HEALTHY WEIGHT BEHAVIORS AND WEIGHT CHANGE IN PARENTS AND PRESCHOOL-AGED CHILDREN

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ABSTRACT

Brooke Tompkins Nezami: Healthy Weight Behaviors and Weight Change in Parents and Preschool-Aged Children
(Under the direction of Deborah F. Tate)

The high prevalence of obesity among children, coupled with the strong link between child weight and parent weight, highlights the importance of identifying successful interventions that use parents as the agent of change to encourage sustainable healthy behaviors in children. The purpose of this dissertation was to identify successful intervention strategies for intervening with parents of young children. Aim One used a serial mediation model to evaluate the mediating effect of exercise barriers and moderate-to-vigorous physical activity (MVPA) changes on the relationship between number of children in the home and weight change of adults (N=263) in an 18-month behavioral weight loss intervention. An increasing number of children in the home was associated with lower percent weight loss at 6 months, which was mediated by greater exercise barriers at baseline and a lower increase in MVPA by 6 months. There was no relationship between number of children in the home and percent weight regain from 6 to 18 months. Aim Two was a 6-month randomized controlled trial that tested the efficacy of an intervention that targeted mothers of children ages 3 to 5 (N=51) to reduce child sugar-sweetened beverage (SSB) consumption and maternal weight through the use of a smartphone-delivered website, text messages, and simplified self-monitoring compared to a waitlist control group. Children in Smart Moms reduced their SSB intake significantly more than children in the control group at 6 months (-9.5 oz. vs. -1.9 oz., $p<.01$). Mothers in Smart Moms lost significantly more weight than mothers in the control group (-2.3 kg vs. +0.9 kg, $p<.01$). Aim Three tested whether changes in the intervention targets mediated the effect of the intervention on child SSB change. Reductions in maternal caloric beverages and parental concern for the child's diet at 3 months mediated the effect of the intervention on child SSB change at 6 months. By adapting the traditional behavioral intervention to a focus on specific dietary behaviors and delivering intervention materials via technology to reduce time demands and increase parental adherence, this dissertation contributes to the emerging evidence base seeking to inform successful strategies to prevent child obesity through family-based approaches.

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CHAPTER I: INTRODUCTION

Overview

Healthy People 2020 reported as one of its objectives to reduce the proportion of adults, adolescents, and children who are obese, with the goal of reducing the rate of obesity in children ages 2-5 from 10.7% to 9.6% in ten years (U.S. DHHS, 2010). Given that 25% of overweight children become overweight by the age of 5 (Harrington et al., 2010), and one in three low-income children are overweight by age 5 (CDC, 2010) it is imperative to focus on increasing children's healthy weight behaviors and preventing weight gain in early childhood. Much research has shown that engaging parents in the treatment or prevention of child obesity increases success (Epstein, Paluch, Roemmich, & Beecher, 2007); however, adults with young children often engage in fewer healthy behaviors compared to adults without children, and have barriers to treatment participation that primarily include the time demands of taking care of a family. Thus, to this date, few parent-targeted interventions to prevent childhood weight gain have been successful, and few have been able to significantly change diet and physical activity behaviors, particularly in young children. What is missing from the literature are successful interventions that target the parent as the agent of change in order to promote healthy behaviors, with the long-term goal of preventing child obesity.

While there are countless determinants of early childhood obesity, some of the strongest and most consistent predictors include maternal and paternal obesity, socioeconomic factors, and consumption of sugar-sweetened beverages (SSBs). In fact, maternal obesity is a particularly important predictor of child weight because mothers play such an important role in children's eating and physical activity behaviors by modeling behavior, monitoring children's behavior, and enforcing limits and rules within the household. Young children of overweight and obese mothers often engage in behaviors similar to their mothers, including SSB consumption and screen time, and thus are at high risk of becoming overweight or obese (Sonneville et al., 2012; Strauss & Knight, 1999). Research to date suggests that interventions that target mothers could be an effective way to promote weight loss while also preventing child weight gain. Unfortunately, observational evidence suggests that having children in the home is associated with increased weight gain among mothers, who are often less physically active than fathers and adults without children (Bellows-Riecken & Rhodes, 2008; Nomaguchi, 2004; Sternfeld, Ainsworth, & Quesenberry, 1999). What is not yet known is if adults with children who are participants in behavioral weight loss interventions experience greater difficulty with behavior change and weight loss. Nonetheless, the most effective childhood obesity prevention interventions for young children thus far have involved significant parent engagement, suggesting that family-based interventions that take into account the needs of both parents and children are needed. Because mothers face many barriers to weight control behavior change, including time demands and lack of childcare, there is a need for interventions that are uniquely targeted to the needs of mothers and children, such that they minimize mothers' need to travel, prevent them from having to rearrange their schedules, and minimize the amount of time spent in participation in order to be successful at weight loss and changing their own and their child's behaviors.

The purpose of this research was to identify successful behavior intervention strategies for intervening with parents of young children in order to change child behavior. The overall objectives of this dissertation were (1) to evaluate the adherence to intervention recommendations and weight loss success of adults with children compared to adults without children in a traditional behavioral weight loss intervention and (2) to test the efficacy of an intervention that targets mothers of children ages 3 to 5 to reduce sugar-sweetened beverage consumption. The specific aims of this dissertation are described below.

Specific Aims

Study 1: Determine if the number of children in the home is associated with weight loss at 6 months and weight regain at 18 months among participants in a behavioral weight loss intervention, and whether those relationships are mediated by barriers to exercise and changes in moderate-to-vigorous activity (MVPA) during the intervention.

Study 2: Develop and evaluate the effect of a 6-month intervention that targets mothers who are overweight or obese and who have a child ages 3-5 on change in child sugar-sweetened beverage consumption at 6 months compared to a waitlist control group, with secondary aims of evaluating maternal weight loss and change in caloric beverage consumption at 6 months.

Study 3: Evaluate change in the intervention targets from baseline to 3 months as mediators of the relationship between the intervention and change in child SSB intake at 6 months.

Significance

This dissertation informs the emerging field of early childhood obesity prevention and has the potential to impact public health by simultaneously improving the health of parents and children. Given the rising proportion of preschoolers who are obese, and given that overweight and obese parents could benefit from programs targeted to the demands of having a family, there is a significant need for sustainable interventions that are effective and maximize adherence among parents. In fact, in a statement released in January 2012, the American Heart Association (AHA) stressed the importance of identifying successful interventions that use parents as the agent of change to encourage sustainable healthy behaviors in children (Faith et al., 2012). There is a critical gap in the literature such that few interventions have been successful at modifying parent and child weight-related behaviors. By adapting the traditional behavioral weight loss intervention to focus on specific dietary behaviors and delivering intervention materials via technology to reduce time demands and increase parental adherence, this intervention contributes to the emerging evidence base seeking to inform successful strategies to prevent childhood obesity through family-based approaches.

CHAPTER II: LITERATURE REVIEW

Problem of Early Childhood Obesity

Childhood obesity is problem of continued public health concern, as rates of overweight and obesity among young children have increased dramatically in the last several decades. In 1976, only 5% of children ages 2-5 were classified as obese (BMI for age ≥ 95th percentile; (Ogden, Flegal, Carroll, & Johnson, 2002), whereas in 2010, 12.1% of preschoolers were obese and 26.7% were overweight (BMI for age ≥ 85th percentile; (Ogden, Carroll, Kit, & Flegal, 2012). Of all overweight and obese children, one in three become overweight before they turn five years old (CDC, 2010), indicating the need to intervene at young ages to prevent the onset of weight gain.

The increase in rates of obesity in the early stages of child development presents a significant challenge for medicine and public health, as children who are obese are at high risk of remaining obese throughout childhood and into adulthood (Gardner et al., 2009; Guo, Wu, Chumlea, & Roche, 2002; Williams et al., 1992). In fact, children who are overweight during their preschool years are more than five times as likely to be overweight at age 12 compared to young children who are not overweight (Nader et al., 2006). Moreover, obesity during childhood is linked to an increased risk of cardiovascular disease, type II diabetes, and hypertension during adulthood (Al Mamun, Cramb, O'Callaghan, Williams, & Najman, 2009; Baker, Olsen, & Sorensen, 2007; Williams et al., 1992). Even at young ages, obese children exhibit traditional risk factors for cardiovascular disease, including high blood pressure, abnormal glucose tolerance, and lipid abnormalities (Sinha et al., 2002; Viner, Segal, Lichtarowicz-Krynska, & Hindmarsh, 2005; Weiss et al., 2004).

In addition to the health outcomes of obesity in childhood, overweight and obese preschoolers are at risk of experiencing weight-based stigmatization when they begin school (Puhl & Latner, 2007). Overweight children experience stigmatization and bullying from their peers, and are seen as less likeable than normal weight children (Kraig & Keel, 2001; Lumeng et al., 2010; Puhl & Latner, 2007). Both peers and teachers view overweight children as more socially withdrawn, more aggressive, and with fewer leadership qualities (Zeller, Reiter-Purtill, & Ramey, 2008), and teasing from peers has been related to poorer school performance (Krukowski et al., 2009). The negative psychosocial consequences of obesity during childhood have the potential to affect children's emotional and academic development, thus re-emphasizing the need to intervene with young children to prevent excessive weight gain.

Problem of Adult Obesity

The prevalence of adult obesity has also increased substantially in the last few decades and continues to be a critical issue of public health. In 2010, 35.7% of adults were obese (body mass index, BMI, ≥ 30 kg/m2) and 68.8% of adults were overweight (Flegal, Carroll, Ogden, & Curtin, 2010). It is concerning that one in three adults are obese, as obesity puts individuals at higher risk of diseases such as hypertension, type II diabetes, dyslipidemia, cardiovascular disease, and cancer (Calle, 2003; Field et al., 2001; Renehan et al., 2010). Moreover, obese adults have a significantly higher risk of all-cause mortality compared to normal weight adults (Flegal, Kit, Orpana, & Graubard, 2013).

Maternal Obesity

Though the obesity rate among all adults is high, there is emerging evidence that suggests that women with children are at higher risk of obesity than women without children. A longitudinal population-based study found that mothers who had at least one child under the age of five in the home had a higher BMI than women without children in the home, but interestingly the same was not true for fathers (Berge, Larson, Bauer, & Neumark-Sztainer, 2011). Another longitudinal study using data from the Coronary Artery Risk Development in Young Adults (CARDIA) cohort study found that women ages 18-30 who became mothers within the 7-year study period gained more weight than women who did not have children (Laroche et al., 2013). In that study, among black women, having a child was associated with an increase of 0.65 BMI units, while among white women, it was associated with an increase of 1.12 BMI units. Similar to the previous study, there were no differences in BMI between men who had children during the study period and men who did not. On the other hand, in the American Changing Lives Survey, both male and female participants with children gained weight more rapidly than participants without children over a period of 15 years (Umberson, Liu, Mirowsky, & Reczek, 2011). The data from multiple national surveys strongly suggests that bringing children into the home is a significant life transition that increases the risk of obesity, and signifies the early years of parenthood as a critical time to intervene for weight control.

Determinants and Correlates of Childhood Obesity

Childhood obesity is a health problem with correlates from many levels of the Socio-Ecological framework that interact with one another, including demographic characteristics, individual diet and physical activity behaviors, the home environment, neighborhood/community environment, and policies (Davison & Birch, 2001). Of particular importance, data from longitudinal cohort studies have suggested that certain parental and early childhood factors act independently and in combination with one another to predict early childhood obesity (Burke, Beilin, & Dunbar, 2001; Flores & Lin, 2013). Consistent predictors of child weight gain include parent BMI, parent dietary intake, parent physical activity, and the diet, physical activity, and sedentary behaviors of the child (Davison & Birch, 2001). A study using data from the Early Childhood Longitudinal Birth Cohort found that, in a multivariate model, maternal pre-pregnancy weight, sugar-sweetened beverage consumption, screen time, and child weight at 2 years old were predictive of severe obesity in kindergarten (Flores & Lin, 2013). In fact, children who crossed the 85th percentile at 2 years of age had 8 times the odds of becoming severely obese in kindergarten compared to those below the 85th percentile at 2 years old. This reinforces the need to identify and intervene upon the strongest risk factors for early childhood obesity, including sugar-sweetened beverage consumption and the home environment, in order to prevent early, rapid weight gain during the preschool years.

Sugar-Sweetened Beverage Consumption

The American Academy of Pediatrics (AAP) recommends that parents not allow children ages 2-5 to consume any sugar-sweetened beverages (Barlow and Expert Committee, 2007). This includes non-juice fruit drinks, sport drinks, caloric sodas, and flavored milks. The AAP acknowledges that 4-6 oz. of 100% fruit juice per day is acceptable and counts as 1 serving of fruit. However, they recommend choosing whole fruits over 100% fruit juice because fruit juice lacks the fiber that whole fruit contains and in addition, drinking fruit juice does not teach preschoolers the eating behaviors that are associated with eating healthy foods over time (Committee on Nutrition, 2001).

Despite the American Academy of Pediatrics' (AAP) recommendation that children ages 2-5 should not be consuming any sugar-sweetened beverages, NHANES data indicates that, on average, preschoolers consume 5 ounces of fruit drinks and 3.25 ounces of soda per day, in addition to 4.7 ounces of 100% fruit juice (O'Connor, Yang, & Nicklas, 2006). Although consumption of non-juice fruit drinks has remained consistent in the last three decades, consumption of 100% fruit juice has increased to more than 50% of children ages 1-5 (Fulgoni & Quann, 2012). In addition, though soda consumption is not as common among preschoolers as it is among adolescents, data from a surveillance study found that 35.9% of 2-year-old children drink soda at least once per week (Garnett, Rosenberg, & Morris, 2013). Children in this age range are consuming an average of 70 calories a day from sugary drinks including caloric carbonated beverages, fruit drinks, and sport drinks (Ogden, Kit, Carroll, & Park, 2011). This increases to 176 calories a day when including consumption of 100% fruit juice (Wang, Bleich, & Gortmaker, 2008). Given that the American Heart Association recommends that the diet of children 2-3 years old be limited to 1000 calories per day and 1200-1400 calories per day for children 4-5 years old (Gidding et al., 2006), calories from SSBs and fruit juices are making up 12-18% of preschoolers' recommended energy intake. The increased intake of fruit juices and sodas among young children is a concerning trend and given the association between SSB consumption and obesity among children, reducing sugar-sweetened beverage consumption seems to be a promising target for intervention to prevent early childhood obesity.

Though much research has been done on the dietary determinants of childhood obesity, including overall caloric intake, fruit and vegetable consumption, and intake of added dietary fats, sugar-sweetened beverage intake is most consistently associated with obesity across studies. Several longitudinal studies have shown that SSB consumption in early childhood is associated with higher BMI later in childhood (DeBoer, Scharf, & Demmer, 2013; Millar et al., 2014; Shroff et al., 2013). In an intervention with over 1,000 children ages 4-12, consumption of sweet drinks was significantly associated with change in BMI z-scores, whereas fruit and vegetable consumption was not associated (Johnson, Kremer, Swinburn, & de Silva-Sanigorski, 2012). It is often assumed that consumption of 100% fruit juice in early childhood is acceptable and even expected, and some studies have found no effect of 100% fruit juice on changes in weight status during childhood (Field, 2003; J. D. Skinner, Carruth, Moran, Houck, & Coletta, 1999). In a cross-sectional NHANES study, consumption of 100% fruit juice, fruit drinks, and soft drinks was associated with increased energy intake, but was not associated with BMI z-score (O'Connor et al., 2006). However, a study examining fruit juice consumption among children ages 1-5 in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program found that, among overweight children, servings of fruit juice per day was associated with excess weight gain, but there was no association among normal weight children (Faith, Dennison, Edmunds, & Stratton, 2006). There have been few studies targeting SSB reduction in children, but results from one study in children ages 4-12 found that replacing SSBs with noncaloric beverages can, in fact, lead to a lower increase in BMI z-scores over time (de Ruyter, Olthof, Seidell, & Katan, 2012).

Home and Family Environment

The home and family environment has been found to be an important environmental determinant of early childhood weight status because, at the preschool age, behaviors are formed primarily in the home. Parents serve as “gatekeepers” in the home by acting as role models for healthy behaviors and by providing children specific food and physical activity opportunities in the home. Consistent with these principles, research has shown that there is an association between characteristics of the home environment and the diet and physical activity behaviors of parents and children (Birch & Davison, 2001; Sonneville et al., 2012; Strauss & Knight, 1999). The link between the home environment and childhood behaviors operates through a variety mechanisms, including parent weight, parent behaviors and role modeling, and aspects of the physical environment that promote or inhibit certain diet and physical activity behaviors. An obesogenic home environment is often characterized by the presence of high calorie foods and SSBs, low availability of fruits and vegetables, an increased number of TVs, a TV in the child's bedroom, and little play/exercise equipment in the home.

Parent Weight. Parent weight is one of the strongest predictors of child weight (Flores & Lin, 2013), and having obese parents is known to increase the risk of being obese as an adult. Although research has documented that child obesity tracks into adulthood (Guo et al., 2002), the relationship is strongest when one or more parents are obese. For obese children ages 1-5 with an obese mother, the odds of remaining obese in adulthood are 3.6 times the odds of those who do not have an obese mother, and the odds ratios are smaller but still significant for having an obese father (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Even more concerning, children with an obese mother have a significantly earlier onset of obesity compared to children without an obese mother (Gordon-Larsen, Adair, & Suchindran, 2007). There is even intervention evidence from a family-based weight loss program that demonstrated that a change in parent BMI was the only significant predictor of change in child BMI, such that a reduction of 1 BMI unit in the parent was associated with a 0.26-unit reduction in child BMI (Boutelle, Cafri, & Crow, 2012). Not only is maternal weight associated with child weight, but interestingly, maternal pre-pregnancy BMI is also independently associated with child SSB consumption (Garnett et al., 2013; Kral et al., 2008), which gives even more weight to the importance of reducing maternal obesity in order to prevent child obesity.

Parent Behaviors. As suggested by observational learning and Social Cognitive Theory, the behavior of children is often correlated with parent behavior. In fact, there is a known correlation between maternal diet and child diet that occurs as early as 6-12 months of age (Robinson et al., 2007). The correlation between child and parent diet and physical activity behaviors is partially due to genetic similarities, but is primarily due to environmental influences (Perusse, Leblanc, & Bouchard, 1988; Vauthier, Lluch, Lecomte, Artur, & Herbeth, 1996). At the preschool age, environmental influences are limited mostly to the family environment. This environment is often the central socialization context for children, and research has demonstrated that parents, as agents of socialization, can influence the health behaviors of their children (Hays, Power, & Olvera, 2001; Lees & Tinsley, 1998). This suggests that parents act as role models for their child's eating and physical activity behaviors (Davison & Birch, 2001), and that after repeated exposure and observation, children will learn to like the foods and behaviors they see their parents modeling (Birch, 1992).

Research on modeling of specific behaviors has found that maternal SSB consumption is correlated with child SSB consumption (Sonneville et al., 2012; Vereecken, Keukelier, & Maes, 2004) and reduction in maternal consumption of SSBs is associated with a reduction in child consumption of SSBs (Klohe-Lehman et al., 2007). An analysis of baseline data from an intervention with overweight and obese mothers of children ages 2-5 found that preschoolers had significantly greater odds of meeting the AAP goals of SSB consumption when their mother also met the goal (Turer et al., 2013). Specifically, among mothers who met the goal of zero ounces of SSB per day, 78% of children also consumed zero ounces, compared to only 45% of children whose mothers did not.

Food and Activity Home Environment. The behavior of children is often affected by the physical context of the home environment. For example, a study on sugar-sweetened beverages found that 80% of SSBs consumed by young children are consumed in the home environment (Wang et al., 2008), and there is evidence that the amount of fruit juice, sodas, and other sweetened drinks available in the home is associated with child SSB consumption (Spurrier, Magarey, Golley, Curnow, & Sawyer, 2008). Because women, especially after having children, serve as gatekeepers to food and activities in the home, it is critical to intervene with mothers to change the aspects of the home environment that can facilitate reductions in SSB consumption.

Limit Setting. There is not as much research that has studied the effect of limit setting and rules on child SSB intake, but research with parent-child dyads has shown that parents of healthy weight were more likely to have family rules and less difficulty with rule enforcement compared to families in which the parent was overweight (Hearst et al., 2012; Lytle et al., 2011). A longitudinal study of children from infancy until the age of 6 years old indicated that the practice of mothers setting limits on sweets and junk food was associated with reduced odds of consuming SSBs more than one time per day (Park, Li, & Birch, 2015).

These relationships indicate that young children with obese mothers are particularly important targets for obesity prevention due to their high risk of becoming obese. Moreover, early childhood is an opportune time for parents to influence their child's healthy weight behaviors by making important changes in their own behaviors and in the home environment. In particular, parents are key targets for changing children's SSB consumption, as they are able to limit and guide these behaviors within the home.

Determinants and Correlates of Maternal Obesity

Mothers of young children may be at particularly high risk of obesity due to many factors, including excessive weight gain during pregnancy and failure to lose weight postpartum (Linne, Dye, Barkeling, & Rossner, 2004; Rooney, Schauberger, & Mathiason, 2005; Rossner & Ohlin, 1995). Compounding the effect of gestational weight gain, mothers may also decrease their physical activity in the transition to motherhood or as they have more children. Cross-sectional studies have shown that mothers engage in less physical activity than women without children (Bellows-Riecken & Rhodes, 2008; Burke, Beilin, Dunbar, & Kevan, 2004; Marcus, Pinto, Simkin, Audrain, & Taylor, 1994; Verhoef & Love, 1994) and fathers (Bellows-Riecken & Rhodes, 2008). After having a child, more than half of active women no longer meet physical activity recommendations (Albright, Maddock, & Nigg, 2005; McIntyre & Rhodes, 2009). Other studies have also indicated that women with children in the home are more sedentary than those without (Marcus et al., 1994; Scharff, Homan, Kreuter, & Brennan, 1999), and mothers with children under the age of 5 are at even greater risk of physical inactivity (Nomaguchi, 2004; Sternfeld, Ainsworth, & Quesenberry, 1999). The relationship between motherhood and nutritional intake is less clear, but a longitudinal study exploring differences between parents of children younger than 5 years and non-parents showed that mothers had a greater consumption of SSBs, greater energy intake, and greater saturated fat intake compared to women without children, but these relationships were not significant between fathers and non-fathers (Berge et al., 2011).

Sugar-Sweetened Beverage Consumption

Among adults, sugar-sweetened beverage consumption is not just associated with obesity, but has also been shown to increase the risk of non-alcoholic fatty liver disease, diabetes, the metabolic syndrome, and cardiovascular disease (Dhingra et al., 2007; Malik et al., 2010; Vartanian, Schwartz, & Brownell, 2007). Laboratory experiments have found that drinking excessive amounts of SSBs for just a short period of time can produce symptoms of metabolic syndrome, decrease low-density lipoproteins and increase high-density lipoproteins, which increases risk for CVD (Aeberli et al., 2011; Vos, Kimmons, Gillespie, Welsh, & Blanck, 2008). In the United States, adults consume 21% of their calories from SSBs alone (Duffey & Popkin, 2007). Baseline data from an intervention study targeting 400 overweight and obese mothers of preschool children found that only 33% were not consuming any sugar-sweetened beverages (Turer et al., 2013).

The literature exploring the hypothesis that a reduction in SSB consumption leads to a reduction in weight has often been conflicting, but recent randomized controlled trials have demonstrated that reducing sugar-sweetened beverage consumption in adults can lead to a reduction in weight. In the first study, decreasing servings of SSBs by 1 per day was associated with a decrease in weight of almost 0.5 kg (Chen et al., 2009). In another study among overweight and obese adolescents, the intervention group significantly decreased SSB after 1 year compared to the control group and the reduction in SSB consumption was associated with a decrease in BMI (Ebbeling et al., 2012). Finally, in a study among adults, participants were randomized to one of 3 groups, in which they were asked to either (1) replace caloric drinks with diet beverages, (2) replace caloric drinks with water, or (3) continue with their normal beverage intake (Tate et al., 2012). The diet beverage and water groups were significantly more likely to lose 5% of their weight at 6 months compared to the control group, which suggests that reducing caloric intake from beverages can lead to clinically meaningful weight loss in the absence of other prescribed changes.

Behavioral Programs for Obesity

Weight Loss and Weight-Related Behavior Programs for Young Children

Behavioral interventions for preschool-aged children have been increasing in number in recent years, but the extant studies have seen only limited success. The goal of some interventions has been to produce weight loss in overweight or obese children, but the goal of others has been to improve diet or physical activity behaviors in order to prevent future weight gain. Among interventions done in the preschool setting that consist of weekly group meetings for the children focused on diet and physical activity and involve little parent contact, none have been effective at changing weight by the end of the intervention (Fitzgibbon et al., 2005, 2006). However, one of those studies, the Hip Hop to Health, Jr. study conducted in Head Start preschools, found that children in the intervention group had gained significantly less weight than children in the control group at 1 and 2 years follow-up (Fitzgibbon et al., 2005). Interventions in preschool settings that targeted specific behaviors rather than weight have been more successful. Two studies added structured physical activity sessions into the preschool curriculum and found an increase in child physical activity (Annesi, Smith, & Tennant, 2013; Trost, Fees, & Dzewaltowski, 2008) and another study specifically targeted caloric drinks in addition to fruit and vegetable consumption and found that the intervention group had significantly lower SSB consumption at the end of the intervention (Bayer et al., 2009). Another successful intervention in preschools was an environmental intervention that used child-care health consultants to assess and improve the nutrition and activity environment of childcare centers, and they found that nutrition improved in the centers that followed the program (Ward et al., 2008).

The active involvement of the parent is known to be a critical factor for success in childhood interventions (Golan, 2006). Especially among preschoolers, the key seems to be a focus on parent engagement or the addition of a parent component to interventions that are conducted in a preschool or childcare center setting (Golan, 2006; Hesketh & Campbell, 2010). In a revised version of Hip Hop to Health, Jr., 6 weekly in-person classes and weekly newsletters for parents were added to the intervention group, compared to a control group that received only general health information. However, at the end of the 14-week study, there were no differences between groups in BMI z-scores and no differences on any diet or physical activity-related measures, including screen time and sedentary behavior (Fitzgibbon et al., 2013). Notably, only 38% of the parents attended the first session, and attendance decreased further after that, which was potentially why no differences were found between groups. In a study where preschools were randomized to an intervention group targeting physical activity and sedentary time or to a control group, parents and their children attended 10 weekly sessions at the school. At the end of the intervention, children in the intervention group engaged in significantly less sedentary time than the control group, and the reduction in sedentary time was associated with parents' physical activity levels and number of TVs in the home (O'Dwyer, Fairclough, Knowles, & Stratton, 2012). An even shorter study randomized parents of overweight children ages 3-10 to a group receiving four weekly 2-hour in-person sessions focused on nutrition, physical activity, and motivation, or to a waitlist control group. At post-intervention, there were no differences in children's screen time, but children in the intervention group significantly decreased BMI compared to the control group (Shelton et al., 2007). In a one-group pre-post study, nutrition and

PA activities were incorporated into Head Start centers, but parents received letters on child BMI, a communication campaign, and participated in a 6-week parent led program. After 6 months, children had increased light PA, reduced TV viewing, and reduced daily energy intake (Davison, Jurkowski, Li, Kranz, & Lawson, 2013).

Many recent studies of early child weight and behaviors have targeted solely parents as the agent of change, with the goal of changing parent behavior in order to lead to changes in child behavior. The KAN-DO study, a large RCT with mother-child dyads of children ages 2-5, was designed to improve diet, physical activity and weight, with the intervention curriculum components delivered via monthly mailed kits, telephone counseling sessions, and child activity materials. They found that mothers in the intervention group reduced their own consumption of SSBs and increased the availability of healthy food in the home; however, there were no differences in maternal sedentary behavior, child SSB consumption, child sedentary behavior, or child screen time (Ostbye et al., 2012). Another 6-month family-based RCT targeted changes in high-calorie foods, beverages, fruits and vegetables, and physical activity, and consisted of 18 group sessions and 6 home visits by staff members. The intervention group had greater decreases in child BMI percentile, caloric intake, and sugar-sweetened beverage consumption compared to the control group (Stark et al., 2011). Notably, the latter intervention seems to have produced greater effects, potentially due to the more intensive nature of the intervention. A shorter intervention, requiring only 8 weekly 2-hour classes on diet and physical activity for moms of children ages 1-3, resulted in significant decreases in maternal weight, child energy intake, and child SSB consumption (1.8 to 1.0 servings per day), which was correlated with a significant reduction in maternal SSB consumption (2.4 to 1.0 servings per day; (Klohe-Lehman et al., 2007). While most interventions targeting parents have focused on broad dietary and physical activity behaviors, one home-based study targeted solely vegetable intake in parents and children ages 2-5, and consisted of 4 newsletters and 2 telephone calls focused on goal setting, problem solving, and tailored feedback (Tabak, Tate, Stevens, Siega-Riz, & Ward, 2012). The intervention successfully increased parents' offering of both fruits and vegetables, indicating that a relatively low intensity intervention aimed at parents as the agent of change can be successful at changing specific behaviors.

A seminal paper by Dietz and Robinson supports the need for parental involvement in the prevention of child obesity, and recommends that parents use four strategies to control weight gain, including controlling the environment, setting goals, monitoring behavior, and rewarding successful behavior change (Dietz & Robinson, 2005). A recent statement by the American Heart Association echoed the Dietz and Robinson paper by creating a conceptual model of core strategies for changing behavior in family-based interventions (Faith et al., 2012). They indicated that identifying the behavior to change is an important first step, after which parents are encouraged to change the environment, set behavioral goals, and develop self-efficacy for that behavior. Of the interventions targeting behavior and weight change in preschool-aged children, some of the most successful interventions were those that specifically targeted the parent as the agent of change and incorporated behavioral change techniques into the intervention.

Weight Loss Programs for Adults

Typical adult behavioral weight loss interventions consist of reducing caloric intake, gradually increasing moderate-to-vigorous intensity exercise, and self-monitoring of diet and exercise (Diabetes Prevention Program Research Group, 2002). The standard behavioral program consists of weekly face-to-face group sessions that last between 60 and 90 minutes, often tapering off to biweekly or monthly following the first 3 to 6 months. Occasionally programs will add additional components such as telephone calls, text messages to prompt self-monitoring and goal setting, or a study website where participants can access study materials and self-monitor their diet and exercise. These interventions are known to be effective and typically result in significant weight losses by 6 months (Wing, Gorin, & Tate, 2006).

Parents in Standard Behavioral and Family-Based Weight Loss Interventions

Because families play a crucial role in the development of child behaviors and preferences, preventing obesity during the preschool years will necessitate the use of effective interventions for working with parents and caregivers. Importantly, family-based interventions take into account the contextual factors within the home, including aspects of daily family life and decision-making. The most effective interventions for both adults and children are those of longer length and those that require a high frequency of group meetings (Perri, Nezu, Patti, & McCann, 1989). Similarly, among adults and families, higher treatment attendance at group meetings is associated with greater weight losses (Golan, Kaufman, & Shahar, 2006; Kalarchian et al., 2009; Wadden et al., 2009). But despite the clinically important weight losses that result from standard behavioral interventions, these programs can be time consuming for parents, and some may have trouble adhering to program requirements and attendance at group meetings. Even with standard behavioral programs, attrition is more likely in longer programs (Peter R. Brown, W. J. Brown, Y. D. Miller, & V. Hansen, 2001b; Wing, Blair, Marcus, Epstein, & Harvey, 1994), but dropout in family-based studies is especially high, ranging from 27-73% (Skelton & Beech, 2011). Families may have difficulty participating in lengthy programs, as they likely have more barriers to participation and challenges with scheduling and time demands than adults without children. In particular, young women with children have many time demands and constraints in their lives, which could preclude their ability to participate in interventions, especially those that require weekly group meetings (P. R. Brown et al., 2001b). Interventions with face-to-face group meetings that have specifically targeted mothers have had poor attendance and retention (Hartman, Hosper, & Stronks, 2011). As an example, in a large RCT of postpartum women with 18 in-person group meetings and additional telephone calls focusing on healthy eating and physical activity, the group meetings had only 27% attendance. There was no difference in weight loss between the intervention and control groups, and no differences in SSB consumption. But importantly, the number of group meetings attended was positively associated with weight loss (Ostbye et al., 2009). A study with mothers of children ages 1-4 that involved 8 weekly 2-hour classes had only 44% of participants in attendance at the first session, and attendance continued to decrease over time (Jordan et al., 2008). One RCT with mothers of infants up to 18 months old required only six 2-hour face-to-face group sessions, and while adherence to group meetings was not reported, 34% of the participants dropped out before the follow-up assessment. This is lower than some other studies, potentially because the meetings were scheduled at the same time as a first-time parents' group that the participants had already been attending prior to the intervention (Lioret et al., 2012). Even with as little as 6 to 8 in-person meetings, the studies described still had problems with retention, indicating that mothers of young children require study components that will fit into their busy schedule.

Interventions using other varied components have had somewhat better retention and in some cases, better outcomes. Correspondence-based interventions, including those that use computer-based and telephone contact, are among the alternatives to group-based interventions and have been successful in promoting weight loss, though weight losses average from 1-4 kg (Black, Coe, Friesen, & Wurzmann, 1984; Forster, Jeffery, Schmid, & Kramer, 1988; Jeffery, Danaher, Killen, Farquhar, & Kinnier, 1982). These weight losses are smaller than that achieved with face-to-face group meetings, but effective for populations who are unable to attend weekly group meetings. In particular, a 6-month weight loss intervention among postpartum mothers delivered via mailed materials and telephone contacts resulted in weight losses of 7.8 kg, and had only 23% dropout compared to a dropout of 40% in the control group (Leermakers, Anglin, & Wing, 1998). In an intervention specific to mothers of children ages 2-5, the intervention group received 12 weekly newsletters and was compared to a group that received a one-time booklet given during the first week of the program. Results indicated that the newsletter group had significant increases in child outdoor play compared to the control group, and had 98% follow-up at 12 weeks (Essery, DiMarco, Rich, & Nichols, 2008). Other research among adults has found that a low maintenance intervention focused on reducing sugar-sweetened beverages by replacing them with either water or diet beverages can result in significant weight losses (Tate et al., 2012).

The evidence reviewed here suggests that interventions that do not require face-to-face group meetings are ideal for parents; however, a critical gap in the intervention literature is the lack of family-based interventions targeted toward mothers of young children that seek to facilitate their attendance and enhance the effectiveness of the interventions. Importantly, there is evidence that adherence to self-monitoring recommendations is associated with better weight losses among children and parents, above and beyond the effect of other treatment adherence measures (Germann, Kirschenbaum, & Rich, 2007; Wrotniak, Epstein, Paluch, & Roemmich, 2005). Unfortunately, there is some emerging evidence to suggest that parents of children have difficulty completing traditional daily self-monitoring diaries of diet and physical activity (Tompkins Nezami, 2011, unpublished data). Therefore, it is possible that a lower maintenance intervention with a focus on monitoring a small set of behaviors could be a promising method for intervening with parents and children.

eHealth and mHealth Behavioral Weight Loss Interventions

Emerging technologies have been used to develop interventions that address the difficulties to attendance and adherence in face-to-face interventions. While the success of in-person interventions is maximized among participants who are most adherent and attend a greater number of group meetings, participants who are unable to fully participate in face-to-face groups may respond better to interventions that are delivered remotely, via the internet and/or text messages.

Interventions that use websites as the primary mode of delivery are common, and while weight losses do not equal those of face-to-face trials, they result in clinically meaningful weight losses of about 1.5 - 4 kg greater than commercial weight loss programs and control groups (Gold, Burke, Pintauro, Buzzell, & Harvey-Berino, 2007; Tate, Jackvony, & Wing, 2006; Tate, Wing, & Winett, 2001). The success of internet-based programs is due in part to the factors that contribute to success in face-to-face interventions, most notably "attendance" and behavior change techniques, which in the case of internet interventions, can consist of logging on to the website, viewing study materials, goal setting, and self-monitoring (Krukowski, Harvey-Berino, Bursac, Ashikaga, & West, 2013; Neve, Morgan, Jones, & Collins, 2010). As an example, an RCT compared a behavior therapy internet program for weight loss to an education-only program, and found that the behavior therapy group had lost 4.1 kg by 6 months compared to only 1.6 kg in the education-only group (Tate et al., 2001). In addition, another RCT found that adding human e-counseling, including feedback on self-monitoring, reinforcement, and encouragement, to an internet weight loss program with automated feedback improved weight loss outcomes by 4.7 kg in comparison to the no-counseling group (Tate et al., 2006).

