. This is important because researchers can use both the SRM and the sibling domains to better understand the dynamics between siblings and how they affect weight status. For example if a sibling pair experiences more hostility in their sibling relationship they may be more likely to be overweight or obese.

**Perceptions of Sibling Relationships**

The sibling relationship has many positive and negative components. How these components relate to childhood obesity is lacking in the literature. This section describes the components that make up the sibling relationship and how they relate to health.

Investigators propose that sibling relationships consist of four domains: 1) warmth and affection, 2) hostility and conflict, 3) rivalry, and 4) relative status/power (Furman, Buhrmester, 1985). Warmth and affection are related to support, help, sharing and admiration between the sibling pair (Lecce, Bernart, Vezzani, Pinto, Primi, 2011). Hostility and conflict can occur during disagreements, such as when one sibling teases or aggravates the other (Lecce, Bernart, 2011). Rivalry describes how children view differences in treatment from their parents, especially affection and attention one receives (Lecce, Bernart, 2011). Relative status/power describes qualities like care giving, leadership, and dominance (Stocker, McHale, 1992).

Furman and colleagues developed a questionnaire to assess perceptions of the sibling relationship in children. The researchers first administered open-ended interviews to 49 children, age 11-13 years old and compiled a list of primary qualities in a sibling relationship
Based on these data, the researchers then developed the Sibling Relationship Questionnaire (SRQ). The SRQ is a self-report questionnaire that assesses the amount of warmth, hostility, rivalry and relative status/power in a sibling dyad. This instrument has been validated with parents who reported on the quality of their sibling relationships. Correlation coefficients for warmth/closeness internalizing and externalizing behaviors ranged from -0.23 to -0.16, sibling relationship with parents internalizing and externalizing behaviors ranged from -0.26 to 0.38, and warmth/closeness and conflict internalizing and externalizing behaviors ranged from -0.40 to 0.15 (Derkman, Scholte, Veld, Engels, 2010). The SRQ was administered to fifth and sixth grade children (n=198) (Furman, Buhrmester, 1985). The researchers concluded same-sex siblings felt greater amounts of warmth and affection towards each other (Furman, Buhrmester, 1985). Younger siblings in same-sex dyads reported their older sibling to be more dominant than in co-ed sibling dyads. Older siblings reported more nurturance and dominance over their younger sibling (Furman, Buhrmester, 1985). Younger siblings reported more companionship, rivalry and parent partiality (Furman, Buhrmester, 1985).

Padilla-Walker and colleagues examined the sibling relationship to determine if it is positively or negatively associated with prosocial behaviors or self-regulation. (Padilla-Walker, Harper, Jensen, 2010). Four hundred and twenty three families participated in the study. The families were either one-parent or two-parent households. The researchers used the SRI to evaluate the sibling relationship, the Novak and Clayton self-regulation measure, the Kindness and Generosity subscale from the Action Inventory of Strengths that captures prosocial behaviors, and a measure to assess externalizing and internalizing behaviors (Padilla-Walker,
Harper, 2010). The SRI differs from the SRQ in that it does not measure relative status/power in the sibling relationship. The SRI measures affection, hostility and rivalry. Results showed that sibling affection was significantly related to prosocial behaviors in both two- (p< .001) and single parent families (p< .05). Sibling affection was negatively related to child internalizing behavior for two- (p< .05) and single parent families (p< .01). The only variable that was significantly related to a child internalizing behavior was sibling hostility (p< .05) for two parent families only (Padilla-Walker, Harper, 2010). Sibling hostility was positively associated with internalizing behaviors such as “I am unhappy or sad” (Padilla-Walker, Harper, 2010). Sibling affection was positively connected to prosocial behaviors such as “I enjoy doing small favors for others” (Padilla-Walker, Harper, 2010). Sibling affection was negatively associated to externalizing behaviors like lying or cheating (Padilla-Walker, Harper, 2010).

It is thought that relationships have an influence over health via the effects on an individual’s self-esteem (Kramer, 2009). Siblings have various relationship qualities (i.e., rivalry versus closeness) that have been connected to self-esteem. Sibling relationships that have positive qualities have been shown to act as protective factors against family conflict, low parental support or supervision, and poor relationships with peers outside of the family (Kramer, 2009). Siblings that have negative relationships can be risk factors for unhealthy coping mechanisms later in life (Kramer, 2009). Positive sibling relationships can act as a mental health buffer when a child has a negative experience with another person (Feinberg et. al., 2011). Negative sibling relationships are associated with depression, anxiety, identity, self-esteem, peer relationships, and substance use; this may increase the individual’s risk for becoming obese or overweight (Kramer, 2009).
Collectively these data suggest that a positive sibling relationship can lead to positive health while a negative sibling relationship can lead to poor health. It is still unclear if the status of the sibling relationship is positively or negatively related to a sibling’s risk for being overweight or obese.

**Exercise within the Sibling Unit**

Siblings have a large impact on each other in regards to everyday behaviors and attitudes. How siblings support each other in PA is an understudied area of childhood obesity. This section describes the few studies that have explored how siblings support each other in physical activity.

Senguttuvan and colleagues conducted a study assessing how sibling intimacy is associated with health and PA, and how this could affect a child’s likelihood of being overweight or obese. Three hundred and twenty six families from various socioeconomic levels participated in the study. The researchers modified various questionnaires to assess sibling relationships. Height and weight measures were self-reported for each child (n=599) to determine BMI-for-age. Results showed the sibling intimacy score and children’s perseverance was positively correlated with overall attitudes toward health (Senguttuvan, et al 2014). The amount of time siblings spent in conflict was not related to the sibling unit’s overall feelings toward health (Senguttuvan, et al. 2014). Sibling intimacy was not associated with youth’s weight status (p>.05), but sibling conflict was a significant predictor of being overweight (p<.001; AOR = 1.99) (Senguttuvan, et al 2014). Older brother and younger sister sibling dyads reported higher levels of PA then sibling dyads with an older sister and younger sister (Senguttuvan, et al. 2014). A weakness in the study is the height and weight measures were self-reported by the families. This study suggests that in order to understand how siblings affect
one another’s health and risk for obesity, future research should collect objective height and weight measure and continues examining the various dimensions (affection, hostility and rivalry) of the sibling relationship.

A team of researchers measured PA levels in siblings (Duncan, T. Duncan, Strycker, Chaumeton, 2004). The researchers used a survey to measure physical activity. Youth participants (age 10-, 12, and 14-) self-reported on his or her own PA levels in the past seven days. Results showed that younger siblings participated in less PA than older siblings (Duncan, et al. 2006). Higher levels of PA were related to a greater amount of family support. Future research is needed to examine how sibling dyads specifically impact individual PA levels, PA levels completed together as a dyad and choices of PA. Based on the findings from this study, a future study could assess the relationship between weight, gender and age of the sibling dyad and the amount and type of PA for each sibling. Siblings (and their family members) could use cameras to document the activities siblings are doing together. A validated Physical Activity Questionnaire and activity monitors could also be used as measurement tools.

**Increasing Physical Activity in Siblings**

Only a few studies have assessed PA levels in siblings, although, to my knowledge, none have explored the relationship between sibling PA levels and risk of obesity in siblings. This section briefly describes the few studies that have assessed PA levels in siblings. Hohepa and colleagues conducted a study assessing social support for youth physical activity and the importance of external support. High schools students between the ages of 12 and 18 (n=3,471) from low socioeconomic schools in South Auckland, New Zealand were recruited to the study. The study measured demographics, PA levels, and perceived encouragement to participate in PA in the participants (Hohepa, Scragg, Schofield, Kolt & Schaaf, 2007). Each participant was
administered a survey that assessed PA in three different areas: active transportation, activity during lunchtime and activity after-school (Hohepa, et al. 2007). The survey was based on the Physical Activity Questionnaire for Children (PAQ-C). A 5-point likert scale was used to evaluate perceived encouragement to participate in PA. Based on their survey responses participants were grouped into high (i.e. reported receiving a lot of encouragement to participate in PA and low (i.e. reported receiving some to no encouragement to participate in PA) (Hohepa, et al. 2007). Sibling/cousin perceived support was correlated with being active during lunchtime for junior and senior students (junior students p< 0.0001, senior students p= 0.0001) (Hohepa, et al. 2007). Sibling/cousin perceived support in regards to after-school activity levels was only significant for students who were juniors (p= 0.0001). Junior students that perceived low sibling support were less likely to be active after-school (Hohepa, et al. 2007). This research suggests siblings may be a powerful support system for each other in after-school PA depending on the age, sex, and types of activities in which are being engaged (Hohepa, et al. 2007). Future studies might begin by conducting focus groups with siblings to explore what things would make them feel more supported to engage in physical activity. Then, next steps might be developing a sibling support intervention from the focus group data and conducting a pilot test of the intervention.

