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Research Article

Early Childhood Overweight and Obesity In Multigenerational Households

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Abstract

This study explores the relationship between child weight status and grandmothers' coresidence up to age nine. Data is drawn from The Fragile Families and Wellbeing Study, a large nationally representative dataset of urban low-income families in the United States. Logistic regression estimates the association between grandmother coresidence and children's unhealthy weight status. Analyses were adjusted for child and mother characteristics, culture, race/ethnicity, SES, parenting practices, and built environment. Children who lived with a grandmother by age three were at increased odds of unhealthy weight levels, even after controlling for contributing factors. Grandmothers' influence on weight gain in three-year-old children appears to fade by age nine. Findings indicate that grandmothers' presence may present risks for the health of three-year-old children, and these risks should be further explored in future research. Explanations for this association are presented.

Keywords: childhood obesity, childhood overweight, multigenerational homes, grandmother coresidence

"Epidemic proportion" not only characterizes obesity prevalence among adults and adolescents, but even very young children (S. E. Anderson & Whitaker, 2009), especially those living in poverty (Irigoyen, Glassman, Chen, & Findley, 2008). Since 1980, obesity has more than doubled among preschool-aged children (Centers for Disease Control & Prevention [CDC], 2008). Twenty-one percent of preschool American children were overweight or obese in 2008 (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010), while almost half of a low-income sample of young children were overweight or obese by age three (Irigoyen et al., 2008). Overweight during preschool years also persists into adolescence and young adulthood (Janssen et al., 2005; Nader et al., 2006; Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008). Proponents of obesity prevention highlight early childhood as a critical stage during which overweight and obesity can develop (Freedman, Khan, Serdula, Ogden, & Dietz, 2006; Ogden et al., 1997; Sherry, Mei, Scanlon, Mokdad, & Grummer-Strawn, 2004; Singh et al., 2008; Strauss & Pollack, 2001; Whitaker & Orzol, 2006).

Many researchers who study obesity acknowledge that the family is an important environmental context for young children (Davison, Francis, & Birch, 2005; Hawkins, Cole, Law, & Group, 2009; Stein, Epstein, Raynor, Kilanowski, & Paluch, 2005). However, many studies of childhood obesity operationalize the "family" as parent-child interaction, overlooking how the family operates as a whole, which may include extended family (Birch & Ventura, 2009; Gibson, Byrne, Davis, Blair, Jacoby,

& Zubrick, 2007; Golan & Weizman, 2001). Obesity has yet to be studied from a family systems perspective that goes beyond the parent-child dyad to consider familial arrangements that include extended kin (Davison & Birch, 2001; Gruber & Haldeman, 2009). Such a perspective is especially appropriate given the changes in American family structures over the past few decades. U.S. Census data reveals that six percent of all children lived with a grandparent in 2008 (Child Trends, 2010). The present research aims to investigate the relationship between co-residence of grandmothers and the weight status among young grandchildren.

Limited research has examined grandmothers' influence on the health of young children living in poverty (Aubel, 2011). Pearce and colleagues (2010) addressed grandmothers' possible role in overweight children using an affluent British sample. The authors found that grandmother childcare was related to higher rates of being overweight among three year-olds. Neglecting relationships among extended family members may be a critical barrier to understanding unhealthy weight gain in children, particularly among disadvantaged populations. This paper examines early childhood excess weight and obesity through age nine in low-income families.

Theoretical Background

The biological process of weight gain is steeped in social context. Overweight is generated in part by interactions between biological susceptibility and environmental triggers (Marti, Martinez-Gonzalez, & Martinez, 2008). Therefore, a multi-contextual model is necessary to understand the complexity of this condition. Bronfenbrenner's bio-ecological model of human development best frames how we understand obesity, as it illustrates the interaction between

organisms and their surroundings (Bronfenbrenner & Morris, 1998). The child's own biology, embedded within certain family and community environments, may allow obesity to develop. Factors within the bio-ecological system frame our understanding about the causes of childhood obesity. These factors include child characteristics, culture and race/ethnicity, socioeconomic status, built environment, and parenting. Though not exhaustive, these factors are relevant for childhood obesity in multigenerational households. This study explores these variables across various contexts that are relevant for both childhood obesity within multigenerational households.

Culture and Race Ethnicity

Children of ethnic minorities are more likely to be obese (Bethell, Simpson, Stumbo, Carle, & Gombojav, 2010). At present in the U.S., Hispanic children are the most overweight or obese followed by African-American youth (Ogden, Carroll, Kit, & Flegal, 2014). Researchers suggest that ethnic minorities have different cultural ideals for body weight (Goodell, Pierce, Bravo, & Ferris, 2008; Kimbro, Brooks-Gunn, & McLanahan, 2007). African American and Hispanic mothers often consider an overweight baby a healthy baby (Rich et al., 2008; Syrad et al., 2014) and a thin baby a sign of deprivation and fragility (Baughcum, Burklow, Deeks, Powers, & Whitaker, 1998; Kaufman & Karpati, 2007). Even in a sample of children that included extreme cases of obesity, only 44% of African American parents or guardians identified their child's weight as a problem (Young-Hyman, Herman, Scott, & Schlundt, 2000). Hispanic and African-American children also engage in lower levels of physical activity than white children (Brodersen, Steptoe,

Boniface, & Wardle, 2007; Eaton et al., 2008), perhaps reflecting less concern about body weight in their cultures (Gordon-Larsen, McMurray, & Popkin, 2000). Eaton and colleagues (2008) report higher proportions of minority youth than Whites in inactivity levels, with up to a 36% difference between non-Hispanic Blacks' and Whites' sedentary behaviors. The present study uses a diverse sample, so that a cultural influence on childhood obesity in multigenerational homes can be identified.

Socioeconomic Factors

Regardless of ethnic background, higher educational attainment among parents is a protective factor against childhood obesity (Rasmussen et al., 2006). More educated parents tend to be more knowledgeable about healthy foods and appropriate portions for children. These parents are also more likely to eat healthier and follow pediatricians' dietary standards for feeding (Munoz, Krebs-Smith, Ballard-Barbash, & Cleveland, 1997; Rasmussen et al., 2006). Forty-four percent of children with parents educated at the graduate level complied with dairy product recommendations in one study, as opposed to 34% of children whose parents only had a high school education (Xie, Gilliland, Li, & Rockett, 2003).

