Mother-daughter resemblance in BMI and obesity-related behaviors

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Mother-Daughter Resemblance in BMI and Obesity-Related Behaviors

Running head: obesity-related behavior resemblance

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improving the health of Kansans." Additional funding was provided by the National Research Initiative Grant number 2005-35215-15418 from the USDA Cooperative State Research, Education, and Extension Service Human Nutrition and Obesity Program.

Abstract

Objective: This study sought to determine the association between mother-daughter resemblance in body mass index (BMI) and obesity-related behaviors, and whether connectedness moderated those associations. Method: Seventy-six Girl Scouts (ages 9 to 13 years) were objectively assessed for BMI, and surveyed via questionnaire. Sixty-eight parents also completed questionnaires assessing height, weight, and obesity-related behaviors. Results: Significant relationships were found for television viewing ($\beta = .351$, $p = .002$), eating while watching television ($\beta = .468$, $p < .001$), fruit consumption ($\beta = .374$, $p = .005$) and vegetable consumption ($\beta = .243$, $p = .050$). Connectedness moderated the maternal BMI and daughter BMI Z-score relationship ($\beta = .307$, $p = .026$), and mother-daughter TV viewing ($\beta = .258$, $p = .043$). Conclusion: Connectedness may influence girls' BMI and behavioral resemblance to mothers. Specific pathways leading to greater similarity between parent and child relative weight need further study.

Key Terms: Child, Parenting, Weight Status, Obesity Prevention, Influences

Introduction

Obesity has rapidly increased across most demographic categories in the United States, and about two thirds of the American adult population is overweight, with a body mass index, or BMI > 25, while over 30% are obese, with a BMI >30. (1) Among youth, one in three aged 6-19 years is overweight (>85th percentile) and one in six aged 6-19 is obese (>95th percentile). (1)

Among behaviors related to obesity, television viewing, eating while watching television, and consuming soda/sugar-sweetened beverage have been shown as obesity risk factors. (2) Consumption of fruits and vegetables and moderate to vigorous physical activity have consistently been shown to be protective against obesity. (3,4)

Body mass index (BMI) tends to be similar in families. Although there is a considerable genetic component to such associations, the focus in the present paper pertains to the social, behavioral, and environmental aspects. The family has strong influence on children's eating practices, (5) so adolescents are also likely to resemble their families in fruit and vegetable intake, (6) and other eating practices. (7) Some studies report a family resemblance in child and adolescent physical activity behavior. (8) Physical activity levels of adolescents resemble those of their parents, across varying levels of socio-economic status and weight status. (9) For sedentary behaviors in general, and television viewing in particular, there is also some evidence of parent-child concordance or familial aggregation. (9)

Parents provide opportunities, exhibit preferences, beliefs, and attitudes, and model behaviors that contribute to an adolescent's weight status. (5, 10) Parents also shape many of the environmental features of the young person's home pertaining to food, beverages, physical activity, and sedentary opportunities. (11) Beyond the home, parents have influence on what they expose their children to in other environments. (12) Along with environmental opportunities, the behavior of parents can foster similar behaviors in their offspring through modeling. (13)

Children and adolescents also exert an influence that likely grows over time on their home environment and parents. A child's weight status can influence parenting behaviors, specifically parent feeding behaviors, which thereby play a further role in the child's behavior. (14) In addition to making their own purchases, children and adolescents take a direct role in parents' consumer behaviors, even when not physically present at the place of food purchase. (15) Along with the direct involvement of teens in food purchasing and preparation, child asking behaviors can also impact the home food environment. (16) Thus, children may be influential on parental obesity-related behaviors and weight status.