**Conclusion**

There is a strong relationship between socioeconomic status, education and income level and risk for childhood obesity. Other factors associated with risk for childhood obesity include poor dietary habits, genetics, lack of PA and environmental factors such as limited access to affordable healthy foods.
Sibling support and the sibling relationship may play an important role in the amount of PA a sibling is likely to engage in and sibling risk for obesity. There is a lack of studies that have explored how sibling relationships’ affect one another’s physical activity and how these variables are related to risk of obesity in the sibling dyad. Evaluating how sibling relationships influence each other’s PA may help design future childhood obesity interventions focused on siblings.
Chapter Three: Methodology

The purpose of this study was to assess associations between the amounts of reported sibling physical activity (PA), reported sibling relationship domains (warmth/closeness, conflict, rivalry and relative status/power) and body mass index (BMI) in sibling dyads, age 8-12 years old. This chapter further describes the methods and procedures employed in this study.

Research Setting
The research settings for this project were Boys and Girls Clubs of Missoula (Bonner and Lolo), Missoula Parks and Recreation after-school program, Boys and Girls Club of the Flathead Reservation (Ronan and Polson), and Target Range School District for the study.

Procedures
Research Design
The research design was a cross-sectional, non-experimental study in sibling dyads.

Recruitment and Subjects
The researcher obtained approval from the Boys and Girls Clubs of Missoula, Missoula Parks and Recreation after-school Program, Boys and Girls Club of the Flathead Reservation, Target Range School District, and University of Montana (UM) Institutional Review Board to conduct the study. Thirty-two sibling dyads, age 8 – 12 years old, and their parent or guardian, were recruited from Boys and Girls Clubs of Missoula (Bonner and Lolo), Missoula Parks and Recreation after-school program, Boys and Girls Club of the Flathead Reservation (Ronan and Polson), Target Range School District programs using direct personal contact. Parents were provided informed consent for themselves and their children; each child was provided informed assent (Appendices 1 and 2). The questionnaires were interviewer-administered to each child participant. Parent participants completed a self-administered a demographic survey.
Child Measurements

Weight and height was collected in all child participants using a SECA scale and stadiometer. Participants removed their shoes and heavy outside clothing (sweatshirts, coats, etc.) before they were weighed. Height and weight measures were then used to determine BMI-for-age percentiles and BMI z-scores. The numbers were entered into a BMI-for-age percentile calculator for pediatrics through the Children’s Hospital of Philadelphia website http://stokes.chop.edu/web/zscore/index.php. The BMI z-score calculator is based on the CDC growth charts (CHOP, 2016).

The Sibling Relationship Questionnaire is a self-report 48-item questionnaire used to assess how siblings feel about one another (Furman, Buhrmester, 1985) and has been validated with in the target population’s age range 8-12. The variables that are measured include warmth/closeness, conflict, rivalry and relative status/power (Furman, Buhrmester, 1985). The questionnaire was interviewer administered to each one of the siblings individually. The items were then scored on a 5-point-Likert scale. The response options range from “hardly at all” to “extremely much.” Warmth/Closeness is the largest scale within the questionnaire containing seven items. This is followed by relative status/power (4 items), conflict (3 items), lastly rivalry that contains 2 items. The researchers validated the SRQ by measuring the quality of relationship with the parents; internalizing and externalizing behavior to show adequate construct validity (Derkman, Scholte, Veld, Engels, 2010). A copy of the SRQ is in Appendix 3.

The Physical Activity Questionnaire-Children (PAQ-C) was used to assess the amount of physical activity each child participates in and what activities each sibling dyad participates in together. The PAQ-C contains 10 items and collects information about self-reported general
levels of physical activity over the past 7 days (Kowalski, Crocker, Donen, 2004). The questionnaire was interviewer-administered to each one of the siblings individually. The researcher added “do you do or not do this activity with your sibling” to the first question of the questionnaire. Each of the nine items in the questionnaire was scored using a 5-point scale (Kowalski, Crocker, Donen, 2004). Each questionnaire was given a score ranging from 1 (low physical activity) to 5 (high physical activity) (Kowalski, Crocker, Donen, 2004). Saint-Maurice and colleagues developed a calibration method for the PAQ-C and Physical Activity Questionnaire for Adolescents (PAQ-A) (Saint-Maurice, Welk, Beyler, Bartee Heelan, 2014). The researchers’ validated the PAQ by converting the PAQ scores to minutes of MVPA per week by developing a calibration equation. A copy of the PAQ-C questionnaire is in Appendix 4.

**Parent Measurements**

Parents completed a brief demographic survey that collected information for age, race and ethnicity, education level and socio-economic status.

**Data Analysis**

All data was entered into Microsoft Office Excel fro Mac 2011 (Microsoft Corporation, Redmond, WA) for organization and storage. Statistical analyses were performed using SPSS 24.0 for Mac (SPSS Inc., Chicago, IL) a computer based data analysis software program. The researcher (SD) assessed participant descriptive data and computed a summary activity score for each of the domains in the SRQ (warmth/closeness, conflict, rivalry, and relative status/power). A summary activity score was calculated for the amount of PA amount of PA each sibling participated in individually.

Univariate analysis (boxplots), bivariate analysis (scatter plots), Quantile-Quantile plots, and Residual plots were developed to assess for normality in the data (see Appendix 5).
The project researcher (SD) then constructed multiple linear regressions models to determine 1) how well the older sibling scores for affection, hostility, rivalry, relative status/power and amount of sibling PA predict the younger sibling’s BMI z-score, 2) how well the younger sibling scores for affection, hostility, rivalry and amount of sibling PA predict the older sibling’s BMI z-scores.

Exploratory analysis was constructed in a third model that includes child scores for sibling relationship domains, amount of sibling PA, gender, demographics, and socioeconomic status to determine how well these independent variables predict BMI z-score.
Chapter Four: Results

The purpose of this study was to assess associations between the amount of reported sibling physical activity (PA), reported sibling relationship domains (affection, hostility, rivalry, and relative status/power) and body mass index (BMI) z-scores in sibling dyads, age 8-12 years old.

All data were collected from voluntary participants (children age 8-12 years old) who participated in an after-school program at six different sites in Bonner, Lolo, Ronan, Polson, Target Range School or Missoula Parks and Recreation. These program sites are hereafter referred to as Site 1, Site 2, Site 3, etc. This chapter reports the results of the SRQ, PAQ-C, and BMI z-scores analyses.

Participant Demographics

Sibling Dyads

A total of 34 parents/guardians voluntarily signed consent for their children to participate in the study, but only 32 sibling dyads completed the study. Reasons for withdrawing from the study were: 1) a sibling dyad became ineligible by moving to a different after-school program that wasn’t in the study, and 2) one of the siblings did not feel comfortable answering questions about the sibling relationship. The parents/guardians of each sibling dyad completed a brief demographic questionnaire. The mean age of the sibling (child) participants was 9.7 years old (Table 1). Demographic characteristics of the siblings were 62% (n=40) Caucasian, 18.8% (n=12) American Indian or Alaskan Native, and 18.8% (n=12) were Other. The Other category includes American Indian or Alaska Native/Caucasian, American Indian or Alaska Native/Hispanic or Latino, Native Hawaiian or other Pacific Islander/Caucasian,
African American/Caucasian. In addition, 46% (n=30) of the participants were female and 53.1% (n=34) were male (Table 1).

The BMI-for age percentile classifications showed 1% (n=1) of the siblings were underweight, 60.9% (n=39) of the siblings were normal weight, 14.1% (n=9) of the siblings were overweight, and 23.4% (n=15) of the siblings were obese. BMI z-score mean was 0.62 (Table 1).

In terms of the after-school program sites, 20% (n=14) of the sibling dyads were at Site 1, 4.7% (n=2) of the sibling dyads were at Site 2, 6.3% (n=4) were at Site 3, 40.6% (n=26) were at Site 4, 25% (n=16) were at Site 5, and 3.1% (n=2) were at Site 6 (Table 1).

The gender composition of the sibling dyads was: 15.6% (n=5) older brother-younger sister, 31.3% (n=10) older brother-younger brother, 28.1% (n=9) older sister-younger brother, and 25% (n=8) older sister-younger sister (Table 2).
Table 1. Descriptive characteristics of the siblings.

<table>
<thead>
<tr>
<th>All Siblings* (n=64)</th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>1</td>
<td>1.59</td>
</tr>
<tr>
<td>Normal Weight</td>
<td>39</td>
<td>60.99</td>
</tr>
<tr>
<td>Overweight</td>
<td>9</td>
<td>14.1</td>
</tr>
<tr>
<td>Obese</td>
<td>15</td>
<td>23.4</td>
</tr>
</tbody>
</table>

BMI percentile mean (sd) 65.9 (28.9)
BMI z-score mean (sd) 0.62 (1.0)
Age mean (sd) 9.7 (1.3)

**Gender**
- Female 30 46.9
- Male 34 53.1

**Race**
- Caucasian 40 62.5
- American Indian/Alaska Native 12 18.8
- Other 12 18.8

**After-School program Site**
- Site 1 13 20.3
- Site 2 3 4.7
- Site 3 4 6.3
- Site 4 26 40.6
- Site 5 16 25
- Site 6 2 3.1

* Centers for Disease Control’s child weight status classifications based on BMI-for-age-and gender (CDC, 2015): Underweight: Less than the <5th percentile; Normal weight: 5th percentile to less than 85th percentile; Overweight: 85th percentile to less than 95th percentile; Obese: 95th percentile or greater.