In contrast to parents' education, the literature shows a positive association between maternal employment and child weight status (Cawley & Liu, 2012; Fertig, Glomm, & Tchernis, 2009). The rise of childhood obesity in America parallels that of women joining the work force. Labor force participation among American mothers with young children, in particular, has drastically increased since 1970, just as weight problems in children began to emerge in the U.S. (P. M. Anderson, Butcher, & Levine, 2003). One

study found that increased hours of maternal employment over the child's life course are associated with increased likelihood of being obese (P. M. Anderson et al., 2003). Researchers purport these associations are attributable to lack of time to prepare balanced meals, grocery shopping, and eating and playing with their children (P. M. Anderson et al., 2003; Cawley & Liu, 2012). Families with working mothers tend to consume fewer fruits, vegetables, and grains in exchange for "take out," pre-prepared convenience foods, or restaurant meals higher in fat (Lindsay, Sussner, Kim, & Gortmaker, 2006).

At the same time, many low-income parents believe it is less expensive to purchase such convenience foods that have less nutritional value or are unsatisfied with the cost of healthy food (ConAgra Foods Foundation, 2012; Davison & Birch, 2001; Williams, Abbott, Crawford, & Ball, 2012). These households often struggle with food insecurity, in which there is not enough money to provide sufficient or balanced meals for the family (Dubois, Farmer, Girard, & Porcherie, 2006; Robaina & Martin, 2013). Children from low-income homes also tend to have less diverse and lower quality diets than higher income children (ConAgra Foods Foundation, 2012; Drewnowski & Eichelsdoerfer, 2010; Wolfe & Campbell, 1993). This paper disentangles socioeconomic status by controlling for parental education, parental employment, and proxies of family income to explain a potential relationship between grandmother's presence and obesity in young children.

Built Environment and Child Lifestyle

Low SES families often cluster in economically depressed neighborhoods, which tend to foster poor eating habits. The concentration of fast food

restaurants continues to exist as supermarkets are less available in low-income minority areas (Sallis & Glanz, 2006; USDA Economic Research Service, 2009), which drastically limits parents' selection of healthy foods (Morland, Wing, Diez Roux, & Poole, 2002; USDA Economic Research Service, 2009). Residents who have restricted access to supermarkets consistently pay more for healthier food substitutions (Cheadle et al., 1991; USDA Economic Research Service, 2009; Walker, Keane, & Burke, 2010).

Compounding the risk fared by families with fewer food options, urban sprawl in America has significantly decreased children's opportunities for regular physical activity. Most children travel to and from school by car or bus instead of walking or biking. A nationally representative study reports only a generation ago, at least half of children walked or biked to school compared to less than 25% today (Beldon & Stewart, 2003; The National Center for Safe Routes to School, 2009). Due to increased distance from the home to school, most parents deem it unsafe for children to walk or bike because of hazardous walking routes or crime. Neighborhood violence also makes recreational activity outside the home a serious risk for child safety (Brown III, Pérez, Mirchandani, Hoelscher, & Kelder, 2008; Kumanyika & Grier, 2006; Nichol, Janssen, & Pickett, 2010). Less time outdoors usually translates into more time spent watching television or using computers in this day and age (Rahman, Cushing, & Jackson, 2011; Sallis & Glanz, 2006). Increased sedentary activity during "screen time" is a common risk factor for obesity among today's youth (Robinson, 1999; Wijga et al., 2010). The present paper attempts to capture the effect of built environment on obesity by gauging access to food

sources, and age-appropriate physical and sedentary activity in three-generation homes.

Parenting

While parents may have little control over the built environment in which they live, they are the primary architects of their home environment. Parents play an integral role in shaping children's food preferences (Birch, 1998; Scaglioni, Arrizza, Vecchi, & Tedeschi, 2011; Vereecken, Legiest, Bourdeaudhuij, & Maes, 2009). Exposure to healthy foods early in life increases children's preferences for those foods while limited exposure to healthy foods increase children's liking for prohibited foods. Parents' tendency to restrict junk food, for instance, can ultimately cultivate a penchant for low-nutrient snacks in children (Birch, 1998, 1999; E. L. Gibson et al., 2012). Research suggests that affective contexts in which children experience food greatly influence their preferences. Children learn to prefer foods served in a positive social atmosphere (E. L. Gibson et al., 2012). Parenting strategies can also influence children's capacity to self-regulate food intake. When given the opportunity to eat a food that is normally prohibited, children tend to eat more than necessary (Joyce & Zimmer-Gembeck, 2009; Savage, Fisher, & Birch, 2007). Restricting foods then shifts focus away from internal cues, like hunger or satiety, toward external cues like palatability and availability (Birch & Fisher, 1998; Joyce & Zimmer-Gembeck, 2009; Scaglioni et al., 2011).

Parents control other aspects of their home environment that impact energy expenditure, such as cognitive stimulation, physical activity, and sedentary behavior. Children in homes with low cognitive stimulation are at increased risk of obesity. High levels

of television viewing, also linked to the occurrence of obesity in children (Boulos, Vikre, Oppenheimer, Chang, & Kanarek, 2012; Dietz & Gortmaker, 1985; Zimmerman & Bell, 2010), is a good indicator of low cognitive stimulation, more sedentary behavior, and little physical activity (LeBlanc et al., 2012; Strauss & Pollack, 2001). Engaging children in public outings, to museums or the zoo for instance, are sources of cognitive stimulation and opportunities for exercise (Kimbro et al., 2007).