Using mobile phones is a relatively novel technique, but one that has shown to be effective across a range of behaviors including smoking cessation and physical activity (Fjeldsoe, Marshall, & Miller, 2009; Head, Noar, Iannarino, & Grant Harrington, 2013). Interventions using text messages and mobile-based websites or applications have the capability to reach many people, as mobile phone use is high and continues to increase among adults in the United States. Among the 91% of Americans who own a cell phone, 63% of them use it to access the internet or email; therefore, 57% of all U.S. adults use a cell phone to access the internet (Duggan & Smith, 2013). This is more than twice the amount in 2009, indicating that mobile web use is increasing quickly and will soon be a technology that most Americans use and have access to. When examining mobile web users by demographic characteristics, 85% of adults ages 18-29 are users, followed closely by 73% of adults ages 30-49. Adults from high-income households, and those from urban and suburban areas as compared to rural, are more likely to access the internet on cell phones. A recent qualitative study indicated that parents preferred online and mobile programs because of their convenience in receiving intervention content, their flexibility, and the ability to access programs at any time (Burrows et al., 2015), and internet- and mobile-based interventions have shown acceptable participation and attendance rates among mothers of young children (Fjeldsoe, Miller, Graves, Barnett, & Marshall, 2015; Knowlden, Sharma, Cottrell, Wilson, & Johnson, 2015). Overall, the current data seem to indicate that accessing the internet on mobile phones occurs across diverse populations, such that using mobile phones to intervene with a variety of populations is now possible.

Text messaging is increasingly being used in behavioral weight loss interventions to supplement existing intervention components. For example, a study among college students randomized to a Facebook group, a Facebook plus text messaging group, or a control group, found that at 8 weeks, the Facebook plus text messaging group had greater weight losses than the Facebook-only group (Napolitano, Hayes, Bennett, Ives, & Foster, 2013). Patrick and colleagues conducted a 16-week RCT comparing an intervention with 3-5 daily personalized text and picture messages, printed materials, and monthly phone calls to a group that received printed materials about weight control on a monthly basis. At 4 months, the intervention group had greater weight losses than the control group, with a difference of almost 2 kg (Patrick et al., 2009). Other interventions have used text messages primarily to increase participants' ease and ability of self-monitoring their behaviors. In the Text4Diet study (Shapiro et al., 2012), the intervention group received 4-5 daily tailored text messages, many of which requested them to self-monitor their weight and daily steps as recorded by a pedometer. The control group received monthly newsletters via email. There were no differences in weight loss at 6 or 12 months; however, weight losses were greater among participants who were more adherent to the intervention (i.e. by responding to text messages that elicited a response). Adherence to self-monitoring via text message in the Text4Diet study ranged from 50-60% throughout the study, which is lower than ideal, although in that particular study, responding to self-monitoring requests required that they had worn their pedometer throughout the day. Though few other studies have specifically measured the feasibility and acceptability of self-monitoring weight-related behaviors via text message, one research study among mothers of infants found that participants reported SMS as an acceptable and convenient way to provide self-monitoring data (Whitford et al., 2012).

In summary, there has been a widespread adoption of eHealth and mHealth interventions, many of which have been effective in producing clinically meaningful changes in behaviors and weight loss. Notably, these interventions would seem to be well suited to populations that have difficulty adhering to the standard face-to-face interventions, including parents of young children, but surprisingly few studies have been done using the internet and/or text messaging as modes of delivery to reduce weight or produce changes in weight-related behaviors among mothers of young children. Due to the barriers and time demands experienced by parents, an intervention that requires self-monitoring of primarily 2 behaviors, via text message or a mobile-based website that is accessible to participants at any time of day, could be a successful technique by which to promote behavior change.

Summary

Over the last 40 years, research has confirmed a trend for the onset of obesity at increasingly younger ages. This is concerning, because, despite the belief among many that children "grow out of their baby fat," excessive weight gain in early childhood is known to increase the risk of obesity and its health-related consequences throughout childhood and into adulthood. The strongest predictors of child weight are maternal weight and weight-related behaviors, including SSB consumption. In addition, mothers of young children are more likely to be overweight or obese due to the time demands and life transitions that occur when having children. This puts young children of overweight and obese mothers at particularly high risk for obesity during their childhood years. Because the development and socialization of children under the age of 5 occurs primarily in the home, this warrants a treatment approach that targets young children within the family environment, addressing the needs of both the mother and her child to improve their health. Little research has examined the adherence and success of adults with children in traditional behavioral weight loss interventions, and even fewer studies have specifically adapted interventions for use in mothers with young children. The critical next step in the literature is to understand the unique barriers to treatment participation among parents, and then to use innovative approaches to treatment that are expected to increase adherence among mothers, in particular, in order to improve weight-related behaviors in both mothers and children.

CHAPTER III: THEORETICAL FRAMEWORK

Social Cognitive Theory

Social Cognitive Theory (SCT) posits that individual, social and environmental factors interact in a reciprocal manner (i.e. reciprocal determinism) to explain behavior (Bandura, 1977). The studies in this dissertation are based on a SCT framework, as the weight-related behaviors of both parents and children can be described in terms of the constructs in SCT that lead to behavior change.

Study One

In the context of Study One, SCT proposes that environmental, personal, and social barriers can inhibit behavior change (Bandura, 1997). If there were no perceived barriers to overcome, behavior change would not be as difficult. But, adults with children report barriers to physical activity, which SCT suggests would inhibit engagement in physical activity and hinder subsequent weight losses (Albright et al., 2005; P. R. Brown et al., 2001b; Miller, 2005; Verhoef & Love, 1994). Many of these barriers are similar to those among all adults, but notably, 98.6% of mothers report that time commitments for children are a barrier to physical activity, followed by time commitments for chores, time commitments for partners, and fatigue (P. R. Brown et al., 2001b). Other barriers to physical activity among mothers include lack of childcare, lack of time, and feeling guilt for taking time away from family-related duties (Albright et al., 2005; Miller, 2005; Pereira et al., 2007; Verhoef & Love, 1994). There is research that suggests that personal perceived barriers to exercise are associated with lower levels of physical activity (Salmon, Owen, Crawford, Bauman, & Sallis, 2003), but what is not known is if parents report more or different barriers to exercise than non-parents.

The analyses proposed in Study One are based on the hypothesis that adults with children in the home will report increased perceived barriers to exercise at the beginning of the study compared to adults without children. In addition, as SCT suggests, the greater amount of exercise barriers will be associated with behavior change, such that their increases in physical activity will be lower than the increases in physical activity seen among adults who are not caring for children in the home. This, in turn, will be associated with lower weight loss during the initial phase of the intervention and a greater weight regain in the maintenance phase.

Studies Two and Three

In a review of parents as the "agent of change" in childhood obesity programs, the American Heart Association concluded that changing the environment leads to a change in behavior, and setting behavioral goals encourages parents to self-monitor their behavior, which also then leads to a change in behavior (Faith et al., 2012). SCT acknowledges and accounts for the effect of interacting levels of influence on behavior. While SCT has frequently been used in studies of childhood overweight, it has most often only applied its constructs, most notably self-efficacy, to the development and/or evaluation of individual behavior and weight change within interventions. There are few studies that have acknowledged the varying levels of influence on child behavior and the reciprocal nature between personal and environmental influences.

As applied to maternal and child obesity in the home, child behavior is a function of individual characteristics, maternal characteristics, including maternal weight, maternal behaviors such as diet and physical activity, and aspects of the home environment including availability of foods, activity equipment, play space, and media equipment. The intervention proposed in this study will target the following constructs from SCT that have been associated with sugar-sweetened beverage consumption in previous studies: self-efficacy, outcome expectations, perceived barriers (i.e. what Bandura refers to as impediments), self-regulation, observational learning, positive reinforcement, and aspects of the home environment. In addition, though not taken from SCT, the intervention will target limit setting within the home. The overall goal is to use SCT to target the behavior of mothers of young children to, in turn, promote behavior change in the child. The conceptual model for the intervention is depicted in Figure 3.1.

Self-Efficacy. Self-efficacy is defined as an individual's confidence in performing a behavior across a variety of situations and circumstances (McAlister, Perry, & Parcel, 2008). Individuals who have self-efficacy for a particular behavior or set of behaviors are confident they can complete it, set higher goals for themselves, and believe that their behavior will have positive outcomes (Bandura, 2004). In the weight loss field, self-efficacy for weight loss is generally assessed as self-efficacy for a variety of diet and physical activity-related behaviors, and has often been associated with weight loss. In this study, self-efficacy for making changes in sugar-sweetened beverage consumption will be of particular interest and the extant research base suggests that this will be a useful target for change in this intervention. In a cross-sectional study of 1- and 5-year olds, higher maternal self-efficacy for limiting non-core foods was associated with lower consumption of SSBs in both 1- and 5-year-olds and with increased water intake in 5-year-olds (Campbell, Hesketh, Silverii, & Abbott, 2010). Yet another set of studies has demonstrated that maternal self-efficacy for limiting unhealthy foods, barriers to limiting SSBs, and rules restricting SSB consumption have all been associated with child consumption of SSBs (Bolling, Crosby, Boles, & Stark, 2009; Campbell et al., 2010; Spurrier et al., 2008). While the above studies have all been cross-sectional and cannot conclude that an increase in self-efficacy is predictive of behavior, the intervention proposed here accounts for a relationship between self-efficacy and behavior that goes in both directions (Figure 3.1), as an increase in self-efficacy could lead to a change in behavior, while success in changing behavior could in turn lead to an increase in self-efficacy, further reinforcing the cycle of behavior change.

Within this intervention, maternal self-efficacy will be specific to making changes in the home environment, reducing personal SSB consumption, and limiting child SSBs. To increase maternal self-efficacy, the intervention will foster performance accomplishments among the participants, which Bandura (1977) proposed as strongly related to self-efficacy. To do this, the intervention will promote short-term, reasonable goal setting in order to change SSB and screen time behaviors gradually over time, and will encourage mothers to keep track of their progress and acknowledge when they have reached a goal. In addition, they will receive performance feedback from the study staff that praises their achievements when they meet one of their goals. Overall, mothers' successful performance in changing the home environment, engaging in limit setting, and changing her own SSB consumption and screen time should lead to further increases in self-efficacy.

Outcome Expectations. Outcome expectations refer to the belief that a given behavior will or will not lead to a certain outcome (Bandura, 1977). In the childhood obesity field, it has been suggested that parents of young children are not concerned about their child's weight, and moreover, are not concerned with specific dietary and sedentary behaviors, but tend to worry more about their child not eating enough food or other kinds of illnesses and overall health. Qualitative research indicates that parents are hesitant to reduce their child's consumption of SSBs, in addition to 100% fruit juice, as they believe that the vitamin C content is important and do not believe that it has a strong relationship with weight (Beck, Takayama, Halpern-Felsher, Badiner, & C Barker, 2013; Bolling et al., 2009). Therefore, a critical part of this intervention will seek to change mothers' expectations about the benefits of reducing SSBs and 100% fruit juice.

Perceived Barriers. Bandura specified that impediments to behavior have to be overcome before the individual can engage in the behavior (Bandura, 2004). Much research has shown that as perceived barriers to behavior change increase, the likelihood of behavior change decreases. The results of one qualitative study suggested that parents are hesitant to restrict 100% fruit juice because they anticipate crying, whining, or temper tantrums from their child (Bolling et al., 2009). While not yet studied among parents of preschoolers, a cross-sectional study with parents of older children found that perceived barriers, including the inability to get the child to follow the rules, lack of time, and the child's dislike of certain foods, were associated with the child's intake of healthy foods (Weber Cullen et al., 2000). To reduce the perceived barriers of mothers in this intervention, they will be encouraged to identify barriers to making changes to SSBs and will brainstorm strategies to overcome those barriers. In addition, they will receive prompts via text message to self-monitor their behaviors and to continue making changes, which will serve as a cue to engage in a behavior despite the perceived barriers.

Self-Regulation. Self-regulation is the idea that an individual can take control of and regulate his or her own behavior (McAlister et al., 2008). In the intervention context, this is often done through goal setting, self-monitoring of behaviors, problem solving, and rewards or reinforcements. To date, no studies have specifically targeted maternal self-monitoring of SSBs, but evidence from behavioral weight loss interventions demonstrates that self-monitoring of behavior, particularly diet and physical activity behaviors, has a strong relationship with weight loss and is an essential component for behavior change (Butryn, Phelan, Hill, & Wing, 2007; Linde, Jeffery, French, Pronk, & Boyle, 2005; Wadden, Butryn, & Wilson, 2007).

Within this intervention, mothers will be asked to self-monitor their own consumption of SSBs, in addition to the SSB consumption of their child each day. Because research has suggested that receiving daily prompting to self-monitor increases the rates of self-monitoring (Greaney et al., 2012), mothers will be prompted multiple times weekly via text message to self-monitor these behaviors.

Observational Learning. Observational learning implies that individuals learn behavior through vicarious learning, or by observing the behavior of others (Bandura, 1977). In family-based interventions, observational learning is a critical factor for change in child behavior, as the child is socialized primarily in the family environment and learns behaviors from his or her parents. There are many studies that show correlations between a variety of parent and child diet and physical activity behaviors. Several cross-sectional studies have found positive relationships between mother and child soft drink consumption in particular (Sonneville et al., 2012; Vereecken et al., 2004), with one indicating that children of mothers who consumed less than 1 serving per day had 5.8 times the odds of also drinking less than one serving per day (Sonneville et al., 2012). An intervention study targeting mothers and children ages 1-3 found correlations in the reductions over time in SSB consumption in mothers and children (Klohe-Lehman et al., 2007). In the current intervention, mothers will be taught about the link between parent and child behaviors, and the importance of role modeling healthy food behaviors. In this manner, children will learn from observing their mothers' behaviors, will develop positive views towards these behaviors, and in the long-term, might make healthy food and activity choices.

Home Environment. SCT posits that environmental factors can directly influence behavior and may interact with personal, behavioral, and other environmental factors to influence behavior (McAlister et al., 2008). The home environment is where young children spend most of their time, and "obesogenic" environments, or those that promote unhealthy diet and limit engagement in physical activity, are known to be associated with child weight status (Sonneville et al., 2012). A cross-sectional study has shown that the availability of fruit juice, fruit drinks, and soft drinks in the home are associated with child SSB consumption (Spurrier et al., 2008). Because mothers serve as the primary gatekeepers to the availability of food and media items in the household, it is critical to intervene with mothers to improve the home environment. Within this intervention, mothers will be asked to decrease the availability of SSBs (100% fruit juices, fruit drinks, lemonade, caloric soft drinks, sweetened teas, sports drinks, and flavored milks) in the home, and increase the availability of water and other healthy foods, such as fruits and vegetables.

Limit Setting. Parental limit setting within the household has been related to child diet and physical activity behaviors. In a cross-sectional study, SSB consumption in preschool children were lower when parents reported restriction of fruit juice and caloric soft drinks (Spurrier et al., 2008). A longitudinal study of children from infancy until the age of 6 years old indicated that the practice of mothers setting limits on sweets and junk food was associated with reduced odds of consuming SSBs more than one time per day (Park et al., 2015). In this study, mothers will be asked to set limits on SSB consumption such that, even when children ask, they are not allowed any SSBs except for those that fall below their weekly goal for consumption. Mothers will be encouraged to clearly communicate these limits with their children, and will be provided with a chart to post in the household on which the child can place stickers for each day a rule is followed.

Positive Reinforcement. Positive reinforcement, a principle taken from operant conditioning, involves introducing a positive stimulus, or outcome, following a desired behavior in order to make the behavior more likely to occur again (B. F. Skinner, 1974). In the case of obesity, it generally means that some kind of verbal praise or tangible reward is provided following engagement in a weight-loss-promoting behavior, such as eating vegetables or engaging in an exercise session. Though positive reinforcement has not been studied in regards to reducing SSB intake among children, there is some evidence that using positive reinforcement strategies can increase children's physical activity, their liking of physical activity, and reduce their preference for sedentary behavior (Epstein, Saelens, Myers, & Vito, 1997). In this study, mothers will be encouraged to use positive reinforcement techniques with their child by using study-provided weekly beverage charts and stickers, with weekly prizes on the weeks that children meet their goal, in order to provide positive outcomes for reducing SSB consumption and making it more fun for the child.

Conceptual Model

As described above, Social Cognitive Theory is the primary theory used to develop this intervention. Maternal outcome expectations, perceived barriers, self-regulation, and self-efficacy were chosen as targets of change due to their specific associations with their own and their child's sugar-sweetened beverage consumption. First, the intervention will directly target outcome expectations, perceived barriers to behavior change, self-regulation, and self-efficacy for behavior change. Through increased self-monitoring, greater self-efficacy, more positive outcome expectations, and reduced perceived barriers to behavior change, it is expected that mothers will then make changes in the home environment to reduce SSBs, will increase the use of positive reinforcement with their child, will reduce their own SSB consumption, and will impose limits on these behaviors in the household. In turn, children will reduce their SSB consumption (Figure 3.1.a.). Because maternal weight loss is a secondary outcome, a similar but modified conceptual model is presented with maternal weight loss as the outcome (Figure 3.1.b.).

Overview of Behavioral Techniques in Study Two

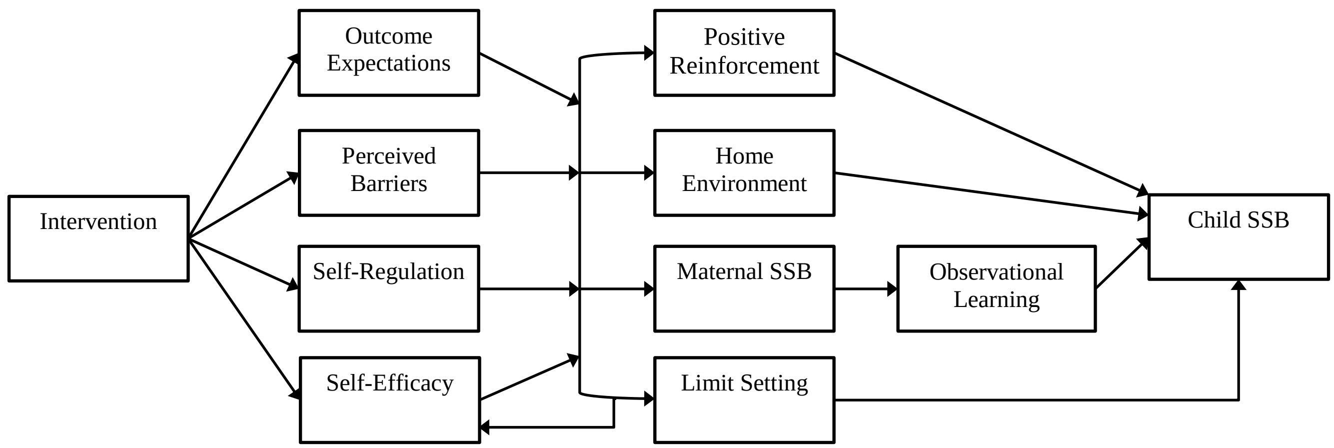
Several reviews of childhood and family-based interventions have been conducted that have evaluated the components and behavioral change techniques within each intervention and determined which are most often present in effective interventions. A review of physical activity and nutrition interventions targeting mothers of young children found that interventions needed to have used at least 3 out of 5 of the following components of intervention development: formative research, based on theory, use of behavior change strategies, evidence-based, and targeted to socio-economic status/ethnicity (Hartman et al., 2011). Based on those criteria, the intervention proposed in this study used 3 of the 5 components to develop the intervention, including being based on theory, using multiple behavior change strategies, and based on evidence, thus increasing the chance that this intervention will be effective.

A separate review analyzed the presence of behavior change techniques as defined by Abraham and Michie (2008) across interventions that targeted parents to change child physical activity and diet behaviors, and found that interventions were most likely to be successful when they included at least one behavioral change technique from each of the 5 processes of behavior change: identify and motivate readiness to change, facilitate motivation to change, provide relevant information and advice, build self-efficacy and independence, and prevent and manage relapse (Golley, Hendrie, Slater, & Corsini, 2011). There are several behavioral change techniques that can be used to address each of the 5 processes of behavior change, and this study used 1-2 behavioral change techniques to target change in each of the SCT constructs (Table 3.1).

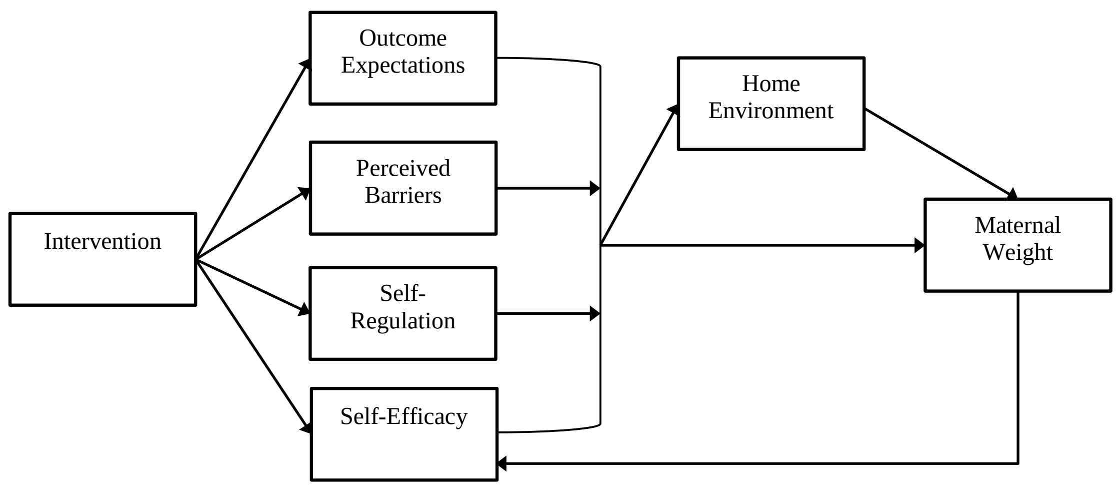
Table 3.1. Theoretical constructs matched to intervention strategies

Determinant	Strategies
Self-efficacy	Prompt self-monitoring[2] Set short-term goals[2] Provide tailored performance feedback[4] Meter of how much money saved from not purchasing SSBs
Outcome Expectations	Provide general information about risk of obesity in young children[1] Provide general information on relationship between SSB, screen time, and obesity[1]
Perceived Barriers	Prompt barrier identification[5] Provide strategies to overcome barriers Prompt behavior change with cues to action/encouragement
Self-Regulation	Prompt self-monitoring[2] Set short-term goals[2]
Home Environment	Environmental restructuring[3]
Limit Setting	Provide tailored performance feedback[4] Stress management
Positive Reinforcement	Provide contingent rewards[3] Praise child for behavior
Observational Learning	Provide information on mother as behavioral role model for child

[1] Identify and motivate readiness to change; [2] Facilitate motivation to change; [3] Provide relevant information and advice/behavior change strategies; [4] Build self-efficacy and independence; [5] Prevent and manage relapse



3.1.a. Conceptual model of change in primary outcome: child sugar-sweetened beverage consumption



3.1.b. Conceptual model of change in secondary outcome: maternal weight change

Figure 3.1: Conceptual models of the intervention outcomes

CHAPTER IV: EFFECT OF CHILDREN IN THE HOME ON EXERCISE BARRIERS, PHYSICAL ACTIVITY AND WEIGHT LOSS IN A BEHAVIORAL WEIGHT LOSS INTERVENTION

Introduction

Physical activity is an important behavior for maintaining a healthy weight, and is known to reduce the risk of weight gain, chronic disease, and mortality (Donnelly et al., 2009; Schoenborn & Stommel, 2011). Despite the health benefits of physical activity, only 20% of adults currently meet the American College of Sports Medicine's recommendations of 150 minutes of moderate physical activity a week or 75 minutes of vigorous physical activity per week, in addition to strength training 2 days a week (CDC, 2015; Haskell et al., 2007). Finding time for 150 minutes or more per week of physical activity may be difficult for many adults who have competing obligations such as demanding work schedules or taking care of a family.

Adults with dependent children in the home are a population at risk of not meeting physical activity guidelines due to their increased responsibilities that include taking care of children, increased household duties, and transporting children to school and extracurricular activities. The epidemiological research has studied the physical activity levels of parents and nonparents using both self-reported and objective measures of activity. Generally, cross-sectional studies using self-report data have shown that adults caring for children have lower physical activity levels than adults without children (Bellows-Riecken & Rhodes, 2008; Berge et al., 2011; Burton & Turrell, 2000; Nomaguchi, 2004). One study showed that parents with children in the home engaged in 23 minutes less per week of self-reported total physical activity than adults without children in the home (Nomaguchi, 2004), and a study among young adults found that parents engaged in approximately one hour less of moderate-to-vigorous physical activity (MVPA) per week than nonparents (Berge et al., 2011). In addition, longitudinal research has demonstrated a causal effect of parenthood on decreased self-reported exercise, with several studies finding that physical activity levels decrease during the transition into motherhood and fatherhood compared to adults who remain childless (Bell & Lee, 2005; Brown & Trost, 2003; Hull et al., 2010).

Two additional studies have used objective measurements to compare the physical activity levels of parents and nonparents but had mixed results. In a large study of over 1800 adults that used accelerometers to measure physical activity, being a parent was not associated with MVPA levels (Candelaria et al., 2012). However, in a study of couples where physical activity was measured objectively across a 12-month period, there was a significant decrease in MVPA among women who had their first child during that time period compared to women who did not have children, but this relationship was not significant for men (Rhodes et al., 2014). Thus, the objective physical activity data do not firmly suggest that MVPA differs between parents and nonparents. However, perhaps there are temporary decreases in MVPA following the birth of a child due to the lifestyle changes that occur that may require that adults reduce their leisure-time physical activity in order to give greater attention to the new child.

As some of the research has shown that the birth of a child could lead to reduced activity levels, it is reasonable to assume that additional time demands required by two or more children would have an even greater impact on parents' ability to prioritize physical activity. A cross-sectional study demonstrated that a greater number of children in the home was associated with a lower likelihood of having high self-reported physical activity levels, but was also associated with a higher likelihood of engaging in increased minutes of household activities (Sternfeld et al., 1999). Three additional studies evaluated the effect of increasing numbers of children in the home on physical activity levels using accelerometers as an objective measure of physical activity. The first study found that there were no differences in daily MVPA minutes between parents with one child or two or more children in the home compared to adults without children (Adamo, 2012). Another study similarly found no differences in MVPA levels between parents with one child, two child, or three or more children compared to no children, but parents with two children in the home had higher levels of light physical activity (LPA) compared to adults with no children (Gaston, Edwards, Doelman, & Tober, 2014). In the Rhodes et al. study, there was no significant decrease in MVPA for women or men who had their second child compared to either the adults with no children or those who had their first child (2014). While this research suggests that parents with multiple children do not have differing MVPA levels compared to adults with only one child or no children, it is important to consider that most of the research has compared parents with one child, two or more children, etc. to the reference group of adults without children. What is needed to make conclusions about the effect of increasing numbers of children in the home is an evaluation of the dose-response relationship between the number of dependent children in the home and parents' physical activity levels.

Social Cognitive Theory (SCT) posits that environmental, personal, and social barriers, or impediments, can inhibit behavior change (Bandura, 1977). If there were no perceived barriers to overcome, behavior change would not be as difficult. But research has shown that adults with children report barriers to physical activity (Albright et al., 2005; Peter R. Brown, Wendy J. Brown, Yvette D. Miller, & Vibeke Hansen, 2001a; Mailey, Huberty, Dinkel, & McAuley, 2014; Miller, 2005; Pereira et al., 2007), which SCT suggests would inhibit engagement in physical activity and thus may impact weight change. Many of parents' perceived exercise barriers are similar to those among all adults, but notably, 98.6% of mothers report that time commitments for children are a barrier to physical activity, followed by time commitments for chores, time commitments for partners, and fatigue (P. R. Brown et al., 2001a). Other barriers to physical activity among mothers and fathers include lack of childcare, lack of time, and feeling guilt for taking time away from family-related duties (Albright et al., 2005; Mailey et al., 2014; Miller, 2005; Pereira et al., 2007). Research has shown that there is a negative association between perceived exercise barriers and physical activity levels (Salmon et al., 2003), but there have been no studies that have directly compared the exercise barriers of parents and non-parents, and whether the association between exercise barriers and actual physical activity levels varies between the two subgroups.

While the evidence reviewed above suggests that there may be differences between adults with and without children in the home in terms of how they perceive, prioritize, and engage in exercise, what has not yet been studied is whether parents report more or different barriers to physical activity than non-parents, whether these barriers are associated with engagement in MVPA, and whether or not parents are more likely to gain weight over time due to increased exercise barriers and lower levels of MVPA. Even less is known about the success of adults with children in behavioral weight loss interventions. During participation in an intervention, engaging in more than 150 minutes of MVPA per week is associated with increased weight losses compared to engaging in less than 150 minutes, and weight loss benefits increase if MVPA exceeds 250 minutes per week (Donnelly et al., 2009). Adults who join a weight loss intervention study are likely motivated to make the dietary and exercise changes needed to lose weight. However, if adults with dependent children in the home enter studies with greater barriers to exercise, they may have difficulty increasing their physical activity to an amount that will help them lose weight. It is not yet known if adults with children who are participants in behavioral weight loss interventions experience greater difficulty with physical activity change and weight loss than adults without children.

The overall objective of this study was to evaluate if the number of children in the home was associated with short- and long-term weight change in a traditional behavioral weight loss intervention, and whether those relationships were mediated in sequence by barriers to exercise and changes in physical activity. The first goal was to evaluate the relationship between number of children in the home, baseline perceived barriers to exercise, initiation of physical activity, and short-term weight change in a behavioral weight loss intervention. We hypothesized that the number of children in the home would be negatively associated with percent weight loss at 6 months and that the relationship would be mediated by baseline exercise barriers and change in MVPA at 6 months, such that the number of children in the home would be positively associated with perceived barriers to exercise at baseline, and in turn higher exercise barriers would be associated with a lower increase in MVPA from baseline to 6 months, which would be associated with lower percent weight loss at 6 months. The second goal was to evaluate the relationship between the number of children in the home, perceived barriers to exercise after the first 6 months of the intervention, maintenance of physical activity changes from 6 to 18 months, and long-term weight maintenance from months 6 to 18. We hypothesized that an increasing number of children in the home would be associated with a greater percent weight regain from 6 to 18 months and that this relationship would be mediated in sequence by change in exercise barriers at 6 months and change in MVPA from 6 to 18 months, such that a greater number of children would be associated with a smaller decrease in exercise barriers from baseline to 6 months, which in turn would be associated with a greater reduction in MVPA from 6 to 18 months, and in turn greater percent weight regain from 6 to 18 months.

Methods

Study Design and Participants

Participants in this study were drawn from a completed 18-month randomized controlled trial that compared a standard behavioral weight loss approach to a stepped approach in which participants were moved to progressively higher stages of contact when they did not meet their weight loss goals (Jakicic et al., 2012). Participants (N=363 randomized) had a BMI between 25 and 40 kg/m^2, were between the ages of 18 and 55, and participated in less than the equivalent of 20 minutes per day of physical activity three times per week. In the standard behavioral weight loss program, participants attended weekly group meetings for 6 months, followed by biweekly meetings for 6 months and monthly meetings for the final 6 months. In the stepped group, face-to-face meetings occurred only once a month for all 18 months of the study, but participants who were moved to progressively higher stages could also receive telephone counseling, individual sessions with study staff, and meal replacements. Participants in both groups were encouraged to reduce their energy intake to 1,200 – 1,500 kilocalories per day, reduce their dietary fat intake to 20-30% of total daily calories, and to gradually progress to 300 minutes per week of MVPA. The current study collapsed data across treatment groups and used only participants with complete data on the variables used in the analyses, including data on how many children under the age of 18 they had in the home, exercise barriers, MVPA data, and weight measurements at 6 and 18 months.

Measures

Percent Weight Loss and Percent Weight Regain. The two outcome variables in this study were percent weight loss (PWL) at 6 months and percent weight regain (PWG), which was the percent of weight lost from baseline to 6 months that was regained between 6 and 18 months. Weight and height were measured at baseline, 6, and 18 months in clinics at UNC Chapel Hill and the University of Pittsburgh. Percent weight change variables were calculated using the following formulas:

$$PWL = \left(\frac{Weight\ at\ 6\ months - Baseline\ Weight}{Baseline\ Weight}\right) \times\ 100$$

$$PWG = \left(\frac{Weight\ at\ 18\ months - Weight\ at\ 6\ months}{Weight\ at\ 6\ months - Weight\ at\ Baseline}\right) \times\ 100$$

The PWL variable has increasingly negative values as weight declines. After calculating PWG, the sign of the variable was reversed, so that it would have increasingly positive values representing greater weight regain.

Number of Children in the Home. As part of the demographics and lifestyle questionnaire, participants indicated the number of children under the age of 18 in the home. The primary independent variable for this aim was the number of children under the age of 18 in the home. Parents were classified as having no children, one child, or two or more children in the home.

Exercise Barriers. Perceived exercise barriers were assessed at baseline and 6 months using the Expected Outcomes and Barriers for Habitual Physical Activity scale, a 26-item scale with 12 items about expected benefits of physical activity and 14 items about barriers to physical activity (Steinhardt & Dishman, 1989). In the original validation sample, the scale had reliability coefficients ranging from 0.47 to 0.78 in its three subscales. The exercise barriers variable was calculated as the sum of the 14 barriers items. Examples of items included "The major reason I do not exercise is that…" "I do not have enough time," "it interferes with work," and "family obligations" (Likert scale from 1 = *strongly disagree* to 5 = *strongly agree*).

Physical Activity. Physical activity was assessed at baseline, 6, and 18 months using the SenseWear Pro Armband (BodyMedia, Inc.). Participants were told to wear the armband for 7 days during each assessment period for at least 10 hours a day. The primary outcome for this aim was total minutes per week of MVPA, calculated using combined bouts of activity that were at least 10 minutes in duration at 3 or more METs.

Statistical Analysis

All analyses were conducted using SAS 9.3 (SAS Institute, Cary, NC). Descriptive statistics, including means and frequencies, were calculated for demographic variables, exercise barriers, MVPA, PWL, and PWG across levels of number of children in the home. Demographic variables were tested for their association with number of children in the home and PWL/PWG using ANOVA for continuous variables and chi-square tests for categorical variables, and significant confounders were included as covariates in the mediation analyses. For descriptive purposes, linear regression models were used to compare exercise barriers, MVPA, and PWL/PWG at each time point across levels of number of children in the home, in which the levels of one child and two or more children were entered as dummy variables compared to no children. After running outlier diagnostics of leverage, discrepancy, and influence, a total of five outliers were removed from the sample; two outliers of MVPA at 6 months (adjusted for baseline), two outliers of MVPA at 18 months (adjusted for 6 months), and one outlier on PWG from 6 to 18 months.

The PROCESS macro for SAS (Hayes, 2013) was used to test hypotheses that the number of children in the home was associated with short- and long-term percent weight change, and that this relationship was mediated in sequence by perceived exercise barriers and changes in MVPA. In simple mediation models, the independent variable (IV) is tested for its association with the dependent variable (DV; *c* path), the IV is also tested for its association with the mediator (*a* path), and the mediator is tested for its association with the DV, controlling for the IV (*b* path). The significance of the indirect effect ($a*b$), or the effect of the independent variable on the dependent variable through its effect on the mediator, can be evaluated using a variety of methods such as the Sobel test (Sobel, 1982) or using bootstrapped approaches (Preacher & Hayes, 2004). In contrast to simple mediation, serial mediation models test the effect of an independent variable on the dependent variable through its effect on two or more mediators in sequence (Figure 4.1). The PROCESS macro for SAS has several advantages over traditional methods of mediation, such as the Sobel test, because it allows for testing of complex models, including serial mediation, and tests the significance of multiple indirect effects without reducing power. PROCESS uses an ordinary least squares regression-based path analytic framework and bias-corrected bootstrapped confidence intervals to evaluate the significance of indirect effects, which are significant when the confidence interval does not include zero.

Two separate serial mediation models were used to evaluate the impact of number of children in the home on exercise barriers, changes in MVPA, and weight change. The variables in each model met the temporal precedence assumption of mediation, such that the measurement of exercise barriers preceded that of physical activity, and physical activity change preceded the weight measurement. The only exception to temporal ordering is in the first model, in which the number of children in the home and exercise barriers at baseline were measured at the same time prior to randomization. The first model, termed the *initiation model*, evaluated the impact of number of children in the home on the initiation of physical activity and weight change at 6 months, whereas the *maintenance model* evaluated the impact of number of children in the home on the maintenance of physical activity changes and weight maintenance from 6 to 18 months. Though an indirect path operating through both exercise barriers and change in MVPA is expected to mediate the relationship between number of children in the home and percent weight change, PROCESS includes estimates for all possible indirect paths, including those that operate through pathways a_2 and b_1, as shown in Figure 4.1.