Table 2. Gender composition of the sibling dyads.

<table>
<thead>
<tr>
<th>Gender Composition</th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older Brother-Younger Sister</td>
<td>5</td>
<td>15.6</td>
</tr>
<tr>
<td>Older Brother-Younger Brother</td>
<td>10</td>
<td>31.3</td>
</tr>
<tr>
<td>Older Sister-Younger Brother</td>
<td>9</td>
<td>28.1</td>
</tr>
<tr>
<td>Older Sister-Younger Sister</td>
<td>8</td>
<td>25</td>
</tr>
</tbody>
</table>

*30*
Older Siblings

The mean age of the older siblings was 10.53 years old (Table 3). Sixty-two percent (n=20) of the older siblings were Caucasian, 18.8% (n=6) of the older siblings were American Indian/Alaska Native, and 18.8% (n=6) of the older siblings were Other. Fifty-three percent (n=17) of the older siblings were female and 46.9% (n=15) of older siblings were male. BMI percentile classifications revealed that none of the older siblings were underweight, that 59.4% (n=19) of the older siblings were normal weight, that 9.4% (n=3) of the older siblings were overweight, and that 31.3% (n=10) of the older siblings were obese (Table 3).

Younger Siblings

The mean age of the younger siblings was 8.9 years old (Table 3). Sixty-two percent (n=20) of the younger siblings were Caucasian, 18.8% (n=6) of the younger siblings were American Indian/Alaska Native, and 18.8% (n=6) of the younger siblings were Other. Gender breakdown for the younger siblings was 40% (n=13) female and 59.4% (n=19) male. BMI percentile classifications revealed 3% (n=1) of the younger siblings were underweight, 62.5% (n=20) of the younger siblings were normal weight, 18.8% (n=6) of the younger siblings were overweight, and 15.6% (n=15.6) of the younger siblings were obese (Table 3).
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Older Siblings (n=32)*</th>
<th>Younger Siblings (n=32)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Normal weight</td>
<td>19 (59.4)</td>
<td>20 (62.5)</td>
</tr>
<tr>
<td>Overweight</td>
<td>3 (9.4)</td>
<td>6 (18.8)</td>
</tr>
<tr>
<td>Obese</td>
<td>10 (31.3)</td>
<td>5 (15.6)</td>
</tr>
<tr>
<td>BMI percentile mean (sd)</td>
<td>69.87 (27.5)</td>
<td>62 (30)</td>
</tr>
<tr>
<td>BMI z-score mean (sd)</td>
<td>0.70 (1.0)</td>
<td>0.53 (1.1)</td>
</tr>
<tr>
<td>Age mean (sd)</td>
<td>10.53 (1)</td>
<td>8.9 (1)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>17 (53.1)</td>
<td>13 (40.6)</td>
</tr>
<tr>
<td>Male</td>
<td>15 (46.9)</td>
<td>19 (59.4)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>20 (62.5)</td>
<td>20 (62.5)</td>
</tr>
<tr>
<td>American Indian/Alaska Native</td>
<td>6 (18.8)</td>
<td>6 (18.8)</td>
</tr>
<tr>
<td>Other</td>
<td>6 (18.8)</td>
<td>6 (18.8)</td>
</tr>
</tbody>
</table>

* Centers for Disease Control’s child weight status classifications based on BMI-for-age-and gender (CDC, 2015): Underweight: Less than the <5th percentile; Normal weight: 5th percentile to less than 85th percentile; Overweight: 85th percentile to less than 95th percentile; Obese: 95th percentile or greater.
Parent/Guardian Demographics

The parent/guardians completed a brief demographic questionnaire. Table 4 shows the results of this survey.

Of those surveyed, 93% (n=30) were the parent to the child, 3.1% (n=1) were the grandparent of the child, and 3.1% (n=1) were listed as other relationship to the child. The mean age of the parents/guardians was 36.13 years old. Sixty eight percent (n=22) of the parents were female and 31.1% (n=10) of the parents were male. Race of the parent/guardian included 71% (n=23) Caucasian, 18.8% (n=6) American Indian/Alaska Native, 9.4% (n=3) of the parents listed their race as Other.

Parent/guardians reported that 6% (n=2) had a yearly family income of less than $10,000, 15.6% (n=5) of the parents had a yearly income of $10,000 to $20,000, 21.9% (n=7) of the parents had a yearly income of $20,000 to $30,000, 3.1% (n=1) of the parents reported a yearly income of $30,000 to $40,000, 15.6% (n=5) of the parents earned $40,000 to $50,000 a year, 28.1% (n=9) of the parents had a yearly income of $50,000 and above, and 9.4% (n=3) of the parents did know their family income. The average number of people supported by the yearly family income was 4.7 people.

Education levels of the parents of the siblings consisted of 21% (n=7) having a high school diploma or general education diploma (GED), 37.5% (n=12) of the parents had some college education, 15.6% (n=5) of the parents had an Associate’s Degree, 18.8% (n=6) of the parents had a college degree, and 6.3% (n=2) of the parents had a graduate degree.
Table 4. Descriptive characteristics of the parents/guardians.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parents (n=32)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age mean (sd)</td>
<td>36.13 (8.21)</td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>22</td>
<td>68.8</td>
</tr>
<tr>
<td>Male</td>
<td>10</td>
<td>31.1</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>23</td>
<td>71.9</td>
</tr>
<tr>
<td>American Indian/Alaska Native</td>
<td>6</td>
<td>18.8</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>9.4</td>
</tr>
<tr>
<td><strong>Yearly Family Income</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ $10,000</td>
<td>2</td>
<td>6.3</td>
</tr>
<tr>
<td>$10,000-$20,000</td>
<td>5</td>
<td>15.6</td>
</tr>
<tr>
<td>$20,000-$30,000</td>
<td>7</td>
<td>21.9</td>
</tr>
<tr>
<td>$30,000-$40,000</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>$40,000-$50,000</td>
<td>5</td>
<td>15.6</td>
</tr>
<tr>
<td>$50,000-above</td>
<td>9</td>
<td>28.1</td>
</tr>
<tr>
<td>Income unknown</td>
<td>3</td>
<td>9.4</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School Diploma/GED</td>
<td>7</td>
<td>21.9</td>
</tr>
<tr>
<td>Some College</td>
<td>12</td>
<td>37.5</td>
</tr>
<tr>
<td>Associate’s Degree</td>
<td>5</td>
<td>15.6</td>
</tr>
<tr>
<td>College Degree</td>
<td>6</td>
<td>18.8</td>
</tr>
<tr>
<td>Graduate Degree</td>
<td>2</td>
<td>6.3</td>
</tr>
<tr>
<td><strong>Relationship to children</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent</td>
<td>30</td>
<td>93.8</td>
</tr>
<tr>
<td>Grandparent</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>3.1</td>
</tr>
</tbody>
</table>

**Sibling Relationship Questionnaire (SRQ)**

The SRQ was used to determine the amounts of affection, rivalry, hostility and relative status/power within each sibling dyad. The SRQ survey data are reported in Table 5.

**Sibling Dyads**

The mean score of sibling dyads for affection was 3.3, rivalry was 0.36, hostility was 2.9 and relative status/power was 2.7.
**Older Sibling Dyads**

The mean score for older sibling dyads for affection was 3.3, rivalry was 0.26, hostility was 3.1 and relative status/power was 2.9.

**Younger Sibling Dyads**

The mean score for younger siblings dyads for affection was 3.2, rivalry was 0.46, hostility was 2.8 and relative status/power was 2.6.

Table 5. Sibling relationship questionnaire.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All Siblings SRQ (n=64)</strong></td>
<td></td>
</tr>
<tr>
<td>Affection (sd)</td>
<td>3.3 (0.71)</td>
</tr>
<tr>
<td>Rivalry (sd)</td>
<td>0.36 (0.48)</td>
</tr>
<tr>
<td>Hostility (sd)</td>
<td>2.9 (0.78)</td>
</tr>
<tr>
<td>Relative Status/Power (sd)</td>
<td>2.7 (0.68)</td>
</tr>
<tr>
<td><strong>Older Sibling SRQ (n=32)</strong></td>
<td></td>
</tr>
<tr>
<td>Affection (sd)</td>
<td>3.3 (0.63)</td>
</tr>
<tr>
<td>Rivalry (sd)</td>
<td>0.26 (0.31)</td>
</tr>
<tr>
<td>Hostility (sd)</td>
<td>3.1 (0.76)</td>
</tr>
<tr>
<td>Relative Status/Power (sd)</td>
<td>2.9 (.57)</td>
</tr>
<tr>
<td><strong>Younger Sibling SRQ (n=32)</strong></td>
<td></td>
</tr>
<tr>
<td>Affection (sd)</td>
<td>3.2 (0.78)</td>
</tr>
<tr>
<td>Rivalry (sd)</td>
<td>0.46 (0.59)</td>
</tr>
<tr>
<td>Hostility (sd)</td>
<td>2.8 (0.79)</td>
</tr>
<tr>
<td>Relative Status/Power (sd)</td>
<td>2.6 (0.76)</td>
</tr>
</tbody>
</table>

**Physical Activity Questionnaire**

The PAQ-C was used to assess the amount of physical activity (PA) each child participates in. The PAQ-C survey data are shown in Table 6.