One potential approach to understand influences on familial resemblance of BMI and obesity-related behaviors may exist in the Social Development Model (SDM), which has proven useful in explaining antisocial and delinquent behaviors such as smoking, alcohol and drug use in adolescents. (17) According to SDM, children and adolescents learn to behave through the influence of socializing agents in the family, at school, and elsewhere. Adolescents who have a very strong connection to their parents should be more likely to behave like their parents do, and one study has found support for this effect in physical activity behaviors. (18)

Stemming from these issues, the purpose of the present study was to determine the level of association between the BMI and obesity-related behaviors of mothers and their daughters, and whether connectedness would moderate observed relationships. We hypothesized that parent-child dyads categorized as having a stronger connectedness would have greater similarity between parents and children than would less connected dyads, for the following variables: 1) Parent body mass index (BMI) and child BMI z-score; 2) Physical activity level of parent and child; 3) Television viewing of parent and child; 4) Eating while watching television of parent

and child; 5) Fruit consumption of parent and child; 6) Vegetable consumption of parent and child; 7) Soda/Sugar-sweetened beverage consumption of parent and child.

Method

Study design

The present paper uses baseline data from the Healthier Troops in a SNAP (Scouting Nutrition and Activity Program) project evaluating the effectiveness of an intervention designed to prevent obesity in Girl Scouts. Present analyses are cross-sectional in nature, with data collected prior to intervention. Girls and parents agreeing to participate from participating Girl Scout Junior troops completed all assessments within a two-week period in October 2007, prior to randomization for the intervention study.

Settings and Participants

Participating girls (ages 9 to 13) were members of Girl Scouts, attending one of seven Junior troops. In the seven troops, parental informed consents were obtained for all but one attending child (n = 76, 100% female). Families with parents or daughters unable to read English were excluded (n = 1). Of all families (n = 72) consenting for their daughter(s) to participate, 68 participated by returning a questionnaire (96% female). Parents agreed to complete a questionnaire for each child attending one of the troops, and four families had more than one child in a troop. Due to the large majority of female respondents, the present study made use of data from only the mothers/female caregivers (n = 65) and their daughters. Participating troops earned a $10 stipend per scout, and each family earned a $10 stipend for taking part in the study.

The Girl Scout troops held meetings in one of three adjacent Midwestern towns, ranging in population from about 4,000 to 50,000. Troop meetings were held either weekly (n = 2) or bi-

monthly (n = 5), between one and two hours in duration. Meetings were held at Girl Scouts "Little House" property (n = 4), at a troop leader's home (n = 2), or at a community center (n = 1). Troops ranged in size from six to sixteen girls (mean = 11).

Table 1 presents demographic characteristics of participating Girl Scouts. Mean age of participating girls was 10.5 $\pm$ 1.2. About half of the parents were college graduates, about one third were lower socio-economic status, and more than three quarters of the girls were non-Hispanic Caucasian. Maternal parity averaged about two and a half children for this sample, and mean parental BMI was 29.0. Parents averaged 2.5 children per household. On average, both parents and girls ate fewer than five servings of fruits and vegetables per day, and most parents and girls did not meet current physical activity recommendations.

Procedures

Girls' height and weight assessments were carried out in semi-private settings without shoes or heavy clothing. Height was measured to the nearest millimeter, using a portable stadiometer (Seca Corp, Model #214 Road Rod, Hanover, MD). Weight was measured to the nearest 0.1 kg with high-precision electronic scales (Seca Corp, Model #770, Hanover, MD). Girls completed questionnaires as a troop, administered according to a standardized script read by the first author. Parents completed a questionnaire either prior to picking up their daughters at the troop meeting, or outside of meeting time at their own convenience.

Measures

Child heights and weights were converted to body mass index (BMI) percentiles and z-scores using the age- and sex-specific LMS parameters from the CDC growth charts (19). Participants were classified as overweight or obese, respectively, if their BMI equaled or

exceeded the age- and sex-specific 85th or 95th percentile (z-scores of 1.036 or 1.645 respectively).