Children also tend to model parents' behaviors, which include eating and exercising habits. In addition to shared genetic factors, modeling could explain consistent links found between parental obesity and child obesity, especially for mothers (Crawford et al., 2010; Klohe-Lehman et al., 2007; Oliveria et al., 1992; Stang & Loth, 2011). Fathers' weight status is less often associated with children's weight (Hood et al., 2000). Having two obese parents presents abundant risk beyond genetic predisposition for overweight in children (Mamun, Lawlor, O'Callaghan, Williams, & Najman, 2005). This study uses the convention of controlling for mothers' weight status as a proxy for an unhealthy home environment and genetic influence. Mothers' weight coupled with other parenting practices and health behavior controls, may help elucidate the process of young children's weight gain in multigenerational family context.

The study reported adjusts for child and mother characteristics, culture, race/ethnicity, SES, parenting practices, in addition to factors that are linked to childhood obesity including mother's health and health behaviors, child lifestyle, and built environment in order to explore how the experience of living with a grandmother influence overweight and obesity in children.

Method

Sample

The sample for this paper draws from the Fragile Families and Child Wellbeing Study, a nationwide birth cohort longitudinal study designed to track the life experiences of families at risk of adverse circumstances for children, including single parenthood and poverty. Purposive oversampling of children born to unmarried parents, roughly 75%, aims to capture family "fragility," as unmarried parents are more likely to be minority and low-income. The Fragile Families Study follows almost 5,000 babies born between 1998 and 2000 in 20 large U.S. cities of 200,000 or more (Reichman, Teitler, Garfinkel, & McLanahan, 2001a).

Mothers and fathers were interviewed at the focal child's birth, and later at ages one, three, five, and nine, totaling five waves of publicly available data. Enrollment began in 1998 and concluded with Wave 5 in 2010. Nearly all maternal interviews were conducted in person at enrollment, while 30% were administered by phone at one year and 98% by phone at years three and five (Bendheim-Thoman Center for Research on Child Wellbeing, 2008). The year-9 follow-up was primarily completed by telephone (Bendheim-Thoman Center for Research on Child Wellbeing, 2011). Parent interviews covered their mental and physical health, and socioemotional and socioeconomic resources. A subset (no less than 70% of the original sample) completed in-home interviews assessing home environment, child health and development at three-year, five-year, and nine-year follow ups. There were no significant differences between those who did and did not complete the in-home interview (Reichman, Teitler, Garfinkel, & McLanahan, 2001b). Data used in the present study are

derived from mother interviews in waves one through five and in-home assessments on non-Hispanic White, non-Hispanic Black, and Hispanic children who have valid information for the child weight status outcome. After excluding those children whose mothers identified as "other" ethnicities, the final sample of children with valid height, weight, and grandmother coresidence data for five waves summed to 3,101.

Measures

Weight status. Child weight status is assessed by calculating Body Mass Index [BMI = weight (kg) / height $(m)^2$], based on height and weight measurements at ages three, five, nine. Measurements were taken by trained interviewers using digital scales during the in-home survey. If the child was not able to be weighed alone, the mother was weighed while holding the child and her individual weight was subtracted from that amount. Mothers' BMI calculations are based on actual height and weight measurements unless they were pregnant, in the two pilot cities, or refused to be measured. BMI was not calculated with any self-reported values, which were excluded from analysis (N=701).

Children's gender-specific BMI-for-age percentile is categorized: normal weight ranging from fifth to 85th percentile. High weight is typically split into two categories: overweight (85th to 94th percentile) and obese ($\geq$ 95th percentile) (Barlow & The Expert Committee, 2007). Consistent with standard practice in the field (Ogden et al., 2014), this paper tests a larger range of risk by combining overweight and obesity (at or above 85th percentile) in the dependent variable as both levels are detrimental to child health (Paxson, Fink, & Brooks-Gunn, 2005). Mother's weight status, a critical indicator of shared

genetics and unhealthy home environment, is similarly categorized into overweight (25th to 29th percentile) and obese (at or above 30th percentile). These two adult categories remain separate covariates in the models presented here.

Grandmother coresidence. The primary independent variable of interest is whether or not a grandmother has ever lived in the same household as the child during his/her first nine years of life. Three dichotomous variables were created: ever coresided by age 3, ever coresided by age 5, and ever coresided by age 9. Another predictor variable estimates the duration of grandmother coresidence ranging from zero to nine years.

Child characteristics. Child gender, age in months, and low birth weight status are held constant in the analysis. First-born children are identified by a dummy variable in the model to account for new parents who might be more inclined to rely on grandmothers for support.

Mother characteristics. Mother's race was specified as non-Hispanic White, non-Hispanic Black, and Hispanic based on mother's self-report. To further capture cultural influences, mother's immigrant status is defined as foreign-born or not. Mother's age at first birth is included to tease out young first-time mothers who may have previously, if not at the time of measurement, selected into coresidence in need of grandmother's help. Mother's relationship status with the baby's father for years three, five, and nine is also held constant.

Socioeconomic factors include mothers' educational attainment, employment status, and receipt

of Supplemental Nutrition Program for Women Infants and Children (WIC) benefits. Income-to-needs ratios were calculated based upon family size and household income, with 1 or less indicating poverty (Sebelius, 2011). A food insecurity scale was also used to create an indicator variable of financial strain that caused hunger or compromised nutritional intake in the household. Mothers were asked 15 questions about how money affected the frequency, size, and nutritional quality of their family's meals. If they answered yes to at least three of the 15 questions their household was classified as "food insecure" (Bendheim-Thoman Center for Research on Child Wellbeing, 2008; Kimbro et al., 2007). This measure was only available for the third and fifth-year interviews.

Maternal health status and health behaviors that influence child health (i.e. genetic influence, modeling poor diet and low activity, etc.) are accounted for with mother's weight status, in addition to whether or not she smoked during pregnancy, a predictor of persistent unhealthy weight for the offspring (Oken, Levitan, & Gillman, 2008), and duration of breastfeeding. The breastfeeding covariate is divided around a threshold of four months, a critical point at which nursing yields protective effects for childhood obesity (Burdette & Whitaker, 2007).

Mothers' emotional wellbeing is derived from 12 questions on a parental stress scale that assessed parents' feelings in various areas of life including sense of control and satisfaction ($\alpha = 0.77$). These questions were drawn from the Early Head Start Study in addition to some that were created for the Fragile Families study. Responses were made on a likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). Once the questions were summed from zero

to 12, mothers were coded as highly stressed if they ranked one standard deviation above the mean.