In the initiation model, the number of children in the home was entered as the independent variable, baseline exercise barriers and change in MVPA at 6 months were entered as serial mediators, and PWL at 6 months was entered as the dependent variable. Change in MVPA was entered as a residualized change score, calculated from a linear regression model in which MVPA at 6 months was regressed on the baseline value of MVPA and the residualized score was the remaining variance in MVPA at 6 months not explained by baseline levels. The maintenance model entered number of children in the home as the independent variable, change in exercise barriers from baseline to 6 months and change in MVPA from 6-18 months as serial mediators, and PWG from 6 to 18 months as the dependent variable. Change in exercise barriers and change in MVPA were entered as residualized change scores, with the 6-month exercise barriers regressed on baseline exercise barriers and 18-month MVPA regressed on 6-month MVPA. To evaluate weight regain as a percentage of initial weight lost, the analyses required that two participants who gained weight from baseline to 6 months be removed from the sample. Analyses were collapsed across treatment groups and both mediation models controlled for gender, race, age, marital status, treatment group, and clinic.

Results

Sample Characteristics

The baseline characteristics of the study sample by number of children in the home are presented in Table 4.1. Overall, participants were 69.3% white and 82.9% female, and had an average BMI of 33.0 (± 3.6) at baseline. Participants with two or more children in the home had a significantly greater BMI at baseline than participants with no children (B = -1.13, p = .01) and a marginally significant higher BMI than participants with one child (B= -1.11, p = .06). There was a linear association between number of children in the home and marital status such that participants with more children in the home were more likely to be married ($p < .0001$).

The means and standard deviations of variables in each model can be found in Table 4.2. A total of 263 participants with complete data at 6 months were included in the analysis of the initiation model. There were no differences in dropout by 6 months by number of children in the home. At 18 months, however, the completers sample was reduced to 202 participants. There were significant differences in retention from baseline to 18 months based on number of children in the home, with 75% retention among participants with no children in the home, 83% retention for participants with one child, and 64% retention among participants with two or more children ($\chi^2 = 7.62$, $p = .02$).

Baseline Exercise Barriers, Initiation of Physical Activity and Weight Loss

Compared to participants with no children in the home, participants with one child had greater exercise barriers at baseline, but there were no differences in baseline exercise barriers between participants with two or more children in the home and those with none. For descriptive purposes, means and standard deviations of specific exercise barriers items can be found in Table 4.3. At 6 months, participants with no children had a percent weight change of -10.8%, participants with one child lost 9.3%, and participants with two or more children lost 8.9%. In bivariate models, the weight loss of adults with two or more children was significantly less than that of adults with no children, but the difference between adults with no children and adults with one child was not significant.

In the serial mediation model, the total effect (*c*) between number of children in the home and percent weight change was significant (B = 1.15, p = .01), such that as children in the home increased, percent weight change decreased. The number of children in the home was positively associated with baseline exercise barriers (a_1), exercise barriers was negatively associated with changes in MVPA from baseline to 6 months (d_{21}), and greater increases in MVPA were significantly associated with greater PWL (b_2). The direct effect (c') between number of children in the home and PWL remained significant after accounting for both mediators. The indirect effect of number of children in the home on PWL operating through exercise barriers at baseline and MVPA change from 0-6 months was significant, but the indirect effect through exercise barriers was not significant and the indirect effect through change in MVPA was not significant (Table 4.4).

Change in Exercise Barriers, Maintenance of Physical Activity and Weight Regain

There were no differences in change in exercise barriers from 0-6 months or change in MVPA from 6-18 months among participants with one child or two or more children compared to participants with no children in the home, although the 6-month level of MVPA of adults with one child compared to adults with no children approached significance. Participants with one child in the home regained significantly more weight from 6 to 18 months compared to participants without children, but there was no difference in weight regain between participants with two or more children and those without.

The total effect (*c*) between number of children in the home and percent weight change was not significant (B = 0.69, p = .20). The only significant pathway in the model was between MVPA change from 6-18 months and PWG from 6-18 months (b_2), such that greater reductions in MVPA were associated with increased PWG. None of the indirect effect pathways between number of children in the home and PWG from 6-18 months were significant.

Discussion

This study showed that the number of children in the home impacted the short-term weight loss success of participants in a behavioral weight loss intervention, which was due to greater perceived barriers to exercise at study entry and in turn, a lower level of MVPA initiation from baseline to 6 months. However, the number of children in the home did not differentially impact changes in perceived exercise barriers or the maintenance of physical activity or weight gain from 6 to 18 months. While some observational studies have shown that parents have lower levels of physical activity than non-parents (Bell & Lee, 2005; Bellows-Riecken & Rhodes, 2008; Berge et al., 2011; Brown & Trost, 2003; Burton & Turrell, 2000; Nomaguchi, 2004; Sternfeld et al., 1999), this is the first study to demonstrate that adults with children in the home beginning a behavioral weight loss intervention also have greater barriers to exercise than adults without children in the home, and that these barriers can inhibit the large increases in MVPA that are necessary to maximize short-term weight loss. This study fills a gap in the literature by using rigorous methods, including mediation models in appropriate temporal sequence and objective measures of physical activity, to demonstrate that having children in the home may preclude full adherence to recommendations in a weight loss intervention.

The finding of a significant total effect between number of children in the home and PWL at 6 months suggests that there are factors related to having children that impede weight loss, even during active participation in a weight loss program. There was a dose-response relationship between number of children in the home and PWL, such that participants with no children lost the most weight and participants with two or more children lost the least amount of weight. However, it is important to note that participants with children still lost an amount of weight that would be considered clinically significant and beneficial for weight-related health outcomes. This particular program provided a high level of support to overcome individual barriers compared to programs of lower intensity, including regular in-person group sessions and telephone counseling, which is likely the reason that participants with children, regardless of how many, were successful at losing weight. However, this high-intensity program is only effective for those who participate, and it is possible that adults with children in the home do not attend as many group sessions, participate in as many phone calls, or self-monitor as often as adults without children. Unfortunately, that data are not available for the current study, but a future direction would be to evaluate the intervention participation and adherence of adults with children.

As hypothesized, the number of children in the home was also positively associated with exercise barriers at baseline. While there have been a wealth of qualitative studies describing parents' barriers to exercise (Albright et al., 2005; P. R. Brown et al., 2001a; Mailey et al., 2014; Miller, 2005), this is the first study to demonstrate that parents perceive greater barriers to exercise than nonparents. This relationship exists even among a sample of participants who were not sufficiently active at baseline, adding even more impact to the effect of having children on perceptions of engaging in exercise. Interestingly, while the results implied that there may be a dose-response relationship between number of children in the home and exercise barriers, the mean exercise barriers do not appear to increase linearly from no children to two or more children. In the bivariate model, only parents with one child had significantly higher barriers than parents with no children. It is unclear why the barriers reported by parents with two or more children would be equivalent to those of parents with no children, but perhaps the longer duration of parenthood has given them time to adjust to the demands of having a family and they no longer feel as though there are as many barriers to exercise. Similarly, though it is not true in all cases, it is more likely that parents with two or more children have children that are school-age and more independent. Without infants and preschool-aged children that need considerable help and observation, parents may perceive fewer barriers to engaging in physical activity during the day.

There was a significant indirect effect between the number of children in the home on PWL at 6 months operating through the effect of the two serial mediators, exercise barriers at baseline and change in MVPA. An increasing number of children in the home was predictive of lower PWL due to its association with greater exercise barriers, which in turn were associated with a lower increase in MVPA from baseline to 6 months. The existing research has suggested that parents may have lower levels of physical activity than nonparents and higher weight at any given point in time (Bellows-Riecken & Rhodes, 2008; Berge et al., 2011; Burton & Turrell, 2000), and other research has shown that the birth of a child can negatively impact physical activity levels (Bell & Lee, 2005; Brown & Trost, 2003; Hull et al., 2010; Rhodes et al., 2014). However, this is the first study to demonstrate that adults with children in the home who are actively seeking out weight loss treatment and who have equivalent levels of activity with nonparents at study entry may have more difficulty increasing their exercise to recommended levels due to a greater number of perceived exercise barriers. In this study, all participants were instructed to gradually increase their exercise to 300 minutes of MVPA per week. Adults with no children had an average of 250 minutes per week at 6 months, whereas adults with one child and two or more children had an average of 202 and 208 minutes, respectively. While the average MVPA of adults with children did not meet program recommendations, it exceeded the recommendations of the physical activity guidelines and indicates that many of the adults with children in the home were successfully able to make changes in their exercise during the first 6 months of the program. However, they were not able to reach the same levels as adults without children, which appeared to impact their weight loss success.

Though it was not a hypothesis of the current study, it was interesting to find that baseline levels of MVPA did not differ among adults with or without children. The Stepped Care study specifically recruited individuals who had low levels of physical activity, which could explain why adults without children had similar levels of MVPA as adults with children. Nonetheless, this result is consistent with some of the observational research that has also used objective measures of physical activity and found that MVPA levels were not different between parents and nonparents (Adamo, 2012; Gaston et al., 2014).

On average, participants regained weight from 6 to 18 months, but there was no total or direct effect of number of children in the home on PWG from 6 to 18 months. It was expected that greater numbers of children in the home would be associated with greater weight regain, and while adults with one child regained significantly more weight than adults without children, there was no difference in the weight regained between adults with two or more children and those without children. It is likely for this reason that there was no total effect between number of children in the home and PWG. Notably, there were significant differences in dropout based on number of children in the home, such that adults with two or more children had the greatest amount of dropout. It is possible that adults with multiple children who encountered difficulty in making recommended changes or who were not as successful at losing weight may have been more likely to drop out. Post-hoc analyses indicated that parents with two or more children in the home who dropped out by 18 months had a PWL of 5.5% at 6 months, had an increase in exercise barriers of 0.6, and increased their weekly MVPA by 53 minutes. This was compared to a PWL of 9.8%, a decrease in exercise barriers of 5.0, and an increase of 146 weekly minutes of MVPA among those that had complete data at 18 months. Logistic regression analyses revealed that the only significant interaction between having two or more children in the home (compared to none) and changes from baseline to 6 months was in change in exercise barriers, such that having two or more children in the home was more strongly associated with dropout at 18 months among those who had smaller changes in their exercise barriers from baseline to 6 months ($p < .05$). Thus, parents with two or more children who remained in the study at 18 months appear to have been at least somewhat more successful at making changes than those who dropped out. There were no significant interactions between having one child in the home and changes from baseline to 6 months. Thus, the finding that parents with one child appear to have regained more weight from 6 to 18 months than parents with two or more children could be explained in the difference in likelihood of dropout by 6 months.

The only significant pathway in the serial mediation model was a significant association between change in MVPA from 6-18 months and PWG. This is the first study to examine the maintenance of weight and physical activity changes in parents and nonparents, and could suggest that the responsibilities and time demands of having children in the home have a greater effect on initiating physical activity than they do on maintaining those changes. Given that most participants in the study decreased their exercise from 6 to 18 months, it is likely that there are factors other than having children in the home that are stronger predictors of physical activity maintenance, such as self-efficacy, screen time behaviors, or previous weight loss success (Boutelle, Jeffery, & French, 2004; Sallis, Hovell, & Hofstetter, 1992).

A strength of this study is that it was the first to use an objective measure of physical activity and serial mediation models to evaluate the exercise barriers, physical activity change, and weight changes of adults with and without children in a behavioral weight loss intervention. The majority of the studies examining physical activity in parenthood have used self-report measures of physical activity. Unfortunately, though self-report is the easiest way to measure physical activity and puts a low burden on participants, it tends to overestimate activity levels and have a high degree of measurement error (Nusser et al., 2012). Objective measures of physical activity such as accelerometers or armbands are preferred, despite their high burden on participants. In addition, the use of serial mediation analyses in the context of an intervention allowed for an assessment of longitudinal change during active treatment for weight loss.

The finding that an increasing number of children in the home can negatively impact the initiation of physical activity and short-term weight loss in a behavioral weight loss intervention has important implications for intervention research. In traditional behavioral weight loss interventions, adults are often asked to attend in-person group meetings, meet a strict caloric goal, increase their exercise up to 45 minutes per day, and self-monitor their calories and exercise daily. For adults caring for dependent children, these requirements may be too difficult to fit into their daily schedule which also includes taking care of children, food preparation for all family members, and transporting children to school or other activities. What may be more successful are interventions designed specifically for families, in which parents are not expected to make the same changes as adults without children, but instead receive behavior change recommendations that are designed to accommodate their busy schedules and reduce their barriers to exercise. Alternatively, traditional adult interventions could target content towards parents, such as specific lessons, tailored feedback, stress management, and problem solving, that acknowledges the difficulties of making changes under strict time demands and encourages them to overcome or reduce their exercise barriers.

While this study showed that increasing numbers of children in the home are associated with reduced initiation of physical activity and weight loss, a limitation of the study is that there were no data available on the ages of children in the home. Therefore, no conclusions can be made about the effect of the age of children in the home on exercise and weight change. Some research has suggested that adults with children under the age of five or six may have lower MVPA levels due to the demands of taking care of infants and other young children, whereas there are no differences in MVPA levels between adults with older children and adults without children (Adamo, 2012; Candelaria et al., 2012; Gaston et al., 2014). It will be important for future research to examine how the ages of children in the home affect participation in a weight loss intervention so that researchers can modify and design interventions that increase adherence among parents of young children.

Another limitation of this study is the amount of missing data at 18 months, particularly with the armband and FFQ measures. This could possibly reflect the difficulty that parents have in sticking to a weight loss program, as parents with two or more children were the most likely to drop out by the end of the study. In addition, the low number of males in the study sample is a limitation, as it was not possible to determine if the relationships between number of children in the home and MVPA and weight change were different between males and females. It is possible that the effect of children in the home on exercise and weight change varies by gender, as mothers have been shown to be less active than fathers (Bellows-Riecken & Rhodes, 2008), but this has yet to be studied within behavioral interventions.

Given the benefit of behavioral weight loss programs to overweight and obese adults, it is important to determine which psychosocial variables are reliable predictors of successful behavior and weight change. This study uniquely contributes to the intervention literature by using temporally-based mediation models and an objective measure of physical activity to demonstrate that the number or children in the home is associated with greater exercise barriers at study entry, and in turn, with reduced MVPA changes and weight loss. However, the number of children in the home did not affect long-term maintenance of MVPA and weight changes among participants who remained in the intervention. This study fills a significant gap in the literature by providing information on the barriers and successes of intervention participants who are providing for and taking care of children in the home, and informs future interventions that may be able to tailor intervention components and strategies to better increase parents' adherence to treatment recommendations.

Table 4.1 Baseline demographic characteristics by number of children in the home

Variable	No Children (n=177)	1 Child (n = 59)	2+ Children (n = 103)
Age (years)[a]	43.7 $\pm$ 9.7	42.8 $\pm$ 8.2	41.2 $\pm$ 6.6
Gender (% female)	82.5%	83.1%	83.5%
Race (%)			
Caucasian	72.9%	64.4%	66.0%
African-American	25.4%	30.5%	28.2%
Other	1.7%	5.1%	5.8%
Marital Status (% married)	49.1%	67.8%	80.6%
Education (% college graduate)	59.1%	59.3%	59.2%
BMI (kg/m^2)[a]	32.70 $\pm$ 3.73	32.72 $\pm$ 3.06	33.83 $\pm$ 3.67
Weight (lbs.)[a]	203.1 $\pm$ 31.7	201.2 $\pm$ 30.9	208.9 $\pm$ 33.9

[a]Means and standard deviations.

Table 4.2 Means across child status for exercise barriers, physical activity, and percent weight change

Initiation Model, 6 Months

	No Children (n = 138)		1 Child (n = 47)		2+ Children (n = 78)	
Variable	Mean	SD	Mean	SD	Mean	SD
Exercise Barriers Baseline	35.84	7.36	39.85**	9.45	37.13	7.61
Average MVPA min/week						
Baseline	86.07	133.92	75.11	134.50	82.17	113.12
6 Months	250.48	232.04	202.30	187.08	208.00	168.92
Percent Weight Change Baseline - 6 Months	-10.84	6.39	-9.32	5.59	-8.90*	5.83

Maintenance Model, 18 Months

	No Children (n = 109)		1 Child (n = 40)		2+ Children (n = 53)	
Variable	Mean	SD	Mean	SD	Mean	SD
Exercise Barriers						
Baseline	35.27	7.53	40.25**	9.40	37.63†	7.86
6 Months	32.18	7.79	34.53	9.01	32.25	7.05
Average MVPA min/week						
6 Months	266.96	229.06	196.04†	173.94	230.70	181.26
18 Months	177.05	208.48	124.84	113.71	181.29	180.86
Percent Weight Regain 6 -18 Months	5.03	91.10	62.95*	162.29	39.15†	136.43

$^{\dagger}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$, for significance of dummy-coded variables for 1 child and 2+ children compared to no children. Model for exercise barriers at 6 months included baseline level as a covariate and model for MVPA at 18 months included 6-month MVPA as a covariate.

Table 4.3 Means of exercise barriers items across number of children and time

	No Children Mean (SD)		1 Child Mean (SD)		2+ Children Mean (SD)	
	Baseline	6 Months	Baseline	6 Months	Baseline	6 Months
…lack of motivation	3.99 (1.17)	2.96 (1.44)	3.96 (1.18)	2.93 (1.42)	3.79 (1.25)	3.08 (1.36)
…that I am too lazy	3.38 (1.34)	2.51 (1.32)	3.64 (1.22)	2.36 (1.28)	3.10 (1.37)	2.40 (1.28)
…that I am too busy	3.48 (1.27)	3.50 (1.28)	3.74 (1.26)†	3.62 (1.39)	3.81 (1.17)	3.59 (1.17)
…that I do not have enough time	3.18 (1.31)	3.53 (1.26)	3.60 (1.38)†	3.62 (1.30)	3.63 (1.22)*	3.51 (1.18)
…that it interferes with school	1.41 (0.96)	1.37 (0.92)	1.74 (1.11)*	1.58 (1.16)	1.38 (0.86)	1.37 (0.84)
…that I am too tired	3.24 (1.32)	2.85 (1.22)	3.70 (1.18)*	2.98 (1.32)	3.27 (1.15)	2.77 (1.06)
…that it interferes with work	2.47 (1.39)	2.32 (1.30)	2.63 (1.48)	2.56 (1.36)	2.52 (1.29)	2.40 (1.29)
…that it is too inconvenient	2.64 (1.21)	2.32 (1.18)	2.81 (1.38)	2.36 (1.07)	2.69 (1.25	2.27 (1.19)
…that the weather is bad	2.20 (1.16)	2.23 (1.29)	2.26 (1.29)	2.38 (1.11)	2.13 (1.14)	1.92 (1.17)
…lack of facilities	2.04 (1.28)	1.61 (0.95)	2.40 (1.41)*	1.91 (1.10)	1.95 (1.15)	1.53 (0.92)
…that exercise is boring	2.70 (1.28)	2.25 (1.23)	2.98 (1.32)	2.40 (1.36)	2.50 (1.19)	2.05 (1.27)
…that I am too fatigued by exercise	2.03 (1.17)	1.78 (0.98)	2.00 (1.18)	2.02 (1.14)	2.09 (1.13)	1.95 (1.03)
…family obligations	1.85 (1.11)	2.10 (1.26)	2.91 (1.51)***	2.98 (1.42)	3.10 (1.31)***	3.22 (1.30)[a]
…that I have health reasons that limit my exercise	1.23 (0.64)	1.40 (0.82)	1.45 (1.00)†	1.58 (1.06)	1.18 (0.45)	1.29 (0.69)

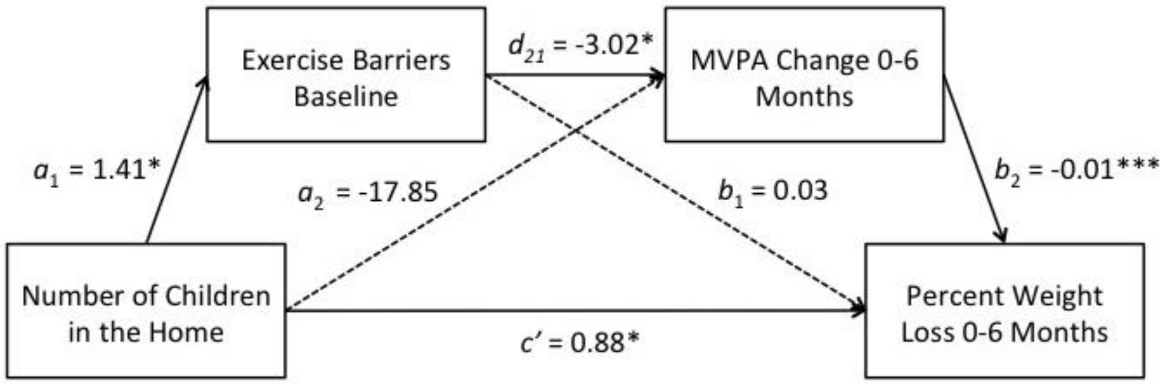
Note. All items begin with "*The major reason when I do not exercise is….*" Significance of between-group differences at baseline in regression with 1 Child and 2+ Children dummy coded and compared to reference group of No Children: †$p < .10$, *$p < .05$, **$p < .01$, ***$p < .0001$.

[a]Significant difference of change from baseline to 6 months compared to reference group (No Children), controlling for baseline, $p < .01$.

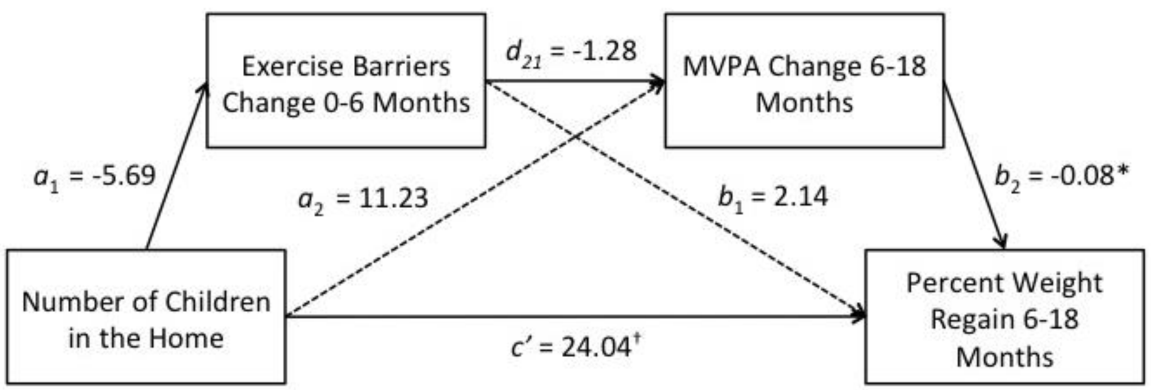
Table 4.4 Indirect effects of number of children in the home on percent weight loss and percent weight regain

Mediators (Pathway)	Est.	95% CI[a]
Initiation Model		
Baseline Exercise Barriers → Change in MVPA 0-6 ($a_1d_{21}b_2$)	0.0418	**(0.0063, 0.1263)**
Baseline Exercise Barriers (a_1b_1)	0.0452	(-0.0511, 0.2094)
Change in MVPA 0-6 (a_2b_2)	0.1756	(-0.0770, 0.4689)
Maintenance Model		
Change in Exercise Barriers 0-6 → Change in MVPA 6-18 ($a_1d_{21}b_2$)	0.1518	(-2.5430, 4.7447)
Change in Exercise Barriers 0-6 (a_1b_1)	0.0069	(-0.1219, 0.3248)
Change in MVPA 6-18 (a_2b_2)	0.8531	(-0.7722, 4.3264)

Notes: Analyses controlled for gender, race, age, marital status, treatment group, and clinic. Change variables entered as residualized change scores from previous value.
[a]Indirect effect is significant when the confidence interval excludes 0.



a. Initiation Model



b. Maintenance Model

Figure 4.1 Depiction of serial mediation models and results of each pathway. MVPA = moderate-to-vigorous physical activity. Significance of unstandardized regression coefficients, †*p* < .10.**p* < .05, ***p* < .01, ****p* < .001.

CHAPTER V: REDUCING SUGAR-SWEETENED BEVERAGE INTAKE IN PRESCHOOL-AGED CHILDREN: RESULTS FROM THE SMART MOMS RANDOMIZED TRIAL

Introduction

Childhood obesity remains a significant public health concern, especially due to its increasing occurrence at younger ages (Ogden et al., 2012). Currently, 22.8% of children ages 2-5 are overweight or obese (Ogden, Carroll, Kit, & Flegal, 2014), and of the approximately 32% of children and adolescents who are overweight or obese, one in three become overweight before they turn five years old (CDC, 2010). Excessive weight gain in early childhood is known to increase the risk of cardiovascular disease, type II diabetes, and obesity during adulthood (Gardner et al., 2009; Guo et al., 2002; Williams et al., 1992). Thus, there is a great need for interventions that can effectively decrease the risk of becoming overweight during early childhood.

Longitudinal epidemiological research has consistently demonstrated that the consumption of sugar-sweetened beverages (SSBs) is prospectively associated with the development of obesity in young children (DeBoer et al., 2013; Flores & Lin, 2013; Millar et al., 2014). In addition, SSB consumption has also been linked to cardiometabolic markers in children ages 3-11, including waist circumference and decreased HDL cholesterol (Kosova, Auinger, & Bremer, 2013). Preschool-aged children consume an average of almost 13 ounces per day of SSBs and 100% fruit juice (O'Connor et al., 2006), which amounts to approximately 176 calories per day from SSBs and 100% fruit juice (Wang et al., 2008). Sugary beverages and fruit juices make up 12-18% of preschoolers' recommended daily energy intake (Gidding et al., 2006), and randomized controlled trials have found that reductions in SSBs have been effective at preventing excessive weight gain in children and adolescents (de Ruyter et al., 2012; Ebbeling et al., 2012).

Behavioral interventions designed to improve the dietary and physical activity behaviors of young children have increased in recent years, with the most successful interventions being those that include active involvement by the parent (Golan, 2006; Hesketh & Campbell, 2010). This is expected, as parents are "gatekeepers" in the home and their support, rules, and modeling of dietary behaviors are associated with child dietary behaviors (Rosenkranz & Dzewaltowski, 2008). In addition, epidemiological research has shown that some of the strongest predictors of child weight are maternal weight and maternal dietary and physical activity behaviors (Davison & Birch, 2001; Flores & Lin, 2013).

The links between SSB consumption, maternal weight, and child weight suggest the need to intervene with mothers in order to change child SSB consumption, with the long-term goal of preventing child obesity. However, to this date childhood weight, dietary, and physical activity programs that have targeted mothers have had limited success, often due to low adherence and high dropout rates (Fitzgibbon et al., 2013; Ostbye et al., 2012; Skelton & Beech, 2011). Several interventions targeting mothers of young children have required regular in-person meetings, but have found that attendance and retention has been low, ranging from 27-66% (Hartman et al., 2011; Jordan et al., 2008; Lioret et al., 2012; Ostbye et al., 2009). What is needed to effectively intervene with mothers of young children are interventions that are adapted to meet their busy schedules, such as those that can be delivered using the internet and mobile phones.

Among adults, weight losses in internet-delivered interventions are not as high as those found in face-to-face interventions (Gold et al., 2007; Tate, Jackvony, & Wing, 2003; Tate et al., 2006), but given that face-to-face interventions are only successful for those who adhere to the program, it may be useful to use internet- and mobile-delivered programs among parents of young children. Interventions that use mobile phones to deliver content may be appropriate for women with young children, as they remove the barrier of accessing in-person programs and reduce the required time demands. Qualitative research has shown that mothers find mHealth programs to be an acceptable and convenient way to receive intervention content and that they are preferred due to their flexibility and ability to access program content at any time (Burrows et al., 2015; Whitford et al., 2012). In addition, recent internet- and mobile-based interventions have shown acceptable participation and attendance rates among mothers of young children (Fjeldsoe et al., 2015; Knowlden et al., 2015). What is needed are interventions that adapt the traditional behavioral intervention to (1) require a limited number of in-person visits, (2) focus on small, specific dietary behaviors, and (3) use simplified self-monitoring so that mothers remain engaged and are successful at changing child behavior.

The purpose of this study was to test the efficacy of a mobile-delivered program to reduce sugar-sweetened beverage consumption among children at high risk of becoming overweight or obese in childhood compared to a waitlist control group. An additional goal of the study was to help mothers lose weight by reducing their own consumption of SSBs and decreasing their intake of high-calorie foods. The primary hypothesis was that children randomized to the intervention group would have a greater decrease in SSB consumption at 6 months (post-intervention) compared to children randomized to the waitlist control group. The secondary hypothesis was that mothers randomized to the intervention group would have greater weight loss at 6 months compared to mothers randomized to the waitlist control group.

Methods

Study Design

Smart Moms was a randomized controlled trial evaluating the effect of a primarily smartphone-based behavioral intervention to reduce sugar-sweetened beverage consumption among preschool-aged children of mothers who were overweight or obese. Mother-child dyads were randomized to either the Smart Moms intervention group or to a modified waitlist control group. Assessments were conducted at baseline, three, and six months following randomization. The study was approved by the UNC non-biomedical IRB on March 18, 2014.

Participants

The eligibility criteria were selected in order to target a population of children with a high risk of obesity, particularly those who had a high consumption of fruit juice and/or sugar-sweetened beverages and who had mothers who were overweight or obese. The eligibility criteria included maternal BMI of 25-50 kg/m^2 and a child between the ages of 3-5 who consumed at least 12 ounces a day of sugar-sweetened beverages (fruit drinks, sport drinks, caloric sodas, sweetened teas, flavored milks, and for the purposes of this study also included 100% fruit juice). This intervention excluded women with a BMI of 50 kg/m^2 or greater, as a more intensive intervention is appropriate for individuals with severe obesity. Mothers were required to have a smartphone with an active data and text messaging plan. Exclusion criteria included: participation in another weight loss program, pregnancy within the last 6 months, planning to become pregnant in the next 6 months, planning on moving from the study area within the 6-month study period, excessive alcohol intake as determined by more than 14 servings a week or a diagnosis of substance abuse, maternal diagnosis of schizophrenia or bipolar disorder, hospitalization for a psychiatric diagnoses in the past year, unable to participate in alternatives to sedentary behavior including standing and walking, and a child medical diagnosis that would prohibit small changes in dietary behaviors. Mothers with multiple children in the home within the eligible age range of 3-5 years were allowed to participate, but the eldest child within the age range who met all inclusion criteria was chosen as the participant in the mother-child dyad.

Recruitment

Participants were recruited from several counties within and surrounding Orange, Durham, and Wake counties. The target population for this intervention is a significant subset of North Carolina residents, as 64.9% of adults in North Carolina are overweight and an additional 27.8% are obese (CDC, 2010). Moreover, up to 50% of adults in NC are not meeting recommendations for sugar-sweetened beverage intake, and 56.2% of children under the age of five drink more than one serving of 100% fruit juice per day and 46.2% drink one or more servings of other sugar-sweetened beverages (NC Child Health Assessment and Monitoring Program, 2013).

Recruitment occurred through a variety of modes including online services (e.g. online newspapers, Craigslist, message boards for local mothers), a paid advertisement on a local parent website (Carolina Parent), an informational email through the university listserv, flyers posted in UNC hospitals, pediatric offices, coffee shops, and other community locations, flyers distributed to childcare center parents, and a paid Facebook advertisement. Recruitment messages were written to draw the attention of mothers hoping to lose some weight while also improving the health of the family. For example, advertisements included recruitment messages such as “Lose a little weight, live a lot better” and “Are you a mom of a child ages 3-5? Do you want to make healthy choices for you and your child?” Recruitment materials directed individuals to the recruitment website which contained detailed information about the study. Interested participants then completed an online Qualtrics screening survey to determine their eligibility. Women who met initial eligibility requirements were followed up by phone for additional screening, and fully eligible participants attended an in-person orientation session where they provided written informed consent to be in the study and completed the baseline assessment. Flexible times were offered for assessment visits, including early mornings, after-work hours, and Saturdays, in order to accommodate mothers' busy schedules and increase the likelihood that they would attend and subsequently enroll in the study.

Participants who completed both the in-person and online portions of the assessment were randomized to either the intervention or the control group. Randomization was stratified by childcare or kindergarten attendance (yes/no) and by child consumption of SSBs at baseline ($<$ 18 fl. oz./day or $\geq$ 18 fl. oz./day).

Power and Sample Size

The primary outcome for the study was change in child SSB intake from baseline to 6 months. Table 5.1 includes evidence from previous interventions that have resulted in significant changes in sugar-sweetened beverages. The studies with large mean differences between groups that were equal to or just above the within-group standard deviations were 6-month studies, while studies with somewhat smaller mean differences and with standard deviations exceeding the mean difference were shorter studies with wide age ranges that also included older children. Several power calculations were completed (Table 5.2) based on the median estimates from previous studies, which are those that ranged from 7-8 weeks and targeted preschool-aged children. Given that this study restricted the age range of children to ages 3-5, and had an active phase of 24 weeks, it was thought that it could result in larger effect differences and smaller standard deviations due to a more homogenous sample. Therefore, based on the best and most conservative power calculations, the study was powered to detect a difference of a 6-ounce reduction between groups at 6 months, with a within-group standard deviation of 6.0. Therefore, with 80% power at an alpha level of .05 and accounting for 20% attrition that is often seen in family-based studies, the study required 21 participants per group for a total of 42 participants to detect a significant difference in SSB reduction.

Intervention Procedures

Kick-Off Group Session. Mothers attended an in-person kick-off session at the beginning of the study. The session lasted approximately 75 minutes and was led by the principal investigator. Participants received and reviewed printed feedback from their baseline assessment. In the session, they were informed that the primary goals of the intervention were to reduce their total caloric beverage consumption (including SSBs, alcoholic beverages and other caloric drinks) and to make gradual reductions in their child's SSB and juice consumption. Information was provided on children's' and adults' average intake of sugary beverages and the health outcomes of excess calories consumed from beverages. In addition to reducing beverages, the mothers were given additional goals to help them lose weight, including limiting their consumption of "red" foods, which are high-calorie, high-fat foods from the Traffic Light Diet (Epstein, 2003), and daily weighing. The session included information on how making small, simple changes in their beverages and red foods could result in a reduction of 100-300 calories per day, which could lead to modest weight losses after several months.

They were also told that the study would additionally focus on the importance of promoting the health of their family, particularly their young child who is in the study. We introduced idea that children learn behaviors from observing their parents, so that mothers could be vigilant about the behaviors that they were modeling. For this reason, they were asked to monitor and reduce their child's SSB and juice consumption. Mothers were encouraged to view their own weight loss efforts as a way to make healthy behavior changes in the home environment and be a positive role model for the benefit of their children's health.

Lastly, the session included instructions on accessing the weekly lesson content on the website and how to send and receive study-related text messages. Participants were sent home with a "toolkit" of study materials, which included a printed copy of the first lesson, a chart with the mother's and child's weekly beverage goals, weekly self-monitoring diaries, sticker charts and stickers, water charts, weekly prizes, two 6-oz. cups with lids for their children for easy measuring, water bottles for the mothers and children, an 8-oz. liquid measuring cup, and a User's Guide with program timelines and instructions along with how to use the website and text messaging components of the program.

Website. The Smart Moms website was created to provide resources to help mothers change their own dietary behaviors and to work with their children to reduce their SSB consumption. The website was responsive, or mobile-optimized, with content that was easily viewable on a smartphone so that mothers could access the information at any time, rather than requiring they be at home near their computer. The website included a homepage that always displayed the most recent lesson, a "Family Corner" page with additional information on how to apply the information learned in the lesson to the whole family, and a "Featured Drink" page that included a recipe for a zero- or low-calorie drink. The content was updated weekly for the first 12 weeks and biweekly for weeks 13-24.

Weekly Lessons. Lessons primarily included information on behavioral strategies to reduce caloric beverages and red foods, but also incorporated topics on dietary intake, reading food labels, snacking, sleep, physical activity, screen time, problem solving, stress management, and relapse prevention strategies (Table 5.3). Participants were notified via email and text message on Mondays when a new lesson was posted to the website in order to increase convenience of accessing the lesson and likelihood of reading the lesson. There were 18 total lessons, 12 weekly lessons and 6 biweekly lessons.

Weekly Goals. Participants were given beverage and red foods goals to meet each week. The long-term beverage goal for children was to consume no more than 4 fluid ounces of 100% fruit juice per day, and no other sugar-sweetened beverages (i.e. fruit drinks, sweetened tea, flavored milk, regular soda, sports and energy drinks). To give children time to adjust to changes in their usual intake of SSBs, shaping was used such that their weekly goals were tapered down from their baseline level of consumption. The goal for the first week was similar to their baseline level, but was gradually reduced to 4 ounces per day by week 8 of the program and remained there for the rest of the program.

Because mothers were trying to lose weight, they had several goals to meet each week. Their weekly beverage goal for the duration of the program was 1 serving, or 8 fluid ounces, of caloric beverages per day (i.e. sweetened beverages described above, milk, coffee with any caloric additions, and alcoholic drinks). Additionally, mothers tracked their intake of red foods during the second week of the program to provide study staff with a baseline level of red foods consumption. A weekly red foods goal was created by dividing the baseline value in half, and participants began using the red foods goal in week 3 of the program. Lastly, mothers were recommended to weigh themselves every day.

