Household structure and children's obesity risks

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Abstract

American children experience diverse family structures, and, given the importance of family for child wellbeing, these diverse and shifting circumstances may affect weight trajectories. This study examines the relationships between family structure and children's obesity risks, one of the major health concerns in the U.S. today. Using the Early Childhood Longitudinal Study Kindergarten Class of 1998-99 (ECLS-K), the largest national study with direct measures of child anthropometrics, we explore longitudinally the relationships between family structure and children's weight. We find that children living in 2-parent families are at greater risk of being obese and have greater increases in weight between Kindergarten and fifth grade compared with children living in alternative arrangements. Being an only child, as well as living with additional adults, including grandmothers, is associated with greater obesity risks and weight gain. Our results point to the possible importance of rules and structure in ensuring healthy weight.

The prevalence of obesity among American children is at an all-time high, with 19.6% of 6 to 11 year-olds having high body mass index (BMI) for their age in 2007-08.(Ogden, Carroll, Curtin, and et al. 2010) Childhood obesity is associated with poorer physical and mental health (Must and Anderson 2003; Pearce, Boergers, and Prinstein 2002) and social exclusion.(Friedlander, Larkin, Rosen, Palermo, and Redline 2003; Pearce, Boergers, and Prinstein 2002; Strauss 2000) Current recommendations emphasize the importance of involving the family for preventing and reversing obesity in children (Barlow and the Expert Committee 2007; Lindsay AC 2006) However, the concept of family is vague in the public health and medical literatures where these debates are centered, and there is insufficient conceptualization of who "the family" is and how different types of families interact, provide care, and access resources in ways that may affect children's nutrition and growth.

This paper examines the relationships between household structure and children's obesity risks in elementary and middle school using the Early Childhood Longitudinal Study Kindergarten Class of 1998-99 (ECLS-K), the largest national longitudinal study measuring child anthropometrics, household structure, and home environment. We hypothesize that household structure will predict children's weight trajectories and obesity risks in elementary and middle school. The extent to which household structure may influence obesity risks warrants investigation, especially in light of the reliance of obesity-related interventions on the family. We expect that the pathway of influence is through child nutrition, which is shaped by household structure and is an important determinant of body weight. The family is an important force in determining, directly and indirectly, children's food behaviors,(Birch and Davison 2001; Patrick and Nicklas 2005)and this may involve the presence or absence of key relatives.(Case, Lin, and McLanahan 1999; Sear, Mace, and McGregor 2000)

The complexity of the family is important to consider, as only 62% of American children live with both biological parents(Kreider and Fields 2005) and over half of children born in the 1990s will have spent some time in single parent or step-parent arrangements.(Deleire and Kalil 2002) Also, despite the focus of interventions on parents, household structure usually includes other individuals whose presence may influence food environment, activity levels, and rules and norms at home: 79% of children share a home with other children, and 15% of children reside with a grandparent, aunt, or uncle.(Kreider and Fields 2005)

Importance of the family

"Especially during early and middle childhood, family environments are the key contexts."(Birch and Davison 2001) Parents influence children's diets, physical and sedentary activities, and body expectations through food access, meal structure, parenting style, modelling, and knowledge.(Golan and Crow 2004) There is a genetic component to the link between weight and the family (Agras, Hammer, McNicholas, and Kraemer 2004; Frankish 2001; Whitaker, Wright, Pepe, Seidel, and Dietz 1997), but behavioral and social factors are likely also important in light of the rapid rise in child obesity, and genetic predispositions work in concert with the family environment.(Birch and Davison 2001)

Previous studies have shown that household structure, or the individuals co-residing with the child and their relationship to the child, affects several outcomes, including education,(McLanahan and Sandefur 1994) health behaviors,(Flewelling and Bauman 1990) and mental and physical health.(Aseltine 1996; Dawson 1991) Household structure also may shape the home environment, which includes food environment, activity and inactivity levels, and family rules and support, all of which can affect children's nutrition and obesity risks.