Girl Survey. Children were surveyed for the obesity-related behaviors that were presumed to extend beyond parental supervision and the home. Questionnaires assessed: 1) Fruit servings typically consumed. Numerous commonly consumed fruits were described, and children were given careful descriptions of how much of various fruits were required to constitute a serving. One previously published item (20) assessed typical servings of fruit per day: "On a typical day, how many servings of fruit do you eat?" Responses were given on a five-point scale ranging from "none" to "4 servings or more"; 2) Vegetable servings typically consumed. This was assessed in a closely analogous manner to fruit, with one previously published item (20); 3) Physical activity level. Physical activity was defined as "Any play, game, sport, or activity that gets you moving and breathing harder" and was discussed with numerous examples provided by both researchers and participants. Two items (α = .758) assessed days in the past week, and in a typical week, "On how many days were you physically active for a total of at least 60 minutes per day?" Responses were given on an eight-point scale ranging from "0 days" to "7 days."; 4) Soda/Sugar-sweetened beverage consumption was assessed with one item: "Over the past week, how often did you drink regular soda or sugar-sweetened beverages?" Responses were given on an eight-point scale, ranging from "never" to "every day." (21); 4) Mother-daughter connectedness was assessed with a previously published two-item scale: "How much do you feel you can talk to your mother (or female caregiver) about your problems?" and "How much do you feel your mother (or female caregiver) cares about you?" Responses were indicated on a five-point scale ranging from "Not at all" to "Very much." (22)

Parent Survey. Parents were surveyed for their own height, weight, and obesity-related behaviors, as well as their daughter's obesity-related behaviors that were presumed to be largely under parental purview. Questionnaires assessed: 1) Fruit servings typically consumed by parent. One item was identical to that of daughter's questionnaire; 2) Vegetables typically consumed by parent. This was also identical to daughter's questionnaire; 3) Physical activity level of parent was assessed using four items from the Behavioral Risk Factor Surveillance System, assessing frequency and duration (in 10-minute bouts or longer) of moderate and vigorous physical activity (20); 4) Frequency of eating while watching television was assessed with three items (mother, father, child, $\alpha = .681$) from the Family Eating and Activity Habits Questionnaire. (21) Responses were given on a five-point scale, ranging from "Never" to "Always." 4) Television viewing was assessed with three items from the Family Eating and Activity Habits Questionnaire, (21) inquiring average television use in hours per week (mother, father, child, $\alpha = .606$). 5) Soda/Sugar-sweetened beverage consumption of parent was assessed with one item: "Over the past week, how often did you drink regular soda or sugar-sweetened drinks?" Responses were given on an eight-point scale ranging from "Never" to "Every Day"; and 6) Mother's height and weight were self-reported in feet, inches, and pounds.

Statistical Analysis

SPSS 16.0 (Chicago, IL) was used for all analyses. Descriptive statistics including means were calculated for all variables. Following the guidelines for testing the moderation hypothesis in a hierarchical multiple regression framework, (23) the two first-order effects (mother's variable, and mother-daughter connectedness score) were centralized by subtracting the mean across individuals from each individual's variable value. Next, the product, or interaction, of the two centered first-order effects was calculated for each analysis run. This interaction term was

then entered into the second step of the regression. A significant change in R^2 from first step to the second step of the regression analysis indicated a significant moderator effect. The *F* value's significance for each regression model indicated whether the model explained a significant proportion of variance in each child outcome variable analyzed. An alpha of .05 was set as the upper-level criterion of significance for all analyses.

Results

Body Mass Index. Table 2 displays the hierarchical multiple regression used to analyze the direct and moderated effects of maternal BMI and connectedness on child BMI z-score. At step 1, an insignificant percentage of variance in child BMI z-score was explained by the model, ($p = .304$), and neither maternal variable made a statistically significant contribution to the model ($p > .05$). At step 2, the model significantly increased in explained variance, accounting for twelve percent of the variation in child BMI z-score. However, the overall model at step 2 did not reach statistical significance, $p = .061$. There was a significant moderation effect evident as the interaction between parent BMI and connectedness showed a significant standardized beta coefficient in the model, $p = .026$. Figure 1 illustrates the moderation effect of connectedness on the relationship between mother and child BMI variables, with sample values calculated in the regression formula. Sample values for "lower" BMI and connectedness represent scores approximately one standard deviation below the mean, while sample values for "higher" BMI and connectedness represent scores approximately one standard deviation above the mean. Children reporting higher connectedness scores had greater similarity to their mother in BMI status. Children reporting lower connectedness scores had less similarity to their mother in BMI status. Thus, no direct effect of connectedness was found, just a moderator effect of connectedness for maternal BMI on child BMI z-score.