Self-Monitoring. Throughout the intervention, mothers self-monitored their weight, their caloric beverage consumption, their intake of red foods, and their child's SSB consumption.

Participants were given paper diaries for each week of the program. While they could use any monitoring method they preferred, they were encouraged to use the paper diaries as they were uniquely designed to match the simplicity of the self-monitoring in this study. Rather than monitoring calories, mothers checked a box each time they had a serving (8 fl. oz.) of a caloric beverage, each time they had a red food (regardless of exact caloric content), and each time their child had a serving (4 fl. oz.) of a SSB.

Participants submitted their self-monitoring information via text message. Each Sunday evening, participants received a text message with a prompt to submit their weekly totals of caloric beverages servings, red foods, their last reported weight, and their child's weekly total of SSBs.

Weekly Tailored Feedback. The weekly self-monitoring data submitted through text message were used to send participants tailored feedback. They received this personalized feedback through email, weekly for the first 12 weeks and biweekly for the second 12 weeks. Generally, feedback messages were tailored to whether or not the child met their beverage goal for the week, whether or not the mother met her beverage goal for the week, whether she met her red foods goal for the week, and mothers' weight loss progress.

Monthly Progress Check-Ins. At the end of each month, participants received a link to a brief, 1-2 minute Qualtrics questionnaire. First, participants were asked to report which of the lessons they had read in the last month. Additionally, when beverage or red foods goals had not been met at least 3 out of 4 weeks in the month, participants received questions about barriers specific to those behaviors. This information was used to provide additional feedback tailored to their specific barriers in the next feedback email.

Tips, Motivational Messages, and Goal Progress Assessment Text Messages. In addition to the self-monitoring prompt text message on Sunday evening and the text notifying them of the new lesson on Monday, all participants received an additional two text messages a week during the first half of the program and an additional one text message per week during the second half of the program. These consisted of tips for behavior change, motivational messages, and goal progress assessments. The goal progress assessment questions were brief multiple-choice questions about the progress that mothers were making towards one of the behaviors that week. Based on their answer, a tailored feedback message was sent in response which usually consisted of encouraging them to continue their good progress or providing them with support if they were having difficulty. These messages were sent at random intervals, as that has been shown to increase the effectiveness of SMS-based interventions (Head et al., 2013).

Child Reinforcement Charts. Participants were given 12 colorful, engaging weekly charts to track the child's beverages together with their child. They were also given stickers and 12 prizes (e.g. $1 toys, games, etc.). Each chart stated the child's beverage goal for that week, and the mothers were instructed to have their child put a sticker on each day that they met their beverage goal. If the child met their total beverage goal for the week, the mother gave them a prize at the end of the week. The charts and prizes served to increase the positive reinforcement for the child's SSB changes during the first half of the program. The study did not provide these charts and prizes after week 12, but mothers were encouraged to use the same principles and to continue with charts and prizes of their own throughout the remainder of the program.

Mothers were encouraged to have their child replace SSBs with water, so the study also provided children with water charts and stickers to provide positive reinforcement for increasing their water intake. There were no specific goals for water intake, but once the chart was full of stickers, the mothers were encouraged to give their child a prize of their own choosing.

Control Group Procedures

The modified waitlist control group attended one group session where they received their randomization and were encouraged to continue with their normal behaviors throughout the next 6 months. They received a modified version of the intervention following the 6-month assessments.

Measures

Participants completed assessments at baseline (prior to randomization), 3 months, and 6 months. Each assessment period included an in-person visit and the completion of online questionnaires. Participants received a $20 honorarium for completing the 3- and 6-month assessments.

Demographics. A lifestyle questionnaire assessed demographics at baseline, including age of the mother and child, race/ethnicity, income, maternal employment status, maternal education, marital status, number of children in the home, and whether the child was in childcare or kindergarten (hereafter referred to as childcare status).

Sugar-Sweetened Beverage Intake/Diet. Mothers completed a single 24-hour dietary recall for her own intake and another 24-hour recall in which she reported her child's intake at each assessment period. Trained staff members that were blind to treatment group assignment completed the dietary recalls in order to avoid any biases. The mother-reported child recall included only food that the parents provided the child, meaning that any food purchased at or provided by childcare, school, or another care provider was not included. The dietary data were entered into the Nutrition Data System for Research (NDSR), which was used to generate reports of the child's sugar-sweetened beverage intake in ounces per day, mothers' caloric beverage intake in ounces per day, average calories that mothers consumed from beverages per day, in addition to other dietary variables such as total calories, fat, and added sugars.

Anthropometrics. Trained research staff not blinded to treatment used standardized protocols to measure mothers' and children's height and weight. Weight was measured using a digital Tanita scale to the nearest 0.1 kg. Height was measured using a wall-mounted stadiometer to the nearest 0.1 cm. The outcome variable was weight in kilograms, but the weight and height of mothers was also converted to BMI (kg/m^2). Percent weight loss (PWL) at 3 and 6 months was also calculated using the following formula: [((Weight at 3/6 months – Baseline Weight)/Baseline Weight) x 100]. The height, weight, age, and gender of the child was used to calculate BMI z-score using the Centers for Disease Control and Prevention growth curves (CDC, 2011). Although BMI z-scores can be a less accurate measure at heavier weights (Cole, Faith, Pietrobelli, & Heo, 2005), in this study that was not a significant concern as most children were normal weight or overweight. As the long-term goal was to prevent excessive weight gain, change in BMI z-score, which accounts for age and growth patterns, was the best manner to represent child weight in this study.

Physical Activity. To assess total weekly minutes of maternal physical activity (PA), mothers completed the Paffenbarger Physical Activity Questionnaire (Paffenbarger, Wing, & Hyde, 1995). It has been used to assess leisure time activity in many weight loss trials and can be scored to provide an estimate of minutes per week and calories expended per week in overall leisure time activity. This questionnaire was administered during the in-person assessment visit by trained study staff.

Adherence. Intervention adherence was measured by summing total self-monitoring texts submitted, summing total goal progress assessment texts, and by summing the self-reported number of lessons read as reported in the monthly progress check-ins. Frequency of use of the weekly positive reinforcement charts with the child was assessed in the program evaluation questionnaire at 6 months.

Statistical Analyses

All analyses were completed using SAS 9.3 (SAS, Cary, NC). Diagnostic tests were completed before conducting outcome analyses. Outliers for child SSB consumption, maternal weight change, and other secondary outcomes were examined using measures of local influence, or the effect of individual cases on the regression coefficient for treatment group. This measure, called DFFITS, has a cutoff of 1.0 for small sample sizes. There were no outliers for any variables, including child SSB consumption and maternal weight change.

The normality of residuals was tested for all dependent variables using q-q plots and the Shapiro-Wilks test, and homoscedasticity of residuals was tested by plotting the residuals against predicted values. Variables that did not meet these assumptions and required a square root transformation included maternal caloric beverage intake and maternal physical activity minutes.

Descriptive statistics, including means and frequencies, were used to describe the sample at baseline. Independent groups t-tests and Chi-square tests were used to determine differences in baseline characteristics between treatment groups. One-way ANOVAs and independent groups t-tests were used to examine differences by demographic characteristics on the outcomes of child SSB intake and maternal weight change. Any characteristics found to be associated with both treatment group and the outcome were determined to be confounders, and thus were included as control variables in the respective outcome analyses.

Intent-to-treat analyses using linear mixed models were used to examine changes in the primary and secondary outcomes. The linear mixed models included a random intercept and effects for treatment group, time, and group by time interactions for both follow-up visits. The primary outcome model examined the effect of treatment group on change in child SSB intake from baseline to 3 and 6 months and controlled for race and childcare status. The secondary outcome model examined the effect of treatment group on change in maternal weight from baseline to 3 and 6 months and controlled for race and the number of children under the age of 18 in the home. Bonferroni adjustments accounted for the effect of comparisons at multiple time points. For descriptive purposes, logistic regression models evaluated any differences between groups in the percentage of mothers who lost 3% and 5% of their body weight. Additional linear mixed models were used to examine between- and within-group change over time in child BMI z-score, maternal caloric beverage intake, maternal calories from beverages, maternal total caloric intake, and maternal physical activity. Correlations were used to examine relationships between adherence measures and primary and secondary outcomes.

Results

Enrollment and Retention

The CONSORT diagram in Figure 5.1 depicts study recruitment, enrollment, and retention. Out of 629 online screening surveys completed, 90 met full eligibility criteria and were scheduled for an orientation and baseline assessment visit. A total of 51 participants attended the kick-off session where they received their randomization to either the intervention group (n = 27) or waitlist control group (n = 24).

At 3 months, 86% of participants completed the assessment, and 82% completed assessments at 6 months. However, of those missing, three participants withdrew from the study for medical reasons prior to 3 months, two due to pregnancy and one due to a serious medical surgery. After removing medical withdrawals from the sample, retention was 92% at 3 months and 88% at 6 months. Dropout at 3 months was not significantly different between groups (11.1% in intervention vs. 16.7% in control; $\chi^2 = 0.33$, $p = .69$). Similarly, dropout at 6 months did not differ by group (14.3% in intervention vs. 20.8% in control; $\chi^2 = 0.32$, $p = .25$). At 6 months, dropout was more likely among non-white participants compared to white participants (38.5% vs. 10.5%, Fisher's exact $\chi^2 = 5.20$, $p = .04$). In addition, mothers who did not return for assessments had a higher baseline BMI than those who returned (36.0 ± 6.0 vs. 31.9 ± 4.9; $t(49) = -2.21$, $p = .03$). There were no other differences between those who dropped out and those who completed their 6-month assessments.

Baseline Characteristics

The baseline characteristics of the study sample can be found in Table 5.4. Participants were 75% white and 22% black, 82% had an income above $50,000, and 80% had a college degree. Mothers were on average 36.4 (± 5.1) years old and had an average BMI of 32.6 (± 5.3). Children were, on average, 4.1 (± 0.8) years old and 51% were male. The average BMI z-score of children was 0.39 (± 0.96); 75% of children were normal weight and 24% were overweight or obese. There were no significant differences by treatment group, although there was a trend for mothers in the intervention group to have greater numbers of children in the home ($\chi^2_{MH} = 6.44$, $p = .09$). For example, 37% of mothers in the intervention group had 3 or more children, compared to only 17% in the control group. The number of children in the home was also associated with maternal weight change at 3 months ($F(3) = 3.35$, $p = .02$), so it was included as a control variable in the model for maternal weight change.

At baseline, children in the study were consuming an average of 14.0 (± 9.0) fluid ounces of SSBs per day, including 4.3 (± 6.6) ounces of 100% fruit juice, 4.5 (± 6.1) ounces of fruit drinks, 3.8 (± 6.8) ounces of flavored milk, and 1.1 (± 3.8) ounces of regular soda per day. Children were consuming 200 (± 137) calories and 39 (± 26) grams of added sugar per day from SSBs at baseline. Mothers were consuming, on average, 213.3 (± 196.9) calories from beverages each day.

Outcome Analyses

The model-adjusted means for child SSB intake, maternal weight, and other secondary outcomes across time can be found in Table 5.5. Using model-adjusted means, from baseline to 3 months, children in the Smart Moms group reduced their SSBs by 9.7 fluid ounces a day, compared to a decrease of 2.8 fluid ounces a day in the control group. At 6 months, children in Smart Moms had reduced their SSB intake a total of 9.5 fluid ounces from baseline, compared to a reduction of 1.9 fluid ounces in the control group (Figure 5.2). The group by time interaction at both 3 and 6 months was significant, indicating that the reduction in child SSBs was significantly greater in the Smart Moms group compared to the control group at both time points. Within the Smart Moms group, 52% of children met the goal of consuming less than 4 ounces per day of SSBs at 6 months, compared to 21% in the control group who consumed 4 ounces or less at 6 months ($p < .05$). For descriptive purposes, Figure 5.3 displays raw means at baseline and 6 months for 100% fruit juice, sugar-sweetened beverages, and water for each treatment group.

Mothers in the Smart Moms group lost an average of 2.3 kg at 3 months, which was significantly different than the weight gain of 1.0 kg observed in control group mothers. Weight loss in the Smart Moms group remained significantly higher than the control group at 6 months, with mothers in the Smart Moms group losing 2.3 kg from baseline compared to a gain of 0.9 kg in the control group (Figure 5.4). At 6 months, a greater proportion of Smart Moms participants had lost 3% of their body weight compared to the control group (37% vs. 4%, $p < .01$), and a greater proportion lost 5% of their body weight compared to the control group (22% vs. 0%; $p < .05$). Mothers in the Smart Moms group reduced their consumption of caloric beverages significantly more than mothers in the control group at 3 and 6 months (3 months: -12.01 fl.oz./day vs. +1.4 fl. oz./day, $p < .01$; 6 months: -12.62 fl. oz./day vs. -0.63 fl. oz./day, $p < .05$).

In addition, mothers in the Smart Moms group had a significant reduction in calories from beverages compared to the control group at both 3 and 6 months (3 months: -122.9 kcals/day vs. 41.0 kcals/day, $p < .05$; 6 months: -129.4 kcals/day vs. 27.7 kcals/day; $p < .01$). Although there appeared to be a trend such that mothers in the Smart Moms group decreased their total daily calories and participants in the control group had no change in total daily calories, there were no significant between-group differences in change in total daily calories. In addition, there were no significant differences in changes in physical activity between groups.

Program Evaluation

All Smart Moms participants attended the in-person group session, as it was required to receive their randomization. Out of 24 weeks, participants submitted an average of 21.5 (± 4.3) weeks of self-monitoring texts, and out of 18 possible weeks, participants responded to an average of 15.4 (± 1.7) goal progress assessment texts. Participants reported that they read an average of 11.7 (± 4.9) lessons out of 18 total lessons on the website. Self-monitoring texts and goal progress assessment texts were associated with maternal weight change at 6 months ($r = -0.52$, $p < .05$; $r = -0.48$, $p < .05$, respectively), such that greater text messages submitted predicted higher weight loss. Number of lessons read was not associated with weight change.

Text messages and lessons were not associated with changes in child SSBs, maternal calories from beverages, or maternal total daily caloric intake.

Many participants followed the daily weighing recommendation of the program, with 40% who weighed daily and an additional 52% who weighed several times per week. While 59% of mothers reported using the sticker chart and prizes to track the child's beverages together with their child "*often*" or "*always*," only 23% continued with their own reward system during the second half of the program. During the first half of the program, 41% of children received weekly prizes at least 10 out of 12 weeks. Use of sticker charts and rewards was not associated with change in child SSBs at 6 months (Table 5.6). All intervention participants reported that they were confident that their child would continue the changes they made in their beverages.

Participants spent approximately 50 minutes (± 39) per week completing study-related activities that included reading lessons and other website material, reading and sending text messages, self-monitoring, self-weighing, and using sticker charts with their child. Smartphones were the most frequently used device for reading lessons and emails, with 44% of participants who reported using their smartphone most often to read the lessons and 57% who used it to read the feedback emails. An additional 17% used a tablet most often to read the lessons, and 13% used a tablet most often to read the feedback emails. All participants reported that they would "probably" or "definitely" recommend the program to a friend, and 91% of participants reported being satisfied with the program.

Discussion

This study found that a primarily mobile-delivered intervention was successful at reducing child SSB consumption and maternal weight compared to a waitlist control group. The Smart Moms program resulted in a reduction of 9.5 fluid ounces of daily SSBs from baseline to 6 months. Moreover, the program was effective at helping mothers lose weight, with an average weight loss of 2.3 kg at 6 months, in addition to reducing mothers' consumption of caloric beverages. This study is one of the first to significantly reduce child SSB consumption and is one of only a few parent-child interventions that has led to parental weight loss.

The reduction in SSB consumption found in this study was greater than that found in previous studies. In a pilot study that involved in-person visits as well as home visits for parents and their children ages 2-5 who were obese, children in the intervention group had a reduction of 0.6 servings at 6 months and 0.5 servings at 12 months (Stark et al., 2011), which is lower than the reduction of approximately 1.5 servings found in the current study. Adherence data were not available for the Stark et al. study, but of note, the program targeted several dietary changes in children, including high-calorie foods, fruits and vegetables, and SSBs. Perhaps a focus on just one behavior produces better outcomes than a focus on multiple behaviors, particularly among families, who may feel that changing multiple dietary behaviors is too time consuming or overwhelming. Alternatively, while baseline SSB consumption was not reported in the pilot study, they recruited children who were obese, but not necessarily who were high consumers of SSBs (Stark et al., 2011). Thus, the greater changes found in the Smart Moms study could be because of the high levels of SSB intake at baseline. Similarly, a single-group study targeting mothers and their children ages 1-3 and requiring eight weekly 2-hour classes on nutrition and lifestyle changes, found that children had a reduction of 0.4 servings per day of SSBs (Klohe-Lehman et al., 2007). Though the changes in SSBs were smaller than in the Smart Moms study, the intervention also had a broader focus on several dietary and physical activity behaviors. In fact, children in the Klohe-Lehman study also had reductions in high-fat foods and fast food consumption, indicating that some additional dietary changes may have been made that would impact long-term weight changes. The results of the study must be interpreted cautiously, however, as there was no comparison group.

Additional studies targeting a reduction in preschoolers' SSBs, among other dietary behaviors, did not produce significant changes. A randomized controlled trial with 400 mothers and their children ages 2-5, the KAN-DO study, targeted changes in dietary and activity behaviors and found that, while mothers reduced their SSB consumption and increased the amount of healthy food available in the home, SSBs did not decrease among children (Ostbye et al., 2012). Less than half of the participants attended the group session and participants completed an average of only 4 of the 8 telephone coaching calls, so it is possible that the limited participation in the study precluded the ability to produce changes in child dietary behaviors. Additionally, a primary-care based intervention with children ages 2-6 who were obese resulted in a 0.6-serving reduction in SSBs at one year follow-up, which was not significantly different from the reduction of 0.3 servings in children in the usual care group (Taveras et al., 2011). There were no significant changes in other dietary behaviors or changes in BMI z-score. Though the intervention was designed to be easily incorporated into parents' busy lives, only half of the 253 participants completed at least 2 of 6 intervention activities (in-person motivational interviewing visits and telephone calls), but greater participation was associated with greater improvements in child dietary behaviors.

The Smart Moms study is the first RCT that has produced changes in a child dietary behavior while also producing similar dietary changes and weight loss in mothers. Mothers in the study by Klohe-Lehman and colleagues had a weight loss of 2.7 kg at 8 weeks and reduced their servings of SSBs from 1.5 to 1.0 serving per day, but it was not a randomized controlled trial (2007). The KAN-DO study resulted in significant reductions in maternal SSB consumption and an increase in fruit and vegetable consumption, but mothers did not have a significant decrease in BMI (Ostbye et al., 2012). As noted above, the failure to find significant changes could possibly have been due to low participation rates. Another study with mothers and their children 9 months – 3 years old and consisting of home visits over the course of 16 weeks resulted in significant reductions in child caloric intake, but no change in maternal BMI (Harvey-Berino & Rourke, 2003). The Harvey-Berino study had a greater focus on parenting skills in addition to informational content about obesity prevention. There was no focus on self-monitoring to meet goals or on daily self-weighing as there was in the Smart Moms study, which could be why weight loss was not achieved. To date, there has been only one study that has successfully changed both parent and preschool-aged child weight outcomes (Quattrin et al., 2014). In that study, 96 children ages 2-5 who were overweight or obese were randomized to a primary care intervention or usual care for 13 sessions over 12 months, with 3 additional lessons from 12 to 24 months. There was a significant weight reduction in both children and parents at 12 and 24 months compared to the control group. While other studies involving in-person sessions have had low attendance, the Quattrin study rescheduled all parents and children if they were not able to attend a session, thus 100% of parent-child dyads attended the sessions as long as they remained in the study (83% remained at 12 months and 73% at 24 months). Ensuring that participants received the intervention contacts was likely part of the reason for significant weight changes in the Quattrin study.

Participation and adherence in the Smart Moms study was considerably higher than in most previous studies with mothers (Lombard, Deeks, Ball, Jolley, & Teede, 2009; Ostbye et al., 2009; Ostbye et al., 2012; Taveras et al., 2011) and could explain the finding of significant SSB changes in both children and mothers, in addition to a significant change in maternal weight.

Mothers completed an average of 81% of the intervention contacts (text messages and lessons), and reported appreciating the flexibility that the mobile-delivered program provided. Adherence to text messages was significantly associated with maternal weight loss, but number of lessons read was not. It is important to note that the measure of text message adherence was objective, whereas the measure of lesson adherence was subjective and prone to recall error, as participants were asked to recall and report which of the lessons they had read. Interestingly, none of the adherence measures were associated with change in child SSBs, including text messages, lessons read, frequency of use of the positive reinforcement charts, or the number of weeks that the child received a prize for meeting their beverage goal. It is unclear why maternal adherence or use of the charts was not associated with child SSB change, but the small sample size limits the ability to test for significant differences. The reported usage frequency of the positive reinforcement charts seem to imply that children who used the charts less often had somewhat greater changes in their beverages, but results were not significant and this must be interpreted with caution. Nonetheless, it is interesting that use of the charts was not associated with child beverage change, and perhaps mothers who used the charts less often with their child were those who were more confident about making changes in their child's beverages, had fewer barriers to making those changes, or had children who were less resistant to reducing their SSB intake. Thus, the mothers did not have to use the positive reinforcement techniques as often in order to promote these new changes.

Using Internet and mHealth strategies to deliver intervention content to families is a relatively new field of research and this is the first study to use a mobile website and text messages to deliver an intervention to mothers of preschool-aged children. One study used an 8-week online program to target mothers of children ages 4-6, compared to a healthy lifestyles control group, and found that fruit and vegetable consumption increased significantly more in the intervention group, but there were no differences in other dietary behaviors or child physical activity (Knowlden et al., 2015). The 8-week program was significantly shorter than the 24-week Smart Moms program, although the beverage reductions in the current study occurred by the 12-week mark of the study. An alternative reason for the differences found in the Smart Moms versus the former study could be that the parents were not actively targeted for their own behavior change and weight loss. Intervening with preschool-aged children remains somewhat controversial, as parents generally report not being concerned about their child's weight or dietary behaviors, even if their child is above normal weight (Eckstein et al., 2006). Mothers in the Smart Mom study were also instructed to reduce their caloric beverages, in addition to reducing high-calorie foods, and a small percentage of intervention content was unrelated to the child, but was specifically directed to mothers for their own weight loss benefit. It is possible that mothers remained engaged and motivated to continue making changes in the home because of their own motivation to lose weight, and combined with the cues to action throughout the study that reminded them to pursue beverage reduction with their child, was enough to lead to significant changes in child SSB consumption.

Despite the lower time demands of the Smart Moms program, 37% of the participants lost at least 3% of their body weight and 52% of child participants met the final SSB goal of 4 ounces or less per day. While the change in maternal weight is less than that found in traditional behavioral weight loss interventions, the changes in weight and beverages in this study were achieved with only one in-person treatment contact, brief online lessons, text messages, and simplified self-monitoring. This low-burden approach efficiently used the limited time of mothers to result in positive dietary behavior change in both the children and mothers.

A strength of this study is that it was the first to use a randomized controlled trial design to determine the efficacy of an innovative mobile-based program to change behavior in mother-child dyads. But despite the innovative nature of this study, there were several limitations. Mothers provided reports of SSB intake and dietary intake through a 24-hour dietary recall, and although self-report for these variables is typical in obesity research, there could have been an increased chance of social desirability bias among intervention participants because of the program's focus on changing beverages. To mitigate this risk, participants were informed that the research assistant conducting the dietary recall was blinded to their treatment group. The research assistants being blind to treatment group also ensured that the completion of the dietary recall and the measurement of the primary outcome was not biased. Another limitation is that the 24-hour dietary recalls were completed for only one day, whereas three days of dietary recalls are considered the gold standard. This is a substantial limitation, as SSB intake likely varies considerably from day to day, and the primary analyses of this study were based on only one day of intake. However, given the time demands required for the mothers to complete recalls for both herself and her child at each of the three assessment periods, it would have been unfeasible to ask mothers to complete six recalls each time. The time burden would also have increased the likelihood that participants would not complete assessment visits. Thus, the use of only one dietary recall in this study was a compromise between several advantages and disadvantages and was ultimately the best choice for dietary and SSB assessment in this population.

Another limitation of the study includes the homogenous sample population, which was a high-income, highly educated, and less diverse sample. While the efficacy of this program can only be generalized to a similar population, the mobile-based nature of the Smart Moms program means that it could potentially be studied for its effectiveness in reaching and intervening with underserved populations who are typically more difficult to recruit, particularly with the increasing numbers of smartphone usage in low-income populations (Duggan & Smith, 2013). Future research should explore whether similar mHealth programs can be used to reach, recruit, and retain low-income mothers and children who are often those that are at highest risk of obesity.

The Smart Moms study showed that a mobile-based program can be effective at keeping mothers engaged despite their busy schedules. Future research could explore how to strengthen the intervention by incorporating parents and siblings such that changes could be made in the family as a whole. As intervention research continues to advance, particularly with the advent of new technologies and the use of multiphase optimization trials, research should explore how to determine what components work best, how to use frequently assessed momentary data to tailor intervention content, and how programs can be developed using technology devices that allow participants to keep using them when the study is over, thus increasing the likelihood of maintaining behavior and weight changes. This study has the potential to inform a novel, innovative family-based approach to obesity prevention by targeting primarily two behaviors and using technology to improve adherence and effectiveness.

In conclusion, the Smart Moms study fills a gap in the literature by demonstrating that an evidence-based intervention delivered through a mobile platform can successfully change the dietary behaviors of mothers and their young children. These results suggest that targeting maternal behaviors for change is an effective manner by which to change child behaviors, thus improving the health of the family while also potentially preventing the onset of obesity in children.

Table 5.1 Evidence to determine sample size

Study	Design	Sample Size	Duration	Intervention	Behavior Change Means	Effect Difference (Pooled Within-Group SD)
Sugar-Sweetened Beverage Consumption						
Stark et al, 2011	RCT Ages 2-5 Intervention vs. pediatrician counseling (PC)	18	6 months	Family-based; 12 weekly 90-min. group sessions, followed by 12 weeks of alternating group sessions and home visits	Intervention: -0.6 (0.9) PC: 0.5 (0.8)	-1.1 (0.84)
Beech et al, 2003	RCT Ages 8-10 Parent vs. parent-child vs. control	n = 39 in parent and control groups	12 weeks	12 90-min. group sessions with nutrition and PA components	Parent: 1.52 (0.77) Control: 2.38 (2.94)	-0.51 (0.99)
Klohe-Lehmen et al, 2007	Single-group design Ages 1-3	91	8 weeks	8 weekly 2-hour classes for parents	Fruit juice: Baseline: 1.0 (0.8) 8 weeks: 0.6 (0.6) Sweetened drinks: Baseline: 0.8 (0.9) 8 weeks: 0.4 (0.5)	-0.8 (1.0)

Table 5.2 Estimates of needed sample size for change in daily servings of sugar-sweetened beverages

	Power Calculation #1	**Power Calculation #2**	**Power Calculation #3**
Power	0.80	0.80	0.80
Alpha (α; two-tailed)	.05	.05	.05
Effect size for difference between groups	1.0	0.75	1.0
Within-group SD	1.0	1.0	0.75
Raw sample size per group	17	29	10
Total sample size needed	34	58	12
Total sample size needed with 20% attrition	42	70	24

Table 5.3 Smart Moms lessons

Week 1	Kick-Off Session
Week 2	Healthy Home Environment
Week 3	Red Foods Refresher
Week 4	Setting Limits
Week 5	Introducing Physical Activity Changes
Week 6	Understanding Portions and Food Labels
Week 7	Being a Role Model for Healthy Eating
Week 8	Beverages, Sugar, and Your Child's Health
Week 9	Eating Outside the Home
Week 10	Focus on Screen Time
Week 11	Barriers to Change
Week 12	Communication
Week 14	Problem Solving
Week 16	Maintaining Motivation
Week 18	Stress Management
Week 20	The Slippery Slope of Lifestyle Change
Week 22	Thoughts, Feelings, and Eating
Week 24	Staying in Control: Life after Smart Moms

Table 5.4 Baseline characteristics

	Intervention (n = 27)	Control (n = 24)	*p* value
Child Characteristics			
Age (months)	56.4 (10.5)	51.3 (9.2)	.07
Gender			
Male	40.7%	56.0%	.21
Female	59.3%	44.0%	
BMI z-score	0.30 (1.02)	0.49 (0.90)	.49
SSB Consumption (fl. oz./day)	15.28 (9.72)	12.45 (7.95)	.26
Maternal Characteristics			
Age	36.6 (5.7)	36.2 (4.3)	.78
Race/Ethnicity			
White	81.5%	66.7%	
African American	14.8%	29.2%	.45
Other	3.7%	4.2%	
Income			
< $50,000	14.8%	21.7%	.53
≥ $50,000	85.2%	78.3%	
Marital Status			
Married or living with partner	92.3%	87.5%	.54
Not married	7.7%	12.5%	
Education			
High school, vocational training, some college	18.5%	20.8%	.84
College degree or more	81.5%	79.2%	
Weight (kg)	87.7 (13.9)	86.8 (15.7)	.82
BMI	33.1 (4.8)	32.0 (5.9)	.47
Beverages (kcals/day)	252.3 (210.3)	169.5 (174.6)	.14

Table 5.5 Sugar-sweetened beverage, weight, and dietary outcomes within and between groups

	Assessment[a]			*p* value				
				Time			Group x time	
	Baseline	3 Months	6 Months	3 months vs. BL	6 months vs. BL	Group	3 mo.	6 mo.
Child SSBs (fl. oz./day)								
Smart Moms	10.6 (7.7, 13.6)	0.9 (-3.1, 4.8)	1.1 (-2.9, 5.0)	< .0001	< .0001	< .05	< .01	< .01
Control	11.9 (9.0, 14.8)	9.1 (5.0, 13.2)	10.0 (5.9, 14.2)	.83	1.00			
Maternal weight (kg)								
Smart Moms	89.4 (83.2, 95.6)	87.1 (80.8, 93.4)	87.1 (80.7, 93.4)	< .01	< .01	.76	< .01	< .01
Control	89.0 (82.8, 95.2)	90.0 (83.8, 96.4)	89.9 (83.6, 96.2)	.93	1.00			
Child BMI-z score								
Smart Moms	0.37 (-0.06, 0.80)	0.38 (-0.06, 0.83)	0.40 (-0.05, 0.84)	1.00	1.00	.76	.65	.33
Control	0.48 (0.07, 0.90)	0.44 (0.01, 0.88)	0.43 (-0.01, 0.87)	1.00	1.00			
Maternal beverages (fl. oz./day)*								
Smart Moms	15.62 (11.12, 20.12)	3.61 (-2.97, 10.20)	3.00 (-3.45, 9.46)	< .01	< .0001	< .01	< .01	< .01
Control	17.85 (13.39, 22.31)	19.25 (12.28, 26.23)	17.22 (10.56, 23.88)	1.00	1.00			
Maternal calories from beverages (kcals/day)*								
Smart Moms	178.8 (122.6, 234.9)	55.9 (-30.0, 141.8)	49.4 (-37.2, 136.1)	< .05	< .01	< .01	< .01	< .01
Control	185.2 (128.9, 241.4)	226.2 (136.0, 316.4)	212.9 (121.7, 304.1)	1.00	1.00			
Maternal total caloric intake (kcals/day)								
Smart Moms	1704 (1509, 1899)	1403 (1105, 1702)	1422 (1121, 1724)	.29	.53	.16	.13	.22
Control	1726 (1531, 1922)	1766 (1452, 2079)	1752 (1435, 2069)	1.00	1.00			

Maternal PA (min/week)								
Smart Moms	122.4 (73.7, 171.0)	138.4 (73.2, 203.5)	150.4 (84.8, 216.1)	1.00	1.00	.55	.24	.32
Control	125.2 (76.8, 173.6)	97.1 (29.7, 164.5)	110.1 (42.0, 178.2)	1.00	1.00			

[a]Model adjusted means and 95% confidence intervals

[*]Analysis used square root transformed variable. Values presented from untransformed variable

Table 5.6 Child SSB change at 3 and 6 months by use of positive reinforcement charts

	Baseline to 3 Months[a] Mean/(SD)	*p* value	Baseline to 6 Months[a] Mean/(SD)	*p* value
Use of charts				
Never or sometimes (n = 9)	-8.75 (8.65)	.92	-10.08 (5.24)	.37
Often or always (n = 13)	-8.37 (8.98)		-6.53 (10.76)	
Received Weekly Prizes				
0-9 weeks (n = 13)	-9.36 (9.63)	.60	-8.12 (8.62)	.93
10-12 weeks (n = 9)	-7.31 (7.35)		-7.79 (9.89)	

[a]Change in average fluid ounces per day as absolute change score from baseline, *p* values from independent groups t-tests at alpha level of .05.

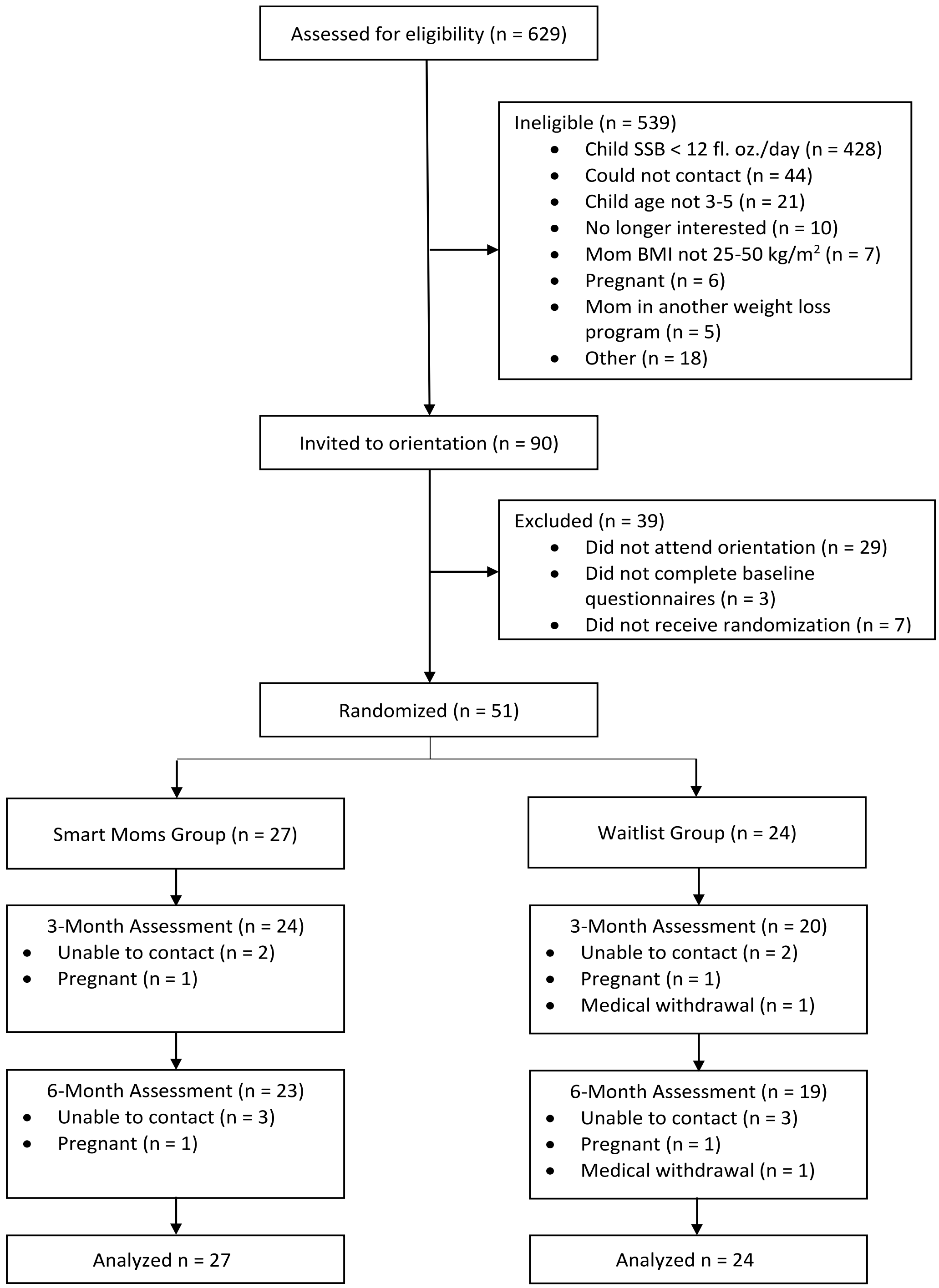


Figure 5.1 Study recruitment, enrollment, and retention (CONSORT)

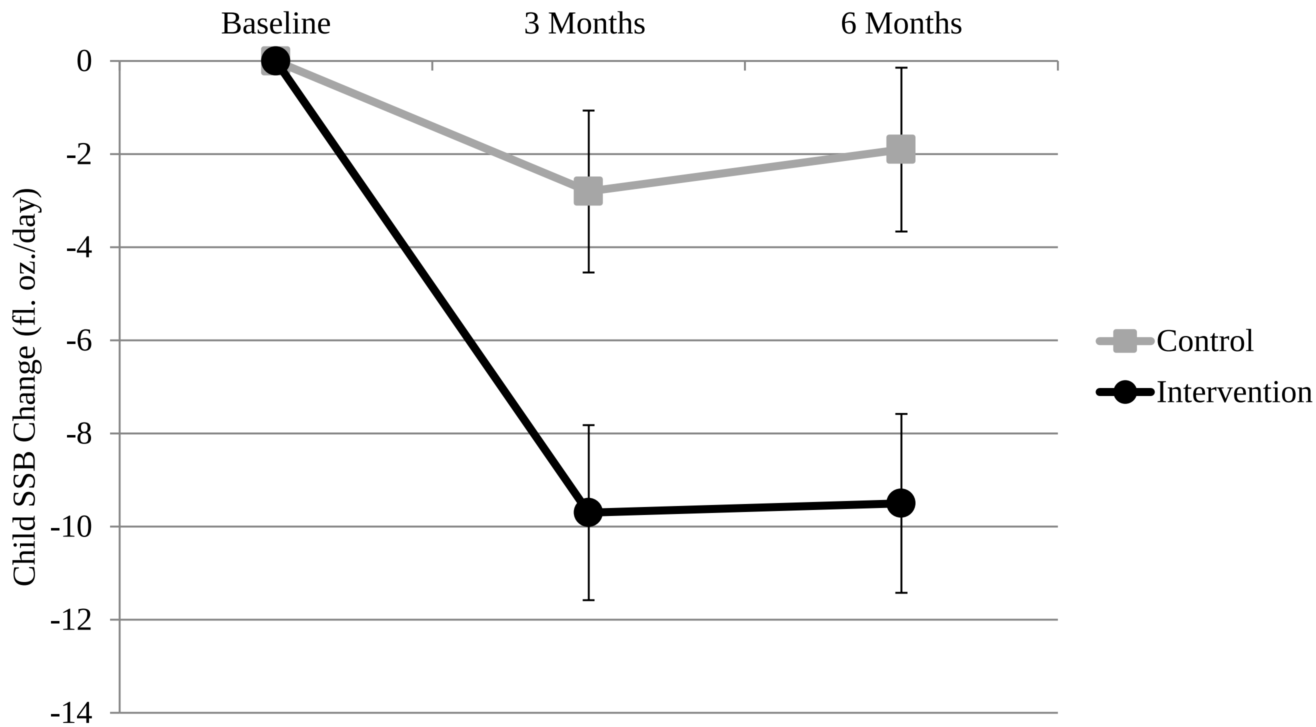


Figure 5.2 Change in child SSB consumption. Values are unadjusted, observed means.