Parenting Practices. Parenting variables attempt to measure the extent of sedentary behavior, physical activity, and cognitive stimulation in which the child is engaged at age 3. These include allowing a child to take a bottle to bed, the number of hours a child watches television per day, and the number of public outings (i.e. to the zoo, museum, etc.) a child is taken on per week. The most regular child care arrangement is also included.

Child's lifestyle. Measures similar to those described in parenting practices were included in year-five models to illustrate a more age-appropriate picture of children's lifestyle. The total number of hours per week children spent away from home in school/structured care and the number of hours playing outdoors on a typical weekday and weekend day are measured as a continuous variable, while the number of hours children spent doing sedentary activities (e.g., watching TV, playing video games, using computer, etc.) on a typical weekday and weekend day was trichotomized (i.e., 0-1 hour, 2-4 hours, or $\geq$ 5 hours).

Built environment. Controls for access to food are seen as proxies for family diet. Respondents were asked to identify their most common sources of food shopping, such as a grocery store/supermarket or smaller store (e.g., corner store, convenience store, or bodega). Limited access to grocery stores was also operationalized as a dummy variable for usual mode of transportation to do food shopping (Kimbro et al., 2007).

Analytic Plan

Bivariate analysis of the dependent and independent variables and the universal grandmother coresidence predictor was conducted using t-tests and chi-square tests whenever appropriate. Multivariate analyses for weight outcomes at 3 years of age included six models of covariates that are associated with childhood obesity and/or grandmother coresidence, whereas the analyses for age 5- and 9-year outcomes included five and four models of covariates respectively. (Fewer models in subsequent years reflected the variables measured and/or availability of data in these waves.) The literature, reviewed above, guided how covariates were grouped into models, in addition to previous work with this dataset (Kimbro et al., 2007). Logistic regression was used to determine the influence of grandmother coresidence on childhood weight status with "overweight or obese" as the dependent variable. Children who have never resided with their grandmother comprised the reference group for the "ever coresided with grandmother" predictor. Logistic regression examined the effect of duration of grandmothers' coresidence as a continuous variable on child weight status. Logistic regression was also used to test the year in a child's life during which coresidence occurred (i.e., 1st year, 2nd year, 3rd year, etc.). These timing predictors are compared to other children who have never experienced coresidence. Analyses were performed using STATA 10.

Results

Descriptive Statistics

Characteristics of the sample are presented in Table 1. Half of the sample (n=1,824) were "coresiders," or children who lived with their grandmother for some time during their first nine years

of life, for a little under one year on average. Though most children in the total sample (63%) had a healthy weight, 37% were overweight or obese by three years old. By nine-years old the proportion of overweight or obese rose to 43% of all children. Half of coresiders (n=912) were first-born children. Most coresiding mothers were Black (55%) or Hispanic (29%). Sixty percent of coresiding mothers were single parents, which ultimately increased to 74% by age nine. On average, coresiding mothers were 20-years-old at their first birth, had less than a high school education when the child was born, lived in poverty, and received WIC during the baby's first year.

Attrition analysis shows slightly more Hispanic ethnicity, marriage, and college education with substantially less WIC participation among mothers who identified as "other" ethnicities or were missing child weight status and/or coresidence information. The resulting sample with valid data, therefore, appears to represent lower socioeconomic status, which corresponds with the Fragile Family Study's intended sample design (Reichman et al., 2001b).

Table 1

Descriptive Statistics for Fragile Families Study 2 Variables by Grandmother Residence

	Total Sample	**Ever Resident Grandmother**	**Never Resident Grandmother**
	%, M (SD)	*%, M (SD)*	*%, M (SD)*
Grandmother Coresidence		50	50
Number of Yrs Lived w/grandmother	--	0.78 (1.49)	--
Child's Weight Status			
Healthy weight, 3yrs	63	61	64

Overweight, 3yrs	18	18	18
Obese, 3yrs	19	21	18
Overweight/Obese, 3yrs	37	39	36
Healthy weight, 5yrs	64	63+	65
Overweight, 5yrs	18	18	18
Obese, 5yrs	18	19	16
Overweight/Obese, 5yrs	36	37	34
Healthy weight, 9yrs	57	56	58
Overweight, 9yrs	17	16	18
Obese, 9yrs	26	28*	24
Overweight/Obese, 9yrs	43	44	42
Child's Characteristics			
Child is a boy	52	53	52
Low birthweight	10	11+	9
First born	38	50***	30
Mother's Background Characteristics			
(White)	22	16***	29
Black	50	55	48
Hispanic	28	29	23
Immigrant	17	13	14
Age at first birth	21.57 (5.24)	20.30 (4.25)***	22.43 (5.68)
(Nonresident baby's father, 3yrs)	46	60***	37
Cohabing w/ baby's father, 3yrs	22	22	21
Married to baby's father, 3yrs	32	18	42
(Nonresident baby's father, 5yr)	55	68***	45
Cohabing w/ baby's father, 5yr	14	25	14
Married to baby's father, 5yr	31	18	41
(Nonresident baby's father, 9yr)	62	74***	52
Cohabing w/ baby's father, 9yr	9	9	9
Married to baby's father, 9yr	29	17	39
Mother's SES %			
Less than high school, birth	35	41***	27
(Completed high school/GED, birth)	30	32	30
Some college, birth	24	22	27
College or beyond, birth	11	5	16
Less than high school, 9yr	22	25***	18
(Completed high school/GED, 9yr)	21	22	20
Some college, 9yr	41	43	41
College or beyond, 9yr	16	10	21
Mother is employed, 3yr	56	55**	60
Mother is employed, 5yr	59	58*	62
Mother is employed, 9yr	62	61*	64
Poor, 3yr	42	48***	36