Much remains to be understood about family influences on child weight. There are counterproductive results to many parent attempts to promote healthy eating. Pressure to eat healthy foods does not promote their intake(Galloway, Fiorito, Francis, and Birch 2006) and

restricting unhealthy foods is associated with children's increased consumption of them and with weight.(Birch and Fisher 2000; Faith, Scanlon, Birch, Francis, and Sherry 2004; Fisher and Birch 1999) At the same time, permissiveness and disengagement from children's eating leads to persistent obesity(Brann and Skinner 2005) and poorer nutrition.(Patrick and Nicklas 2005)

Conceptual framework

To unpack the pathways of influence within the home, we propose that the home environment can be understood in terms of *family structure*, that is, the individuals co-residing in the home with the child, and *family interactions*, that is, the activities of the family in the home domain (though not necessarily *at* home). We expect that family structure determines home interactions, that is, the family consists of a collection of individuals who collectively engage in interactions. Not all family interactions affect nutrition and weight, but those that do we categorize as *food environment*, *activity and inactivity levels*, and amount of control exerted by authority figures at home, conceptualized as *rules and structure*. These interactions are shaped by family structure and change with changes in family structure, as the arrival, departure, or change in status of family members can change the norms, preferences, resources and care in the family. In turn, we expect that home interactions directly affect child nutrition and weight through availability, preferences, and norms of consumption, activity, inactivity, and monitoring. These interactions are likely to vary with characteristics of the child, with some children being more likely to be monitored, encouraged, or susceptible. Different types of families (eg. multi-generational, single parent) are expected to engage in different activities and the effects of family interactions are expected to vary with family structure.

-Figure 1 here -

Parents

The presence and relationship status of parents in the home affect many aspects of child wellbeing (see below). Prior studies of child obesity have noted the importance of parents, but have failed to consider how different parental arrangements may shape children's weight trajectories. We classify the characteristics of parental living arrangements that are important for child wellbeing as *number, relatedness to the child,* and *relationship of the parents*.

Number of co-residing parents: Children living with two parents have better outcomes than children living with just one parent. Children in single-parent families experience more negative outcomes in terms of education, (McLanahan and Sandefur 1994) health behaviors,(Flewelling and Bauman 1990) and mental and physical health.(Aseltine 1996; Dawson 1991) Previous studies have not directly examined weight and nutrition in single and two parent households, though corresponding differences may exist. We will test whether children are also better off in terms of nutrition and weight if they live with two parents.

Relatedness of co-residing parents to the child: Step-parents have been shown to invest less in children than biological parents: In the US, the presence of stepchildren of the mother is associated with lower food expenditure.(Case, Lin, and McLanahan 1999) Spending varies with the strength of ties between mother and child, with less spent on adoptive than biological children, less on step than on adoptive children, and less on foster than on stepchildren. In South Africa, when a child's biological mother is the head or spouse of the household head, the household spends more on food, in particular milk, fruit and vegetables.(Case, Lin, and McLanahan 2000) American children living with stepmothers are significantly less likely to have routine doctor and dentist visits, to have a health care provider, to wear seatbelts and to live in a non-smoking home. By these measures, children living with a father and step-mother are no better off than those living only with a father.(Case and Paxson 2001) In a comparison of half-siblings where one of the siblings is the

biological child of both parents and the other is the biological child of only one parent, step-children had inferior outcomes in terms of education, health investments, and social wellbeing.

Relationship of the child's co-residing parents: In the US and elsewhere, the children of married parents are healthier on a myriad of indicators, including health at birth(Manderbacka, Merilainen, and Hemminki 1992; Miller 1991; Reichman and Pagnini 1997) and survival.(Beise 2005; Leonetti, Nath, Hemam, and Neill 2005) In the US, teenagers in non-marital families have poorer educational outcomes and poorer health behaviors.(Deleire and Kalil 2002) In terms of some investments, marriage may be a more important determinant of parental investments than is biological relatedness. (Hofferth and Anderson 2003) In terms of nutrition, families spend less on food when the man is raising the child of his non-marital partner. (Case, Lin, and McLanahan 1999) We will test whether such differences also exist with respect to nutrition and weight.