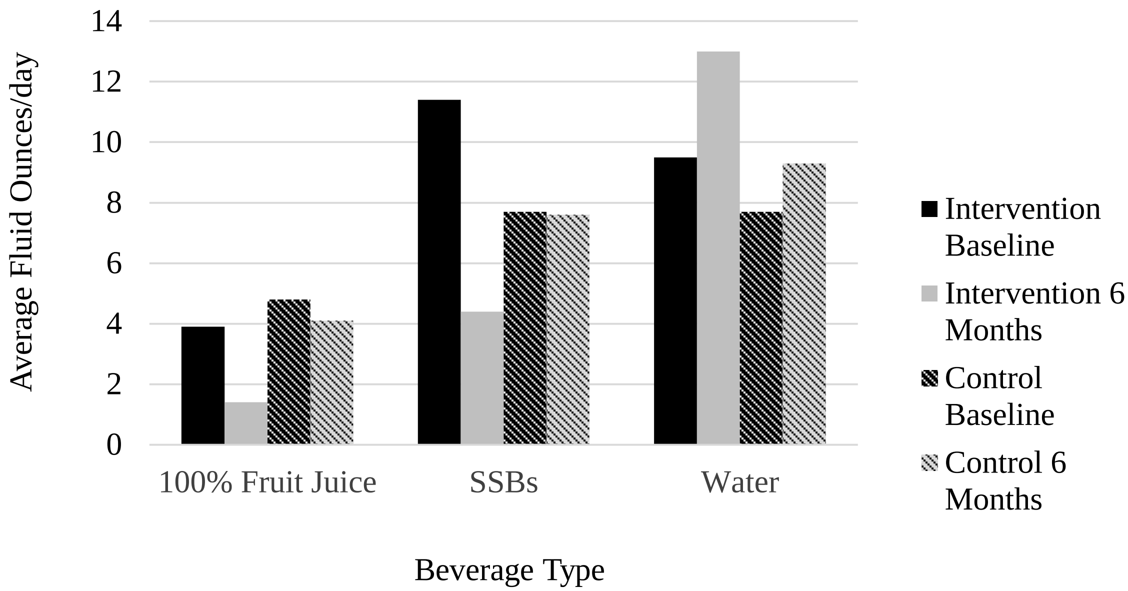


Figure 5.3 Child 100% fruit juice, SSBs, and water at baseline and 6 months. Values are unadjusted, observed means.

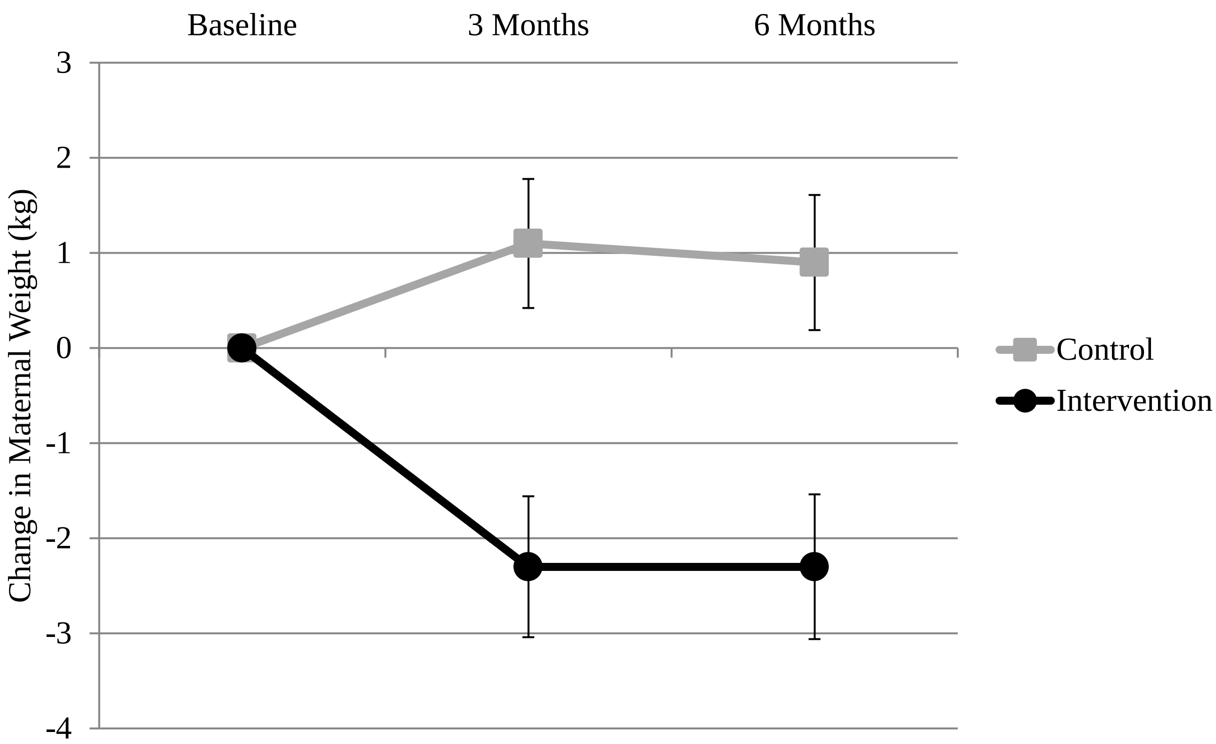


Figure 5.4 Change in maternal weight. Values are unadjusted, observed means.

CHAPTER VI: EFFECT OF THE SMART MOMS INTERVENTION ON THEORETICAL AND BEHAVIORAL INTERVENTION TARGETS AS MEDIATORS OF CHANGE IN CHILD SUGAR-SWEETENED BEVERAGE INTAKE

Introduction

Sugar-sweetened beverage (SSB) consumption has been shown to be one of the strongest predictors of child weight (DeBoer et al., 2013; Flores & Lin, 2013; Millar et al., 2014), and has also been linked to cardiovascular outcomes in childhood, including waist circumference and HDL cholesterol (Kosova et al., 2013). Because of the effect that excessive SSB consumption has on weight-related outcomes, the American Academy of Pediatrics (AAP) recommends that preschool-aged children consume no more than 4-6 ounces per day of 100% fruit juice, and consume no other sugar-sweetened beverages, including fruit drinks, flavored milk, regular soda, or sports drinks (Barlow and Expert Committee, 2007). Despite this recommendation, the average consumption among preschool-aged children is almost 13 ounces per day of SSBs and 100% fruit juice combined (O'Connor et al., 2006). Randomized controlled trials that have provided school-aged children with non-caloric beverages to replace sugar-sweetened beverages have found that a reduction in SSB intake is effective at limiting excessive weight gain (de Ruyter et al., 2012; Ebbeling et al., 2012). Intervening during the preschool-aged years to reduce sugar-sweetened beverage consumption is part of a wide range of actions that can be taken to help reduce the proportion of children who become overweight or obese in childhood. However, existing behavioral interventions have had limited success in reducing SSB intake among young children, with effective interventions resulting in small effect sizes (Klohe-Lehman et al., 2007;

Stark et al., 2011) and other interventions resulting in no change (Ostbye et al., 2012; Taveras et al., 2011).

Social Cognitive Theory (SCT) is one of the most frequently used health behavior theories in developing weight-related interventions, and it is typically used by incorporating strategies and behavioral techniques targeting a change in SCT constructs, which in turn will produce changes in the outcome. While there are theory-based interventions that have been shown to change the dietary behaviors of young children (Hartman et al., 2011), few studies have tested whether the intervention effect on the outcome operated through changes in targeted theoretical constructs or behaviors.

Social Cognitive theory suggests that self-efficacy and outcome expectations are associated with behavior (Bandura, 2004). With regard to young children, it is the mothers' self-efficacy and outcome expectations that are hypothesized to be associated with changes in child's dietary behaviors. Observational studies have shown that maternal self-efficacy for limiting SSBs is associated with child consumption of SSBs (Bolling et al., 2009; Campbell et al., 2010; Spurrier et al., 2008). There is little research available on maternal outcome expectations for child SSBs, but qualitative research suggests that parents are hesitant to reduce their child's consumption of SSBs, particularly 100% fruit juice, as they believe that the vitamin C content is important and do not believe that it has a strong relationship with weight (Beck et al., 2013; Bolling et al., 2009). Limit setting, while not a specific construct in SCT, has been associated with reduced SSB consumption in a cross-sectional study among young children (Park et al., 2015). There has been little other evidence documenting the effect of limit setting on child dietary behaviors, and none that have evaluated its predictive utility in interventions.

In family-based interventions, the SCT construct of observational learning is a critical factor for change in child behavior, as the child is socialized primarily in the family environment and learns behaviors from his or her parents (Hays et al., 2001; Lees & Tinsley, 1998). Parent role modeling of SSB consumption is a form of observational learning and has been correlated with child SSB intake (Sonneville et al., 2012; Vereecken et al., 2004) in cross-sectional studies. While there is no longitudinal research on the effect of observational learning on child SSB intake, a one-group intervention study showed that a reduction in maternal consumption of SSBs was associated with a reduction in child consumption of SSBs (Klohe-Lehman et al., 2007). Notably, it cannot be determined whether it is role modeling or simply changes that the parents make in the home food environment that mediate the relationship between parent and child behavior.

SCT posits that environmental factors can directly influence behavior and may interact with personal, behavioral, and other environmental factors to influence behavior (McAlister et al., 2008). Over 80% of SSBs consumed by young children are consumed in the home environment (Wang et al., 2008), and the presence of SSBs and juice in the home are associated with child SSB consumption (Spurrier et al., 2008). Dietary behaviors of children are also affected by social aspects of the environment, including family mealtime routines, the parents' concern for the child's dietary behaviors, and the use of food as reward (Berge, 2009; Spence, Campbell, Crawford, McNaughton, & Hesketh, 2014). However, there has been no research specifically exploring these factors as predictors of child beverage intake.

Overall, while many interventions have been developed to target evidence-based determinants of child dietary behaviors, few of these studies have evaluated the mechanisms of change in the study, and whether or not the intervention successfully produced changes in the targeted mediators. To address gaps in the existing child intervention research, Social Cognitive Theory was used to guide the planning of a 6-month maternal-targeted intervention called Smart Moms to reduce SSB consumption in children ages 3-5. After the 6-month intervention, children in the Smart Moms group had a significant reduction in SSB intake compared to the control group at 6 months (observed mean changes -9.2 ± 10.5 fl. oz./day vs. -0.88 ± 8.8 fl. oz./day).

The primary objective of the current study was to test the effects of the Smart Moms intervention on the intervention targets that were hypothesized to lead to change in child SSB consumption, including maternal SSB consumption, self-efficacy, outcome expectations, the physical and social home food environment, and limit setting. It was hypothesized that mothers randomized to the intervention group would have a greater decrease in SSB consumption at 3 months compared to mothers randomized to the waitlist control group, mothers in the intervention group would have greater improvements in the physical and social home environment at 3 months compared to mothers in the control group, and mothers in the intervention group would have a greater increase in self-efficacy, outcome expectations, and limit setting at 3 months compared to mothers in the waitlist control group. An additional objective of the study was to determine if the intervention targets that were significantly changed by the intervention operated as mediators between the intervention and change in SSB consumption at 6 months.

Methods

Participants

Eligible participants were mothers who were overweight or obese (BMI of 25-50 kg/m^2) who had a child between the ages of 3-5 who consumed at least 12 ounces a day of sugar-sweetened beverages (including 100% fruit juice, fruit drinks, sport drinks, caloric sodas, sweetened teas, and flavored milks). Additional exclusion criteria included: not having a smartphone with a data plan, participation in another weight loss program, pregnancy within the last 6 months, planning to become pregnant in the next 6 months, planning on moving from the study area within the 6-month study period, excessive alcohol intake as determined by more than 14 servings a week or a diagnosis of substance abuse, maternal diagnosis of schizophrenia or bipolar disorder, hospitalization for a psychiatric diagnosis in the past year, unable to participate in alternatives to sedentary behavior including standing and walking, or a child medical diagnosis that would prohibit small changes in dietary behaviors.

Participants were recruited from the surrounding counties using traditional methods such as flyers and contact with childcare centers and pediatricians' offices, in addition to advertising on local parents' websites and Facebook. A total of 629 women completed the online screening survey, but of those, only 90 were fully eligible to participate. Ultimately, 51 participants completed their baseline assessment visit and were randomly assigned to either the Smart Moms intervention group or the waitlist control group.

Intervention Description

The primary objective of the Smart Moms study was to reduce child SSB consumption to no more than 4 fluid ounces per day, with secondary objectives of reducing maternal caloric beverage consumption and "red" (high-fat, high-calorie) foods in order to help mothers lose weight. The conceptual model for the intervention that includes depictions of how the intervention was hypothesized to affect the intervention targets, and in turn child SSB intake, can be found in Figure 3.1.a. The Smart Moms intervention strategies were designed to increase maternal self-efficacy for reducing the child's SSB intake, improve mothers' outcome expectations about SSB intake, increase the limits set on SSBs in the home, change aspects of the physical and social home environments to promote reduced SSB intake, and reduce maternal beverage consumption to serve as a positive role model and promote observational learning.

Mothers in the intervention group attended one kick-off group session and had access to the Smart Moms website which had lessons updated weekly for the first 12 weeks and biweekly for the final 12 weeks. The lessons provided mothers with the knowledge and skills to make changes to their own and their child's beverage consumption, with the goal of changing their outcome expectations, increasing their self-efficacy for making changes, changing aspects of the home environment, and increasing positive mother-child observational learning. Additionally, mothers self-monitored their child's SSB consumption, their own beverage consumption, their red foods, and their weight daily. This form of self-regulation was intended to have a positive effect on their own beverage consumption, changes in the home environment, and limit setting for child beverages. They submitted their self-monitoring information via text message and received tailored feedback on their progress via email weekly for the first half of the program and biweekly for the second half, which was intended to increase their self-efficacy for changing child SSBs. Assessments were completed in-person and online at baseline, 3 months, and 6 months.

Measures

Sugar-Sweetened Beverage Intake. Maternal and child beverage intake was measured using 24-hour dietary recalls. At each assessment visit, the mother completed one mother-reported child recall and one self-reported recall of all food and beverage intake the day prior. Trained staff members that were blind to treatment group assignment completed the dietary recalls in order to avoid bias. The mother-reported child recall included only food that the parents provided the child and excluded food provided by daycare, school, or another care provider. Dietary data was entered into the Nutrition Data System for Research (NDSR), which was used to generate reports of the child's average sugar-sweetened beverage intake in fluid ounces per day (child SSBs) and the average fluid ounces of caloric beverages that mothers consumed each day (maternal beverages), which included all sugar-sweetened beverages, milk, alcohol, and coffee with added cream or sugar (black coffee was excluded).

Social Cognitive Theory Constructs. There are no existing validated questionnaires that measure theoretical constructs specific to parents reducing the SSB consumption of young children. Therefore, this study used a series of questions drawn from several previous research studies and developed specifically for use in this study.

To assess self-efficacy for reducing their child's SSB consumption, mothers completed four items that were adapted from two previous studies that assessed self-efficacy for limiting child SSBs and screen time (Lampard, Jurkowski, & Davison, 2013; Taveras, Mitchell, & Gortmaker, 2009). For example, mothers were asked "How confident are you that you can keep your home free of all soda and sweetened drinks?" with responses ranging from 1 = *not confident* to 4 = *extremely confident*. The self-efficacy score for reducing child's SSB was calculated by summing the four items. The self-efficacy items exhibited acceptable internal consistency at baseline (Cronbach's alpha $\alpha = .76$)

An additional item adapted from a previous study (Lampard et al., 2013) was added to assess outcome expectations for limiting 100% fruit juice, "If my child drinks more than 6 ounces per day of 100% fruit juice it will increase his/her risk of becoming overweight," which was rated on a Likert scale from 1 = *very strongly disagree* to 7 = *very strongly agree.*

Limit Setting. Mothers' practice of limit setting with SSB and juice consumption was assessed with two items used and adapted from a previous study (Hesketh, Ball, Crawford, Campbell, & Salmon, 2007), which included "In the last month, I limited how many servings of 100% fruit juice my child consumed," and "In the last month, I limited how many servings of other sweetened beverages (fruit drinks, sport drinks, or sodas) my child consumed" with responses made on a Likert scale ranging from 1 = *very strongly disagree* to 7 = *very strongly agree*. Because these two items are not part of a validated scale and because intake of 100% fruit juice was within the recommendation given to intervention group participants, the items were evaluated separately in all analyses.

Physical Home Food Environment. The physical food environment was assessed using a food availability measure developed for a previous study among adolescents (Cullen et al., 2004). Participants reported whether or not each of 71 food items was present in the home in the last week (1 = *yes*, 0 = *no*). The fruit and vegetable subscale assessed the availability of 17 fruits and 18 vegetables in the home. The fruit juice subscale assessed the availability of four types of 100% fruit juice in the home. Two additional scales measured the availability of 17 low-fat and 15 high-fat foods in the home. The subscales of interest in this study included those on fruit juice and fruit and vegetable availability.

Social Home Food Environment. The social food environment was assessed with the Meals in Our Household questionnaire (Anderson, Must, Curtin, & Bandini, 2012). The questionnaire consisted of 50 items across six subscales: structure of family meals, problematic child mealtime behaviors, use of food as a reward, parental concern about child's diet, spousal stress related to child's mealtime behaviors, and influence of child's food preferences on what other family members eat. The subscales of interest in the current study include structure of family meals, use of food as a reward, and parental concern about child's diet.

The Family Meals subscale measures traditional aspects of family mealtimes, such as the presence of a TV and family members eating at the same time. An example question includes “We eat meals in the kitchen or dining room,” and responses range from 1 = *never* to 5 = *always or almost always*. The 10 items are summed to a total score with a maximum of 50. A higher score indicates a more positive family mealtime structure. The subscale had acceptable internal consistency in this sample (α = .74).

The Food as Reward subscale consists of six items that measure how often foods are given as a reward for child behavior or achievement, such as “I give my child food to reward him/her for good behavior.” Responses range from 1 = *never* to 5 = *very often*, for a maximum subscale score of 30. The subscale had acceptable internal consistency in this sample (α = .78).

The Parental Concern subscale measures the concerns that parents have about what their child eats or does not eat. It contains 17 items, such as “Child eats too much sugar,” and is scored on a Likert scale of 1 = *not at all concerned* to 6 = *extremely concerned*. The subscale has a maximum of 102, with higher scores indicating greater parental concern for what the child is eating. The subscale exhibited good internal consistency in this sample (α = .87).

Statistical Analyses

All analyses were conducted using SAS 9.3 (SAS Institute, Cary, NC). Before conducting the primary analyses, diagnostic tests were completed to ensure the normality and homoscedasticity of residuals for all outcome variables. The variable for maternal beverages required a square root transformation and the variables for limit setting for 100% fruit juice, limit setting for SSBs, and outcome expectations were squared in order to meet the assumption of normality of residuals.

Observed means and standard deviations for all intervention targets at baseline and 3 months were calculated for each treatment group. To determine if the intervention had a significant effect on the intervention targets, intent-to-treat principles using linear mixed models were used to compare changes in the intervention targets from baseline to 3 months between treatment groups. Adjusted mean change scores for each intervention target were calculated from the linear mixed models for descriptive purposes. Separate models were conducted for each intervention target, and included a random intercept, main effects for treatment group and time, and a group by time interaction.

Intervention targets that changed significantly between groups from baseline to 3 months were tested in a multiple mediation model using observed data to evaluate their significance as mediators between the intervention and 6-month child SSB change. The models were constructed in order to meet the temporal precedence assumption of mediation, such that the change in intervention targets at 3 months occurred prior to the measure of change in child SSBs at 6 months. The PROCESS macro for SAS (Hayes, 2013) was used to evaluate direct relationships between the intervention (IV) and child SSB change (DV), relationships between the intervention and change in intervention targets (mediators: maternal beverages, SCT constructs, home environment variables) and to evaluate change in the intervention targets as mediators between the intervention and child SSB change. One advantage of the PROCESS macro over traditional methods of mediation, such as the Sobel test, is that it tests the significance of multiple indirect effects without reducing power. PROCESS uses an ordinary least squares regression-based path analytic framework and bias-corrected bootstrapped confidence intervals to evaluate the significance of indirect effects, which are significant when the confidence interval does not include zero. Results include the *total effect*, or the effect of the

IV on the DV, the effect of the IV on the mediator (*a* path), the effect of the mediator on the DV, controlling for the IV (*b* path), and the *indirect effect* of the IV on the DV through the mediator (*a*b*). The *direct effect* (*c'*) is the effect of the IV on the DV after removing the variance associated with the effect of the mediators. In the multiple mediation model, treatment group was entered as the IV, residualized change scores for change in intervention targets from baseline to 3 months were entered as mediators, and a residualized change score for change in child SSB consumption from baseline to 6 months was entered as the DV. Figure 6.1 depicts the pathways in the multiple mediation model.

Results

Participants

A total of 51 mother-child dyads were randomly assigned to the Smart Moms intervention or the waitlist control group. Baseline demographic characteristics of the study sample are depicted in Table 5.4. There were no significant differences in demographic characteristics or child SSB consumption at baseline by treatment group. Participants were 75% white, 82% had an income above $50,000, and 80% had a college degree. Children were, on average, 4.1 (± 0.8) years old and were consuming 13.95 (± 8.96) ounces of SSBs per day at baseline. Mothers were on average 36.4 (± 5.1) years old, had an average BMI of 32.6 (± 5.3), and were consuming 213 (± 197) calories a day from beverages at baseline. There were no differences in dropout between groups at 3 months (11.1% in intervention vs. 16.7% in control, p = .69) or 6 months (14.3% in intervention vs. 20.8% in control; p = .25).

Effect of Intervention on Intervention Targets

Observed values of maternal beverage intake, SCT constructs, and home environment constructs are depicted in Table 6.1, along with adjusted mean change scores. Compared to the control group, mothers in the Smart Moms group had a significant reduction in caloric beverage intake from baseline to 3 months, had a significant increase in limit setting for 100% fruit juice, and had a significant decrease in parental concern for child diet. All changes were in the expected direction as a result of the intervention. The change in fruit and vegetable availability in the household reached, but did not fall below, the significance level of .05, such that availability increased in the intervention group but did not change in the control group. Other variables that changed within the Smart Moms group but did not have a significant group by time interaction included an increase in limit setting for SSBs, an increase in family meals, and a decrease in food as a reward. The use of food as a reward also decreased significantly within the control group. The means for self-efficacy for limiting child SSBs increased slightly in the intervention group, with a p value below 0.10, but it did not reach significance and was not different than the changes found in the control group.

Multiple Mediation Model

The constructs that had a significant change from baseline to 3 months in the Smart Moms group compared to the control group were entered into the multiple mediation model. The model included intervention group as the IV, child SSB change from baseline to 6 months as the DV, and included adjusted change in maternal beverages, limit setting for 100% fruit juice, and parental concern for child diet at 3 months as mediators. Results can be found in Figure 6.1 and Table 6.2. As previously reported, there was a significant total effect between the intervention and change in child SSBs, such that the intervention group had a significantly greater reduction in SSBs than the control group. The indirect effects for maternal beverages and parental concern were significant, indicating that they were mediators of the effect of the intervention on change in child SSBs after controlling for the other mediators. Limit setting for 100% fruit juice did not mediate the relationship between the intervention and change in child SSBs.

Discussion

The objective of this study was to evaluate the effectiveness of the Smart Moms intervention at changing the intervention targets that were intended to produce changes in child SSB consumption. The intervention successfully led to reductions in maternal beverage consumption, an increase in setting limits on 100% fruit juice, and a reduction in parental concern for the child's diet, but there were no significant changes in other potential mediators compared to the control group. The changes in maternal beverages and concern for the child's diet mediated the effect of the intervention on child SSB change.

As hypothesized, the Smart Moms intervention had a significant effect on change in mothers' consumption of caloric beverages from baseline to 3 months by almost 12 ounces per day. This was a large decrease, but notably, included coffee with any amount of caloric additions (cream/milk or sugar). Thus, some coffee drinks may have had a low number of calories, but were included in the measure of total fluid ounces. The maternal reduction in beverages amounted to a decrease of 123 calories per day from beverages, which was in contrast to a gain of 45 calories from beverages in the control group. The finding that the decrease in caloric beverages at 3 months was predictive of a decrease in child SSBs at 6 months is likely reflective of the fact that mothers made changes in the home environment to reduce the availability of caloric beverages. In addition, a focus on observational learning was a large part of the Smart Moms program, and its relevancy to mothers may have been strengthened by the fact that they were also encouraged to reduce their beverage intake for their own benefit in order to lose weight. Thus, it is possible that the reduction in child beverages was partially aided by observing mothers change their own beverage habits, but this cannot be tested in this study. The current findings differ from those of two parent-targeted interventions with children below the age of 5. In the first, the intervention successfully reduced maternal consumption of sugary beverages, but there was no SSB decrease among children (Ostbye et al., 2012). In the second, the intervention did not lead to changes in maternal diet (Spence et al., 2014), and in turn, maternal diet did not mediate the intervention effect on the child diet outcome. Both of these studies had a broad focus on several dietary behaviors, which may have diluted the intervention effect on any one specific behavior, whereas the Smart Moms intervention focused on helping moms to implement a single dietary behavior change for children. In addition, both the Ostbye (2012) and Spence (2014) studies used a food frequency questionnaire (FFQ) to measure diet, which is more susceptible to recall bias than the 24-hour recalls used in the current study.

The intervention was expected to change the SCT constructs from baseline to 3 months, but these hypotheses were not supported. The means for self-efficacy for limiting child SSBs appeared to increase in the intervention group, but it did not reach significance. Of the few intervention studies that have evaluated parental mediators of change in young children's behavior, self-efficacy has not been shown to be a significant mediator of treatment effects on dietary behaviors (Fletcher et al., 2013; Spence et al., 2014). Thus, while parent self-efficacy is known to have cross-sectional associations with child SSB intake (Bolling et al., 2009; Campbell et al., 2010; Spurrier et al., 2008), research has not yet established that interventions can successfully increase parental self-efficacy in order to have positive effects on child dietary behavior. Similarly, there was no change in outcome expectations in the current study. A study among fathers of young children found that their beliefs about the child's diet mediated the effect of the intervention on changes in their consumption of healthy foods (Lloyd, Lubans, Plotnikoff,

& Morgan, 2015). The finding that outcome expectations for children's 100% fruit juice did not change in the intervention group, despite content targeted toward a greater understanding of the risks associated with excessive fruit juice consumption, indicates that maybe some skepticism remained regarding the health outcomes of 100% fruit juice and the need to monitor their child's intake (Beck et al., 2013; Bolling et al., 2009).

The intervention led to significant increases in limit setting for 100% fruit juice and limit setting for other SSBs within the intervention group, but the group by time interaction was significant only for limit setting for 100% fruit juice. Nonetheless, the results indicate that mothers in the intervention group increased the limits that they placed on their child's consumption of juice and SSBs. In the multiple mediation model, however, limit setting for 100% fruit juice did not mediate the effect of the intervention on child SSB change, and the pathway between limit setting and change in child SSBs was not significant. Due to the focus on replacing SSBs and juice with water, it is possible that mothers did not feel as though they were limiting sugary beverages as opposed to increasing water, but this is a hypothesis that cannot be tested in this study. Nonetheless, there is cross-sectional evidence showing that limit setting for juice and SSBs is associated with child beverage intake (Park et al., 2015; Spurrier et al., 2008), but there is not yet any evidence that indicates that increases in maternal limit setting for preschool-aged children within an intervention context are associated with improvements in child diet.

Aspects of the physical home food environment were also hypothesized to be impacted by the intervention, and despite the intervention's focus on limiting 100% fruit juice intake to one serving per day, there was no change in the number of 100% fruit juices offered in the home. Notably, a limitation of the measure is that it assessed only the presence or lack thereof of four different types of 100% fruit juices, instead of assessing the total amount present in the home (e.g. purchasing two gallons of apple juice per week vs. one), and there was no measure of other types of SSBs in the home. This was a trade-off that was considered when choosing to use a previously existing, validated measure in this study, versus creating a new, untested measure that assessed the presence of all SSBs in the home. It is unknown if a significant effect would have been found for the availability of 100% fruit juice if the measure were different, but one previous intervention study with preschool children found that limiting the availability of foods high in fat, salt, and sugar was associated with a reduction in child intake of those foods (Fletcher et al., 2013). Interestingly, there was a between-group difference in change in fruit and vegetable availability, which increased slightly in the intervention group but did not reach a within-group level of significance. It was for this reason that it was not included in the multiple mediation model, but simple mediation analyses (not reported here) indicated that fruit and vegetable availability did not mediate the effect of the intervention on change in child SSBs.

Lastly, the only construct in the social home food environment that was changed as a result of the intervention was parental concern for child's diet. Mothers in the intervention group decreased their concern for their child's eating behaviors. It is not possible to determine if this decrease was because the dietary behaviors of the children improved, or because mothers changed their level of concern. Though the study used dietary recalls, there is no valid measure of total caloric intake among children, as food provided by childcare centers or school was not reported in the dietary recall. Cross-sectional research has shown that greater parental concern for eating habits is associated with higher weight (Johannsen, Johannsen, & Specker, 2006), and previous intervention studies have shown that decreases in parental concern are associated with improvements in child weight status (Burrows, Warren, & Collins, 2010; Daniels et al., 2012).

While the structure of family meals score improved significantly at 3 months in the Smart Moms group, the group by time interaction was not significant. Positive family mealtime behaviors are associated with better dietary behaviors and lower weight among adolescents (Larson, Neumark-Sztainer, Hannan, & Story, 2007), but have not been studied in younger children. This construct has also not yet been tested in other intervention studies with young children, and so its role in an intervention context is still unknown. Interestingly, the use of food as a reward decreased in both the intervention group and the control group. The reason for this is unknown, as the control group received no intervention content. In a prior study of mothers with toddlers, the use of food as a reward was a mediator between the intervention and an improvement in child diet (Spence et al., 2014). While it is possible that the use of food as reward would also be associated with overall child diet in the current study, the dietary measure reported here is limited to SSB intake, as described above. It is possible that questions specific to using sugary beverages or sweets as a reward would have exhibited changes over time, but cannot be evaluate in the current study.

Overall, this study found that the Smart Moms intervention led to significant reductions in maternal caloric beverage consumption, increases in limit setting for 100% fruit juice, and decreases in parental concern for child diet at 3 months, although only maternal beverage consumption and parental concern for child diet mediated the effect of the intervention on the reduction in child SSBs at 6 months. The primary strength of this study is that it is the first to identify mediators of the effect of a mobile-based parent-targeted intervention on dietary behaviors in preschool-aged children, and thus fills a significant gap in the literature by informing critical targets of mHealth interventions for parents that produce dietary changes in both the parent and the child.

An additional strength of this study is that it tested potential mediators simultaneously in a multiple mediation model, as opposed to separate simple mediation models that are often presented in mediation studies. Interventions target many variables for change, and expected changes in these mediators (e.g. theoretical constructs, psychosocial variables) do not have an additive effect, but work together and share variance in the outcome. Thus, it is important to evaluate the effect of potential mediators after controlling for the effect of other mediators in the model.

A significant limitation of this study is the lack of existing, validated scales to measure SCT-related constructs for reducing child SSB consumption. The items used in this study to measure self-efficacy, outcome expectations, and limit setting were adapted from previous studies and have no psychometric data available. This means that the results must be interpreted cautiously, and future research should create and evaluate measures that assess theoretical constructs that relate to changing specific behaviors.

In conclusion, this study contributes to the early childhood intervention literature by elucidating the mechanisms by which a mobile-based program targeting mothers improved child SSB consumption. Interventions for young children are still relatively rare compared to those that target children of other ages, so it remains critical to examine which theoretical and behavioral constructs to target with parents so that the most effective strategies can be used to develop future programs. While this study focused on a single dietary behavior, similar intervention strategies could potentially be used to target mediators of other dietary behaviors in young children, although they should be explored further. Though this study is a useful first step in determining how interventions can change child dietary behaviors, future studies should focus on using psychometrically reliable and valid measures for potential mediators so that more concrete conclusions can be drawn. In addition, because the strategies used in interventions cannot be isolated, it may be more beneficial to use structural equation modeling to evaluate the full conceptual model of interventions, rather than evaluating single mediating pathways.

Table 6.1 Change in intervention targets from baseline to 3 months within and between groups

	Baseline Mean (SD)	3 Months Mean (SD)	Mean Change Mean (95% CI)	Time *p* value	Group x time *p* value
Maternal beverages (fl. oz.)[a]					
Smart Moms	23.19 (15.88)	11.30 (10.87)	**-11.89 (-18.76, -5.02)**	**< .001**	**< .01**
Control	18.82 (14.55)	21.66 (8.36)	2.08 (-5.47, 9.63)	.22	
Fruit Juice Availability					
Smart Moms	1.52 (1.22)	1.21 (0.72)	-0.27 (-0.67, 0.13)	.18	.75
Control	1.54 (0.98)	1.25 (1.07)	-0.18 (-0.61. 0.26)	.41	
Fruit and Vegetable Availability					
Smart Moms	12.96 (4.72)	14.08 (4.64)	1.02 (-0.68, 2.72)	.23	.05
Control	14.17 (5.58)	11.95 (4.37)	-1.46 (-3.31, 0.39)	.12	
Limit Setting - 100% FJ[b]					
Smart Moms	4.74 (1.85)	6.38 (0.97)	**1.62 (0.87, 2.38)**	**< .0001**	**< .01**
Control	4.33 (1.81)	4.60 (1.60)	0.27 (-0.55, 1.08)	.60	
Limit Setting – SSBs[b]					
Smart Moms	5.78 (1.42)	6.46 (0.88)	0.66 (-0.08, 1.40)	**< .05**	.21
Control	5.29 (1.94)	5.40 (1.67)	0.14 (-0.66, 0.94)	.89	
Self-Efficacy					
Smart Moms	11.63 (2.39)	12.63 (3.08)	0.98 (-0.10, 2.05)	.07	.39
Control	10.82 (2.53)	10.95 (2.54)	0.29 (-0.88, 1.46)	.62	
Outcome Expectations[b]					
Smart Moms	5.26 (0.98)	5.25 (1.75)	-0.17 (-1.09, 0.75)	.57	.28
Control	4.63 (1.56)	5.40 (1.10)	0.19 (-0.80, 1.18)	.05	
Family Meals					
Smart Moms	37.54 (5.01)	38.94 (4.52)	**1.21 (0.22, 2.20)**	**< .05**	.18
Control	36.30 (5.40)	36.45 (5.09)	0.22 (-0.85, 1.28)	.68	
Food as Reward					
Smart Moms	14.37 (3.96)	12.58 (3.62)	**-1.57 (-2.59, -0.55)**	**< .01**	.56
Control	14.92 (3.63)	13.75 (4.33)	**-1.13 (-2.25, -0.02)**	**< .05**	
Parental Concern					
Smart Moms	39.19 (14.83)	31.88 (13.56)	**-5.75 (-8.50, -3.00)**	**< .0001**	**< .05**
Control	37.79 (12.55)	37.65 (15.34)	-1.33 (-4.34, 1.68)	.38	

Note. Observed means and SD at baseline and 3 months. Mean changes and significance tests for within and between groups across time are estimated from linear mixed models.