Poor, 5 yr	41	47***	36
Poor, 9yr	37	42***	33
Food Insecurity, 3yr	17	17	16
Food Insecurity, 5yr	15	15	15
Participated in WIC at yr 1[a]	73	81***	68
Mother's Health & Health Behaviors			
(Healthy weight, 3yr)	31	31	31
Overweight, 3yr	27	26	27
Obese, 3yr	42	43	42
(Healthy weight, 5yr)	28	29+	26
Overweight, 5yr	29	27	31
Obese, 5yr	43	44	43
(Healthy weight, 9yr)	63	61***	38
Overweight, 9yr	13	12	22
Obese, 9yr	24	27	40
High stress level, 3yr	17	17	16
High stress level, 5yr	14	14	14
Smoked during pregnancy	20	21**	17
(Never breastfed)	43	48***	39
Breastfed < 4 months	29	30	29
Breastfed ≥ 4 months	28	22	32
Parenting Characteristics, 3yr			
Takes bottle to bed	7	7	7
(At-home care by parent)	41	37**	42
In-home childcare	30	35	29
Center-based childcare	29	28	29
(Child watches TV 0-1 hrs/day)	20	17***	24
Child watches TV 2-4 hrs/day	59	60	58
Child watches TV ≥ 5 hrs/day	21	23	18
(Child takes 0 public outings/wk)	39	40	37
Child takes 1-2 public outings/wk	52	51	53
Child takes ≥ 3 public outings/wk	9	9	10
Child Lifestyle, 5yr			
Hrs/wk in school or childcare center	29.16 (11.97)	30.44 *** (11.37)	28.06 (12.34)
(Sedentary activity 0-1 hrs/wkday)	20	17***	24
Sedentary activity 2-4 hrs/wkday	57	56	56
Sedentary activity ≥ 5 hrs/wkday	23	27	20
(Sedentary activity 0-1 hrs/wkend	13	11**	14
Sedentary activity 2-4 hrs/wkend	42	38	45
Sedentary activity ≥ 5 hrs/wkend	45	51	41
Hrs of outdoor play/wk day	2.05 (1.90)	2.13 (2.02)***	2.06 1.86)
Hrs of outdoor play/wkend day	3.24 (2.40)	3.36 (2.55)***	3.22 (2.30)
Built Environment, 3yr			
Doesn't shop at grocery	5	4	4
Walks/taxi/bus to shop at grocery	28	31***	22

N	3652	1824	1828

[1]+ p<.10; *p<.05; **p<.01; ***p<.001from chi-square or t-tests for differences between Ever Lived w/Grandmother and Never Lived w/Grandmother (two-tailed tests); Parentheses indicate reference category
[a]WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

Multivariate Analyses

Logistic regression analyses revealed an increased risk of childhood overweight and obesity in homes where grandmothers reside. Table 2 presents odds ratios for whether or not a child had ever lived with a grandmother by age three, regressed on overweight and obesity in three-year-old children. Children from multigenerational homes were more likely to be overweight or obese than those who never lived with a grandmother after adjusting for all covariates (1.47, p<0.01). Covariates in models 2-6 were linked with overweight/obesity at age 3 as expected. Notably, none of the factors that demonstrated an association with child weight status diminished the link between grandmother coresidence and child weight status at age three.

Table 2

Logistic Regression of Overweight & Obesity in 3 year-olds by Grandmother Coresidence

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
GM Coresidence by 3yrs	1.225*	1.267*	1.331**	1.414*	1.439**	1.467**
	(0.111)	(0.120)	(0.142)	(0.190)	(0.198)	(0.202)
Child Characteristics						
Male		0.922	0.919	0.935	0.939	0.950

	(0.0825)	(0.0864)	(0.112)	(0.116)	(0.118)
Child age in months	1.042*	1.045*	0.998	0.995	0.997
	(0.0194)	(0.0210)	(0.0317)	(0.0318)	(0.0322)
Low birthweight	0.618**	0.711*	0.701	0.684	0.684
	(0.105)	(0.122)	(0.162)	(0.159)	(0.158)
First born	0.936	0.829+	0.932	0.949	0.946
	(0.0890)	(0.0871)	(0.127)	(0.133)	(0.133)
Mother Characteristics					
Background Characteristics					
Black		0.956	0.785	0.817	0.811
		(0.134)	(0.138)	(0.151)	(0.151)
Hispanic		1.819**	1.763**	1.780**	1.804**
		(0.290)	(0.353)	(0.366)	(0.373)
Immigrant		1.115	0.820	0.694	0.645+
		(0.187)	(0.194)	(0.168)	(0.159)
Age at first birth		1.006	1.004	0.999	0.999
		(0.0124)	(0.0162)	(0.0163)	(0.0164)
Cohab w/baby's father		1.030	0.954	0.917	0.916
		(0.115)	(0.136)	(0.134)	(0.134)
Married to baby's father		0.844	0.753	0.734	0.741
		(0.132)	(0.157)	(0.155)	(0.157)
Socioeconomic Status					
Less than HS education		0.990	0.885	0.870	0.868
		(0.119)	(0.136)	(0.138)	(0.138)
Some college education		1.005	0.952	0.963	0.980
		(0.134)	(0.161)	(0.165)	(0.168)
College and beyond		1.021	1.061	0.969	0.983
		(0.231)	(0.292)	(0.281)	(0.288)
Working		1.215+	1.361*	1.590**	1.609**
		(0.123)	(0.177)	(0.236)	(0.239)
Poor		0.894	0.983	0.975	0.966
		(0.101)	(0.142)	(0.144)	(0.145)
Food Insecurity		1.053	1.030	1.018	1.009

	(0.132)	(0.168)	(0.168)	(0.167)
WIC participation	0.803+	0.723*	0.719*	0.724*
	(0.102)	(0.115)	(0.117)	(0.119)
Health & Health Behaviors				
Mom overweight		1.268	1.299	1.303
		(0.211)	(0.221)	(0.223)
Mom obese		1.803**	1.805**	1.789**
		(0.274)	(0.282)	(0.281)
High stress level		1.184	1.250	1.262
		(0.200)	(0.216)	(0.219)
Smoked during pregnancy		0.916	0.924	0.922
		(0.149)	(0.152)	(0.152)
breastfed < 4months		1.121	1.133	1.132
		(0.170)	(0.174)	(0.175)
breastfed > 4months		1.151	1.157	1.157
		(0.184)	(0.192)	(0.193)
Parenting Characteristics				
Child takes bottle to bed			2.777**	2.745**
			(0.667)	(0.667)
In-Home childcare			0.769	0.775
			(0.128)	(0.130)
Center-based childcare			0.774	0.772
			(0.130)	(0.130)
Child watches TV2-4 hrs/day			0.965	0.952
			(0.153)	(0.151)
Child watches TV >5 hrs/day			0.795	0.782
			(0.159)	(0.157)
Child takes 1-2 outings/wk			1.130	1.144
			(0.152)	(0.154)
Child takes>3 outings/wk			0.952	0.991