Physical activity. Table 2 shows the models used to assess the direct and moderated effects of parental physical activity on child physical activity. At step 1, the model did not explain a significant proportion of child physical activity variance ($p = .306$), and neither variable's standardized β-coefficient was significant ($p > .05$). At step 2, the model remained

non-significant (p = .192). Further, the change in R^2 did not reach significance (p = .125), indicating a lack of significant moderation effect for connectedness. Thus, the model containing mother physical activity, connectedness, and the interaction between mother physical activity and connectedness was not significant, and no moderation effect of connectedness was apparent.

Television viewing. Table 2 displays the direct and moderated effects of mother's TV viewing on child TV viewing. At step 1, the model explained 35% (p < .001) of the variance in child television viewing, and both mother's TV viewing (β = .351, p = .002) and mother-daughter connectedness (β = -.367, p = .002) were significant contributors to the model. At step 2, the model remained significant (p < .001), and the interaction term was also significant, (β = .258, p = .043) indicating a moderation effect. Thus, there were both direct and moderated effects by connectedness of parental TV viewing on child TV viewing.

Eating while watching television. Table 2 shows the models used to assess the direct and moderated effects of maternal eating while watching TV on child eating while watching TV. At step 1, the model explained approximately 23% of the variance in child eating while watching TV (p < .001). Parental eating while watching TV made a significant contribution to this model (β = .468, p < .001), and connectedness also featured a significant coefficient (β = .240, p = .043). At step 2, the model remained significant, (R^2 = .229, p = .001). However, the interaction term was not significant (β = -.039, p = .773), indicating no significant moderation effect. Thus, there was a significant direct effect of mother's eating while watching TV on child eating while watching TV, but no significant moderation effect.

Fruit consumption. Table 2 displays the model used to assess the direct and moderated effects of mother's fruit consumption on child fruit consumption. At step 1, the model explained

approximately 14% of the variance in child fruit consumption (p = .010). Mother's fruit consumption made a significant contribution to this model (β = .374, p = .005), but connectedness did not make a significant contribution (β = .007, p = .958). At step 2, the model remained significant, R^2 = .176, p = .000. However, the interaction term was not significant (β = .211, p = .121) indicating no significant moderation effect. Thus, there was a significant direct effect for mother's fruit consumption on child fruit consumption, but no significant moderation.

Vegetable consumption. Table 2 shows the model used to assess the direct and moderated effects of vegetable consumption on child vegetable consumption. At step 1, the model explained approximately 16% of the variance in child vegetable consumption (p = .005). Mother's vegetable consumption made a significant contribution to this model (β = .243, p = .050), and connectedness also made a significant contribution (β = .260, p = .036). At step 2, the model remained significant (R^2 = .158, p = .016). However, the interaction term was not significant (β = .014, p = .911), indicating no significant moderation effect. Thus, there were significant direct effects for both mother's vegetable consumption and mother-daughter connectedness on child vegetable consumption, but no significant moderation effect.

Soda/SSB consumption. Table 2 displays the model used to analyze the direct and moderated effects of parental soda/SSB consumption on child soda/SSB consumption. At step 1, an insignificant percentage of the variance in child soda/SSB consumption was explained by the model (R^2 = .009, p = .750). Neither mother's consumption (β = .099, p = .450) nor connectedness (β = .024, p = .857) contributed significantly to the model. At step 2, the model remained non-significant (p = .025), and no moderation was apparent (β = -.131, p = .328). There were no direct or moderated effects of parental soda consumption on child soda consumption.