[a]Means are raw data, mean changes are from linear mixed models of raw data, *p* values from linear mixed models using square root transformed variable.

[b] Means are raw data, mean changes are from linear mixed models of raw data, *p* values from linear mixed models using squared transformed variable.

Table 6.2 Multiple mediation indirect effects on child SSB change at 6 months

	Coefficient (s.e.)	95% confidence interval
Total effect (*c* path)	7.06 (2.23)	**2.52, 11.59**
Direct effect (*c*’ path)	8.87 (3.25)	**2.27, 15.47**
Indirect effects		
Maternal beverages (fl. oz./day)	-2.36 (1.27)	**-5.78, -0.54**
Parental concern about child’s diet	1.33 (0.92)	**0.01, 3.95**
Limit Setting- 100% FJ	-0.78 (2.89)	-7.59, 3.19

Note. Effects are significant when the 95% bias-corrected confidence interval excludes zero. Mediators are residualized change scores created by regressing 3-month value on baseline value.

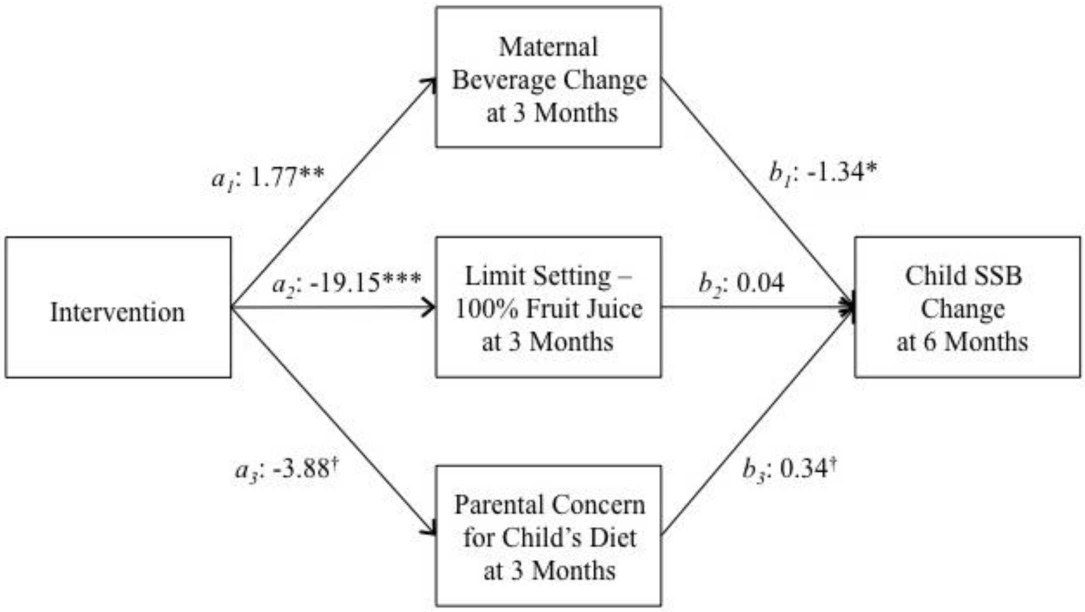


Figure 6.1 Multiple mediation model and results.

CHAPTER VII: SYNTHESIS OF FINDINGS AND RECOMMENDATIONS

Summary of Findings

Given the increasing proportion of preschool-aged children who are overweight or obese, and given that overweight and obese parents could benefit from programs targeted to the demands of having a family, there is a significant need for sustainable interventions that are effective and maximize adherence among parents. The purpose of these studies was to identify parents' barriers to participation in interventions and conduct a randomized controlled trial targeting mothers as the agent of change for young children's dietary behaviors. The primary findings of this project were that (1) the number of children that parents have in the home impacted the short-term weight loss success of participants in a behavioral weight loss intervention, which was due to greater perceived exercise barriers and lower initiation of MVPA, but did not impact the longer-term maintenance of physical activity and weight, (2) a mobile-based intervention effectively led to reductions in child SSB intake and maternal weight compared to a control group, and (3) maternal reduction in caloric beverages and parental concern for the child's diet mediated the effect of the intervention on reduced child SSB intake. Overall, the results of this dissertation suggest that there are significant time barriers that may inhibit the engagement and weight loss success of parents in behavioral interventions, and also indicate that a parent-child intervention with lower time demands and delivered primarily using smartphones may be a promising way to maximize the adherence of parents to dietary changes while leading to changes in both child and parent dietary behaviors.

To this date, behavioral interventions for parents and young children have not reached the same level of efficacy as traditional interventions delivered to a general population of adults. Observational research has shown that compared to adults without children, those with young children in the home engage in less physical activity, have poorer nutritional intakes, and have higher rates of weight gain, though the relationship is stronger among mothers compared to fathers (Bellows-Riecken & Rhodes, 2008; Berge et al., 2011; Laroche et al., 2013; Nomaguchi, 2004; Sternfeld et al., 1999). This suggests that bringing children into the home is a significant life transition that increases the risk of obesity and signifies the early years of parenthood as a critical time to intervene for weight control. However, further research is needed to evaluate the success of parents within traditional weight loss interventions that require frequent face-to-face meetings and detailed monitoring of calories and physical activity.

Study One sought to determine if the number of children that participants in a behavioral weight loss intervention had in the home was associated with barriers to exercise, engagement in recommend levels of physical activity, and weight loss compared to participants without children. A serial mediation analysis was conducted using data from an 18-month randomized controlled trial that compared two active forms of behavioral weight loss treatment, both with a focus on making reductions in caloric intake, large increases in moderate-to-vigorous physical activity, detailed self-monitoring, and attendance at regular in-person groups. At study entry, participants with one child in the home reported having greater barriers to exercise than participants with no children (39.9 vs. 35.8), but there was no significant difference between participants with two or more children and no children (two children: 37.1 vs. 35.8). However, participants with two or more children had the lowest weight loss at 6 months (8.9% vs. 9.3% with one child and 10.8% with no children). The bivariate models suggested that there were no significant differences in change in MVPA from baseline to 6 months by number of children in the home. However, the mediation analyses revealed that exercise barriers and change in MVPA from baseline to 6 months were serial mediators of the effect of number of the children in the home on weight change at 6 months. This means that the number of children in the home was positively associated with exercise barriers at baseline, which was in turn associated with a lower increase in initiation of MVPA in the first 6 months of the intervention, which, in turn, was predictive of lower weight loss.

Interestingly, adults with one child in the home had greater percent weight regain from 6 to 18 months than other adults (63.0% vs. 39.2% for two or more children, 5.03% for no children). However, the number of children in the home was not predictive of a greater decrease in exercise barriers from baseline to 6 months or a greater decrease in MVPA From 6 to 18 months as expected, and thus change in exercise barriers maintenance of MVPA did not mediate the relationship between number of children the home and percent weight gain from 6 to 18 months.

To our knowledge, this is the first study to evaluate the barriers, behavior change, and weight loss success of adults with children in the home in a traditional behavioral weight loss intervention. Overall, the results of Study One supported the hypothesis that adults with children in the home would not be as successful at initiation of behavior and weight change in a weight loss intervention, and point to the need for specific interventions or intervention techniques targeted to adults who are taking care of children in the home. In fact, there have been a number of interventions that have specifically targeted adults with children, with a sole focus on changing parent behavior (vs. child behavior), but most of them have been among women with infants or young children (Cramp & Brawley, 2006; Fahrenwald, Atwood, Walker, Johnson, &

Berg, 2004; Fjeldsoe et al., 2015; Havas et al., 2003; Jordan et al., 2008; Lombard et al., 2009; Ostbye et al., 2009). Several of these interventions have resulted in significant changes in physical activity or weight, but effect sizes have been small, ranging from 0.5-2.7 kg lost (Cramp & Brawley, 2006; Fahrenwald et al., 2004; Jordan et al., 2008; Lombard et al., 2009). In Study One of the current project, while parents may not have lost the same amount of weight at 6 months as adults without children, it is important to note that they still lost over 8% of their body weight, which is well above the weight losses in the studies described above. These results indicate that for parents who are likely highly motivated to change due to their willingness to join a behavioral weight loss intervention, the benefit of a traditional intervention with group meetings and detailed self-monitoring may be worth the time demands required. Or alternatively, even if adherence is not as high among parents compared to nonparents, their level of participation is enough to reach clinically significant levels of weight loss. Nonetheless, this does not preclude the need to determine more effective ways to intervene with parents, as their weight, physical activity, and dietary behaviors have an influence not only on their own health, but also on the health of children in the home. Moreover, it suggests that lower intensity programs will need to address the barriers to behavior change experienced by adults with children in the home in order to maximize adherence and success.

Therefore, an alternative to having parents participate in a standard behavioral weight loss intervention for adults would be to develop interventions that take into account the specific needs of adults with young children and target the dietary behaviors or physical activity of both the parent and the child simultaneously. Given that the existing weight-related interventions for young children have had mixed results (Hesketh & Campbell, 2010), and knowing that the active involvement of the parent in interventions increases the likelihood of child behavior change

(Golan, 2006; Hesketh & Campbell, 2010), the logical next step is to test interventions that are targeted toward behavior change in both the parent and child. However, because dropout in previous family-based studies has been high, especially in those that have required regular in-person treatment contacts (Brown et al., 2001b; Hartman et al., 2011; Skelton & Beech, 2011), it is critical to design interventions that are more easily accessible to parents so that they can follow treatment recommendations and maximize the effect of the treatment. This suggests that an intervention using mobile technology could be a feasible way to deliver content to parents of young children, giving them the flexibility to read and interact with intervention content at times that fit into their schedule.

Study Two tested the efficacy of the 6-month Smart Moms mobile-based intervention that targeted a reduction in child sugar-sweetened beverages (SSB) and maternal weight. Mothers can be a difficult population to recruit into intervention studies that focus on child weight or behavior change. Knowing this, the Smart Moms study maximized the interest of mothers by emphasizing the program's focus on helping mothers lose weight while also making healthy dietary changes in the home that would benefit both themselves and their child. A total of 629 women were interested in the study, but after removing ineligible participants (68% of ineligible participants were ineligible due to child SBB intake below 12 fl. oz./day), and those who did not complete baseline questionnaires, 51 mother-child dyads were randomized to either the intervention or waitlist control group. With the exception of one in-person kick-off session, the intervention was delivered primarily through the use of a mobile-optimized website and text messages. Intervention strategies were based on Social Cognitive Theory, such that the interaction between individual behaviors, personal characteristics, and aspects of the home environment formed the context within which mothers made changes in their child's SSB consumption. Though the primary outcome was a change in child SSBs, mothers were also recommended to reduce their own consumption of SSBs, in addition to “red” (high-fat, high-calorie) foods, in order to help them lose a little bit of weight.

The Smart Moms intervention produced a significant decrease in child SSB consumption at 3 months, which was maintained at 6 months even after a period of reduced contact with mothers. The SSB difference scores observed in this study exceeded those found in previous studies, with a 7.6-ounce-greater reduction in SSBs per day in the intervention group compared to the control group, in contrast to reductions ranging from 0 to 1.5 servings (0-6 ounces) per day in parent-targeted studies for child dietary behaviors (Beech et al., 2003; Ostbye et al., 2012; Stark et al., 2011; Taveras et al., 2011). Additionally, two intervention studies with a one-group pre-post design found a reduction in SSB intake of approximately 4 ounces per day (Keita et al., 2014; Klohe-Lehman et al., 2007), but the results cannot be directly compared to the current study because of the design limitations. A substantial difference between the Smart Moms study and the previous studies is that the primary objective of the study was to reduce sugar-sweetened beverage consumption in children, rather than a primary outcome of child weight or a broad focus on several dietary behaviors. Mothers in the Smart Moms study reported that they appreciated the simplicity of the study in its focus on specific dietary behaviors, and perhaps the focus on a single behavior increased the ease with which mothers were able to make changes with their child. Young children are not able to understand the reasons for making changes to their diet and are likely to be resistant to parents reducing things they enjoy consuming, such as sugary beverages, sweets, or unhealthy snacks. Thus, a focus on one behavior at a time may be a promising approach to making healthy changes in a child’s diet.

The changes in SSBs observed in Smart Moms may have an important impact on the health of children in the study. By reducing SSBs and 100% fruit juices, children in the intervention group reduced their calories from beverages by 145 calories a day, which is 10-15% of the daily recommended calories for preschool-aged children. Moreover, added sugar from beverages was reduced from 43.5 grams per day at baseline to 16.2 grams per day at 6 months. If maintained, this reduction in calories and added sugars will contribute to a lower risk of becoming overweight in childhood and adulthood. While the observed means suggest that water consumption increased by approximately 3.5 ounces per day, and milk consumption increased by approximately 1 ounce, the statistical analyses did not examine the significance of these changes within or between groups. Similarly, a limitation of the study is that it was not able to determine if reductions in SSB intake were replaced with added sugar or calories from additional foods. Because the dietary recall only captured food and beverage intake while the child was in the care of the mother or her partner, the children in the study have varying proportions of their daily dietary intake that were captured by the recall. For example, a child who was in childcare from 7am-5pm and ate breakfast, lunch, and snacks provided by the childcare would have the majority of their intake for the day missing from the dietary recall, but a child who was at home all day with the mother would have a full day of reported dietary intake. The purpose of the intervention was to target dietary behaviors in the home environment, where children of preschool age spend most of their time and consume most of their calories and where parents are in control of food and beverage portions. However, it means that total caloric intake and substitution of beverages with other foods cannot be evaluated.

Study Two also found differences in maternal weight and maternal beverage consumption, with mothers in the Smart Moms group losing 2.3 kg compared to a gain of 0.9 kg in the control group, and reducing their beverages by more than 12 ounces per day compared to no change in the control group. This suggests that even in an intervention with a primary objective to change child SSB intake, mothers can also make dietary changes to lose modest amounts of weight. Participation in the Smart Moms intervention was high, with most participants submitting at least 23 out of 24 weeks of self-monitoring data and reading almost two-thirds of the lessons available on the Smart Moms mobile-optimized website. During study recruitment, it was emphasized that the study would require less time per week than a "traditional" weight loss intervention and included a simplified version of self-monitoring that did not involve detailed calorie tracking. Responses in the program evaluation indicated that, on average, mothers spent approximately 50 minutes per week in intervention-related activities. This is much less than the time requirements of a standard behavioral weight loss intervention that would require travel to and from group meetings, attendance at the group meetings of at least one hour in duration, in addition to the time required to track detailed caloric intake and exercise. The lower time demands of the Smart Moms study could be a reason that the study had high adherence and participation. However, the weight changes observed, while statistically significant, are less than those observed in standard behavioral weight loss interventions. The adults with children in the home in Study One of this dissertation lost at least 8% of their body weight at 6 months, compared to approximately 2.7% in the current study. This is an important contrast, and raises questions about the benefit of high-demand, highly effective interventions versus low-demand, but less effective interventions. However, a key difference between the interventions in Study One and Study Two are that the former was an intervention for adults, while the latter targeted both adults and children. In addition, the former study encouraged detailed self-monitoring and a reduction in calories of 500-1000 per day, which is known to produce large weight losses, compared to a simplified self-monitoring approach in the Smart Moms study. The weight loss observed in Smart Moms is similar to that found in other studies that have focused on just one dietary manipulation, such as the CHOICE study, which focused on reducing calories from beverages by 100-200 per day and resulted in weight losses of 2.5% (Tate et al., 2012).Thus, while the Smart Moms study did not result in maternal weight losses equivalent to those of standard behavioral interventions, it was successful in its primary objective to reduce child SSB consumption, in addition to producing positive changes for mothers. Given the wealth of research indicating that parental weight and dietary behaviors are the strongest predictors of child weight (Davison & Birch, 2001; Flores & Lin, 2013), and considering that the rate of overweight and obese among young children remains a significant public health problem in the United States, interventions that simultaneously work towards improving the weight status of parents while also improving the dietary and physical activity behaviors of their children could be a way to impact the rising rates of obesity in young children.

As described in Chapter 2 of this dissertation, the Smart Moms study was developed with careful attention to theoretical and empirical evidence of successful strategies that had been used in previous interventions targeting dietary changes in parents and children. The intervention was purposefully developed to include strategies that had previously been found to change theoretical and behavioral intervention targets, and with some epidemiological and intervention evidence that changes in the intervention targets would lead to changes in child SSB intake and maternal weight.

The objective of Study Three was to evaluate if the Smart Moms intervention produced changes in the hypothesized intervention targets, and if the intervention targets mediated the effect of the intervention on the change in child SSBs. The intervention was expected to change child sugar-sweetened beverage consumption through its changes in maternal beverage intake (observational learning), changes in the physical and social home food environment, increases in limit setting, and changes in the SCT constructs of self-efficacy, outcome expectations, perceived barriers, positive reinforcement, and self-regulation (Figure 2.1). The Smart Moms intervention produced a significant reduction in maternal caloric beverage intake, a significant increase in limit setting for 100% fruit juice, and a decrease in parental concern for child diet at 3 months. Only changes in maternal beverage intake and parental concern for child diet mediated the effect of the Smart Moms intervention on the change in child SSBs at 6 months. The mediating effect of the change in maternal beverages on change in child beverages was expected, given that out of all the predictors of child diet, maternal diet emerges as the strongest (Davison & Birch, 2001). The effect of maternal beverage change on child SSB change likely occurred through two mechanisms, through the effect of role modeling and through changes that were made in the home environment. In a previous one-group intervention study, change in maternal beverage consumption was associated with change in child SSB consumption (Klohe-Lehman et al., 2007), but this is the first randomized trial to demonstrate that mothers' changes in a specific dietary behavior were predictive of the same changes in the child. This finding has promise for future interventions conducted with parents and children by suggesting that targeting other dietary or physical activity behaviors for change in parents could be an effective way to improve the weight-related behaviors of young children at an early age, thus reducing the risk of obesity.

Parental concern for child diet was found to decrease as a result of the intervention, and significantly mediated the effect of the intervention on the reduction in child SSBs. Parental concern was just one aspect of the social environment that was hypothesized to affect child SSB intake, and it is unclear why it was the only environmental factor to mediate the intervention effect. Cross-sectional research has shown that greater parental concern for eating habits is associated with higher weight (Johannsen et al., 2006), and previous intervention studies have shown that decreases in parental concern are associated with improvements in child weight status (Burrows et al., 2015; Daniels et al., 2012). Future research should explore the parental feeding behaviors that are associated with a decrease in concern within the intervention context in order to increase the understanding of why and how interventions should target parental concern as a mechanism for child behavior change.

The results of Study Three suggest that the intervention was not successful at impacting the other hypothesized intervention targets. It is unclear why this was the case, but it could be at least partially due to some substantial limitations in measurement. Firstly, there was no standardized measure of perceived barriers or self-regulation. Participants in the intervention group completed questions monthly about their barriers to change, and self-monitoring data throughout the 24 weeks is available as a proxy for self-regulation. However, these measures are not available in the control group and thus concrete analyses cannot be completed to determine the effect of the intervention on these two constructs. In addition, the measure of the physical home food environment did not include an assessment of the presence of SSBs other than 100% fruit juice in the home, which is a substantial omission given the focus of this study, as well as the significant epidemiological association of SSBs with child weight. The measure was chosen in order to use a previously developed, validated measure of the home food environment, however, with the disadvantage that it did not assess all relevant aspects of the environment. On the other hand, there were no validated scales to measure the SCT constructs specific to reducing children's' SSB intake, including maternal self-efficacy, outcome expectations and limit setting. The questions used in this study were adapted from previous studies, but unfortunately were not a part of validated scales. Thus, it is unclear whether relationships were not found between the intervention and potential mediators because of the failure of the intervention to change the intervention targets, or because of poor measurement.

A strength of the Smart Moms study is that it was able to recruit and retain a population of mothers of young children, and because of high adherence rates, was able to test the efficacy of the intervention on the change in child SSB intake. A related strength is that it targeted a single dietary behavior for change in both mothers and children, thus simplifying the goals of the program and potentially leading to greater success. Research shows that many parents are not concerned about the weight or diet of children under the age of 5 (Beck et al., 2013; Bolling et al., 2009), and it can be difficult to recruit parents for studies that focus only on the child, with no perceived benefit to the parent. Thus, while child SSB intake was the primary outcome of the Smart Moms study, a focus on maternal beverage reduction and weight loss was an integral part of the program because it kept mothers interested and engaged by helping them lose weight while also giving them the tools they needed to make healthy changes with their child.

Perhaps the most important strength of this dissertation study was the ability to use mobile technologies to reach and retain a study sample of mothers and their young children, and moreover, produce significant dietary and weight changes. The simplified self-monitoring in this study was received as feasible and effective by mothers. Instead of detailed monitoring of calories, mothers tracked only the number of servings of SSBs their child consumed, the number of servings of caloric beverages they consumed themselves, and only the number of red foods that they consumed each day. This method of tracking was much less precise in terms of measuring caloric intake, but showed that it could still be effective in producing dietary and weight changes. But given that the weight changes among mothers were modest, a future avenue of research could compare a treatment involving simplified self-monitoring versus more detailed self-monitoring, evaluating the feasibility, adherence, and effectiveness for parents and young children.

Implications for Research and Future Directions

The results of this dissertation contribute to the development and dissemination of interventions for parent and children in several ways. First, it demonstrates that parents may not be as successful at making behavior changes for weight loss in traditional behavioral weight loss interventions as adults without children, thus underscoring the need for more appropriate interventions for adults with children in the home. Next, it identifies theory-based intervention strategies delivered using mobile health methods that can effectively maximize adherence, retention, and sugar-sweetened beverage change success among mothers and their preschool-aged children. It also identifies significant theoretical and behavioral mediators of the effect of the intervention on changes in child SSB intake.

The Smart Moms study, due to its delivery primarily via mobile methods, holds promise for dissemination across a wide range of populations. Though it required one in-person group session and several in-person assessment visits, the program could be adapted to be delivered using only the internet and mobile technologies. The current study was limited in its technological abilities due to budgetary constraints, as much of the internet- and text message-related strategies had to be created and maintained manually. This is appropriate for an efficacy study where messages and algorithms are being developed. Since the intervention was successful in changing the primary target, future research should seek to develop more automated mobile methods that can be translated into sustainable, community-based programs.

The use of eHealth and mHealth interventions has increased in recent years, and these interventions would seem to be well suited to populations that have difficulty adhering to the standard face-to-face interventions, including parents of young children. But there are still relatively few studies using the internet and/or text messaging as modes of delivery to reduce weight or produce changes in weight-related behaviors among mothers of young children. Thus, intervention research should continue to explore how to use mobile methods to reach and intervene with parents in order to change parent and child behaviors. Moreover, the use of mHealth methods holds promise for intervening with populations that are more difficult to recruit and retain in studies. Low-income families are a population that could benefit most from simplified, mobile-based studies, but they are a population that is often hardest to recruit. Finding effective ways to recruit and retain low-income families in weight-related programs should be at the forefront of obesity intervention research going forward.

Though the current study demonstrates that a single child dietary behavior can be impacted by a relatively low-burden parent-targeted intervention, future research should explore if similar interventions can impact more than one child behavior, such as other dietary behaviors, physical activity, or sedentary behaviors that have a long-term impact on child weight. It will remain important to determine how to best intervene with mothers to balance the need for a program that fits into their busy schedules while providing enough contact and behavioral strategies to change additional dietary or physical activity behaviors in their children.

Relatedly, there is a need for better insight into how interventions lead to changes in the behavior of parents and young children. The current study had several limitations of measurement, including self-report measures of beverage intake and other measures, in addition to a significant lack of validated scales to measure mechanisms of change in the intervention.

Determining the behavioral intervention strategies that lead to change among parents and children is a key need in order to continue refining programs. To do so, it may help to continue creating validated measures that assess parental constructs for changing child behavior. The use of common, validated scales would allow for comparison across research studies, thus ensuring that the field of family-based intervention research is moves forward in finding the most effective intervention strategies.

Given that parents often have difficulty remaining in long-term programs (Barlow, Ohlemeyer, 2006), a finding that was confirmed by the higher dropout rate at 18 months in Study One of this dissertation, an important avenue for future research is to determine how to use mobile health methods to retain parents in studies of duration longer than 6 months. Little is known about the maintenance of child behavior changes after a short intervention, but the use of mobile programs holds promise for sustaining at least minimal treatment contact with parents and children for longer time periods. With the potential to create mHealth intervention components that are more automated, there is a possibility that participants could have continual access and prompting from studies through the use of smartphone applications, text messaging, or both.

Conclusion

The innovative studies in this dissertation have the potential to make a large impact in the study of family, maternal and child obesity. Given that parents of young children often have difficulty participating in traditional behavioral weight loss programs, and also given the mixed success of the extant interventions targeted at preschoolers and their families, this study informs a novel, innovative family-based approach to obesity prevention by targeting specific dietary behaviors and using technology to improve adherence and effectiveness. In addition, the results of the Smart Moms intervention suggests that targeting maternal behaviors for change is an effective manner by which to change child behaviors, thus improving the health of the family while also potentially preventing the onset of obesity in children.

APPENDIX I: ONLINE SCREENING SURVEY

Q1.1 Welcome to the Smart Moms screening questionnaire. These questions will take you approximately 10-15 minutes to complete. The survey will ask you about your demographic background, medical, and health history to determine your initial eligibility for the study. There are no physical risks to you completing this screening procedure and information given during this survey will be kept confidential. If you are found to be ineligible, the information will be kept on file until the end of the study. At that time your personal information will be removed and the responses to the questions will be kept for descriptive purposes. Once you complete the screener and submit your responses, a Smart Moms staff member will contact you by phone or by email. *If at any point during the survey you would like to stop and finish it later, your responses will be saved, but be sure to return to the questionnaire using the same device (computer, phone, etc.). If you cannot access your saved responses, please email smartmoms@unc.edu. Do you give your permission to continue with the online questionnaire and to be contacted by study staff if you are determined to be eligible for this study?

- ❍ Yes
- ❍ No

Q1.2 Do you have an email address?

- ❍ Yes, email me at: ____________________
- ❍ No (please enter phone number below) ____________________

Q1.3 How did you hear about this program?

- ❍ Email (please indicate who email was from) ______
- ❍ Website (please indicate what site)_____
- ❍ Flyer (please indicate where you saw flyer) _______
- ❍ Another participant in the program
- ❍ Other ____________________

Q1.4 What is your gender?

- ❍ Male
- ❍ Female

Q1.5 What is your date of birth?

mm/dd/yyyy

Q1.6 What is your current weight (in pounds)?

Q1.7 What is your height?

Feet

Inches

Q1.8 Do you consider yourself to be Hispanic or Latino? Select one.
- ❍ Hispanic or Latino
- ❍ Not Hispanic or Latino

Q1.9 What race do you consider yourself to be? Select one or more of the following:
- ❑ American Indian or Alaska Native
- ❑ Asian
- ❑ Black or African American
- ❑ Native Hawaiian or Other Pacific Islander
- ❑ White
- ❑ Other ____________________

Q1.10 Are you able to read and write in English?
- ❍ Yes
- ❍ No

Q1.11 How many children ages 2-5 do you have currently living in your home?
- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3 or more

Q1.12 What are the exact ages of your children ages 2-5, starting with the oldest down to the youngest?

	Years				Months										
	5	4	3	2	1	2	3	4	5	6	7	8	9	10	11
Child 1	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Child 2	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Child 3	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Child 4	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Child 5	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

Q1.13 Are you currently pregnant?
- ❍ Yes
- ❍ No

Q1.14 Are you planning to become pregnant in the next 6 months?
- ❍ Yes
- ❍ No

Q1.15 Have you ever been told by a doctor or other medical provider that you have any of the following conditions?

	Yes	No
Heart Attack	❍	❍
Stroke	❍	❍
Diabetes	❍	❍
Cancer	❍	❍
High Blood Pressure	❍	❍
High Triglycerides or High Cholesterol	❍	❍
Heart Disease	❍	❍
Bipolar Disorder	❍	❍
Schizophrenia	❍	❍
Substance or Alcohol Dependence	❍	❍

Q1.16 Is a doctor or health care provider currently treating you for any other physical or psychological reasons?
- ❍ Yes, please specify: ____________________
- ❍ No

Q1.17 Have you been hospitalized for any psychological reasons in the last year?
- ❍ Yes
- ❍ No

Q1.18 Do you use a computer to access the internet at home?
- ❍ Yes
- ❍ No

Q1.19 Do you have a cell phone?
- ❍ Yes
- ❍ No

Q1.20 What kind of cell phone do you have?
- ❍ Smartphone (with access to internet, email, and applications)
- ❍ Conventional cell phone
- ❍ Other (specify) ____________________

Q1.21 How often do you use your smartphone to access the internet or check your email?
- ❍ Several times a day
- ❍ About once each day
- ❍ Every few days
- ❍ About once per week
- ❍ Less than once per week
- ❍ Never

Q1.22 Do you use text messages?
- ❍ Yes
- ❍ No

Q1.23 What is your texting plan?
- ❍ Unlimited
- ❍ Limited number per month
- ❍ Pay per text

Q1.24 How many text messages do you send each week?
- ❍ None
- ❍ 1-25
- ❍ 26-50
- ❍ 51-100
- ❍ More than 100

Q1.25 How much do you like communicating using text messages?
- ❍ Not at all
- ❍ Very little
- ❍ Some
- ❍ A fair amount
- ❍ A lot

Q1.26 You will now be asked questions about the foods and drinks you typically consume. These include items prepared at home, in a restaurant or purchased from a store. Please answer honestly and to the best of your ability.

Q1.27 In the past month, how often did you eat at a fast food restaurant?
- ❍ Never or less than once per month
- ❍ 1-4 times per month
- ❍ 2-6 times per week
- ❍ 1 time per day
- ❍ 2 times per day
- ❍ 3 or more times per day

Q1.28 In the past month, how often did you consume fried foods? (For example: french fries, chips, donuts, fried fish or chicken, fried okra, etc.)
- ❍ Never or less than once per month
- ❍ 1-4 times per month
- ❍ 2-6 times per week
- ❍ 1 time per day
- ❍ 2 times per day
- ❍ 3 or more times per day

Q1.29 In the past month, how often did you consume sweets? (For example: candy, chocolate bars, pie, cake, cookies, ice cream, snack cakes, pastries, etc.)
- ❍ Never or less than once per month
- ❍ 1-4 times per month
- ❍ 2-6 times per week
- ❍ 1 time per day
- ❍ 2 times per day
- ❍ 3 or more times per day

For the following questions that will ask you how often you have drank each beverage, and how much you drank each time, use the following picture to estimate your serving sizes:

In the past month, please indicate your response for each beverage type by marking an "X" in the bubble for "how often" and "how much each time". Indicate how often you drank the following beverages, for example, if you drank 5 glasses of water per week, mark 4-6 times per week. Indicate the approximate amount of beverage you drank each time, for example, if you drank 1 cup of water each time, mark 1 cup under "how much each time".

Type of Beverage	HOW OFTEN (select one)							HOW MUCH EACH TIME (select one)				
	Never or less than 1 time per week	1 time per week	2-3 times per week	4-6 times per week	1 time per day	2+ times per day	3+ times per day	Less than 6 fl oz (3/4 cup)	8 fl oz (1 cup)	12 fl oz (1 ½ cup)	16 fl oz (2 cups)	More than 20 oz (2 ½ cups)
1. Water												
2. 100% Fruit Juice												
3. Sweetened Juice Beverage/Drink (fruit drinks, lemonade, punch, Sunny Delight)												
4. Whole Milk												
5. Reduced Fat Milk (2%)												
6. Low Fat/Fat Free Milk (Skim, 1%, Buttermilk, soymilk)												
7. Soft drinks, regular												
8. Diet soft drinks/Artificially sweetened drinks (Crystal Light)												
9. Sweetened Tea												
10. Tea or Coffee,												

with cream and/or sugar (includes non-dairy creamer)												
11. Tea or coffee, black, with/without artificial sweetener												
12. Beer, ales, wine coolers, or light beer												
13. Non-alcoholic beer												
14. Hard liquor (shots, rum, tequila, etc.)												
15. Mixed alcoholic drinks (daiquiris, margaritas, etc.)												
16. Wine (red or white)												
17. Sports and energy drinks (Gatorade, Powerade, Red Bull, Rockstar, etc.)												

Q3.1 Now think about your child who is ${q://QID282%231/ChoiceGroup/SelectedAnswers/1} years old. You will now be asked questions about the foods and drinks that they typically consume. These include items prepared at home, in a restaurant or purchased from a store.

Q3.2 In the past month, how often did your child eat at a fast food restaurant?
- Never or less than once per month (1)
- 1-4 times per month (2)
- 2-6 times per week (3)
- 1 time per day (4)
- 2 times per day (5)
- 3 or more times per day (6)

Q3.3 In the past month, how often did your child consume fried foods? (For example: french fries, chips, donuts, fried fish or chicken, fried okra, etc.)
- Never or less than once per month (1)
- 1-4 times per month (2)
- 2-6 times per week (3)
- 1 time per day (4)
- 2 times per day (5)
- 3 or more times per day (6)

Q3.4 In the past month, how often did your child consume sweets? (For example, candy, chocolate bars, pie, cake, cookies, ice cream, snack cakes, pastries, etc.)
- Never or less than once per month (1)
- 1-4 times per month (2)
- 2-6 times per week (3)
- 1 time per day (4)
- 2 times per day (5)
- 3 or more times per day (6)

For the following questions that will ask you how often your child drank each beverage, and how much your child drank each time, use the following picture to estimate their serving sizes:

In the past month, please indicate your response for each beverage type by marking an "X" in the bubble for "how often" and "how much each time". Indicate how often your child drank the following beverages, for example, if your child drank 5 glasses of water per week, mark 4-6 times per week. Indicate the approximate amount of beverage your child drank each time, for example, if your child drank 1 cup of water each time, mark 1 cup under "how much each time".

	HOW OFTEN (select one)							**HOW MUCH EACH TIME (select one)**				
Type of Beverage	Never or less than 1 time per week	1 time per week	2-3 times per week	4-6 times per week	1 time per day	2+ times per day	3+ times per day	Less than 6 fl oz (3/4 cup)	8 fl oz (1 cup)	12 fl oz (1 ½ cup)	16 fl oz (2 cups)	More than 20 oz (2 ½ cups)
1. Water												
2. 100% Fruit Juice												
3. Sweetened Juice Beverage/Drink (fruit drinks, lemonade, punch, Sunny Delight)												
4. Whole Milk												
5. Reduced Fat Milk (2%)												
6. Low Fat/Fat Free Milk (Skim, 1%, Buttermilk, soymilk)												
7. Soft drinks, regular												
8. Diet soft drinks/Artificially sweetened drinks												

(Crystal Light)												
9. Sweetened Tea												
10. Sports and energy drinks (Gatorade, Powerade, Red Bull, Rockstar, etc.)												

Q2.1 How willing would you be to make small changes to your diet for a minimum of 6 months in order to help you lose weight?
❍ Not willing at all
❍ Slightly willing
❍ Pretty willing
❍ Extremely willing

Q2.2 How willing would you be to make small changes to your physical activity for a minimum of 6 months in order to help you lose weight?
❍ Not willing at all
❍ Slightly willing
❍ Pretty willing
❍ Extremely willing

Q2.3 How willing would you be to give up or change certain foods that you currently eat for at least 6 months?
❍ Not willing at all
❍ Slightly willing
❍ Pretty willing
❍ Extremely willing

Q2.4 How willing would you be to give up or change certain beverages that you currently drink for at least 6 months?
❍ Not willing at all
❍ Slightly willing
❍ Pretty willing
❍ Extremely willing

Q2.5 Will you be available to attend 1 group session and 3 assessment visits that last approximately 1 hour to 1 hour and 15 minutes at the UNC Weight Research Program in Chapel Hill, NC?