Grandparents and other co-residing adults

15% of American children live with adult relatives in addition to parents.(Kamo 2000; Kreider and Fields 2005) The presence of additional adults is usually positively associated with child health. Studies from around the world have shown that children who have access to a grandmother are healthier in terms of several indicators, including survival (Beise 2005; Leonetti, Nath, Hemam, and Neill 2005; Mace, R., and McGregor 2000; Sear, Steele, McGregor, and Mace 2002; Voland and Beise 2002) and growth.(Duflo 2003) A review found that 9 of 13 studies examining the effects of grandmothers on child survival found positive effects, as did 2 of 12 among studies of grandfathers.(Sear and Mace 2008) In the US, grandmother's co-residence was associated with better cognition, behavior, and health at age 3.(Pope, Whiteside, Brooks-Gunn, Kelleher, Rickert, Bradley, and Casey 1993) Teenagers living with a single mother and a grandparent have education outcomes and health behaviors equal to or better than those in married families.(Deleire and Kalil 2002) Children living with a single mother and grandparents had better school outcomes than those living with only a single mother, (Entwisle and Alexander 1996; Thomas 2006) though the evidence is not always consistent. (McLanahan and Sandefur 1994) The role of grandparents is complicated because it is often entangled with parents' living arrangements.(Landry-Meyer 1999) Grandparents can mitigate the negative outcomes that would otherwise be experienced by children living in non-intact families.(Geronimous 1997)

In terms of nutrition and obesity risks, co-residing adults, especially grandmothers, may be especially important, because they are often in charge of child care and preparation of meals. They may provide supervision, care, and home-cooked meals, promoting better nutrition and more activity. That said, grandparents may not appreciate the possible negative consequences of child obesity. Chinese grandparents tended to encourage children to eat more, used food as an emotional tool, and favored heavy size in children.(Jingxiong, Rosenqvist, Huishan, Greiner, Guangli, and Sarkadi 2007) Children living with grandparents also had poorer weight-related behavior.(Wu, Yu, Wei, and Yin 2003) Mothers have reported pressure from grandmothers, who are concerned about children being too thin.(Bruss, Morris, and Dannison 2003)

Other co-residing children

About 80% of American children live with other children. (Kreider and Fields 2005) The relationship between number of children in the household and their health is ambiguous in the literature. A recent review found that in 5 of 6 studies from around the world older siblings improved survival up to age 15.(Sear and Mace 2008) In terms of nutrition and weight, multiple children in the home entail more competition for resources but create more opportunities for active play. Sibling's engagement in physical activity correlates with decreases in BMI z-scores. (Timperio, Salmon, Ball, Baur, Telford, Jackson, Salmon, and Crawford 2008)

The reasons for these differential outcomes related to family structure are under debate. It may be that families with 2 biological parents have the most resources,(McLanahan and Sandefur 1994) or that parents selected into step-parenthood are lower quality parents.(Ginther and Pollak 2004) It may also be that social norms entail lower expectations for involvement from people who are not biological or married parents.(Hofferth and Anderson 2003) Alternatively, the different outcomes may result from purposeful differential investment, either to promote the success of closest kin to carry on the genetic family line, as suggested by evolutionary theory,(Emlen 1995) or to ensure an informal, long-term safety net against risks(Schoeni 1997) through the success and loyalty of children most likely to be supportive. Evolutionary theory predicts altruistic behavior towards related children by adult relatives and older siblings.(Hamilton 1964) Such investments in children can also represent insurance against risk or investment in a long-term relationship with the child's parents. The implications for investment in nutrition and healthy weight in a resource-rich setting are less clear than in terms of other investments. Here, providing maximum nutrition and shielding from physical exertion may actually be detrimental. So, the lower spending on food in step and adoptive families may be good for children in the U.S., even if it is not optimal in less food-rich circumstances. (Case, Lin, and McLanahan 1999) That is, non-biological parents may be stricter and buy less junk food, leading to less excess weight gain.