					(0.208)	(0.217)
Built Environment						
Doesn't shop at grocery store						1.935+
						(0.674)
Walks/Taxi/Bus to grocery shop						1.041
						(0.162)
Observations	2,235	2,163	2,021	1,332	1,304	1,301
Pseudo R-squared	0.0300	0.0932	0.0859	0.465	0.586	0.524

Note. Odds ratios are presented. Standard errors are in parentheses. WIC = Special Supplemental Nutrition Program for Women, Infants and Children. + p<.10; *p<.05; **p<.01; ***p<.001.

Grandmother coresidence during the first three years demonstrated limited long-term associations with child's overweight and obesity status at ages five and nine. Models 2 and 3 in Table 3 show an increased likelihood of overweight or obesity at age five if the child ever lived with a grandmother by age three. These models highlight the same child and mother characteristics that were emphasized in the first regression, including lower odds for low birthweight, first born, and poverty, but higher odds among Hispanic children. As for overweight and obesity at age nine, only one model in Table 4 exhibits a significant link to coresidence by age three. Controlling for child characteristics yielded a modest increase in the likelihood of unhealthy weight at nine years old that approaches statistical significance (1.16, $p<0.10$). Unlike previous models, boys showed decreased odds for being overweight or obese at age nine ($p<0.05$).

Table 3

Logistic Regression of Overweight & Obesity in 5 year-olds on Grandmother Coresidence by Age 3

	Model 1	Model 2	Model 3	Model 4	Model 5
Grandmother Coresidence by 5yrs	1.141	1.186+	1.250*	1.157	1.043
	(0.110)	(0.120)	(0.139)	(0.155)	(0.162)
Child Characteristics					
Male		0.924	0.932	0.988	0.871
		(0.0874)	(0.0918)	(0.118)	(0.121)
Child age in months		1.007	0.991	1.004	1.012
		(0.0199)	(0.0205)	(0.0252)	(0.0302)
Low birthweight		0.702*	0.736+	1.029	1.071
		(0.121)	(0.130)	(0.227)	(0.272)
First born		0.873	0.807+	0.814	0.751+
		(0.0884)	(0.0887)	(0.110)	(0.116)
Mother Characteristics					
Background Characteristics					
Black			1.009	0.837	0.844
			(0.144)	(0.148)	(0.187)
Hispanic			1.346+	1.322	1.221
			(0.221)	(0.263)	(0.293)
Immigrant			1.282	1.261	1.215
			(0.234)	(0.283)	(0.323)
Age at first birth			1.014	1.014	1.012
			(0.0131)	(0.0157)	(0.0175)
Cohab w/baby's father			0.976	0.867	0.800
			(0.142)	(0.151)	(0.167)
Married to baby's father			0.861	0.680*	0.661*
			(0.117)	(0.113)	(0.128)
Socioeconomic Status					
Less than HS education			1.024	1.002	0.929
			(0.128)	(0.155)	(0.172)
Some college education			0.952	0.782	0.760

	(0.130)	(0.129)	(0.141)
College and beyond	0.753	0.728	0.833
	(0.176)	(0.207)	(0.257)
Working	1.065	1.031	1.053
	(0.114)	(0.133)	(0.163)
Poor	0.779*	0.713*	0.762
	(0.0917)	(0.102)	(0.128)
Food Insecurity	1.173	1.246	1.275
	(0.161)	(0.206)	(0.246)
Health & Health Behaviors			
Mom overweight		1.356+	1.309
		(0.230)	(0.260)
Mom obese		2.712**	2.893**
		(0.421)	(0.525)
High stress level		0.729+	0.669+
		(0.134)	(0.149)
Smoked during pregnancy		1.031	1.017
		(0.163)	(0.191)
Breastfed < 4months		1.171	1.243
		(0.176)	(0.215)
Breastfed > 4months		1.245	1.209
		(0.203)	(0.228)
Child's Lifestyle			
Hrs in school or center/wk			1.002
			(0.00614)
Sedentary 2-4hrs/weekday			0.982
			(0.184)
Sedentary >5hrs/weekday			1.041
			(0.255)
Sedentary 2-4hrs/weekend			1.065
			(0.244)
Sedentary > 5hrs weekend			1.400
			(0.339)
Hrs of outdoor play/ weekday			0.995
			(0.0494)

Hours of outdoor play weekend					1.045
					(0.0390)
Observations	2,004	1,947	1,825	1,357	1,021
Pseudo R-Squared	0.0310	0.482	1.030	0.343	0.215

Note. Odds ratios are presented. Standard errors are in parentheses. WIC = Special Supplemental Nutrition Program for Women, Infants and Children. + p<.10; *p<.05; **p<.01; ***p<.001.