**Older Siblings**

Older siblings had a summary activity score of 3.2. When asked what prevented them from participating in PA, 75% (n=24) of the older siblings said nothing prevented them from
participating, 3.1% (n=1) of the older siblings said they had boy scouts, 18.8% (n=6) of the older siblings said they were sick, and 3.1% (n=1) of the older siblings said they had head lice.

*Younger Siblings*

The younger siblings had a summary activity score of 3.3. When asked what prevented them from participating in PA, 78.1% (n=25) of the younger siblings said nothing prevented them from participating, 12.5% (n=4) of the younger siblings said they were sick, and 6.3% (n=2) of the older siblings said they had complications due to asthma.
Table 6. Physical activity questionnaire

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All Siblings PAQ-C (n=64)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary activity score</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td><strong>Did anything prevent you from participating your normal PA?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>15</td>
<td>23.4</td>
</tr>
<tr>
<td>No</td>
<td>49</td>
<td>76.6</td>
</tr>
<tr>
<td><strong>What prevented you from participating in your normal PA?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No prevented from activity</td>
<td>49</td>
<td>76.6</td>
</tr>
<tr>
<td>Boy Scouts</td>
<td>1</td>
<td>.4</td>
</tr>
<tr>
<td>Sick</td>
<td>10</td>
<td>15.6</td>
</tr>
<tr>
<td>Lice</td>
<td>1</td>
<td>.4</td>
</tr>
<tr>
<td>Asthma</td>
<td>2</td>
<td>.9</td>
</tr>
<tr>
<td>Dental Problems</td>
<td>1</td>
<td>.4</td>
</tr>
<tr>
<td><strong>Older Siblings PAQ-C (n=32)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary activity score</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td><strong>Did anything prevent you from participating your normal PA?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>No</td>
<td>24</td>
<td>75</td>
</tr>
<tr>
<td><strong>What prevented you from participating in your normal PA?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not prevented from activity</td>
<td>24</td>
<td>75</td>
</tr>
<tr>
<td>Boy Scouts</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>Sick</td>
<td>6</td>
<td>18.8</td>
</tr>
<tr>
<td>Lice</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>Asthma</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dental Problems</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Younger Siblings PAQ-C (n=32)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary activity score</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td><strong>Did anything prevent you from participating your normal PA?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>7</td>
<td>21.9</td>
</tr>
<tr>
<td>No</td>
<td>25</td>
<td>78.1</td>
</tr>
<tr>
<td><strong>What prevented you from participating in your normal PA?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not prevented from activity</td>
<td>25</td>
<td>78.1</td>
</tr>
<tr>
<td>Boy Scouts</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sick</td>
<td>4</td>
<td>12.5</td>
</tr>
<tr>
<td>Lice</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Asthma</td>
<td>2</td>
<td>6.3</td>
</tr>
</tbody>
</table>
Multiple Regression Models

Prior to fitting the multiple linear regression models, the assumptions for multiple linear regression were computed. The data was found to be normal (see Appendix 5). Three separate multiple linear regression models were then constructed. The BMI z-score was the dependent variable (DV) in each model. The summary activity score, affection, rivalry, hostility, and relative status/power, and parent demographic variables (age, gender, race, income, education level, and relationship to the children) were the independent variables (IV’s) in each model. Model 1 includes the DV older sibling BMI z-scores and the IV’s younger sibling summary activity score, affection, rivalry, hostility, and relative status/power scores. Model 2 includes the DV younger sibling BMI z-scores and the IV’s older sibling summary activity score, affection, rivalry, hostility, and relative status/power scores. Model 3 includes the DV BMI z-score for the sibling dyads (combined) and the IV’s parent demographics (age, gender, race, income, education level, and relationship to the children).

Model 1: Older Sibling BMI z-scores

Younger sibling mean activity scores ($r^2=0.067, p=0.19$) were not significantly associated with older sibling BMI z-scores. In addition, younger sibling affection, ($r^2=0.067, p=0.88$), younger sibling rivalry scores ($r^2=0.067, p=0.24$), younger sibling hostility scores ($r^2=0.067, p=0.39$), and younger sibling relative status/power scores ($r^2=0.067, p=0.19$) were not associated with older sibling BMI z-scores (Table 7).

Model 2: Younger Sibling BMI z-scores

Older sibling mean activity scores ($r^2=0.026, p=0.34$) were not significantly associated with younger sibling BMI z-scores. Older sibling affection scores ($r^2=0.026, p=0.96$) were not significantly associated with younger sibling BMI z-scores. Older sibling rivalry scores
(r²=0.026, p=0.11) were not significantly associated with younger sibling BMI z-scores. Older sibling hostility scores (r²=0.026, p=0.97) were not significantly associated with younger BMI z-scores. Older sibling relative status/power scores (r²=0.026, p=0.42) were not significantly associated with younger sibling BMI z-scores (Table 8).

Model 3: Sibling Dyad BMI z-scores

Parent/guardian age (r²=-0.32, p=0.61) was not significantly associated with all child participants BMI z-scores. Parent/guardian yearly income (r²=-0.32, p=0.89) was not significantly associated with all child participants BMI z-scores. Parent/guardian race (r²=-0.32, p=0.16) was not significantly associated with all child participants BMI z-scores. The amount of people the parent/guardian’s yearly income supports (r²=-0.32, p=0.97) was not significantly associated with all child participants BMI z-scores. The parent/guardian education level (r²=-0.32, p=0.74) was not significantly associated with all child participants BMI z-scores (Table 9).

Table 7. Multiple regression models between older siblings BMI z-scores and younger sibling PAQ-C adn SRQ scores (Model 1).

<table>
<thead>
<tr>
<th>Older Sibling BMI z-score, Younger Sibling PAQ-C &amp; SRQ (n=32)</th>
<th>Unstandardized Beta Coefficients</th>
<th>Standard Error</th>
<th>T-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.10</td>
<td>1.5</td>
<td>-0.06</td>
<td>0.94</td>
</tr>
<tr>
<td>Younger Sibling PAQ-C</td>
<td>0.43</td>
<td>0.32</td>
<td>1.3</td>
<td>0.19</td>
</tr>
<tr>
<td>Younger Sibling Affection</td>
<td>-0.05</td>
<td>0.35</td>
<td>-0.14</td>
<td>0.88</td>
</tr>
<tr>
<td>Younger Sibling Rivalry</td>
<td>0.44</td>
<td>0.37</td>
<td>1.18</td>
<td>0.24</td>
</tr>
<tr>
<td>Younger Sibling Hostility</td>
<td>0.24</td>
<td>0.28</td>
<td>0.87</td>
<td>0.39</td>
</tr>
<tr>
<td>Younger Sibling Relative Status/Power</td>
<td>-0.49</td>
<td>0.37</td>
<td>-1.3</td>
<td>0.19</td>
</tr>
</tbody>
</table>
Table 8. Multiple regression model between younger sibling BMI z-score and older sibling PAQ-C and SRQ scores (Model 2).

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Unstandardized Beta Coefficients</th>
<th>Standard Error</th>
<th>T-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.8</td>
<td>1.8</td>
<td>0.98</td>
<td>0.33</td>
</tr>
<tr>
<td>Older Sibling PAQ-C</td>
<td>-0.25</td>
<td>0.26</td>
<td>-0.96</td>
<td>0.34</td>
</tr>
<tr>
<td>Younger Sibling Affection</td>
<td>0.01</td>
<td>0.37</td>
<td>0.04</td>
<td>0.96</td>
</tr>
<tr>
<td>Older Sibling Rivalry</td>
<td>1.1</td>
<td>0.71</td>
<td>1.6</td>
<td>0.11</td>
</tr>
<tr>
<td>Older Sibling Hostility</td>
<td>0.008</td>
<td>0.27</td>
<td>0.03</td>
<td>0.97</td>
</tr>
<tr>
<td>Older Sibling Relative Hostility</td>
<td>-0.29</td>
<td>0.36</td>
<td>-0.81</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Table 9. Multiple regression model between all siblings BMI z-scores and parent demographics (Model 3).