Discussion

Our study sought to determine the association between maternal obesity-related variables and their corresponding daughter's obesity-related variables, and also whether mother-daughter connectedness moderated these associations. The main finding of our study was that connectedness moderated the relationship between mother's BMI and daughter's BMI z-score, and the relationship between mother and daughter TV viewing. This finding supports our hypothesis arising from the Social Development Model that those children most connected to a socializing agent will bear most resemblance to that person. Girls who reported higher connectedness with their mother/female caregiver had relative weights and TV viewing amounts more similar to their moms than did children reporting lower connectedness. There were significant associations between mother's and daughter's eating while watching TV, and fruit and vegetable consumption behaviors, but level of connectedness did not moderate these relationships. Also, we did not find a significant main effect of maternal BMI on child BMI z-score. Although this relationship was hypothesized and frequently seen in previous studies, our null finding is also common in the literature. (24)

Critics of the Social Development Model would argue that children are not merely passive recipients of socialization, but rather are active contributors to the process, and likely are responsible for influencing the behaviors of parents to a substantial degree as well. Although the Social Development Model would suggest that parents with a high connection are particularly potent in shaping the behavior of their children, it is equally possible that the associations and moderation effects observed here could represent significant influences arising from the child and acting to bring parents to a greater level of resemblance to their children. Much more study

is needed with regard to influences on familial resemblance in BMI and related behavior, and the present study serves as just one starting point.

According to an energy-balance framework, the similarities between parents and children in body mass index should be due to behaviors related to obesity development or prevention. The results of our study suggest that television viewing, and perhaps by extension, sedentary behavior, could have played a role as the behavioral mechanism by which these higher-connected mother-daughter dyads were more similar in body mass index. Although we assessed many other behaviors shown to influence child weight status, we may not have assessed some important determinants (e.g., total energy intake). Beyond explaining similarity in mother-daughter dyads, we found un-moderated relationships between mother and daughter behavior for both fruit and vegetable consumption, which are protective against obesity, (3) and for television and eating while watching television, which are risk factors for obesity. (11) We also found direct relationships between connectedness and child TV viewing (inverse), and between connectedness and vegetable consumption (positive), showing that girls who feel more connected to their moms watch less TV and eat more vegetables than do less connected girls. Our study did not find significant direct mother-daughter behavior relationships for physical activity or soda/SSB consumption. The extant literature is clear that mothers are influential on the obesity-related behaviors of their daughters, (25) but less is known regarding the influence of daughters on their mothers. What our study adds is that the degree of connectedness between mothers and daughters may play an important role with regard to modeling of behavior, other social pressures, and amount of time spent together in shared activities or environments. Future studies could consider whether environmental aspects (e.g., fruit and vegetable

availability/accessibility) may operate additively or interactively with parent-child connectedness, using larger samples and perhaps longitudinal research designs.

Using the Social Development Model in the obesity-prevention literature is a novel application. To our knowledge, only one currently published study has tested the model in the area of nutrition or physical activity. This previous study (18) of parent and child physical activity after school showed a significant moderation effect by mother-daughter connectedness, such that those with higher connectedness were more similar in physical activity levels after school. The present study did not find a significant moderation effect in physical activity. It is noteworthy that our study differed from previous work as we assessed more global physical activity levels via different measures, in an all-girl sample of children. However, our study appears to be the first to show that mother-daughter connectedness influences the weight status and TV viewing similarity between mothers and daughters.

Along with the novel application of the Social Development Model, our study featured some other notable strengths. We obtained objective measurement of child BMI z-score, rather than relying on parental report or other less reliable indices of relative weight. We assessed parents and children separately with questionnaires, which should reduce bias from children being instructed how to respond, or feeling self-conscious about their responses, particularly for connectedness. Also, we were able to obtain anthropometric and questionnaire data from about 98% of the children in our target population of Girl Scout troops, offering a nearly complete and representative sample of this population. We were also able to obtain parent questionnaire data from about 90% of the girls, which is noteworthy in a community sample. Limitations of our study included our cross-sectional design, modest sample size, reliance on self-report measures,

and inability to obtain self-reported height and weight from several of the participating mothers (n = 5), presumably due to discomfort in disclosing this information.

Overall, our study makes a contribution to the literature by examining the associations between mothers' and daughters' key behavioral influences on weight status, and considering whether connectedness may help determine parent-child similarity in the development of obesity. Future work can use more rigorous behavioral measures in a larger and more diverse sample of children and parents to determine whether the present paper's findings generalize beyond our current sample. Longitudinal designs could help assess the degree to which resemblance comes from the influences of parents versus children, along with potential interactions between them.