Table 4

Logistic Regression of Overweight & Obesity in 9 year-olds on Grandmother Coresidence by Age 3

	Model 1	Model 2	Model 3	Model 4
Grandmother Coresidence by 3yrs	0.12	1.156+	1.125	1.167
	(0.076)	(0.0933)	(0.101)	(0.136)
Child Characteristics				
Male		0.829*	0.802**	0.853
		(0.0628)	(0.0638)	(0.0893)
Child age in months		1.011	1.005	1.020
		(0.00885)	(0.00956)	(0.0143)
Low birthweight		0.734*	0.712*	0.817
		(0.0983)	(0.0983)	(0.145)
First born		0.938	0.896	0.821+
		(0.0751)	(0.0792)	(0.0962)
Mother Characteristics				
Background Characteristics				
Black			1.477**	1.207
			(0.167)	(0.183)
Hispanic			1.556**	1.440*
			(0.208)	(0.260)

Immigrant			1.148	1.306
			(0.166)	(0.271)
Age at first birth			1.019*	1.030*
			(0.00966)	(0.0132)
Cohab w/baby's father			1.251	1.282
			(0.178)	(0.227)
Married to baby's father			0.861	0.775+
			(0.0896)	(0.109)
Socioeconomic Status				
Less than high school education			0.831	0.899
			(0.105)	(0.147)
Some college education			0.738**	0.776+
			(0.0784)	(0.109)
College or beyond			0.509**	0.593**
			(0.0754)	(0.116)
Working			1.042	1.073
			(0.0915)	(0.123)
Poor			0.827*	0.805+
			(0.0783)	(0.0986)
Health & Health Behaviors				
Mom overweight				1.383*
				(0.202)
Mom obese				2.074**
				(0.262)
Smoked during pregnancy				1.000
				(0.139)
Breastfed < 4 months				0.982
				(0.128)
Breastfed > 4 months				0.807
				(0.112)
Observations	3,050	2,859	2,657	1,595
Pseudo R-Squared	0.046	0.249	0.388	0.0628

Note. Odds ratios are presented. Standard errors are in parentheses. WIC = Special Supplemental Nutrition Program

for Women, Infants and Children. + p<.10; *p<.05; **p<.01; ***p<.001.

Having ever coresided with a grandmother by age five had almost the exact same association with unhealthy weight at 9 years old as the age three predictor (data not shown). Odds slightly increased for overweight and obesity at age nine (1.16, p<0.10) only when controlling for child characteristics. There was no evidence of unhealthy weight at age nine for children who lived with their grandmothers at nine years old.

A dosage effect was also tested, in which the total number of years a grandmother has lived in the household was regressed on overweight and obesity for each child (data not shown). A dosage effect up to year three is revealed with the same regression models 1 through 6 as those in presented in Table 2. Results indicate that every additional year of grandmother coresidence up to age three was associated with increased odds of child overweight and obesity at three years old with full adjustments (1.13, p<0.05). Other associations with covariates were similar to the series of regressions in Table 2. Again, the dosage association is not explained by any of the covariates and remains significant in the full model. A dosage effect was not found for grandmother coresidence through nine years.

Developmental timing, or the year in a child's life during which coresidence occurred, was also explored (data not shown). Coresidence at each wave up to age three was tested because previous models indicate these first three waves as most predictive. Findings show that coresiding with a grandmother during the first year of life was linked to increased odds (1.35, p<0.05) of becoming overweight or obese at three years old compared children who experienced coresidence in other years when child and mother's background characteristics are held constant.

Discussion

The results from the present study illustrate the importance of considering the extended family system within a bio-ecological model when investigating the phenomenon of early childhood obesity. Findings indicate that disadvantaged young children in America who have ever lived with a grandmother are at a substantially increased risk of obesity at age three, an association that has not been found in the literature to date. Grandmother's presence during the first year of life is particularly associated with overweight children at age three compared to other children who experienced coresidence with grandmothers. The longer a child lives with a grandmother, the greater the likelihood of an unhealthy weight status at three years old. These associations diminish by age nine, which suggests that the timing and sequence of contextual experiences may only affect the development of obesity in very early childhood.

These findings support other research that notes recent changes in normative growth trajectories among young children (Rolland-Cachera, Deheeger, Maillot, & Bellisle, 2006). Typically after the first year, BMI decreases until ages 5 to 7, at which point it begins to increase again. Adiposity rebound refers to the period where BMI increases after reaching its lowest point. Studies show earlier adiposity rebound, between ages 3 and 6, is occurring more often and is a strong predictor of overweight in adulthood (Rolland-Cachera et al., 2006). Grandmother coresidence may not only contribute to the premature occurrence of adiposity rebound, but may also reduce the nadir of their growth curve. In other words, children in multigenerational homes may not become as lean as they should before their BMI begins to increase. This phenomenon further emphasizes a discrete and unique time period early in life that is critical for shaping lifelong health trajectories.

Notably, the link between grandmother coresidence and child unhealthy weight at age three was robust to characteristics of the child, mother, parenting, and built environment in the logistic regression. Though none of these factors explained the link between grandmother coresidence and child weight, many of the findings align with existing obesity research.

What could be driving this grandmother association? Selection into multigenerational households is one plausible explanation. In this sample, mothers living with grandmothers appear to be more vulnerable as they tend to be new mothers, younger, Black, single, less educated, poor, or eligible for public aid; all of which are risk factors for unhealthy child weight status. Perhaps these characteristics also demonstrate more need for grandmothers' assistance. Inexperienced young, less educated, or first-time mothers may not know how to provide a healthy start for their child's life (Aubel, 2011; Xie et al., 2003), and thus, rely on grandmothers parenting knowledge. Poor mothers seeking financial stability may decide to live with grandmothers for financial support (Simmons & O'Neill, 2001; Wightman, Patrick, Schoeni, & Schulenberg, 2013), or may be limited to inexpensive low-nutrient foods for their family (Drewnowski & Eichelsdoerfer, 2010; Dubois et al., 2006). Both Black and single mothers tend to turn to grandmothers for parenting assistance (Cohen & Casper, 2002; Luo, LaPierre, Hughes, & Waite, 2012), but there is also evidence of increased obesity in their children (Huffman, Kanikireddy, & Patel, 2010). Although these markers of vulnerability were controlled for in all analytic models, there may also be unmeasured variables associated with grandmother coresidence that are operating.

One such unmeasured aspect of vulnerability is conflict. Extended households likely involve a diffusion of responsibility that can give rise to a power struggle

between the mother and grandmother, leading to conflict (Chase-Lansdale, Gordon, Coley, Wakschlag, & Brooks-Gunn, 1999; Glassman, Figueroa, & Irigoyen, 2011). Such discord may involve disagreement and/or miscommunication about appropriate feeding methods (Glassman et al., 2011), which could potentially lead to overfeeding and might foster unhealthy food associations for the child. Moreover, the presence of conflict in and of itself may create a stressful environment for children, which in turn, can affect their eating habits and the way their bodies process food. Studies show that social stress can ultimately result in insulin resistance and central obesity through activation of the sympathoadrenal system (Innes, Vincent, & Taylor, 2007; Li, Li, Zhou, & Messina, 2013; Seematter, Binnert, & Tappy, 2005).