Data

We use the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K), developed by the National Center for Education Statistics. The ECLS-K, a study of children's early school experiences, follows a large cohort from kindergarten to 8th grade. Multistage probability sampling was used to select a nationally representative sample. The survey includes interviews with parents, teachers and principals, student records abstracts, one-on-one direct child assessments and child interviews.(Tourangeau, Nord, Lê, Pollack, and Atkins-Burnett 2006) Measures include direct anthropometric, cognitive and academic assessments, and detailed information on the home and school environments. The 5th and 8th grade waves collected information about food and drink availability, consumption and purchases at school from children and school administrators.

The base year sample, with 21,260 kindergartners in 1,277 schools, was collected in the Fall of 1998, followed by full waves in Spring 1999, 2000, 2002, 2004, and 2007 and a 30% sub-sample in Fall 1999. The longitudinal sample is representative of individuals who were in kindergarten in 1998-99 or in 1st grade in 1999-2000. Children were retained in the sample if they fell behind or advanced ahead in grades. A random sample of students who transferred schools was followed, with over-sampling of children whose home language was not English. There are no significant differences between respondents and non-respondents, and non-response bias is addressed by the use of appropriate weights.(Bose and West 2006)

We begin by looking at the 18,065 children with direct anthropometric measures in Kindergarten, and then we focus on children with data from all full waves from Kindergarten through eighth grade.

Methods

Weight status

The ECLS-K records height and weight, each measured twice per wave by trained assessors: height in inches to the nearest 0.25 inch using a Shorr Board and weight in pounds using a digital scale.(U.S. Department of Education - National Center for Education Statistics 2004) This is a major advantage over datasets that collect self-reported or parent-reported data, which has been shown to be systematically biased. We will use the age and sex-specific 2000 CDC Growth Reference.

Consistent with prior studies, BMI z-score will be constructed from children's weight, height, sex, and age, and children will also be categorized according to the International Obesity Taskforce cutoff points for normal weight, overweight, and obese. We will evaluate several measures of change: change in BMI z-scores, change in weight category, and change in raw BMI and report differences.

Household structure

Household structure indicators are: co-residence arrangement of parents (both biological parents, mother only, mother and step-father, father only, father and step-mother, or adopted and other arrangements); other adults in the home (less than 3 adults or more than 3 adults in the home; grandmother co-resides); other children in the home (no other, one other, or two or more others). Because household structure data are updated at every wave, changes therein can be examined.

Control variables

Child characteristics associated with weight include gender, race/ethnicity and age, all of which are included in analyses. While we do not have information on genetic predispositions, we consider as possible proxies the child's weight at birth and whether a parent is dieting. Because early life conditions are also important for weight and eating behavior, the mother's age and marital status at birth, whether the family experienced financial problems since child's birth and child care arrangement before kindergarten are included. Additional relevant household characteristics are: parent's education and fulltime employment, SES scale and poverty indicator, and whether this is an immigrant family. The home does not operate in a vacuum, so school and neighborhood characteristics are considered: public/private school; proportion of students eligible for reduced/free lunch; proportion minority children; hours of physical education, provision of school meals, availability of sodas and snacks, after-school sports, and US region and residence in an urban, sub-urban, or rural area.