- ❍ Yes
- ❍ No

Q2.6 Thank you for completing these questions. In order to complete your eligibility screening, a study staff member will need to contact you by phone. Please enter your contact information below.

Q2.7 Contact Information:

First name
Last name
Home phone
Work phone
Cell phone
Home address
Home address 2
City
State
Zip code

Q2.8 What is the best time to reach you Monday-Friday?

Q2.9 What phone number should we use to contact you during that time? Check all that apply.

- ❑ Home phone
- ❑ Work phone
- ❑ Cell phone

APPENDIX II: LIFESTYLE QUESTIONNAIRE

Welcome to the baseline questionnaire for the Smart Moms study. This questionnaire will take you between 30 and 45 minutes to complete. You do not need to complete this survey all at one time. Your answers are saved each time you move to a new page. You can always return to where you left off by clicking on the link in the email sent to you. If you are uncomfortable answering any of the questions, feel free to move to the next one. Please answer honestly and to the best of your ability. We appreciate your time and participation. If you have any questions or encounter any problems, please email smartmoms@unc.edu.

Q1 What is the highest grade in school you finished?
- ○ Did not complete high school (1)
- ○ Graduated high school (2)
- ○ Technical school or vocational training (beyond high school) (3)
- ○ Some college (less than 4 years) or associate degree (4)
- ○ College/university degree (5)
- ○ Graduate school or professional education (6)

Q2 What is the total income of your household? Include all sources of income like your (and your partner's) wages or salary, child support, and government assistance.
- ○ Less than $10,000 (1)
- ○ $10,000 or more, but less than $20,000 (2)
- ○ $20,000 or more, but less than $30,000 (3)
- ○ $30,000 or more, but less than $40,000 (4)
- ○ $40,000 or more, but less than $50,000 (5)
- ○ $50,000 or more, but less than $75,000 (6)
- ○ $75,000 or more, but less than $100,000 (7)
- ○ $100,000 or more (8)
- ○ Prefer not to answer (9)

Q3 Are you currently: (Please check all that apply)
- ☐ Working full-time (1)
- ☐ Working part-time (2)
- ☐ A full-time student (3)
- ☐ A part-time student (4)
- ☐ Retired (5)
- ☐ Not working (6)
- ☐ Looking for work (7)

Q4 Marital Status:
- ❍ Married (1)
- ❍ Separated (2)
- ❍ Divorced (3)
- ❍ Widowed (4)
- ❍ Single (5)
- ❍ Living with partner (6)

Q5 What type of internet connection do you have at home?
- ❍ Modem (dial-up access over normal telephone line) (1)
- ❍ DSL (2)
- ❍ Cable (3)
- ❍ Satellite (4)
- ❍ Public wi-fi (5)
- ❍ Mobile (USB key, laptop card) (6)

Q6 Where do you access your email? (Check all that apply)
- ❑ Home (1)
- ❑ Work (2)
- ❑ Public computer (e.g., library, community center) (3)
- ❑ Cell phone (4)
- ❑ Other (specify): (5) ____________________

Q7 How frequently do you check your email?
- ❍ Several times a day (1)
- ❍ About once a day (2)
- ❍ Every few days (3)
- ❍ About once per week (4)
- ❍ Less than once per week (5)

Q8 On average, how many hours per week do you spend using the internet for things other than email (e.g., going to different websites for information or entertainment, shopping)?

Q9 How would you rate your current internet or web skills?
- ❍ Very poor (1)
- ❍ Poor (2)
- ❍ Fair (3)
- ❍ Good (4)
- ❍ Very Good (5)

Q10 How many children ages 0-18 are currently living in your home?
- ❍ 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 or more (6)

Q11 Please indicate the age and weight status of the children you live with below.

	Underweight (1)	Normal Weight (2)	Overweight (3)	Obese (4)
Child #1 (Enter Age) (1)	❍	❍	❍	❍
Child #2 (Enter Age) (2)	❍	❍	❍	❍
Child #3 (Enter Age) (3)	❍	❍	❍	❍
Child #4 (Enter Age) (4)	❍	❍	❍	❍
Child #5 (Enter Age) (5)	❍	❍	❍	❍

Q12 Do you live with a romantic partner or spouse?
- ❍ Yes (1)
- ❍ No (2)

Q13 Please indicate their weight status.
- ❍ Underweight (1)
- ❍ Normal weight (2)
- ❍ Overweight (3)
- ❍ Obese (4)

Q14 Do you live with any other family members?
- ❍ Yes (1)
- ❍ No (2)

Q15 Please indicate your relationship to other family members you live with and their weight status.

	Underweight (1)	Normal Weight (2)	Overweight (3)	Obese (4)
Relationship: (1)	❍	❍	❍	❍
Relationship: (2)	❍	❍	❍	❍
Relationship: (3)	❍	❍	❍	❍

Q16 Currently, how often do you weigh yourself? (Check the answer that best applies).
- ❍ Several times a day (1)
- ❍ One time a day (2)
- ❍ Several times per week (3)
- ❍ One time per week (4)
- ❍ Less than one time per week (5)
- ❍ Less than one time per month (6)
- ❍ I never weigh myself (7)

Q17 Have you ever tried to lose weight in the past (i.e., purposefully or intentionally lost weight)?
- ❍ Yes (1)
- ❍ No (2)

Q18 What have you done to try and lose weight? (check all that apply)
- ❑ Commercial program (e.g., Weight Watchers / Jenny Craig / NutriSystem) (1)
- ❑ Support Group (e.g., Overeaters Anonymous / TOPS) (2)
- ❑ Individual counseling with a nutritionist, physician, or psychologist (3)
- ❑ Structured exercise program (e.g., classes or trainer) (4)
- ❑ Weight loss surgery. If yes, enter type: (ex: liposuction, gastric bypass, gastric banding, etc) (5) ____________________
- ❑ Medication (e.g., prescription or over-the-counter) (6)
- ❑ Followed a diet from a book (e.g., Atkins, Zone) (7)
- ❑ Used my own approach without following any published diet (e.g., decreased calories) (8)
- ❑ Tried to lose weight with a friend or family member (9)
- ❑ Used an Internet weight loss site (10)

Q19 Over the past 6 months, have you gained weight, lost weight, or stayed about the same weight?
- ❍ Gained weight (specify amount in pounds): (1) ____________________
- ❍ Lost weight (specify amount in pounds): (2) ____________________
- ❍ Stayed about the same weight (3)

Q20 On a scale of 1-10, how confident are you that you will be able to make changes in your diet to lose weight?

- ❍ 1 - Not at all confident (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 (7)
- ❍ 8 (8)
- ❍ 9 (9)
- ❍ 10 - Very Confident (10)

Q21 On a scale of 1-10, how confident are you that you will be able to make changes in your physical activity to lose weight?

- ❍ 1 - Not at all confident (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 (7)
- ❍ 8 (8)
- ❍ 9 (9)
- ❍ 10 - Very confident (10)

Please answer the next set of questions about your child who is participating in the Smart Moms study.

Q22 What is your child's date of birth? (Enter as mm/dd/yyyy).

Q23 Is your child taking any daily medications for attention or hyperactivity problems?

- ❍ Yes (1)
- ❍ No (2)

Q24 Please indicate if your child is at any of the following places on any or all weekdays (check all that apply):

- ❑ Kindergarten (1)
- ❑ Daycare (2)
- ❑ Preschool (3)
- ❑ Taken care of by family member or friend (4)
- ❑ None of the above (5)

APPENDIX III: MEASURES OF SELF-EFFICACY, OUTCOME EXPECTATIONS, AND LIMIT SETTING

Please tell me how confident you are that you can do the following things:

	Not confident (1)	Somewhat confident (2)	Very confident (3)	Extremely confident (4)
Limit child’s television viewing. (1)	❍	❍	❍	❍
Remove the television from your child’s bedroom. (2)	❍	❍	❍	❍
Reduce your child’s intake of soda, juice, or other sweetened drinks. (3)	❍	❍	❍	❍
Reduce your child’s intake of fast food. (4)	❍	❍	❍	❍
Change family’s eating patterns to keep your child from being overweight. (5)	❍	❍	❍	❍
Change family’s activity patterns to keep your child from being overweight. (6)	❍	❍	❍	❍
Keep your home free of all soda and sweetened drinks (not including fruit juice). (7)	❍	❍	❍	❍
Master the skills necessary to limit your child’s consumption of	❍	❍	❍	❍

juice and sweetened drinks. (8)				
Continue to influence your child's consumption of juice and sweetened drinks as he or she gets older. (9)	❍	❍	❍	❍

Please rate how strongly you agree with the following statements:

	1 - Very strongly disagree (1)	2 (2)	3 (3)	4 - Do not agree or disagree (4)	5 (5)	6 (6)	7 - Very strongly agree (7)
Watching TV (including movies and programs on a tablet/smartphone) for more than 2 hours per day will increase my child's risk of becoming overweight. (1)	❍	❍	❍	❍	❍	❍	❍
100% fruit juice is good for my child. (2)	❍	❍	❍	❍	❍	❍	❍
If my child drinks more than 6 ounces per day of 100% fruit juice it will increase his/her risk of becoming overweight. (3)	❍	❍	❍	❍	❍	❍	❍

Thinking of your child's TV and dietary behaviors in the last month, please rate how strongly you agree with the following statements:

	1 - Very strongly disagree (1)	2 (2)	3 (3)	4 - Do not agree or disagree (4)	5 (5)	6 (6)	7 - Very strongly agree (7)
I have to be sure that my child does not watch too much TV (including movies and programs on a tablet/smartphone). (1)	❍	❍	❍	❍	❍	❍	❍
I have turned off the TV (including movies and programs on a tablet/smartphone) if I think my child is watching too much. (2)	❍	❍	❍	❍	❍	❍	❍
I have let my child watch TV/ movies (including movies and programs on a tablet/ smartphone) in exchange for good behavior. (3)	❍	❍	❍	❍	❍	❍	❍
I have limited how much time my child spent watching TV (including movies and programs on a tablet/ smartphone). (4)	❍	❍	❍	❍	❍	❍	❍
I have not allowed the TV to be on during mealtimes. (5)	❍	❍	❍	❍	❍	❍	❍
I have I let my child have fruit	❍	❍	❍	❍	❍	❍	❍

juice, fruit drinks or sodas in exchange for good behavior. (6)							
I limited the amount of fast food my child consumed. (7)	❍	❍	❍	❍	❍	❍	❍
I limited how many servings of 100% fruit juice my child consumed. (8)	❍	❍	❍	❍	❍	❍	❍
I limited how many servings of other sweetened beverages (fruit drinks, sport drinks, or sodas) my child consumed. (9)	❍	❍	❍	❍	❍	❍	❍

APPENDIX IV: MEALS IN OUR HOUSEHOLD MEASURE

Mealtimes are different for different families. We are interested in what meals are like in your household. For each of the following items, please choose how often the statement describes mealtimes with your child and/or in your household.

	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	Always or Almost Always (5)
My child eats meals with myself or other family members (1)	❍	❍	❍	❍	❍
The television is on in the same room when my child is eating meals. (2)	❍	❍	❍	❍	❍
Our family eats an evening meal at a regular time. (3)	❍	❍	❍	❍	❍
Meals in our household are rushed. (4)	❍	❍	❍	❍	❍
We eat meals in the kitchen or dining room. (5)	❍	❍	❍	❍	❍
We eat meals in the car. (6)	❍	❍	❍	❍	❍
Everyone in our household eats something different at meals. (7)	❍	❍	❍	❍	❍
At meals, my child eats the same food as	❍	❍	❍	❍	❍

everyone else. (8)					
Someone in our household cooks meals. (9)	❍	❍	❍	❍	❍
We say grace or have a ritual at the start of meals. (10)	❍	❍	❍	❍	❍

Children's behavior at mealtimes can be an issue for parents and in families. Sometimes children behave well at meals and sometimes they could behave better. Parents also have different expectations for children's behavior at meals. For each of the following statements, please choose how often the statement describes your child's behavior during the past 3 months, and for each statement choose how much of a problem that aspect of your child's behavior is for you. Please note that a behavior that occurs often may be a large problem in one family and may be not a problem or a small problem in another family. Likewise, a behavior that occurs rarely may be a large problem or may be not a problem.

	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	Very Often (5)
My child refuses to come when it is time to eat. (1)	❍	❍	❍	❍	❍
My child has tantrums or acts out during meals. (2)	❍	❍	❍	❍	❍
My child complains about what is served. (3)	❍	❍	❍	❍	❍
I argue with my child about what he/she eats. (4)	❍	❍	❍	❍	❍
My child seeks a lot of attention during meals. (5)	❍	❍	❍	❍	❍
My child does not stay seated during meals. (6)	❍	❍	❍	❍	❍
My child squirms or fidgets while eating. (7)	❍	❍	❍	❍	❍
My child has	❍	❍	❍	❍	❍

poor table manners. (8)					
My child overstuffs his/her mouth with food. (9)	❍	❍	❍	❍	❍
My child refuses to eat what is served. (10)	❍	❍	❍	❍	❍

Parents use many ways to reward and encourage children. For each of the following, please tell us, by checking one box per row, how often the statement describes you and/or your child.

	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	Always or Almost Always (5)
I give my child food to keep him/her quiet when shopping or traveling. (1)	❍	❍	❍	❍	❍
I give my child food to reward him/her for good behavior. (2)	❍	❍	❍	❍	❍
I withhold a food my child likes as a consequence for bad behavior. (3)	❍	❍	❍	❍	❍
My child expects to be given a favorite food as a reward. (4)	❍	❍	❍	❍	❍
I give my child a special food to celebrate an achievement. (5)	❍	❍	❍	❍	❍
I give my child food to persuade him/her to do something he/she does not really want to do.	❍	❍	❍	❍	❍

(6) My child's food preferences influence what I, myself, eat. (7)	❍	❍	❍	❍	❍

Some parents have concerns about what their child eats and other parents have few or no concerns about what their child eats. For each of the following, please rate how concerned you are.

	Not at all concerned (1)	A little concerned (2)	Somewhat concerned (3)	Quite concerned (4)	Very concerned (5)	Extremely concerned (6)
Child is not eating enough. (1)	❍	❍	❍	❍	❍	❍
Child is eating too much. (2)	❍	❍	❍	❍	❍	❍
Child eats a lot of junk food. (3)	❍	❍	❍	❍	❍	❍
Child eats only a few types of food. (4)	❍	❍	❍	❍	❍	❍
Child is not getting good nutrition. (5)	❍	❍	❍	❍	❍	❍
Child has poor eating habits. (6)	❍	❍	❍	❍	❍	❍
Child will not try new foods. (7)	❍	❍	❍	❍	❍	❍
Child is not flexible about what he/she eats. (8)	❍	❍	❍	❍	❍	❍
Child has food allergies or intolerances. (9)	❍	❍	❍	❍	❍	❍
Child will eat foods I don't want him/her to.	❍	❍	❍	❍	❍	❍

(10)						
Child eats too much fat. (11)	❍	❍	❍	❍	❍	❍
Child eats too much sugar. (12)	❍	❍	❍	❍	❍	❍
Child does not eat breakfast. (13)	❍	❍	❍	❍	❍	❍
Child does not eat vegetables. (14)	❍	❍	❍	❍	❍	❍
Child does not eat fruits. (15)	❍	❍	❍	❍	❍	❍
Child does not drink milk. (16)	❍	❍	❍	❍	❍	❍
Child does not eat meat. (17)	❍	❍	❍	❍	❍	❍

If you have a spouse or partner who lives with you, please tell us how much you agree or disagree with the following statements.

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
My child's behavior at meals bothers my spouse/partner. (1)	❍	❍	❍	❍	❍
My spouse/partner does not enjoy eating with my child. (2)	❍	❍	❍	❍	❍
My child's mealtime behavior is a source of stress in my relationship with my spouse/partner. (3)	❍	❍	❍	❍	❍
My spouse/partner and I have different expectations about my child's mealtime behavior. (4)	❍	❍	❍	❍	❍
My child's food preferences influence what my spouse/partner eats. (5)	❍	❍	❍	❍	❍
My child's food preferences	❍	❍	❍	❍	❍

influence what other children in our household eat. (6)					

APPENDIX V: HOME FOOD ENVIRONMENT MEASURE

We are interested in knowing about the foods you may or may not have had in your home this past week. Please read each food listed, paying attention to whether it is the regular or low-fat variety. Please check the box beside any food that you had in your home this past week.

- Regular bacon or sausage (1)
- Reduced fat bacon or sausage (2)
- Regular yogurt (3)
    - Low-fat yogurt (4)
- Margarine (5)
- Reduced fat margarine (6)
- Mayonnaise (7)
- Reduced fat mayonnaise (8)
- Whole milk (9)
- 2% milk (10)
- 1% milk (11)
- Skim milk (12)
- Salad Dressing (13)
- Reduced fat salad dressing (14)
- Pudding (15)
- Reduced fat pudding (16)
- Cookies or cakes (17)
- Low-fat cookies or cakes (18)
- Chips (19)
- Reduced fat chips (20)
- Ice cream (21)
- Low-fat ice cream (22)
- Granola bars (23)
- Low-fat granola bars (24)
- TV dinners (25)
- Reduced fat TV dinners (26)
- Cheese (27)
- Low-fat cheese (28)
- Hot dogs (29)
- Reduced fat hot dogs (30)
- Donuts (31)
- Pretzels (32)
- 100% orange juice (33)
- 100% apple juice (34)
- 100% grape juice (35)
- Other 100% juice (36)
- Apples (37)
- Bananas (38)
- Cantaloupe or musk melon (39)
- Grapes (40)
- Oranges (41)
- Pears (42)
- Plums (43)
- Kiwi (44)
- Strawberries (45)
- Pineapple (46)
- Grapefruit (47)
- Fruit salad or fruit cocktail (48)
- Applesauce (49)
- Watermelon (50)
- Raisins (51)
- Dried fruit (52)
- Peaches (53)
- Carrots (54)
- Celery (55)
- Greens (56)
- Spinach (57)
- French fried potatoes (58)
- Potato salad (59)
- Other white potatoes (60)
- Corn (61)
- Green peas (62)
- Tomatoes (63)
- Broccoli (64)
- Lettuce (65)
- Green beans (66)
- Cole slaw (67)
- Cooked beans (pinto, black eyed peas, pork ‘n’ beans) (68)
- Sweet potatoes (69)
- Cabbage (70)
- Okra (71)

REFERENCES

Abraham, C., & Michie, S. (2008). A taxonomy of behavior change techniques used in interventions. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association, 27*(3), 379-387. doi:10.1037/0278-6133.27.3.379; 10.1037/0278-6133.27.3.379

Adamo, K. K. B. (2012). Young Children and Parental Physical Activity Levels. *American Journal of Preventive Medicine, 43*(2), 168-175. doi:10.1016/j.amepre.2012.02.032 pmid:

Aeberli, I., Gerber, P. A., Hochuli, M., Kohler, S., Haile, S. R., Gouni-Berthold, I., . . . Berneis, K. (2011). Low to moderate sugar-sweetened beverage consumption impairs glucose and lipid metabolism and promotes inflammation in healthy young men: a randomized controlled trial. *The American Journal of Clinical Nutrition, 94*(2), 479-485. doi:10.3945/ajcn.111.013540; 10.3945/ajcn.111.013540

Al Mamun, A., Cramb, S. M., O'Callaghan, M. J., Williams, G. M., & Najman, J. M. (2009). Childhood overweight status predicts diabetes at age 21 years: a follow-up study. *Obesity (Silver Spring, Md.), 17*(6), 1255-1261. doi:10.1038/oby.2008.660; 10.1038/oby.2008.660

Albright, C., Maddock, J. E., & Nigg, C. R. (2005). Physical activity before pregnancy and following childbirth in a multiethnic sample of healthy women in Hawaii. *Women & health, 42*(3), 95-110.

Anderson, S. E., Must, A., Curtin, C., & Bandini, L. G. (2012). Meals in Our Household: reliability and initial validation of a questionnaire to assess child mealtime behaviors and family mealtime environments. *J Acad Nutr Diet, 112*(2), 276-284.

Annesi, J. J., Smith, A. E., & Tennant, G. A. (2013). Effects of the Start For Life treatment on physical activity in primarily African American preschool children of ages 3-5 years. *Psychology, Health & Medicine, 18*(3), 300-309. doi:10.1080/13548506.2012.712704; 10.1080/13548506.2012.712704

Assessment, N. C. C. H., & Monitoring, P. (2013). *Children's physical activity and nutrition: North Carolina 2011*. Retrieved from

Baker, J. L., Olsen, L. W., & Sorensen, T. I. (2007). Childhood body-mass index and the risk of coronary heart disease in adulthood. *The New England journal of medicine, 357*(23), 2329-2337. doi:10.1056/NEJMoa072515

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychology Review, 84*(2), 191-215. doi:10.1016/0146-6402(78)90002-4

Bandura, A. (1997). *Self-efficacy: The efficacy of control*. New York: W. H. Freeman and Company.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior, 31*(2), 143-164. doi:10.1177/1090198104263660

Barlow, S. E., & Committee, E. (2007). Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics, 120 Suppl 4*, S164-192. doi:10.1542/peds.2007-2329C

Bayer, O., von Kries, R., Strauss, A., Mitschek, C., Toschke, A. M., Hose, A., & Koletzko, B. V. (2009). Short- and mid-term effects of a setting based prevention program to reduce obesity risk factors in children: a cluster-randomized trial. *Clinical nutrition (Edinburgh, Scotland), 28*(2), 122-128. doi:10.1016/j.clnu.2009.01.001; 10.1016/j.clnu.2009.01.001

Beck, A. L., Takayama, J. I., Halpern-Felsher, B., Badiner, N., & C Barker, J. (2013). Understanding How Latino Parents Choose Beverages to Serve to Infants and Toddlers. *Maternal and child health journal*. doi:10.1007/s10995-013-1364-0

Beech, B. M., Klesges, R. C., Kumanyika, S. K., Murray, D. M., Klesges, L., McClanahan, B., . . . Pree-Cary, J. (2003). Child- and parent-targeted interventions: the Memphis GEMS pilot study. *Ethn Dis, 13*(1 Suppl 1), S40-53.

Bell, S., & Lee, C. (2005). Emerging adulthood and patterns of physical activity among young Australian women. *Int J Behav Med, 12*(4), 227-235. doi:10.1207/s15327558ijbm1204_3

Bellows-Riecken, K. H., & Rhodes, R. E. (2008). A birth of inactivity? A review of physical activity and parenthood. *Preventive medicine, 46*(2), 99-110. doi:10.1016/j.ypmed.2007.08.003

Berge, J. M. (2009). A review of familial correlates of child and adolescent obesity: what has the 21st century taught us so far? *Int J Adolesc Med Health, 21*(4), 457-483.

Berge, J. M., Larson, N., Bauer, K. W., & Neumark-Sztainer, D. (2011). Are parents of young children practicing healthy nutrition and physical activity behaviors? *Pediatrics, 127*(5), 881-887. doi:10.1542/peds.2010-3218

Birch, L. L. (1992). Children's preferences for high-fat foods. *Nutr Rev, 50*(9), 249-255.

Birch, L. L., & Davison, K. K. (2001). Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Pediatric clinics of North America, 48*(4), 893-907.

Black, D. R., Coe, W. C., Friesen, J. G., & Wurzmann, A. G. (1984). Minimal interventions for weight control: a cost-effective alternative. *Addictive Behaviors, 9*(3), 279-285.

Bolling, C., Crosby, L., Boles, R., & Stark, L. (2009). How pediatricians can improve diet and activity for overweight preschoolers: a qualitative study of parental attitudes. *Academic pediatrics, 9*(3), 172-178. doi:10.1016/j.acap.2009.01.010

Boutelle, K. N., Cafri, G., & Crow, S. J. (2012). Parent predictors of child weight change in family based behavioral obesity treatment. *Obesity (Silver Spring, Md.), 20*(7), 1539-1543. doi:10.1038/oby.2012.48; 10.1038/oby.2012.48

Boutelle, K. N., Jeffery, R. W., & French, S. A. (2004). Predictors of vigorous exercise adoption and maintenance over four years in a community sample. *Int J Behav Nutr Phys Act, 1*(1), 13. doi:10.1186/1479-5868-1-13

Brown, P. R., Brown, W. J., Miller, Y. D., & Hansen, V. (2001a). Perceived Constraints and Social Support for Active Leisure Among Mothers With Young Children. *Leisure sciences, 23*(3), 131-144. doi:10.1080/014904001316896837

Brown, P. R., Brown, W. J., Miller, Y. D., & Hansen, V. (2001b). Perceived Constraints and Social Support for Active Leisure Among Mothers With Young Children. *Leisure sciences, 23*(3), 131; 131-144; 144. doi:10.1080/014904001316896837 pmid:

Brown, W. J., & Trost, S. G. (2003). Life transitions and changing physical activity patterns in young women. *Am J Prev Med, 25*(2), 140-143.

Burke, V., Beilin, L. J., & Dunbar, D. (2001). Family lifestyle and parental body mass index as predictors of body mass index in Australian children: a longitudinal study. *International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity, 25*(2), 147-157. doi:10.1038/sj.ijo.0801538

Burke, V., Beilin, L. J., Dunbar, D., & Kevan, M. (2004). Changes in health-related behaviours and cardiovascular risk factors in young adults: associations with living with a partner. *Preventive medicine, 39*(4), 722-730. doi:10.1016/j.ypmed.2004.02.038

Burrows, T., Hutchesson, M., Kheng Chai, L., Rollo, M., Skinner, G., & Collins, C. (2015). Nutrition Interventions for Prevention and Management of Childhood Obesity: What Do Parents Want from an eHealth Program? *Nutrients, 7*(12), 10469-10479. doi:10.3390/nu7125546

Burrows, T., Warren, J. M., & Collins, C. E. (2010). The impact of a child obesity treatment intervention on parent child-feeding practices. doi:395887

Burton, N. W., & Turrell, G. (2000). Occupation, hours worked, and leisure-time physical activity. *Prev Med, 31*(6), 673-681. doi:10.1006/pmed.2000.0763

Butryn, M. L., Phelan, S., Hill, J. O., & Wing, R. R. (2007). Consistent self-monitoring of weight: a key component of successful weight loss maintenance. *Obesity (Silver Spring, Md.), 15*(12), 3091-3096. doi:10.1038/oby.2007.368; 10.1038/oby.2007.368

Calle, E. E. (2003). Overweight, Obesity, and Mortality from Cancer in a Prospectively Studied Cohort of U.S. Adults. *The New England journal of medicine, 348*(17), 1625; 1625-1638; 1638. doi:10.1056/NEJMoa021423 pmid:

Campbell, K., Hesketh, K., Silverii, A., & Abbott, G. (2010). Maternal self-efficacy regarding children's eating and sedentary behaviours in the early years: associations with children's food intake and sedentary behaviours. *International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 5*(6), 501-508. doi:10.3109/17477161003777425; 10.3109/17477161003777425

Candelaria, J. I., Sallis, J. F., Conway, T. L., Saelens, B. E., Frank, L. D., & Slymen, D. J. (2012). Differences in physical activity among adults in households with and without children. *Journal of physical activity & health, 9*(7), 985-995.

CDC (2010). [Obesity among low-income preschool children]. Web Page.

CDC. (2015). *Early release of selected estimates based on data from the 2014 National Health Interview Survey, 2014*. Retrieved from http://www.cdc.gov/nchs/data/nhis/earlyrelease/earlyrelease201506_07.pdf

Chen, L., Appel, L. J., Loria, C., Lin, P. H., Champagne, C. M., Elmer, P. J., . . . Caballero, B. (2009). Reduction in consumption of sugar-sweetened beverages is associated with weight loss: the PREMIER trial. *The American Journal of Clinical Nutrition, 89*(5), 1299-1306. doi:10.3945/ajcn.2008.27240; 10.3945/ajcn.2008.27240

Cole, T. J., Faith, M. S., Pietrobelli, A., & Heo, H. (2005). What is the best measure of adiposity change in growing children: BMI, BMI %, BMI z-score or BMI centile? *European Journal of Clinical Nutrition, 59*, 419-425.

Committee on, N. (2001). American Academy of Pediatrics: The use and misuse of fruit juice in pediatrics. *Pediatrics, 107*(5), 1210-1213.

Cramp, A. G., & Brawley, L. R. (2006). Moms in motion: a group-mediated cognitive-behavioral physical activity intervention. *The international journal of behavioral nutrition and physical activity, 3*, 23. doi:10.1186/1479-5868-3-23

Cullen, K. W., Klesges, L. M., Sherwood, N. E., Baranowski, T., Beech, B., Pratt, C., . . . Rochon, J. (2004). Measurement characteristics of diet-related psychosocial questionnaires among African-American parents and their 8- to 10-year-old daughters: results from the Girls' health Enrichment Multi-site Studies. *Prev Med, 38 Suppl*, S34-42. doi:10.1016/j.ypmed.2003.05.002

Daniels, L. A., K.M., M., Battistutta, D., Nicholson, J. M., Perry, R., & Magarey, A. (2012). Evaluation of an intervention to promote protective infant feeding practices to prevent childhood obesity: outcomes of the NOURISH RCT at 14 months of age and 6 months post the first of two intervention modules. *International journal of obesity, 36*(10), 1292-1298. doi:doi:10.1038/ijo.2012.96

Davison, K. K., & Birch, L. L. (2001). Childhood overweight: a contextual model and recommendations for future research. *Obesity reviews : an official journal of the International Association for the Study of Obesity, 2*(3), 159-171.

Davison, K. K., Jurkowski, J. M., Li, K., Kranz, S., & Lawson, H. A. (2013). A childhood obesity intervention developed by families for families: results from a pilot study. *The international journal of behavioral nutrition and physical activity, 10*, 3-5868-5810-5863. doi:10.1186/1479-5868-10-3; 10.1186/1479-5868-10-3

de Ruyter, J. C., Olthof, M. R., Seidell, J. C., & Katan, M. B. (2012). A Trial of Sugar-free or Sugar-Sweetened Beverages and Body Weight in Children. *N Engl J Med, 367*(15), 1397-1406. doi:10.1056/NEJMoa1203034; M3: doi: 10.1056/NEJMoa1203034; 15 10.1056/NEJMoa1203034

DeBoer, M. D., Scharf, R. J., & Demmer, R. T. (2013). Sugar-sweetened beverages and weight gain in 2- to 5-year-old children. *Pediatrics, 132*(3), 413-420. doi:10.1542/peds.2013-0570

Dhingra, R., Sullivan, L., Jacques, P. F., Wang, T. J., Fox, C. S., Meigs, J. B., . . . Vasan, R. S. (2007). Soft drink consumption and risk of developing cardiometabolic risk factors and the metabolic syndrome in middle-aged adults in the community. *Circulation, 116*(5), 480-488. doi:10.1161/CIRCULATIONAHA.107.689935

Dietz, W. H., & Robinson, T. N. (2005). Clinical practice. Overweight children and adolescents. *The New England journal of medicine, 352*(20), 2100-2109. doi:10.1056/NEJMcp043052

Donnelly, J. E., Blair, S. N., Jakicic, J. M., Manore, M. M., Rankin, J. W., & Smith, B. K. (2009). American College of Sports Medicine Position Stand. Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. *Med Sci Sports Exerc, 41*(2), 459-471. doi:10.1249/MSS.0b013e3181949333

Duffey, K. J., & Popkin, B. M. (2007). Shifts in patterns and consumption of beverages between 1965 and 2002. *Obesity (Silver Spring, Md.), 15*(11), 2739-2747. doi:10.1038/oby.2007.326

Duggan, M., & Smith, A. (2013). *Cell internet use 2013*. Retrieved from Washington, D.C.:

Ebbeling, C. B., Feldman, H. A., Chomitz, V. R., Antonelli, T. A., Gortmaker, S. L., Osganian, S. K., & Ludwig, D. S. (2012). A randomized trial of sugar-sweetened beverages and adolescent body weight. *N Engl J Med, 367*(15), 1407-1416. doi:10.1056/NEJMoa1203388

Eckstein, K. C., Mikhail, L. M., Ariza, A. J., Thomson, J. S., Millard, S. C., & Binns, H. J. (2006). Parents' perceptions of their child's weight and health. *Pediatrics, 117*(3), 681-690. doi:10.1542/peds.2005-0910

Epstein, L. H., Saelens, B. E., Myers, M. D., & Vito, D. (1997). Effects of decreasing sedentary behaviors on activity choice in obese children. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association, 16*(2), 107-113.

Essery, E. V., DiMarco, N. M., Rich, S. S., & Nichols, D. L. (2008). Mothers of preschoolers report using less pressure in child feeding situations following a newsletter intervention.

Journal of nutrition education and behavior, 40(2), 110-115. doi:10.1016/j.jneb.2007.02.008; 10.1016/j.jneb.2007.02.008

Fahrenwald, N. L., Atwood, J. R., Walker, S. N., Johnson, D. R., & Berg, K. (2004). A randomized pilot test of "Moms on the Move": a physical activity intervention for WIC mothers. *Annals of Behavioral Medicine : A Publication of the Society of Behavioral Medicine, 27*(2), 82-90. doi:10.1207/s15324796abm2702_2

Faith, M. S., Dennison, B. A., Edmunds, L. S., & Stratton, H. H. (2006). Fruit juice intake predicts increased adiposity gain in children from low-income families: weight status-by-environment interaction. *Pediatrics, 118*(5), 2066-2075. doi:10.1542/peds.2006-1117

Faith, M. S., Van Horn, L., Appel, L. J., Burke, L. E., Carson, J. A., Franch, H. A., . . . Council on the Kidney in Cardiovascular, D. (2012). Evaluating parents and adult caregivers as "agents of change" for treating obese children: evidence for parent behavior change strategies and research gaps: a scientific statement from the American Heart Association. *Circulation, 125*(9), 1186-1207. doi:10.1161/CIR.0b013e31824607ee; 10.1161/CIR.0b013e31824607ee

Field, A. E. (2003). Association between fruit and vegetable intake and change in body mass index among a large sample of children and adolescents in the United States. *International journal of obesity and related metabolic disorders, 27*(7), 821; 821-826; 826.

Field, A. E., Coakley, E. H., Must, A., Spadano, J. L., Laird, N., Dietz, W. H., . . . Colditz, G. A. (2001). Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Archives of Internal Medicine, 161*(13), 1581-1586.

Fitzgibbon, M. L., Stolley, M. R., Schiffer, L., Kong, A., Braunschweig, C. L., Gomez-Perez, S. L., . . . Dyer, A. R. (2013). Family-based hip-hop to health: outcome results. *Obesity (Silver Spring, Md.), 21*(2), 274-283. doi:10.1002/oby.20269; 10.1002/oby.20269

Fitzgibbon, M. L., Stolley, M. R., Schiffer, L., Van Horn, L., KauferChristoffel, K., & Dyer, A. (2005). Two-year follow-up results for Hip-Hop to Health Jr.: a randomized controlled trial for overweight prevention in preschool minority children. *The Journal of pediatrics, 146*(5), 618-625. doi:10.1016/j.jpeds.2004.12.019

Fitzgibbon, M. L., Stolley, M. R., Schiffer, L., Van Horn, L., KauferChristoffel, K., & Dyer, A. (2006). Hip-Hop to Health Jr. for Latino preschool children. *Obesity (Silver Spring, Md.), 14*(9), 1616-1625. doi:10.1038/oby.2006.186

Fjeldsoe, B. S., Marshall, A. L., & Miller, Y. D. (2009). Behavior change interventions delivered by mobile telephone short-message service. *American Journal of Preventive Medicine, 36*(2), 165-173. doi:10.1016/j.amepre.2008.09.040; 10.1016/j.amepre.2008.09.040

Fjeldsoe, B. S., Miller, Y. D., Graves, N., Barnett, A. G., & Marshall, A. L. (2015). Randomized Controlled Trial of an Improved Version of MobileMums, an Intervention for Increasing

Physical Activity in Women with Young Children. *Ann Behav Med, 49*(4), 487-499. doi:10.1007/s12160-014-9675-y

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. *JAMA : the journal of the American Medical Association, 303*(3), 235-241. doi:10.1001/jama.2009.2014

Flegal, K. M., Kit, B. K., Orpana, H., & Graubard, B. I. (2013). Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. *JAMA : the journal of the American Medical Association, 309*(1), 71-82. doi:10.1001/jama.2012.113905; 10.1001/jama.2012.113905

Fletcher, A., Wolfenden, L., Wyse, R., Bowman, J., McElduff, P., & Duncan, S. (2013). A randomised controlled trial and mediation analysis of the 'Healthy Habits', telephone-based dietary intervention for preschool children. *Int J Behav Nutr Phys Act, 10*, 43. doi:10.1186/1479-5868-10-43

Flores, G., & Lin, H. (2013). Factors predicting severe childhood obesity in kindergarteners. *International journal of obesity (2005), 37*(1), 31-39. doi:10.1038/ijo.2012.168; 10.1038/ijo.2012.168

Forster, J. L., Jeffery, R. W., Schmid, T. L., & Kramer, F. M. (1988). Preventing weight gain in adults: a pound of prevention. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association, 7*(6), 515-525.