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Unstandardized Beta Coefficients</th>
<th>Standard Error</th>
<th>T-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.46</td>
<td>0.94</td>
<td>0.49</td>
<td>0.62</td>
</tr>
<tr>
<td>Parent/ Guardian Age</td>
<td>0.10</td>
<td>0.02</td>
<td>0.51</td>
<td>0.61</td>
</tr>
<tr>
<td>Parent/ Guardian Income</td>
<td>0.01</td>
<td>0.08</td>
<td>0.12</td>
<td>0.89</td>
</tr>
<tr>
<td>Number of People Supported by the yearly income</td>
<td>-0.14</td>
<td>0.10</td>
<td>-1.4</td>
<td>0.16</td>
</tr>
<tr>
<td>Parent/ Guardian Race</td>
<td>0.003</td>
<td>0.08</td>
<td>0.03</td>
<td>0.97</td>
</tr>
<tr>
<td>Parent/ Guardian Education Level</td>
<td>0.04</td>
<td>0.13</td>
<td>0.32</td>
<td>0.74</td>
</tr>
</tbody>
</table>
Chapter Five: Discussion

Research shows that 70% of children who are obese will grow up to be an overweight or obese adult and may face lasting mental and physical health complications including heart disease, diabetes, and joint problems (CDC, 2012). The sibling relationship consists of four major domains: 1) warmth and affection, 2) hostility and conflict, 3) rivalry, and 4) relative status/power (Furman, Buhrmester, 1985), and these may be associated with sibling levels of physical activity and risk for obesity. As discussed in the review of literature (Chapter 2), the literature lacks studies assessing how sibling relationships affect one another’s physical activity and how these variables are related to the risk of obesity within the sibling dyad. Therefore, the purpose of this study was to assess associations between the amounts of sibling physical activity (PA), sibling relationship domains (affection, hostility, rivalry and relative status/power) and body mass index (BMI) in sibling dyads. We assessed these variables and correlations in 32 sibling dyads, age 8 to 12 years old (n=64). The results of our study suggest that older and younger BMI z-scores are not significantly (p<0.05) related to the other sibling’s amount of PA, affection, rivalry, hostility or relative status/power.

Some research indicates that sibling gender and birth order is associated with risk of childhood obesity (Pachicki, 2014; Senguttuvan, et al 2014). However, it remains unclear if sibling relationship domains and levels of PA are related to a sibling’s risk for being overweight or obese. Very few studies exist that look specifically at these variables. Our results showing that a sibling’s amount of PA, and the relationship domains of affection, rivalry, hostility or relative status/power are not significantly correlated to their sibling’s risk for being overweight or obese, can add some exploratory information to the paucity of literature in this area. The risks of being overweight or obese are complex and often influenced by many internal and
external factors. For example, poor dietary habits, genetics, and environmental factors such as limited access to affordable healthy foods and increased advertising of unhealthy food and beverage products are related to risk of childhood obesity (CDC, 2015). The data we collected in the current study did not include these additional factors. We encourage investigators to assess these additional variables when conducting studies similar to ours.

Senguttuvan and colleagues conducted a study that assessed how sibling intimacy is associated with health and PA, and how this could affect a child’s likelihood of being overweight or obese. The age range of siblings in the study was 12 – 19 years old (n=326). Project staff administered questionnaires to parents that assessed how sibling intimacy is associated with health and levels of PA in their children and asked parents to report the height and weight of their child (Senguttuvan, et al. 2014). We also assessed sibling relationships, levels of PA and weight status in our study, but unlike Senguttuvan et al, our siblings were younger (8 – 12 years old), a trained interviewer administered the questionnaires to each child (not their parent) and objectively measured the height and weight of each child. Objective height and weight measures allow for consistency and reduce bias within the measurements versus subjective (self-report) measures.

While Senguttuvan and colleagues did not find a significant association between sibling affection and youth’s weight status (p>0.05), they did find that sibling conflict was a significant predictor of being overweight (p<.001; AOR = 1.99; Senguttuvan, et al 2014). Conflicts within a sibling relationship may intensify as children mature, and may be more apparent in an older child cohort (i.e., 12 to 19 years old) versus a younger child cohort (i.e., 8 to 12 years old). We found a somewhat similar trend, although not significant (r²=0.026, p=0.11) between older
sibling rivalry and younger sibling BMI z-scores. These findings suggest that as siblings get older the conflicts between them may result in a greater amount of stress on each individual. The increased stress may be a primary trigger for weight gain as sibling dyads mature. A future study might use a longitudinal design, which assesses sibling relationships at multiple time points throughout childhood and adolescence to determine if and when certain stressors are occurring, and their relationship to childhood obesity.

Senguttuvan and colleagues measured sibling intimacy using an adaption of Blyth, Hill and Thiel’s 8-item scale (Blyth, Hill, Thiel, 1982). The researchers also measured sibling conflict using 5-items from Furman and Buhrmester’s Network Relationship Inventory (NRI) (Furman, Buhrmester, 1985b; Senguttuvan, et al 2014). Unlike the Senguttuvan study, we used all 48-items within the validated SRQ (Furman, Buhrmester, 1985) to quantify the amount of affection, rivalry, hostility, and relative status/power in the sibling dyads. The SRQ may be a more sensitive measure of sibling relationships compared to the 5-item adapted survey used by Senguttuvan et al (Senguttuvan, et al 2014) and may be another reason why our findings differ from that study. Additionally, our sample size was much smaller than the sample in the study by Senguttuvan (n=64 versus n=326, respectively), which may be another reason why the findings disagree between these two studies.

The 48-item SRQ assesses four primary domains in the sibling relationship (affection, rivalry, hostility, relative status/power). Relative status/power includes attributes like caregiving, leadership, and dominance (Stocker, McHale, 1992). By using the SRQ and measuring sibling weight, researchers can to determine if relative status/power emerges as a significant piece of the sibling relationship and determine if it predicts weight status. Relative
status/power reflects a lack of equality in the sibling relationship. Our results showed relative
status/power was not significantly associated with sibling weight, (i.e., BMI z-scores). This
finding suggests that this sibling domain may not be a strong predictor for weight status. This
may be because the older sibling associates dominance and leadership as a positive quality,
which may lower their stress and associated risk of being overweight or obese. Likewise, the
younger sibling may view relative status/power as being loved by the older sibling, which may
also lower the younger sibling’s stress and related risk for being overweight or obese. As stated
previously, it would be helpful to include measures of stress in future studies exploring sibling
relationships and risk of obesity.

Our results showed older siblings reported having slightly more hostility and relative
status/power in the sibling relationship than younger siblings (i.e., older sibling hostility = 3.1 ±
0.76 versus younger sibling hostility = 2.8 ± 0.79; older sibling relative status/power = 2.9 ± 0.57
versus younger sibling relative status/power = 2.6 ± 0.76). In contrast, older siblings reported
having slightly less rivalry in the sibling relationship than younger siblings (i.e., older sibling
rivalry = 0.26 ± 0.31 versus younger sibling rivalry = 0.46 ± 0.59). Our findings for affection,
hostility and rivalry are different than a study conducted by Furman and colleagues’ (Furman,
Buhrmester, 1985). In that study, younger siblings reported more affection, conflict, and rivalry
than the older siblings, and these mean scores were different than each other. However, our
findings of the older sibling reporting slightly more relative status/power than the young sibling
are similar to Furman and colleagues (Furman, Buhrmester, 1985). That these study findings
agree tends to make sense as the older sibling typically takes more of a leadership and
dominance role in the sibling relationship. The younger siblings in both studies also reported
more rivalry than older siblings. Rivalry is the way children view differences in treatment from their parents. The younger sibling may view the freedoms and privileges the older sibling receives from the parent as unfair or unjust.

In Furman’s study (Furman, Buhrmester, 1985) the participants were primarily middle to upper class. In our study, 43.5% of the participants (n=14) were low to middle class. The average number of people supported by the parent’s/guardian’s yearly income was 4.7. According to healthcare.gov the federal poverty level for a family of four is $24,300 and a family of five is $28,440 (healthcare.gov, n.d.). The difference in family income levels in our study compared to Furman et al may be why there were different findings in the amount of sibling affection, rivalry, hostility and relative status/power between these two studies. Do siblings living in middle to upper class families, compared to siblings living in low to middle class families have lower or higher levels of affection, rivalry, hostility and relative status/power?

Our findings seem to suggest there may be family income influences on these aspects of sibling relationships, however, when these data were analyzed, the relationship between these variables was not significant. Nonetheless, studies having a larger sample size of siblings and parent/guardians should be conducted to more rigorously explore these questions.

The parent demographic survey in the current study was subjective, as parents/guardians self-reported their yearly income. Thus, these data have limitations that are inherent in self-report measures. For example, when completing the survey, participants may inflate their yearly income to appear wealthier than they are. Thus, there may be even more participants in our study who are low to middle class. More research is needed that assesses how the parent’s/guardian’s income level affects the sibling relationship. Collecting objective
information about the parent/guardian income level, such as pay stubs or tax return information, could decrease participant bias and strengthen this measure.

Hohepa and colleagues conducted a study assessing social support for youth physical activity and the importance of external support in 3,471 youth age 12 to 19 years old. Sibling/cousin perceived support was significantly correlated with being active during lunchtime for junior and senior students (junior students p< 0.0001, senior students p= 0.0001) (Hohepa, et al. 2007). Junior students that perceived low sibling support were less likely to be active after-school (Hohepa, et al. 2007). Hohepa and colleagues found that siblings may be a powerful support system for each other in after school PA depending on the age, sex, and types of activities in which are being engaged. Although our study did not specifically address the domains of support that each sibling feels they receive to participate in PA, we did assess how the domain of affection (which is similar to support) is related to sibling’s weight status and found no significant relationship between these variables. A future study could explore whether or not the Hohepa et al findings are generalizable to sibling dyads between the ages of 8 – 12 years old by using a larger sample size than the one used in our study, and having this age group participate in the study.