Other family process theories specific to parenting could be at work in multigenerational households. Because parenting is critical for shaping children's food preferences and their ability to self-regulate food intake (Benton, 2004; Birch & Fisher, 1998; Patrick, Nicklas, Hughes, & Morales, 2005; Scaglioni et al., 2011), poor parenting could be a potential pathway. Both mothers' and grandmothers' exhibit less positive parenting skills and knowledge in situations of prolonged coresidence (Chase-Lansdale et al., 1999; Gordon, Chase-Lansdale, & Brooks-Gunn, 2004; Scaramella, Neppl, Ontai, & Conger, 2008; Wakschlag, Chase-Lansdale, & Brooks-Gunn, 1996). Mothers who lack parenting skills might not learn how to respond appropriately to infants' cues of hunger or satiety or might rely on food as a parenting tool to placate a crying child for lack of an alternative solution through toddlerhood. Further research should measure parenting capacity and practice in three-generation homes to explore this theory.

One could also speculate about generational mechanisms that foster overweight and obesity in young children. Grandparents are infamous for "spoiling"

grandchildren (Cherlin & Furstenberg, 1986; Fuller-Thomson, Serbinski, & McCormack, 2014; Ross, Hill, Sweeting, & Cunningham-Burley, 2005). There is a common tendency for grandparents to indulge their grandchildren in the pleasures of life, which includes food. Grandmothers who ascribe to the American tradition of spoiling kids, may feed their grandbabies too often or introduce solids or unhealthy foods too soon. Furthermore, feeding babies is a natural and common way of bonding with a young child. Therefore, it is reasonable to assume that more women in the household with the desire to nurture a baby may result in over feeding the child as well.

Healthy feeding standards have also changed from generation to generation (Barnes, 1987; Davis & Saltos, 1999). Consequently, grandmothers may not be aware of current doctor recommendations or may simply disagree with them in favor of "old school" customs. Such an association could indicate that supplementation is occurring. Older generations might also consider heavier babies healthier. In terms of physical activity, grandmothers could simply be physically unable to be active with young children. Engaging in more sedentary activities with the grandmother may foster an inactive lifestyle that can lead to children's unhealthy weight status. Future work should explore potential generational factors existing in extended households that may influence overweight and obesity during early childhood.

These proposed mechanisms may explain the short-term grandmother effect, but does not clarify why grandmother's influence on child weight status fades over time. One simple reason may be that most coresident grandmothers in this sample moved out of their grandchild's household in later waves. Of those grandmothers who coresided with their grandchild at some point during the first three years, only 23% and 14% remained in the household by ages 5 and 9 respectively.

Another possibility to consider is that the potential mechanisms that caused a short-term effect (e.g. conflict, poor parenting, etc.) may improve over time. Perhaps mothers who were initially less confident in their parenting, gain confidence with every year of practice or learn how to co-parent more effectively. Interestingly, the proportion of obese mothers in multigenerational households declines by age 9 compared to those who did not live with a grandparent (Table 1), suggesting that the family could be becoming healthier also.

Characteristics of the distinct developmental periods measured may give insight into why grandmother influence wanes. Preschool-age and school-age are qualitatively different developmental stages that may implicate grandmothers' involvement in different ways. When children begin school, they become more exposed to different contexts. Influences outside the home including peers and teachers (Davison & Birch, 2001b; Ross et al., 2005) may compete with grandmothers' influence. As both the child and the grandmother grow older, they may become generationally disconnected from one another. The nature of their relationship may change by spending less time together or just spending time differently. For instance, if grandmothers connected with young children by feeding them, this may not be as appealing or enjoyable for five and nine year olds.

Limitations

Future research should also address the limitations of this study. There is no distinction between grandmother-headed and mother-headed households nor who is the primary caregiver in this sample, which has implications for power dynamics and conflict in parenting (Bachman & Chase-Lansdale, 2005; Glassman et al., 2011). Measures on family roles and daily routines with a particular focus on eating behaviors and physical activity are necessary to

better understand the association. Future work should include family interrelationship, co-parenting, and time-use data before and after birth that test some of the explanations proposed above and may also elucidate selection into extended family households.

Causal claims cannot be made until endogeneity is addressed to capture potential bias from correlated variables unobserved here. Families may sort into different living arrangements based on characteristics that are also associated with raising an overweight or obese three year old. Fixed-effects analyses is one way of testing this, but may not be suitable for this sample given limited variation in child weight status across waves. Fifty-eight percent of those who have complete data for weight in ages 3, 5, and 9 exhibit stable weight over time, which can make selection findings undetectable through fixed effects. Future studies should explore other methodologies that would account for this sample characteristic.

Conclusion

The present study extends knowledge in the field by identifying grandmother coresidence as a risk factor for overweight and obesity in young disadvantaged children. Because unhealthy weight early in life is predictive of unhealthy weight later in life (Janssen et al., 2005; Nader et al., 2006; Singh et al., 2008), these findings are theoretically important to understand the nature of the problem and practically relevant for prevention. This study suggests that prevention efforts should identify multigenerational households as at risk for early childhood obesity and employ family-based approaches that pay particular attention to practices within disadvantaged families. Family-based obesity prevention and weight management programs could be more beneficial for young children in multigenerational homes if they include coresident grandmothers in their framework. Healthcare

providers who use patient-centered approaches should be sensitive to the influence of extended kin, culture, and feeding routines on child weight status. More study is needed to better understand the mechanisms at work in order to craft effective prevention and intervention strategies. An even more thorough application of a multi-contextual model that nests the family within larger extrafamilial systems (i.e. including communities, institutions, and culture) may elucidate interconnections among various levels of context that may facilitate the occurrence of obesity among young children in three-generation family structures.

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