Fulgoni, V. L., 3rd, & Quann, E. E. (2012). National trends in beverage consumption in children from birth to 5 years: analysis of NHANES across three decades. *Nutrition journal, 11*, 92-2891-2811-2892. doi:10.1186/1475-2891-11-92; 10.1186/1475-2891-11-92

Gardner, D. S., Hosking, J., Metcalf, B. S., Jeffery, A. N., Voss, L. D., & Wilkin, T. J. (2009). Contribution of early weight gain to childhood overweight and metabolic health: a longitudinal study (EarlyBird 36). *Pediatrics, 123*(1), e67-73. doi:10.1542/peds.2008-1292; 10.1542/peds.2008-1292

Garnett, B. R., Rosenberg, K. D., & Morris, D. S. (2013). Consumption of soda and other sugar-sweetened beverages by 2-year-olds: findings from a population-based survey. *Public health nutrition, 16*(10), 1760-1767. doi:10.1017/S1368980012004399; 10.1017/S1368980012004399

Gaston, A., Edwards, S. A., Doelman, A., & Tober, J. A. (2014). The impact of parenthood on Canadians' objectively measured physical activity: an examination of cross-sectional population-based data. *BMC public health, 14*, 1127. doi:10.1186/1471-2458-14-1127

Germann, J. N., Kirschenbaum, D. S., & Rich, B. H. (2007). Child and parental self-monitoring as determinants of success in the treatment of morbid obesity in low-income minority children. *Journal of pediatric psychology, 32*(1), 111-121. doi:10.1093/jpepsy/jsl007

Gidding, S. S., Dennison, B. A., Birch, L. L., Daniels, S. R., Gillman, M. W., Lichtenstein, A. H., . . . American Heart, A. (2006). Dietary recommendations for children and adolescents: a guide for practitioners. *Pediatrics, 117*(2), 544-559. doi:10.1542/peds.2005-2374

Golan, M. (2006). Parents as agents of change in childhood obesity--from research to practice. *International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 1*(2), 66-76.

Golan, M., Kaufman, V., & Shahar, D. R. (2006). Childhood obesity treatment: targeting parents exclusively v. parents and children. *The British journal of nutrition, 95*(5), 1008-1015.

Gold, B. C., Burke, S., Pintauro, S., Buzzell, P., & Harvey-Berino, J. (2007). Weight loss on the web: A pilot study comparing a structured behavioral intervention to a commercial program. *15*(1), 155-164.

Golley, R. K., Hendrie, G. A., Slater, A., & Corsini, N. (2011). Interventions that involve parents to improve children's weight-related nutrition intake and activity patterns - what nutrition and activity targets and behaviour change techniques are associated with intervention effectiveness? *Obes Rev, 12*(2), 114-130. doi:10.1111/j.1467-789X.2010.00745.x

Gordon-Larsen, P., Adair, L. S., & Suchindran, C. M. (2007). Maternal obesity is associated with younger age at obesity onset in U.S. adolescent offspring followed into adulthood. *Obesity (Silver Spring, Md.), 15*(11), 2790-2796. doi:10.1038/oby.2007.331

Greaney, M. L., Sprunck-Harrild, K., Bennett, G. G., Puleo, E., Haines, J., Viswanath, K. V., & Emmons, K. M. (2012). Use of email and telephone prompts to increase self-monitoring in a Web-based intervention: randomized controlled trial. *Journal of medical Internet research, 14*(4), e96. doi:10.2196/jmir.1981; 10.2196/jmir.1981

Guo, S. S., Wu, W., Chumlea, W. C., & Roche, A. F. (2002). Predicting overweight and obesity in adulthood from body mass index values in childhood and adolescence. *The American Journal of Clinical Nutrition, 76*(3), 653-658.

Hartman, M. A., Hosper, K., & Stronks, K. (2011). Targeting physical activity and nutrition interventions towards mothers with young children: a review on components that contribute to attendance and effectiveness. *Public health nutrition, 14*(8), 1364-1381. doi:10.1017/S1368980010001941

Harvey-Berino, J., & Rourke, J. (2003). Obesity prevention in preschool native-american children: a pilot study using home visiting. *Obes Res, 11*(5), 606-611. doi:10.1038/oby.2003.87

Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., . . . Bauman, A. (2007). Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc, 39*(8), 1423-1434. doi:10.1249/mss.0b013e3180616b27

Havas, S., Anliker, J., Greenberg, D., Block, G., Block, T., Blik, C., . . . DiClemente, C. (2003). Final results of the Maryland WIC Food for Life Program. *Preventive medicine, 37*(5), 406-416.

Hayes, A. (2013). [Introduction to mediation, moderation, and conditional process analysis]. Web Page.

Hayes, A. F. (2013). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. New York, NY: Guilford Press.

Hays, J., Power, T. G., & Olvera, N. (2001). Effects of maternal socialization strategies on children's nutrition knowledge and behavior. *Journal of applied developmental psychology, 22*(4), 421; 421-437; 437. doi:10.1016/S0193-3973(01)00088-0 pmid:

Head, K. J., Noar, S. M., Iannarino, N. T., & Grant Harrington, N. (2013). Efficacy of text messaging-based interventions for health promotion: A meta-analysis. *Social science & medicine (1982), 97*, 41-48. doi:10.1016/j.socscimed.2013.08.003; 10.1016/j.socscimed.2013.08.003

Hearst, M. O., Sevcik, S., Fulkerson, J. A., Pasch, K. E., Harnack, L. J., & Lytle, L. A. (2012). Stressed out and overcommitted! The relationships between time demands and family rules and parents' and their child's weight status. *Health education & behavior : the official publication of the Society for Public Health Education, 39*(4), 446-454. doi:10.1177/1090198111426453; 10.1177/1090198111426453

Hesketh, K., Ball, K., Crawford, D., Campbell, K., & Salmon, J. (2007). Mediators of the relationship between maternal education and children's TV viewing. *American Journal of Preventive Medicine, 33*(1), 41-47. doi:10.1016/j.amepre.2007.02.039

Hesketh, K. D., & Campbell, K. J. (2010). Interventions to prevent obesity in 0-5 year olds: an updated systematic review of the literature. *Obesity (Silver Spring, Md.), 18 Suppl 1*, S27-35. doi:10.1038/oby.2009.429; 10.1038/oby.2009.429

Hull, E. E., Rofey, D. L., Robertson, R. J., Nagle, E. F., Otto, A. D., & Aaron, D. J. (2010). Influence of marriage and parenthood on physical activity: a 2-year prospective analysis. *J Phys Act Health, 7*(5), 577-583.

Jakicic, J. M., Tate, D. F., Lang, W., Davis, K. K., Polzien, K., Rickman, A. D., . . . Finkelstein, E. A. (2012). Effect of a stepped-care intervention approach on weight loss in adults: a randomized clinical trial. *JAMA : the journal of the American Medical Association, 307*(24), 2617-2626. doi:10.1001/jama.2012.6866; 10.1001/jama.2012.6866

Jeffery, R. W., Danaher, B. G., Killen, J., Farquhar, J. W., & Kinnier, R. (1982). Self-administered programs for health behavior change: smoking cessation and weight reduction by mail. *Addictive Behaviors, 7*(1), 57-63.

Johannsen, D. L., Johannsen, N. M., & Specker, B. L. (2006). Influence of parents' eating behaviors and child feeding practices on children's weight status. *Obesity (Silver Spring), 14*(3), 431-439. doi:10.1038/oby.2006.57

Johnson, B. A., Kremer, P. J., Swinburn, B. A., & de Silva-Sanigorski, A. M. (2012). Multilevel analysis of the Be Active Eat Well intervention: environmental and behavioural influences on reductions in child obesity risk. *International journal of obesity (2005), 36*(7), 901-907. doi:10.1038/ijo.2012.23; 10.1038/ijo.2012.23

Jordan, K. C., Freeland-Graves, J. H., Klohe-Lehman, D. M., Cai, G., Voruganti, V. S., Proffitt, J. M., . . . Bohman, T. M. (2008). A nutrition and physical activity intervention promotes weight loss and enhances diet attitudes in low-income mothers of young children. *Nutrition research (New York, N.Y.), 28*(1), 13-20. doi:10.1016/j.nutres.2007.11.005

Kalarchian, M. A., Levine, M. D., Arslanian, S. A., Ewing, L. J., Houck, P. R., Cheng, Y., . . . Marcus, M. D. (2009). Family-based treatment of severe pediatric obesity: randomized, controlled trial. *Pediatrics, 124*(4), 1060-1068. doi:10.1542/peds.2008-3727; 10.1542/peds.2008-3727

Keita, A. D., Risica, P. M., Drenner, K. L., Adams, I., Gorham, G., & Gans, K. M. (2014). Feasibility and acceptability of an early childhood obesity prevention intervention: results from the healthy homes, healthy families pilot study. *J Obes, 2014*, 378501. doi:10.1155/2014/378501

Klohe-Lehman, D. M., Freeland-Graves, J., Clarke, K. K., Cai, G., Voruganti, V. S., Milani, T. J., . . . Bohman, T. M. (2007). Low-income, overweight and obese mothers as agents of change to improve food choices, fat habits, and physical activity in their 1-to-3-year-old children. *Journal of the American College of Nutrition, 26*(3), 196-208.

Knowlden, A. P., Sharma, M., Cottrell, R. R., Wilson, B. R., & Johnson, M. L. (2015). Impact evaluation of Enabling Mothers to Prevent Pediatric Obesity through Web-Based Education and Reciprocal Determinism (EMPOWER) Randomized Control Trial. *Health Educ Behav, 42*(2), 171-184. doi:10.1177/1090198114547816

Kosova, E. C., Auinger, P., & Bremer, A. A. (2013). The relationships between sugar-sweetened beverage intake and cardiometabolic markers in young children. *J Acad Nutr Diet, 113*(2), 219-227. doi:10.1016/j.jand.2012.10.020

Kraig, K. A., & Keel, P. K. (2001). Weight-based stigmatization in children. *International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity, 25*(11), 1661-1666. doi:10.1038/sj.ijo.0801813

Kral, T. V., Stunkard, A. J., Berkowitz, R. I., Stallings, V. A., Moore, R. H., & Faith, M. S. (2008). Beverage consumption patterns of children born at different risk of obesity. *Obesity (Silver Spring, Md.), 16*(8), 1802-1808. doi:10.1038/oby.2008.287; 10.1038/oby.2008.287

Krukowski, R. A., Harvey-Berino, J., Bursac, Z., Ashikaga, T., & West, D. S. (2013). Patterns of success: online self-monitoring in a web-based behavioral weight control program. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association, 32*(2), 164-170. doi:10.1037/a0028135; 10.1037/a0028135

Krukowski, R. A., West, D. S., Philyaw Perez, A., Bursac, Z., Phillips, M. M., & Raczynski, J. M. (2009). Overweight children, weight-based teasing and academic performance. *International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 4*(4), 274-280. doi:10.3109/17477160902846203; 10.3109/17477160902846203

Lampard, A. M., Jurkowski, J. M., & Davison, K. K. (2013). Social-cognitive predictors of low-income parents' restriction of screen time among preschool-aged children. *Health education & behavior : the official publication of the Society for Public Health Education, 40*(5), 526-530. doi:10.1177/1090198112467800; 10.1177/1090198112467800

Laroche, H. H., Wallace, R. B., Snetselaar, L., Hillis, S. L., Cai, X., & Steffen, L. M. (2013). Weight Gain among Men and Women Who Have a Child Enter Their Home. *Journal of the Academy of Nutrition and Dietetics*. doi:10.1016/j.jand.2013.05.022; 10.1016/j.jand.2013.05.022

Larson, N. I., Neumark-Sztainer, D., Hannan, P. J., & Story, M. (2007). Family meals during adolescence are associated with higher diet quality and healthful meal patterns during young adulthood. *J Am Diet Assoc, 107*(9), 1502-1510. doi:10.1016/j.jada.2007.06.012

Leermakers, E. A., Anglin, K., & Wing, R. R. (1998). Reducing postpartum weight retention through a correspondence intervention. *International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity, 22*(11), 1103-1109.

Lees, N. B., & Tinsley, B. J. (1998). Patterns of parental socialization of the preventive health behavior of young Mexican origin children. *Journal of applied developmental psychology, 19*(4), 503. doi:10.1016/S0193-3973(99)80053-7 pmid:

Linde, J. A., Jeffery, R. W., French, S. A., Pronk, N. P., & Boyle, R. G. (2005). Self-weighing in weight gain prevention and weight loss trials. *Annals of Behavioral Medicine : A Publication of the Society of Behavioral Medicine, 30*(3), 210-216. doi:10.1207/s15324796abm3003_5

Linne, Y., Dye, L., Barkeling, B., & Rossner, S. (2004). Long-term weight development in women: a 15-year follow-up of the effects of pregnancy. *Obesity research, 12*(7), 1166-1178. doi:10.1038/oby.2004.146

Lioret, S., Campbell, K. J., Crawford, D., Spence, A. C., Hesketh, K., & McNaughton, S. A. (2012). A parent focused child obesity prevention intervention improves some mother obesity risk behaviors: the Melbourne infant program. *The international journal of behavioral nutrition and physical activity, 9*(1), 100. doi:10.1186/1479-5868-9-100

Lloyd, A. B., Lubans, D. R., Plotnikoff, R. C., & Morgan, P. J. (2015). Paternal Lifestyle-Related Parenting Practices Mediate Changes in Children's Dietary and Physical Activity Behaviors: Findings From the Healthy Dads, Healthy Kids Community Randomized Controlled Trial. *J Phys Act Health, 12*(9), 1327-1335. doi:10.1123/jpah.2014-0367

Lombard, C. B., Deeks, A. A., Ball, K., Jolley, D., & Teede, H. J. (2009). Weight, physical activity and dietary behavior change in young mothers: short term results of the HeLP-her cluster randomized controlled trial. *Nutr J, 8*, 17. doi:10.1186/1475-2891-8-17

Lumeng, J. C., Forrest, P., Appugliese, D. P., Kaciroti, N., Corwyn, R. F., & Bradley, R. H. (2010). Weight Status as a Predictor of Being Bullied in Third Through Sixth Grades. *Pediatrics, 125*(6), e1301-e1307. doi:10.1542/peds.2009-0774

Lytle, L. A., Hearst, M. O., Fulkerson, J., Murray, D. M., Martinson, B., Klein, E., . . . Samuelson, A. (2011). Examining the relationships between family meal practices, family stressors, and the weight of youth in the family. *Annals of Behavioral Medicine : A Publication of the Society of Behavioral Medicine, 41*(3), 353-362. doi:10.1007/s12160-010-9243-z; 10.1007/s12160-010-9243-z

Mailey, E. L., Huberty, J., Dinkel, D., & McAuley, E. (2014). Physical activity barriers and facilitators among working mothers and fathers. *BMC public health, 14*, 657. doi:10.1186/1471-2458-14-657

Malik, V. S., Popkin, B. M., Bray, G. A., Despres, J. P., Willett, W. C., & Hu, F. B. (2010). Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: a meta-analysis. *Diabetes care, 33*(11), 2477-2483. doi:10.2337/dc10-1079; 10.2337/dc10-1079

Marcus, B. H., Pinto, B. M., Simkin, L. R., Audrain, J. E., & Taylor, E. R. (1994). Application of theoretical models to exercise behavior among employed women. *American Journal of Health promotion : AJHP, 9*(1), 49-55.

McAlister, A., Perry, C., & Parcel, G. (2008). How individuals, environments, and health behavior interact; social cognitive theory. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behavior and health education: Theory, research, and practice* (Vol. 4, pp. 167-188). San Francisco, CA: Jossey-Bass.

McIntyre, C. A., & Rhodes, R. E. (2009). Correlates of leisure-time physical activity during transitions to motherhood. *Women & health, 49*(1), 66-83. doi:10.1080/03630240802690853; 10.1080/03630240802690853

Millar, L., Rowland, B., Nichols, M., Swinburn, B., Bennett, C., Skouteris, H., & Allender, S. (2014). Relationship between raised BMI and sugar sweetened beverage and high fat food consumption among children. *Obesity (Silver Spring), 22*(5), E96-103. doi:10.1002/oby.20665

Miller, Y. D. (2005). Determinants of Active Leisure for Women with Young Children—an "Ethic of Care" Prevails. *Leisure sciences, 27*(5), 405; 405-420; 420. doi:10.1080/01490400500227308 pmid:

Nader, P. R., O'Brien, M., Houts, R., Bradley, R., Belsky, J., Crosnoe, R., . . . Human Development Early Child Care Research, N. (2006). Identifying risk for obesity in early childhood. *Pediatrics, 118*(3), e594-601. doi:10.1542/peds.2005-2801

Napolitano, M. A., Hayes, S., Bennett, G. G., Ives, A. K., & Foster, G. D. (2013). Using Facebook and text messaging to deliver a weight loss program to college students. *Obesity (Silver Spring, Md.), 21*(1), 25-31. doi:10.1002/oby.20232; 10.1002/oby.20232

Neve, M., Morgan, P. J., Jones, P. R., & Collins, C. E. (2010). Effectiveness of web-based interventions in achieving weight loss and weight loss maintenance in overweight and obese adults: a systematic review with meta-analysis. *Obesity reviews : an official journal of the International Association for the Study of Obesity, 11*(4), 306-321. doi:10.1111/j.1467-789X.2009.00646.x; 10.1111/j.1467-789X.2009.00646.x

Nomaguchi, K. K. M. (2004). Exercise Time: Gender Differences in the Effects of Marriage, Parenthood, and Employment. *Journal of marriage and family, 66*(2), 413-430. doi:10.1111/j.1741-3737.2004.00029.x pmid:

Nusser, S. M., Beyler, N. K., Welk, G. J., Carriquiry, A. L., Fuller, W. A., & King, B. M. (2012). Modeling errors in physical activity recall data. *J Phys Act Health, 9 Suppl 1*, S56-67.

O'Connor, T. M., Yang, S. J., & Nicklas, T. A. (2006). Beverage intake among preschool children and its effect on weight status. *Pediatrics, 118*(4), e1010-1018. doi:10.1542/peds.2005-2348

O'Dwyer, M. V., Fairclough, S. J., Knowles, Z., & Stratton, G. (2012). Effect of a family focused active play intervention on sedentary time and physical activity in preschool children. *The international journal of behavioral nutrition and physical activity, 9*, 117-5868-5869-5117. doi:10.1186/1479-5868-9-117; 10.1186/1479-5868-9-117

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *JAMA : the journal of the American Medical Association, 307*(5), 483-490. doi:10.1001/jama.2012.40

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *Jama, 311*(8), 806-814. doi:10.1001/jama.2014.732

Ogden, C. L., Flegal, K. M., Carroll, M. D., & Johnson, C. L. (2002). Prevalence and trends in overweight among US children and adolescents, 1999-2000. *JAMA : the journal of the American Medical Association, 288*(14), 1728-1732.

Ogden, C. L., Kit, B. K., Carroll, M. D., & Park, S. (2011). *Consumption of sugar drinks in the United States, 2005-2006. NCHS data brief, no 71*. Retrieved from Hyattsville, MD:

Ostbye, T., Krause, K. M., Lovelady, C. A., Morey, M. C., Bastian, L. A., Peterson, B. L., . . . McBride, C. M. (2009). Active Mothers Postpartum: a randomized controlled weight-loss intervention trial. *American Journal of Preventive Medicine, 37*(3), 173-180. doi:10.1016/j.amepre.2009.05.016; 10.1016/j.amepre.2009.05.016

Ostbye, T., Krause, K. M., Stroo, M., Lovelady, C. A., Evenson, K. R., Peterson, B. L., . . . Zucker, N. L. (2012). Parent-focused change to prevent obesity in preschoolers: results from the KAN-DO study. *Preventive medicine, 55*(3), 188-195. doi:10.1016/j.ypmed.2012.06.005; 10.1016/j.ypmed.2012.06.005

Paffenbarger, R. S., Jr., Wing, A. L., & Hyde, R. T. (1995). Physical activity as an index of heart attack risk in college alumni. 1978. *Am J Epidemiol, 142*(9), 889-903; discussion 887-888.

Park, S., Li, R., & Birch, L. (2015). Mothers' child-feeding practices are associated with children's sugar-sweetened beverage intake. *J Nutr, 145*(4), 806-812. doi:10.3945/jn.114.207233

Patrick, K., Raab, F., Adams, M. A., Dillon, L., Zabinski, M., Rock, C. L., . . . Norman, G. J. (2009). A text message-based intervention for weight loss: randomized controlled trial. *Journal of medical Internet research, 11*(1), e1. doi:10.2196/jmir.1100; 10.2196/jmir.1100

Pereira, M. A., Rifas-Shiman, S. L., Kleinman, K. P., Rich-Edwards, J. W., Peterson, K. E., & Gillman, M. W. (2007). Predictors of change in physical activity during and after pregnancy: Project Viva. *American Journal of Preventive Medicine, 32*(4), 312-319. doi:10.1016/j.amepre.2006.12.017

Perri, M. G., Nezu, A. M., Patti, E. T., & McCann, K. L. (1989). Effect of length of treatment on weight loss. *Journal of consulting and clinical psychology, 57*(3), 450-452.

Perusse, L., Leblanc, C., & Bouchard, C. (1988). Familial resemblance in lifestyle components: results from the Canada Fitness Survey. *Canadian journal of public health = Revue canadienne de sante publique, 79*(3), 201-205.

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behav Res Methods Instrum Comput, 36*(4), 717-731.

Puhl, R. M., & Latner, J. D. (2007). Stigma, obesity, and the health of the nation's children. *Psychological bulletin, 133*(4), 557-580. doi:10.1037/0033-2909.133.4.557

Quattrin, T., Roemmich, J. N., Paluch, R., Yu, J., Epstein, L. H., & Ecker, M. A. (2014). Treatment outcomes of overweight children and parents in the medical home. *Pediatrics, 134*(2), 290-297. doi:10.1542/peds.2013-4084

Renehan, A. G., Soerjomataram, I., Tyson, M., Egger, M., Zwahlen, M., Coebergh, J. W., & Buchan, I. (2010). Incident cancer burden attributable to excess body mass index in 30 European countries. *International journal of cancer.Journal international du cancer, 126*(3), 692-702. doi:10.1002/ijc.24803; 10.1002/ijc.24803

Rhodes, R. E., Blanchard, C. M., Benoit, C., Levy-Milne, R., Naylor, P. J., Symons Downs, D., & Warburton, D. E. (2014). Physical activity and sedentary behavior across 12 months in cohort samples of couples without children, expecting their first child, and expecting their second child. *J Behav Med, 37*(3), 533-542. doi:10.1007/s10865-013-9508-7

Robinson, S., Marriott, L., Poole, J., Crozier, S., Borland, S., Lawrence, W., . . . Southampton Women's Survey Study, G. (2007). Dietary patterns in infancy: the importance of maternal and family influences on feeding practice. *The British journal of nutrition, 98*(5), 1029-1037. doi:10.1017/S0007114507750936

Rooney, B. L., Schauberger, C. W., & Mathiason, M. A. (2005). Impact of perinatal weight change on long-term obesity and obesity-related illnesses. *Obstetrics and gynecology, 106*(6), 1349-1356. doi:10.1097/01.AOG.0000185480.09068.4a

Rosenkranz, R. R., & Dzewaltowski, D. A. (2008). Model of the home food environment pertaining to childhood obesity. *Nutr Rev, 66*(3), 123-140. doi:10.1111/j.1753-4887.2008.00017.x

Rossner, S., & Ohlin, A. (1995). Pregnancy as a risk factor for obesity: lessons from the Stockholm Pregnancy and Weight Development Study. *Obesity research, 3 Suppl 2,* 267s-275s.

Sallis, J. F., Hovell, M. F., & Hofstetter, C. R. (1992). Predictors of adoption and maintenance of vigorous physical activity in men and women. *Prev Med, 21*(2), 237-251.

Salmon, J., Owen, N., Crawford, D., Bauman, A., & Sallis, J. F. (2003). Physical activity and sedentary behavior: a population-based study of barriers, enjoyment, and preference. *Health Psychol, 22*(2), 178-188.

Scharff, D. P., Homan, S., Kreuter, M., & Brennan, L. (1999). Factors associated with physical activity in women across the life span: implications for program development. *Women & health, 29*(2), 115-134. doi:10.1300/J013v29n02_08

Schoenborn, C. A., & Stommel, M. (2011). Adherence to the 2008 adult physical activity guidelines and mortality risk. *Am J Prev Med, 40*(5), 514-521. doi:10.1016/j.amepre.2010.12.029

Shapiro, J. R., Koro, T., Doran, N., Thompson, S., Sallis, J. F., Calfas, K., & Patrick, K. (2012). Text4Diet: a randomized controlled study using text messaging for weight loss behaviors. *Preventive medicine, 55*(5), 412-417. doi:10.1016/j.ypmed.2012.08.011; 10.1016/j.ypmed.2012.08.011

Shelton, D., Le Gros, K., Norton, L., Stanton-Cook, S., Morgan, J., & Masterman, P. (2007). Randomised controlled trial: A parent-based group education programme for overweight children. *Journal of paediatrics and child health, 43*(12), 799-805. doi:10.1111/j.1440-1754.2007.01150.x

Shroff, M. R., Perng, W., Baylin, A., Mora-Plazas, M., Marin, C., & Villamor, E. (2013). Adherence to a snacking dietary pattern and soda intake are related to the development of adiposity: a prospective study in school-age children. *Public health nutrition*, 1-7. doi:10.1017/S136898001300133X

Sinha, R., Fisch, G., Teague, B., Tamborlane, W. V., Banyas, B., Allen, K., . . . Caprio, S. (2002). Prevalence of impaired glucose tolerance among children and adolescents with marked obesity. *The New England journal of medicine, 346*(11), 802-810. doi:10.1056/NEJMoa012578

Skelton, J. A., & Beech, B. M. (2011). Attrition in paediatric weight management: a review of the literature and new directions. *Obesity reviews : an official journal of the International Association for the Study of Obesity, 12*(5), e273-281. doi:10.1111/j.1467-789X.2010.00803.x; 10.1111/j.1467-789X.2010.00803.x

Skinner, B. F. (1974). Behavior modification. *Science (New York, N.Y.), 185*(4154), 813.

Skinner, J. D., Carruth, B. R., Moran, J., 3rd, Houck, K., & Coletta, F. (1999). Fruit juice intake is not related to children's growth. *Pediatrics, 103*(1), 58-64.

Sobel, M. E. (1982). Asymptotic intervals for indirect effects in structural equations models. In S. Leinhart (Ed.), *Sociological methodology* San Francisco: Jossey-Bass.

Sonneville, K. R., Rifas-Shiman, S. L., Kleinman, K. P., Gortmaker, S. L., Gillman, M. W., & Taveras, E. M. (2012). Associations of obesogenic behaviors in mothers and obese children participating in a randomized trial. *Obesity (Silver Spring, Md.), 20*(7), 1449-1454. doi:10.1038/oby.2012.43; 10.1038/oby.2012.43

Spence, A. C., Campbell, K. J., Crawford, D. A., McNaughton, S. A., & Hesketh, K. D. (2014). Mediators of improved child diet quality following a health promotion intervention: the Melbourne InFANT Program. *Int J Behav Nutr Phys Act, 11*, 137. doi:10.1186/s12966-014-0137-5

Spurrier, N. J., Magarey, A. A., Golley, R., Curnow, F., & Sawyer, M. G. (2008). Relationships between the home environment and physical activity and dietary patterns of preschool children: a cross-sectional study. *The international journal of behavioral nutrition and physical activity, 5*, 31-5868-5865-5831. doi:10.1186/1479-5868-5-31; 10.1186/1479-5868-5-31

Stark, L. J., Spear, S., Boles, R., Kuhl, E., Ratcliff, M., Scharf, C., . . . Rausch, J. (2011). A pilot randomized controlled trial of a clinic and home-based behavioral intervention to decrease obesity in preschoolers. *Obesity (Silver Spring, Md.), 19*(1), 134-141. doi:10.1038/oby.2010.87; 10.1038/oby.2010.87

Steinhardt, M. A., & Dishman, R. K. (1989). Reliability and validity of expected outcomes and barriers for habitual physical activity. *J Occup Med, 31*(6), 536-546.

Sternfeld, B., Ainsworth, B. E., & Quesenberry, C. P. (1999). Physical activity patterns in a diverse population of women. *Preventive medicine, 28*(3), 313-323. doi:10.1006/pmed.1998.0470

Strauss, R. S., & Knight, J. (1999). Influence of the home environment on the development of obesity in children. *Pediatrics, 103*(6), e85.

Tabak, R. G., Tate, D. F., Stevens, J., Siega-Riz, A. M., & Ward, D. S. (2012). Family ties to health program: a randomized intervention to improve vegetable intake in children. *Journal of nutrition education and behavior, 44*(2), 166-171. doi:10.1016/j.jneb.2011.06.009; 10.1016/j.jneb.2011.06.009

Tate, D. F., Jackvony, E. H., & Wing, R. R. (2003). Effects of Internet behavioral counseling on weight loss in adults at risk for type 2 diabetes: a randomized trial. *JAMA : the journal of the American Medical Association, 289*(14), 1833-1836. doi:10.1001/jama.289.14.1833

Tate, D. F., Jackvony, E. H., & Wing, R. R. (2006). A randomized trial comparing human e-mail counseling, computer-automated tailored counseling, and no counseling in an Internet weight loss program. *Archives of Internal Medicine, 166*(15), 1620-1625. doi:10.1001/archinte.166.15.1620

Tate, D. F., Turner-McGrievy, G., Lyons, E., Stevens, J., Erickson, K., Polzien, K., . . . Popkin, B. (2012). Replacing caloric beverages with water or diet beverages for weight loss in adults: main results of the Choose Healthy Options Consciously Everyday (CHOICE) randomized clinical trial. *The American Journal of Clinical Nutrition, 95*(3), 555-563. doi:10.3945/ajcn.111.026278; 10.3945/ajcn.111.026278

Tate, D. F., Wing, R. R., & Winett, R. A. (2001). Using Internet technology to deliver a behavioral weight loss program. *JAMA : the journal of the American Medical Association, 285*(9), 1172-1177.

Taveras, E. M., Gortmaker, S. L., Hohman, K. H., Horan, C. M., Kleinman, K. P., Mitchell, K., . . . Gillman, M. W. (2011). Randomized controlled trial to improve primary care to prevent and manage childhood obesity: the High Five for Kids study. *Arch Pediatr Adolesc Med, 165*(8), 714-722. doi:10.1001/archpediatrics.2011.44

Taveras, E. M., Mitchell, K., & Gortmaker, S. L. (2009). Parental confidence in making overweight-related behavior changes. *Pediatrics, 124*(1), 151-158. doi:10.1542/peds.2008-2892

Trost, S. G., Fees, B., & Dzewaltowski, D. (2008). Feasibility and efficacy of a "move and learn" physical activity curriculum in preschool children. *Journal of physical activity & health, 5*(1), 88-103.

Turer, C. B., Stroo, M., Brouwer, R. J., Krause, K. M., Lovelady, C. A., Bastian, L. A., . . . Ostbye, T. (2013). Do high-risk preschoolers or overweight mothers meet AAP-recommended behavioral goals for reducing obesity? *Academic pediatrics, 13*(3), 243-250. doi:10.1016/j.acap.2013.01.003; 10.1016/j.acap.2013.01.003

Umberson, D., Liu, H., Mirowsky, J., & Reczek, C. (2011). Parenthood and trajectories of change in body weight over the life course. *Social science & medicine (1982), 73*(9), 1323-1331. doi:10.1016/j.socscimed.2011.08.014; 10.1016/j.socscimed.2011.08.014

Vartanian, L. R., Schwartz, M. B., & Brownell, K. D. (2007). Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *American Journal of Public Health, 97*(4), 667-675. doi:10.2105/AJPH.2005.083782

Vauthier, J. M., Lluch, A., Lecomte, E., Artur, Y., & Herbeth, B. (1996). Family resemblance in energy and macronutrient intakes: the Stanislas Family Study. *International journal of epidemiology, 25*(5), 1030-1037.

Vereecken, C. A., Keukelier, E., & Maes, L. (2004). Influence of mother's educational level on food parenting practices and food habits of young children. *Appetite, 43*(1), 93-103. doi:10.1016/j.appet.2004.04.002

Verhoef, M. J., & Love, E. J. (1994). Women and exercise participation: the mixed blessings of motherhood. *Health care for women international, 15*(4), 297-306. doi:10.1080/07399339409516122

Viner, R. M., Segal, T. Y., Lichtarowicz-Krynska, E., & Hindmarsh, P. (2005). Prevalence of the insulin resistance syndrome in obesity. *Archives of Disease in Childhood, 90*(1), 10-14. doi:10.1136/adc.2003.036467

Vos, M. B., Kimmons, J. E., Gillespie, C., Welsh, J., & Blanck, H. M. (2008). Dietary fructose consumption among US children and adults: the Third National Health and Nutrition Examination Survey. *Medscape journal of medicine, 10*(7), 160.

Wadden, T. A., Butryn, M. L., & Wilson, C. (2007). Lifestyle modification for the management of obesity. *Gastroenterology, 132*(6), 2226-2238. doi:10.1053/j.gastro.2007.03.051

Wadden, T. A., West, D. S., Neiberg, R. H., Wing, R. R., Ryan, D. H., Johnson, K. C., . . . Look, A. R. G. (2009). One-year weight losses in the Look AHEAD study: factors associated with success. *Obesity (Silver Spring, Md.), 17*(4), 713-722. doi:10.1038/oby.2008.637; 10.1038/oby.2008.637

Wang, Y. C., Bleich, S. N., & Gortmaker, S. L. (2008). Increasing Caloric Contribution From Sugar-Sweetened Beverages and 100% Fruit Juices Among US Children and Adolescents, 1988–2004. *Pediatrics, 121*(6), e1604-e1614. doi:10.1542/peds.2007-2834

Weber Cullen, K., Baranowski, T., Rittenberry, L., Cosart, C., Owens, E., Hebert, D., & de Moor, C. (2000). Socioenvironmental influences on children's fruit, juice and vegetable consumption as reported by parents: reliability and validity of measures. *Public health nutrition, 3*(3), 345-356.

Weiss, R., Dziura, J., Burgert, T. S., Tamborlane, W. V., Taksali, S. E., Yeckel, C. W., . . . Caprio, S. (2004). Obesity and the metabolic syndrome in children and adolescents. *The New England journal of medicine, 350*(23), 2362-2374. doi:10.1056/NEJMoa031049

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *The New England journal of medicine, 337*(13), 869-873. doi:10.1056/NEJM199709253371301

Whitford, H. M., Donnan, P. T., Symon, A. G., Kellett, G., Monteith-Hodge, E., Rauchhaus, P., & Wyatt, J. C. (2012). Evaluating the reliability, validity, acceptability, and practicality of SMS text messaging as a tool to collect research data: results from the Feeding Your Baby project. *Journal of the American Medical Informatics Association : JAMIA, 19*(5), 744-749. doi:10.1136/amiajnl-2011-000785; 10.1136/amiajnl-2011-000785

Williams, D. P., Going, S. B., Lohman, T. G., Harsha, D. W., Srinivasan, S. R., Webber, L. S., & Berenson, G. S. (1992). Body fatness and risk for elevated blood pressure, total cholesterol, and serum lipoprotein ratios in children and adolescents. *American Journal of Public Health, 82*(3), 358-363.

Wing, R. R., Blair, E., Marcus, M., Epstein, L. H., & Harvey, J. (1994). Year-long weight loss treatment for obese patients with type II diabetes: does including an intermittent very-low-calorie diet improve outcome? *The American Journal of Medicine, 97*(4), 354-362.

Wing, R. R., Gorin, A. A., & Tate, D. F. (2006). Strategies for Changing Eating and Exercise Behavior. In R. Russell & B. Bowman (Eds.), *Presenting Knowledge in Nutrition* (Vol. 9, pp. 822-837).

Wrotniak, B. H., Epstein, L. H., Paluch, R. A., & Roemmich, J. N. (2005). The relationship between parent and child self-reported adherence and weight loss. *Obesity research, 13*(6), 1089-1096. doi:10.1038/oby.2005.127

Zeller, M. H., Reiter-Purtill, J., & Ramey, C. (2008). Negative Peer Perceptions of Obese Children in the Classroom Environment. *Obesity, 16*(4), 755-762. doi:10.1038/oby.2008.4