We found similar, moderate PA levels in both older (3.1) and younger (3.2) siblings. This activity level is consistent with previous research conducted in children with similar ages (8-12 years old). For example, a study conducted by Crocker and colleagues reported a mean activity score of 3.07 in 466 children in grades 5-8 (Crocker, Eklund, Kowalski, 2000). That PA scores are similar in sibling pairs suggests if PA levels of one sibling increase, the other sibling may have similar increases in PA levels. Our study used a validated PA questionnaire to determine the
amount of PA each child participated in the previous seven days. A limitation of both our study and Crocker and colleagues is the subjective nature of self-report surveys like the PAQ-C. For example, the participant may report participating in more or less PA than he or she actually did (i.e., participant bias). Using accelerometers is a more objective tool to measure levels of PA than a survey instrument, and increases the measurement rigor of this aspect of the study. Future studies should use accelerometers when measuring levels of PA in children to more objectively determine the relationship between sibling PA and risk of obesity.

Parents/guardians were asked to complete a self-administered survey to collect information on their socio-economic status (SES). SES is determined by the parent’s/guardian’s income, career and education levels (American Psychological Association, n.d). There is a connection between childhood obesity and SES; however it also may be influenced by the gender and age of the parent/guardian (Wang, Lim, 2012). It has been shown that dietary intake and PA levels vary across various SES levels (Fradkin et al., 2015). In our study we measured parent age, gender, race, income, education level, relationship to the child, and how many people the yearly family income supports. Although we did not have a hypothesis directly related to parent SES levels, sibling relationships and BMI z-scores, one of the linear regression models (Model 3) assessed the relationship between parent/guardian demographic data (parent/guardian age, gender, income, race, education level, and number of people supported by the yearly income) and all sibling BMI z-scores. We were unable to find any significant correlations between parent/guardian demographic data and all sibling BMI z-scores. Our inability to show any relationships between these variables may (again) be due to small sample size and the self-report nature of most of these measures.
Limitations

This study had limitations. First, only 32 sibling dyads participated in the study. Due to the small sample size it may be difficult to generalize the results from this study to other sibling dyads between the ages of 8-12 years old. In general, a smaller sample size will create difficulties in finding significance in the relationships being tested (USC, 2016).

Secondly, there may be differences between the participants who volunteered for the study and those who did not volunteer to participate. Although the PAQ-C and SRQ have been found valid and reliable, participant biases may still occur. There are four types of biases that may occur in survey research. These are: 1) selective memory which is when a participant remembers or does not remember certain experiences that have occurred, 2) telescoping: remembering an event that occurred at a different time than being reported, 3) attribution: is when a participant credits positive events to themself and negative events to external forces, and 4) exaggeration which is when a participant overemphasizes their information to appear more significant (USC, 2016). For example, our study participants may have reported more affection and PA and less hostility, rivalry and relative status/power because they thought those were the correct answers. In addition participants may have unintentional exercised telescoping when reporting specific PA that had been participated in over the last seven days. For example a participant, who reported playing soccer in the last seven days may not have actually played soccer in the last month but they recalled playing soccer, thus reported it.

Finally, our study was a cross-sectional study that looked at one population (children 8-12 years old) at a single point in time. This type of design doesn’t provide any definite information about cause-and-effect relationships, such as whether or not sibling domains and
PA levels cause (or do not cause) childhood obesity, mainly because these studies offer a snapshot of a single moment in time. A stronger design would be a longitudinal study, which allows researchers to detect changes in the characteristics of the target population (i.e., siblings) at both the group and individual level. Because longitudinal studies extend beyond a single moment in time, they can establish a sequence of events. In terms of the sibling relationships, PA and weight variables looked at in in our study, a longitudinal study design would allow several observations of the same sibling dyads over a period of time which could then establish sequences of events in the sibling dyad that protect, enhance or have no effect on risk of obesity in each sibling.

**Strengths**

The study has several strengths. Each survey was administered to the participants individually. This was done to minimize external distractions and influences from the participant’s brother or sister. Each participant was informed there were no correct answers to the questions, the questions were not a test, and to try and answer the questions as honestly as possible. In addition while the interviewer asked the participant if they had partaken in a specific PA (i.e. soccer, badminton, football) the interviewer made sure to add the prompt “in the last seven days” after each question. This was done in an attempt to reduce telescoping by reminding the participant that he or she should only be thinking about PA within the last week.

The height and weight measures were collected by the researcher, as opposed, to being self-reported by the participants’ parent/guardian. The benefits of collecting height and weight measures objectively are that it eliminates the parent’s/guardian’s under or over reporting of their children’s measurements and creates consistency within the measurements. Self-report
data may create a psychological barrier for the parent/guardian and increase bias for this measure. The parent/guardian may want to believe their child is of normal weight, thus reporting a normal weight. Collecting the actual height and weight in participants eliminates self-report/participant bias for this measure.

Finally, to our knowledge, our study is the first in the literature to report on the sibling relationships, level of PA and risk of obesity in American Indian/Alaska Native (AI/AN) children. That we could feasibly recruit and enroll AI/AN children and their parents in this research, informs future studies in this population that experiences high rates of childhood and adult obesity.

**Conclusions and Suggestions for Future Research**

Although siblings play an important role in each other’s lives, in our study, we found that the amount of sibling PA, affection, rivalry, hostility and relative status/power does not appear to have a significant impact on their siblings BMI z-score.

Although this study did not find significant results like previous research; future research could include the use of accelerometers that objectively measure physical activity. By utilizing accelerometers the researcher can objectively determine when siblings are most physically active together. Qualitative means of collecting data through interviews could be used as supplemental information to the accelerometer data to determine what PA the siblings are participating in together (i.e. dance, soccer, karate) and why. For example, interviews could discover that siblings mostly participate in free play together rather than structured play like tennis or football. From there, researchers may be able to determine which type of PA is most likely to be used by sibling dyads of a certain age. For example, the most frequent PA sibling
dyads age 8-12 years old may participate in is tag but sibling dyads age 15-18 years old may like to play tennis. The interviews could provide an initial inside look at what siblings most like to do together.

An intervention could be developed from sibling SRQ and PA data. These data describe how physically active siblings are together and when they are most active together. An intervention developed for siblings could include activities that promote positive sibling relationships such as companionship, support, and guidance. The intervention could also include ways to cope with arguments or competitiveness in the sibling relationship. A PA component could include ways the siblings could be physically active together such as two-person games, dances or sports. Ideally, the intervention would also educate parents on ways to increase PA levels in their children and promote the growth of positive sibling relationships.

Although this study did not yield significant results connecting sibling PA and SRQ scores to BMI z-scores, this topic does stimulate interest in the connections between sibling relationships and risk of childhood obesity. The relationship siblings share or do not share may influence healthy and unhealthy coping behaviors. These coping mechanisms may or may not influence a child’s risk for being overweight or obese. Thus, it is important for future researchers to continue to understand the sibling domains, PA between siblings and how they affect weight status, when designing obesity prevention interventions that specifically target siblings and their families.
References:


Appendices

Appendix One: Informed Consent

Study Title: Determining the links between sibling bonds and their amount of physical activity, and the risk of childhood obesity

Investigator(s):

Graduate student: Samantha Dalton
Faculty Supervisor: Dr. Blakely Brown
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Missoula, MT 59812
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406-243-6524

Inclusion Criteria:

• Sibling pairs age 8-12 years old.
• Siblings must live in the same house.
• Parent or guardian of siblings.

Purpose:

Childhood obesity has been on the rise over the last ten years. Being overweight can lead to heart disease, high blood pressure, and joint problems. Children who are overweight or obese are more likely to become overweight or obese adults.

The sibling bond is made up of many things. Some of these things are teasing, love, and pride. Older siblings are a source of help and may act as a caretaker towards their younger siblings. When siblings are loving toward each other or show support for each other they are more likely to share and help each other. The sibling bond has three parts: 1) love, 2) anger, and 3) rivalry.

There has been very little research done on how the sibling bond affects weight. Siblings that do not get along may have fear or stress and poor self-esteem. This may increase a child’s risk for becoming overweight or obese.

The purpose of this study is to evaluate links between the amount of sibling physical activity, sibling bonds (love, anger and rivalry) and weight in sibling pairs, age 8-12 years old.

Procedures:

This study will be done in one meeting [during the after-school program] and will take about one hour.
Child Measurements:
Height and weight will be collected in all child participants. Participants will remove their shoes and heavy outside clothing (sweatshirts, coats) before they are weighed. To measure body fat the participant will be asked to stand on a scale. The scale is a safe. The scale is a valid way of determining body fat.

The Physical Activity survey will be used to evaluate the amount of exercise that each sibling took part in over the last seven days. The survey has 10 questions. The survey will be read to each one of the siblings individually. This will take about 15 minutes.

The Sibling Relationship survey has 48 questions and is used to evaluate how siblings feel about one another. The survey will be read to each one of the siblings individually. This survey will last for about 20 minutes.

Parent Measurements:
Parents will complete a brief survey which collects information on age, race, education level and income level.

The results of the whole study will be given to each individual after-school program to deliver to each of the families.

Risks/Discomforts:
This project involves very little risk to the participant. Taking the height, weight and body fat health measures may be a little stressful for the child. Answering the questions about the amount and type of physical activity the child takes part in, or talking about their relationship with their sibling, may cause them to think about feelings that make them sad or upset. We will ask each child several times during the 45 minutes it takes to complete the measures to see if he/she is okay and willing to keep participating in the measures. Also, if the child does not want to provide a certain health measure, or answer a certain question on the surveys, they do not have to do so.