Analysis

We use survey-corrected linear regressions to estimate the effect of child and family characteristics in earlier waves on children's weight trajectories through 8th grade. We first establish overall change (K-8) and then piecewise changes (K-1,1-3,3-5,.5-8) to identify the most influential periods.

$$\Delta BMI = \beta_0 + \beta_1 r_f + \beta_2 s_a + \beta_3 t_k + \beta_4 V_c + \beta_5 W_p + \beta_6 X_h + \beta_7 Y_s + \beta_8 BMIz + e \quad (1)$$

where the indicators of household structure are: r_f (parental arrangements); s_a (other adults) and t_k (other children). The following vectors of controls are also included: V_c for child characteristics; W_p for parental characteristics; X_h for household characteristics; Y_s for school characteristics. The advantage of this strategy is that it accounts for the cumulative nature of weight gain, with caloric surpluses accumulating over time into excessive weight gain. Thus, we explore whether children of similar weight status in kindergarten but living in different home environments experience different weight trajectories. The differencing and the inclusion of initial BMI z-score absorb many time-invariant determinants of weight.

Second, since a substantial number of children experience changes in household structure, we explore whether these changes are followed by changes in weight by estimating the following first difference models(Liker, Augustyniak, and Duncan 1985):

$$\Delta BMI = \beta_0 + \beta_1 \Delta r_f + \beta_2 \Delta s_a + \beta_3 \Delta t_k + \beta_4 \Delta V_c + \beta_5 \Delta W_p + \beta_6 \Delta X_h + \beta_7 \Delta Y_s + \Delta e \quad (2)$$

Third, to examine the patterns of change in the trajectories of weight status exhibited by elementary school children, a growth model are estimated using hierarchical linear modeling

(HLM).(Bryk and Raudenbush 1987; Raudenbush 2001) This method allows us to model both individual and group trajectories, as well as specification of within- and between-child variation. A three-level model is estimated,(Raudenbush, Bryk, Cheong, Congdon, and du Toit 2005) with BMI z-score modeled as the outcome, as a function of age at level-1, time-invariant predictors at level-2, and random effects at level 3. A two-stage approach is used to model change within individual children and between-child parameters,(Callaghan and Rankin 2002) an approach which allows us to examine systematic variation in growth as a function of individual characteristics as well as overall patterns of growth as a function of differences between racial and ethnic sub-populations.

Preliminary results

Table 1 shows the distribution of Kindergartners across family types. While the majority of children live with both biological parents, almost 1 in 4 lived with just 1 parent, most often the mother. Many families included more than two adults (12.4), and almost 1 in 10 had a grandmother living in the home. The vast majority of children co-resided with siblings and other children under age 18, with less than 16% being only children. Though not shown in the table, we found that over 10% of children experienced changes in household structure each year.

- Insert Table 1 here –

Children's body weight increased relative to the reference population between kindergarten and fifth grade. Many children entered into the obese category: over 21% were in 5th grade, compared with only 10% in Kindergarten (see Table 2).

- Insert Table 2 here –

In cross-sectional analysis of children's odds of being obese in Kindergarten, we find that each of the components of family structure identified in our conceptual framework is associated with obesity. Children living with both biological parents had significantly higher odds of being obese compared with children living in most other family arrangements. Children living with a biological parent and a step-parent were at lowest risk of being obese, as were children living with adoptive parents. Living with more than two adults in the home is not associated with obesity risks; however, children living with a grandmother are at significantly higher odds of being obese, even after controlling for parental arrangements and number of adults in the home. Finally, the presence of multiple children in the home is associated with healthier weight. The odds of obesity decrease with number of children under the age of 18 living together, with significantly higher odds of obesity found among only-children.