Targeting parents and children's obesity prevention behaviors through interventions that promote parent-child connectedness could help to make healthful changes more sustainable. For children with less health-conscious parents, it may be important to promote obesity-prevention skills and healthful opportunities with adult leaders in environments modeling and supporting healthy behaviors. It may also be possible to influence mothers' behaviors through health promotion interventions directed at daughters, especially those who have high parent-child connectedness. Finally, overweight and obese parents may need socially marketed messages conveying the dire health consequences for children of parents who model poor dietary habits, sedentary lifestyle, and fail to provide obesity-preventive behavioral opportunities for their children.

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Tables & Figures

Table 1

Descriptive statistics for outcome and moderating variables

	Total Mean (SD)
Demographic Variables	
Percent parents are college graduates	52.1
Percent lower socio-economic status	31.9
Percent girls non-Hispanic Caucasian	77.0
Number of children in household	2.5 (1.0)
Girl's BMI	19.4 (3.4)
Girl's Age	10.5 (1.2)
Variables of Interest	
Mother-daughter connectedness scale (0-4)	3.4 (0.7)
Girl BMI z-score	0.45 (0.82)
Mother BMI	29.0 (6.9)
Girl days/week 60min MVPA (0-7)	4.4 (1.9)
Percent of mothers meeting MVPA standard	41.4
Girl TV watching time (hours/week)	13.5 (9.3)
Mother TV watching time (hours/week)	9.8 (7.2)
Girl eating while watching TV scale (0-4)	1.7 (0.8)
Mother eating while watching TV scale (0-4)	1.9 (0.9)
Girl fruit servings/day (0-4)	2.2 (1.2)
Mother fruit servings/day (0-4)	1.6 (0.9)
Girl vegetable servings/day (0-4)	2.0 (1.1)
Mother vegetable servings/day (0-4)	2.2 (1.0)
Girl Soda/SSB consumption scale (0-7)	2.8 (2.4)
Mother Soda/SSB consumption scale (0-7)	2.4 (2.6)

Note: SD = standard deviation; BMI = body mass index (kg/m^2);

MVPA = moderate-to-vigorous physical activity; TV = television;

SSB = sugar-sweetened beverages

Table 2

Hierarchical multiple regression analyses testing the relationship between seven mother and daughter variables

	β	R^2	ΔR^2
Child BMI Z-Score			
Step 1		.040	
Mother BMI	.142		
Connectedness	.159		
Step 2		.120	.080*
Mother's BMI x connectedness	.307*		
Child physical activity (child reported)			
Step 1		.039	
Mother met PA standard	.204		
Connectedness	.064		
Step 2		.078	.039
Mother MVPA x connectedness	-.241		
Child television viewing (mother reported)			
Step 1		.350*	
Mother television viewing	.351*		
Connectedness	-.367*		
Step 2		.394*	.044*
Mother TV x connectedness	.258*		
Child eating while watching TV (mother reported)			
Step 1		.228*	
Mother eating while watching TV	.468*		
Connectedness	.240		
Step 2		.229*	.001
Mother eating while watching TV x connectedness	-.039		
Child fruit consumption (child reported)			
Step 1		.142*	
Mother fruit consumption	.374*		
Connectedness	.007		
Step 2		.176*	.034
Mother fruit consumption x connectedness	.211		
Child vegetable consumption (child reported)			
Step 1		.158*	
Mother vegetable consumption	.243*		
Connectedness	.260*		
Step 2		.158*	.000
Mother vegetable consumption x connectedness	.014		
Child Soda/SSB consumption (child reported)			
Step 1		.009	

Mother Soda/SSB consumption	.099		
Connectedness	.024		
Step 2		.025	.016
Mother Soda/SSB consumption x connectedness	-.131		

Note: β = standardized regression coefficient; R^2 = multiple correlation squared; and ΔR^2 = change in squared multiple correlation. *p < .05

Figure 1. Moderation of relationship between mother BMI and daughter BMI Z-score