Benefits:
Although you and your children may not directly benefit from taking part in this study, the findings will add to the body of work focusing on links between the amount of sibling physical activity, the sibling bond, and risk of childhood obesity in sibling pairs. This information may help plan future childhood obesity interventions targeting siblings and their family.

Payment:
Each family will receive $10.00 for taking part in the study. The $10.00 will be given to the parent or guardian once their family has completed the study measures.

Keeping private information private:
You and your children’s records will be kept private and will not be released without you and your children’s permission except as demanded by law.
You and your children’s identity will be kept private. If the results of this study are printed in a scientific journal or presented at a scientific meeting, you and your children’s name will NOT be used. A summary of the research (with no names) will be provided to the Missoula Boys and Girls Club and Parks and Recreation. The data will be stored in a locked file cabinet. You and your children’s signed permission and assent forms will be stored in a cabinet separate from the data.

**Voluntary Participation/Withdrawal:**
You and your children’s decision to take part in this study is something you and your children chose to do but is not required. You and your children may refuse to take part in or you and your children may leave from the study at any time without penalty or loss of benefits to which you are normally entitled. You and your children may be asked to leave the study for any of the following reasons:
1. Failure to follow the Project Director’s instructions;
2. The Project Director thinks it is in the best interest of your health and welfare; or
3. The study is ended.

**Questions:**
If you have any questions about the research now or during the study, please contact:

Samantha Dalton  
610-823-5335  
Samantha.dalton@umontana.edu

If you have any questions related to your rights as a research subject, you may contact the UM Institutional Review Board (IRB) at (406) 243-6672.

**Parent’s Statement of Permission:**
I (the Parent/Guardian) have read the above account of this study. I (the Parent/Guardian) have been informed of the risks and benefits to my children. All my (the Parent/Guardian) questions have been answered to my liking. I (the Parent/Guardian) am sure that a member of the research team will answer any future questions my children or I may have. I (the Parent/Guardian) voluntarily agree to all my children to take part in this study. I (the Parent/Guardian) understand I (the Parent/Guardian) will get a copy of this consent form.

Printed Name of Parent/Guardian

________________________

Parent/Guardian’s Signature  Date
Appendix Two: Child Assent

Project Staff Person Script:

You are being asked to take part in a study. You do not have to take part in this study if you do not want to. I am going to describe the things that you will be asked to do. Then you can tell me if you would like to take part in this study. It will take about one hour.

We will measure your weight, height, and body fat. We will collect information about your activity and fitness levels, and your relationship with _______________(insert name of sibling).

We are going to ask you to answer questions that will be read to you. The first set of questions will ask you about the physical activity you have done in the past week. The second set of questions will ask you about your relationship with ______________ (insert name of sibling). These questions will ask about the amount of love, fighting and competitiveness is in your relationship with ______________ (insert name of sibling).

Do you understand what I have described?

[Wait for confirmation or explain further, if necessary.]

[Investigator then asks if the child has any questions. If no questions and the child agrees to participate, investigator fills in ‘Printed name of child’, and the child is asked to sign and date the assent form.]

________________________________________
Printed name of child

________________________________________
Signature

________________________________________
Date
## Appendix Three: Sibling Relationship Questionnaire

1. Some siblings do nice things for each other a lot, while other siblings do nice things for each other a little. How much do both you and this sibling do nice things for each other?

   - [ ] Hardly at all
   - [ ] Not too much
   - [ ] Somewhat
   - [ ] Very much
   - [ ] EXTREMELY MUCH

2. Who usually gets treated better by your mother, you or this sibling?

   - [ ] My sibling almost always gets treated better
   - [ ] My sibling often gets treated better
   - [ ] We get treated about the same
   - [ ] I often get treated better
   - [ ] I almost always get treated better

3. How much do you show this sibling how to do things he or she doesn't know how to do?

   - [ ] Hardly at all
   - [ ] Not too much
   - [ ] Somewhat
   - [ ] Very much
   - [ ] EXTREMELY MUCH

4. How much does this sibling show you how to do things you don't know how to do?

   - [ ] Hardly at all
   - [ ] Not too much
   - [ ] Somewhat
   - [ ] Very much
   - [ ] EXTREMELY MUCH

5. How much do you tell this sibling what to do?

   - [ ] Hardly at all
   - [ ] Not too much
   - [ ] Somewhat
   - [ ] Very much
   - [ ] EXTREMELY MUCH

6. How much does this sibling tell you what to do?

   - [ ] Hardly at all
   - [ ] Not too much
   - [ ] Somewhat
   - [ ] Very much
   - [ ] EXTREMELY MUCH
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
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</table>
| 7. Who usually gets treated better by your father, you or this sibling?   | [ ] My sibling almost always gets treated better  
[ ] My sibling often gets treated better  
[ ] We get treated about the same  
[ ] I often get treated better  
[ ] I almost always get treated better |
| 8. Some siblings care about each other a lot while other siblings don’t care about each other that much. How much do you and this sibling care about each other? | [ ] Hardly at all  
[ ] Not too much  
[ ] Somewhat  
[ ] Very much  
[ ] EXTREMELY MUCH |
| 9. How much do you and this sibling go places and do things together?     | [ ] Hardly at all  
[ ] Not too much  
[ ] Somewhat  
[ ] Very much  
[ ] EXTREMELY MUCH |
| 10. How much do you and this sibling insult and call each other names?    | [ ] Hardly at all  
[ ] Not too much  
[ ] Somewhat  
[ ] Very much  
[ ] EXTREMELY MUCH |
| 11. How much do you and this sibling like the same things?                | [ ] Hardly at all  
[ ] Not too much  
[ ] Somewhat  
[ ] Very much  
[ ] EXTREMELY MUCH |
| 12. How much do you and this sibling tell each other everything?          | [ ] Hardly at all  
[ ] Not too much  
[ ] Somewhat  
[ ] Very much  
[ ] EXTREMELY MUCH |
| 13. Some siblings try to out-do or beat each other at things a lot, while other siblings try to out-do each other a little. How much do you and this sibling try to out-do each other at things? | [ ] Hardly at all  
[ ] Not too much  
[ ] Somewhat  
[ ] Very much  
[ ] EXTREMELY MUCH |
| 14. How much do you admire and respect this sibling?                     | [ ] Hardly at all  
[ ] Not too much  
[ ] Somewhat  
[ ] Very much  
[ ] EXTREMELY MUCH |
| 15. How much does this sibling admire and respect you?                   | [ ] Hardly at all  
[ ] Not too much  
[ ] Somewhat  
[ ] Very much  
[ ] EXTREMELY MUCH |
| 16. How much do you and this sibling disagree and quarrel with each other? | [ ] Hardly at all  
[ ] Not too much  
[ ] Somewhat  
[ ] Very much  
[ ] EXTREMELY MUCH |
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
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<tbody>
<tr>
<td>17. Some siblings cooperate a lot, while other siblings cooperate a little. How much do you and this sibling cooperate with other?</td>
<td>[ ] Hardly at all</td>
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<td></td>
<td>[ ] Not too much</td>
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<td>[ ] Somewhat</td>
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<td>[ ] Very much</td>
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<td></td>
<td>[ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>18. Who gets more attention from your mother, you or this sibling?</td>
<td>[ ] My sibling almost always gets more attention</td>
</tr>
<tr>
<td></td>
<td>[ ] My sibling often gets more attention</td>
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<tr>
<td></td>
<td>[ ] We get about the same amount of attention</td>
</tr>
<tr>
<td></td>
<td>[ ] I often get more attention</td>
</tr>
<tr>
<td></td>
<td>[ ] I almost always get more attention</td>
</tr>
<tr>
<td>19. How much do you help this sibling with things he or she can’t do by him or herself?</td>
<td>[ ] Hardly at all</td>
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<td></td>
<td>[ ] Not too much</td>
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<td></td>
<td>[ ] Somewhat</td>
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<td>[ ] Very much</td>
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<td></td>
<td>[ ] EXTREMELY MUCH</td>
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<tr>
<td>20. How much does this sibling help you with things you can’t do by yourself?</td>
<td>[ ] Hardly at all</td>
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<td></td>
<td>[ ] Not too much</td>
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<td>[ ] Somewhat</td>
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<td>[ ] Very much</td>
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<td>[ ] EXTREMELY MUCH</td>
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<tr>
<td>21. How much do you and this sibling have in common?</td>
<td></td>
</tr>
<tr>
<td>22. How much do you and this sibling share secrets and private feelings?</td>
<td></td>
</tr>
<tr>
<td>23. How much do you and this sibling compete with each other?</td>
<td></td>
</tr>
<tr>
<td>24. How much do you look up to and feel proud of this sibling?</td>
<td></td>
</tr>
<tr>
<td>25. How much does this sibling look up to and feel proud of you?</td>
<td></td>
</tr>
<tr>
<td>26. How much do you and this sibling get mad at and get in arguments with each other?</td>
<td></td>
</tr>
<tr>
<td>27. How much do both you and your sibling share with each other?</td>
<td></td>
</tr>
</tbody>
</table>
28. Who does your mother usually favor, you or this sibling?