- Insert Table 3 here –

The patterns observed in kindergarten hold for children's weight change during elementary school. Children living with a father and step-mother gained significantly less weight by fifth grade compared with children living with both biological parents, as did children living with adoptive parents. In fact, children living with two biological parents may have gained the most weight in elementary school. Children living with more than 3 adults gained significantly more weight than those living with just 2 adults, though no additional effects were seen if the additional adult was a grandmother. Children living with siblings may have gained less weight than only-children , though

the differences are not statistically significant. Similar patterns were observe in weight changes between Kindergarten and third grade.
- Insert Table 4 here –

Figure 1: Conceptual Framework

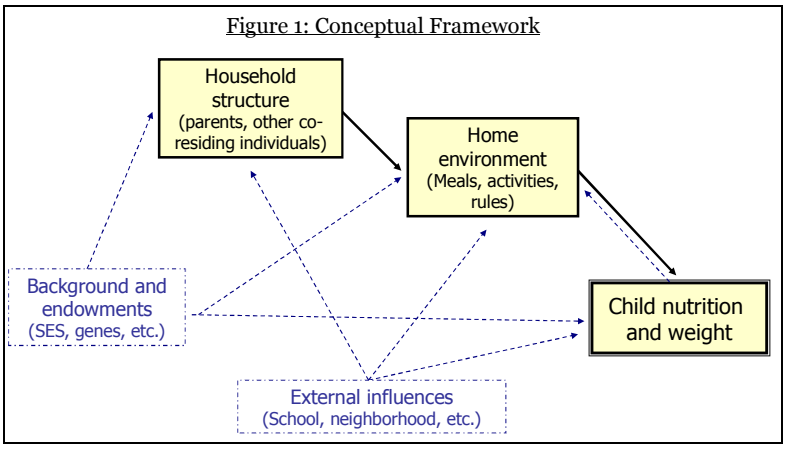

Table 1: Family structure variables and their distribution in Kindergarten

Co-residing parents	**(%)**
Both biological parents	65.0
Mother only	21.2
Mother and step-father	8.8
Adopted	2.9
Father only	1.6
Father and step-mother	0.6
Other adults in the home	
Less than 3 adults	87.6
At least 3 adults in the home	12.4
Grandmother co-resides	9.9
Other children in the home	
No other	15.6
1 other	42.9
2 or more others	41.5

Data Sources: ECLS-K, 1999 (weighted)

Table 2: Children's BMI in Kindergarten through fifth grade

	Kindergarten Spring	1st grade Spring	3rd grade Spring	5th grade Spring
Mean BMI	16.63	16.90	18.66	20.58
Mean BMI-for-age z-score	0.51	0.56	0.84	0.78
% Obese	10.2%	13.0%	20.9%	21.4%

Data source: ECLS-K Longitudinal data

Table 1: Family structure and child obesity risks in Kindergarten:

Odds ratios from survey-adjusted logistic regression

Variable	
Co-residing parents (Omitted = Both biological parents)	
Adopted	0.69*
Father and step-mother	0.48+
Father only	1.09
Mother and step-father	0.77*
Mother only	0.89
Other children in the home (Omitted = No other)	
1 other	0.79**
2 or more others	0.61**
At least 3 adults in the home	1.01
Grandmother co-resides	1.41**
Observations	18,065

Notes: Standard errors in parentheses. Data source: ECLS-K. + p<.10; * p<.05; ** p<.01
Model controls for race/ethnicity, age, gender, birth weight, parent's education, household socioeconomic status and poverty status, mother's employment, parents' dieting, urbanicity, and US region.

Table 4: Family structure and change in BMI between Kindergarten and fifth grade

Variable	
Co-residing parents (Omitted = Both biological parents)	
Mother only	0.06
	(0.17)
Mother and step-father	-0.27
	(0.24)
Father only	-0.21
	(0.52)
Father and step-mother	-1.84**
	(0.24)
Adopted	-0.91*
	(0.40)
Other children in the home (Omitted = no other children)	
1 other	-0.16
	(0.19)
2 or more others	-0.23
	(0.18)
At least 3 adults in the home	0.50*
	(0.21)
Grandmother co-resides	0.14
	(0.29)
Observations	8,557

Notes: Standard errors in parentheses. Data source: ECLS-K. + p<.10; * p<.05; ** p<.01
Model controls for race/ethnicity, age, gender, birth weight, parent's education, household socioeconomic status and poverty status, mother's employment, parents' dieting, urbanicity, and US region.

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