- My sibling almost always is favored
- My sibling is often favored
- Neither of us is favored
- I am often favored
- I am almost always favored

29. How much do you teach this sibling things that he or she doesn't know?

- Hardly at all
- Not too much
- Somewhat
- Very much
- EXTREMELY MUCH

30. How much does this sibling teach you things that you don’t know?

- Hardly at all
- Not too much
- Somewhat
- Very much
- EXTREMELY MUCH

31. How much do you order this sibling around?

- Hardly at all
- Not too much
- Somewhat
- Very much
- EXTREMELY MUCH

32. How much does this sibling order you around?

- Hardly at all
- Not too much
- Somewhat
- Very much
- EXTREMELY MUCH

33. Who does your father usually favor, you or this sibling?

- My sibling almost always is favored
- My sibling is often favored
- Neither of us is favored
- I am often favored
- I am almost always favored

34. How much is there a strong feeling of affection (love) between you and this sibling?

- Hardly at all
- Not too much
- Somewhat
- Very much
- EXTREMELY MUCH
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>35. Some kids spend lots of time with their siblings, while others don’t spend so much. How much free time do you and this sibling spend together?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Somewhat  [ ] Very much  [ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>36. How much do you and this sibling bug and pick on each other in mean ways?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Somewhat  [ ] Very much  [ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>37. How much are you and this sibling alike?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Somewhat  [ ] Very much  [ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>38. How much do you and this sibling tell each other things you don’t want other people to know?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Somewhat  [ ] Very much  [ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>39. How much do you and this sibling try to do things better than each other?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Somewhat  [ ] Very much  [ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>40. How much do you think highly of this sibling?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Somewhat  [ ] Very much  [ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>41. How much does this sibling think highly of you?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Somewhat  [ ] Very much  [ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>42. How much do you and this sibling argue with each other?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Somewhat  [ ] Very much  [ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>43. How much are you and this sibling alike?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Somewhat  [ ] Very much  [ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>44. How much do you and this sibling tell each other things you don’t want other people to know?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Somewhat  [ ] Very much  [ ] EXTREMELY MUCH</td>
</tr>
<tr>
<td>45. How much do you and this sibling try to do things better than each other?</td>
<td>[ ] Hardly at all  [ ] Not too much  [ ] Very much  [ ] EXTREMELY MUCH</td>
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<td>#</td>
<td>Question</td>
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</tr>
<tr>
<td>46</td>
<td>How much do you think highly of this sibling?</td>
</tr>
<tr>
<td>47</td>
<td>How much does this sibling think highly of you?</td>
</tr>
<tr>
<td>48</td>
<td>How much do you and this sibling argue with each other?</td>
</tr>
</tbody>
</table>
Appendix Four: Physical Activity Questionnaire - Older Children

We are trying to find out about your physical activity from the last 7 days (in the last week). This includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.

Remember:
1. There are not right and wrong answers - this is not a test.
2. Please answer all the questions honestly and accurately as you can - this is very important.

1. Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (Mark only one circle per row)

<table>
<thead>
<tr>
<th>Activity</th>
<th>No</th>
<th>1-2</th>
<th>3-4</th>
<th>5-6</th>
<th>7 times or more</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skipping</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rowing/canoeing</td>
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<tr>
<td>In-Line Skating</td>
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<tr>
<td>Tag</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Walking for exercise</td>
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</table>

Did you do, or not do, this activity with your sibling
2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check only one).

   I don’t do PE................................................................. ⬜
   Hardly ever ...................................................................... ⬜
   Sometimes ....................................................................... ⬜
   Quite Often ........................................................................ ⬜
   Always ............................................................................. ⬜

3. In the last 7 days, what did you do most of the time at recess? (Check one only.)

   Sat down (talking, reading, doing schoolwork).... ⬜
   Stood around or walked around......................... ⬜
   Run or played a little bit........................................... ⬜
   Ran around and played quite a bit......................... ⬜
   Ran and played hard most of the time..................... ⬜

4. In the last 7 days, what did you normally do at lunch (besides eat lunch)? (Check one only.)

   Sat down (talking, reading, doing schoolwork).... ⬜
   Stood around or walked around......................... ⬜
   Run or played a little bit........................................... ⬜
   Ran around and played quite a bit......................... ⬜
   Ran and played hard most of the time..................... ⬜

5. In the last 7 days, on how many days right after school, did you do sports, dance, or play games in which you were very active? (Check one only).

   None............................................................................. ⬜
   1 time last week........................................................... ⬜
   2 or 3 times last week ................................................ ⬜
   4 times last week.......................................................... ⬜
   5 times last week ........................................................... ⬜

6. In the last 7 days, on how many evenings did you do sports, dance, or play games in which you were very active? (Check one only).

   None............................................................................. ⬜
   1 time last week........................................................... ⬜
   2 or 3 times last week ................................................ ⬜
   4 times last week.......................................................... ⬜
   5 times last week ........................................................... ⬜
7. On the last weekend, how many times did you do sports, dance or play games in which you were very active? (Check one only.)

- None.......................................................... □
- 1 time........................................................... □
- 2 - 3 times..................................................... □
- 4 - 5 times..................................................... □
- 6 or more times............................................. □

8. Which one of the following describes you best for the last 7 days? Read all five statements before deciding on the one answer that describes you.

A. All or most of my free time was spent doing things that involve little physical effort.......................................................... □
B. I sometimes (1-2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics).................. □
C. I often (3-4 times last week) did physical things in my free time.................. □
D. I quite often (5-6 times last week) did physical things in my free time........ □
E. I very often (7 or more times last week) did physical things in my free time...

9. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

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<th>Very Often</th>
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10. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one).

Yes.......................................................... □
No............................................................ □

If Yes, what prevented you? ____________________________________________
Appendix Five: Assumption Data

Boxplots
Younger sibling BMI Percentile
Younger Sibling BMI z-score
Younger sibling affection
Younger sibling hostility
Younger sibling relative status/power
Older Sibling BMI for-age-and gender Percentile
Older Sibling rivalry
Older Sibling hostility
Scatterplots: BMI for-age-and gender Percentile
Younger sibling BMI for-age-and gender Percentile older sibling PAQ-C

$R^2$ Linear = 0.033
Younger sibling BMI for-age-and gender Percentile older sibling affection

Younger Sibling BMI Percentile

Older Sibling Affection

R² Linear = 0.092
Younger sibling BMI for age and gender Percentile older sibling rivalry

$R^2$ Linear = 0.183
Younger sibling BMI for-age-and gender Percentile older sibling hostility

\[ R^2 \text{ Linear } = 0.003 \]
Younger sibling BMI for-age-and gender Percentile older sibling relative status/power

$R^2$ Linear = 0.027
Older Sibling BMI for-age-and gender Percentile, Younger sibling PAQ-C

R² Linear = 0.008
Older Sibling BMI for age and gender Percentile, Younger sibling affection

R² Linear = 0.094
OlderSiblingBMIfor-age-andgenderPercentile,Youngersiblingrivalry

R² Linear = 0.068
Older Sibling BMI for-age-and gender Percentile, Younger sibling hostility

$R^2$ Linear = 0.001
Older Sibling BMI for-age-and gender Percentile, Younger sibling relative status/power

R^2 Linear = 0.019
Scatterplots: BMI z-scores
Younger Sibling BMI Z-score, Older Sibling PAQ-C

$R^2$ Linear = 0.042
Younger Sibling BMI Z-score, Older Sibling Affection

R² Linear = 0.052
Younger Sibling BMI Z-score, Older Sibling Rivalry

$R^2$ Linear = 0.127
Younger Sibling BMI Z-score, Older Sibling Hostility

R² Linear = 7.328E-4
Younger Sibling BMI Z-score, Older Sibling Relative Status/Power

$R^2$ Linear = 0.044
Older Sibling BMI Z-score, Younger Sibling PAQ-C

$R^2$ Linear = 0.018
Older Sibling BMI Z-score, Younger Sibling Affection

$R^2_{Linear} = 0.110$
Older Sibling BMI Z-score, Younger Sibling Rivalry

R^2 Linear = 0.097
Older Sibling BMI Z-score, Younger Sibling Hostility

R² Linear = 0.002
Older Sibling BMI Z-score, Younger Sibling Relative Status/Power
### Older Sibling BMI for-age-and gender Percentile, Younger Sibling SRQ & PAQ-C Scores

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### Younger Sibling BMI for-age-and gender Percentile, Older Sibling SRQ & PAQ-C Scores

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## Older Sibling BMI z-scores, Younger Sibling SRQ & PAQ-C Scores

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Histogram
Dependent Variable: Older Sibling BMI z-score

- Mean = 4.63E-16
- Std. Dev. = 0.915
- N = 32
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Histogram
Dependent Variable: Younger Sibling BMI z-score

Mean = 1.04E-16
Std. Dev. = 0.915
N = 32
Normal P-P Plot of Regression Standardized Residual

Dependent Variable: Younger Sibling BMI z-score

Expected Cum Prob

Observed Cum Prob