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Economic Stressors and Childhood Obesity: Differences by Child Age and Gender

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1. Introduction

Childhood obesity is a public health challenge in the United States (U.S.) and elsewhere in the world. Additionally, those who are obese are heavier than in the past (Anderson & Butcher, 2006). In the U.S., one in three children is overweight or obese (Ogden et al., 2010), a prevalence that has tripled since 1970 (Anderson & Butcher, 2006; Kumanayika & Grier, 2006; Wang & Zhang, 2006). In response to this public health issue, Healthy People 2010 (US/DHHS, 2000) and President Obama (US/Office of the President, 2010) have identified childhood obesity as a national health priority as it has immediate consequences for a child's physical and psychological health (Puhl & Latner, 2007; Raman, 2002; Strauss, 1999; US/DHHS, 2000), as well as implications for future health (Freedman et al., 2007; Raman, 2002; Strauss, 1999; US/DHHS, 2000). Beyond negative health outcomes, there are also economic costs (e.g., greater need for health care) associated with childhood obesity (Marder & Chang 2006; Skinner et al., 2008). Thus, identifying factors related to childhood obesity not only has implications for the health and quality of life of children, but it also has important implications for family expenditures and health care costs.

It is commonplace to focus on physical inactivity and dietary factors as the cornerstones of the childhood obesity epidemic, but stress is another common feature of the landscape facing American families today. Stress manifests itself across numerous dimensions at both the individual and family level. While stress can be managed successfully by many individuals and families, in some cases stress can become severe enough to lead to serious health consequences. A vast literature has demonstrated the effects of stress on numerous health outcomes for children and adults (e.g., Dearing et al., 2006; Evans & English, 2002; Gee & Walsemann, 2009; Kort-Butler, 2009; Schilling et al., 2008), including childhood obesity (Eisenmann, 2006; Garasky et al., 2009; Gundersen et al., 2008; Lohman et al., 2009).

While this work has provided policymakers with important insights, a central issue related to this research must be addressed. Through regression analyses this work has found positive associations between stress and childhood obesity after controlling for a host of potential confounding factors, but it has not ascertained whether unobserved factors

correlated with stress (e.g., a child's ability to cope with adverse conditions) may be the cause of the association. That is, these studies have implicitly assumed that time invariant unobserved factors were similar between different children and have ignored the possibility that children in households experiencing stress are different in unobserved ways from children in households not experiencing stress. To address this issue, the current study examined panel data using fixed effects models that controlled for time-invariant differences between children by using only within-individual variation to estimate the regression coefficients (Allison, 2005).

We examined data from the first two waves of the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID). Our results indicated that exposure to housing-related economic stressors leads to a higher probability of a child being obese and to higher levels of obesity, especially for younger females. Other forms of stress examined here (financial and neighborhood) were not related to child weight status. These findings were robust across a range of model specifications and suggest that efforts to reduce housing stress may also lead to reductions in childhood obesity.

2. Background

2.1 Theoretical framework

Child health is an important aspect of family well-being. The ecological theory of human development identifies four levels of influence faced by families attempting to maximize their well-being (Bronfenbrenner & Morris, 1998). These levels are the microsystem (e.g., individuals and families), the mesosystem (e.g., neighborhoods and social networks), the exosystem (e.g., community), and the macrosystem (i.e., larger cultural context). Theoretical work on the "stress process" defines *stress* as a negative physiological response and *stressors* as the external factors that cause this negative response (e.g., Aneshensel, 1992; Boss, 1988; Chrousos & Gold, 1992; Pearlin, Menaghan, Lieberman & Mullan, 1981; Pearlin, Schieman, Fazio & Meersman, 2005).

While genetic factors have consistently been shown to be central to whether a child is obese (e.g., Crossman et al., 2006; Gibson et al., 2007), environmental factors at the microsystem and mesosystem levels such as family, parental, and economic influences matter as well (e.g., Anderson et al., 2003; Cutler et al., 2003; Dietz & Robinson, 2008; Loureiro & Nayga, 2005). Environmental factors combined with a biological predisposition toward obesity provide the conditions for one's propensity for obesity to come to fruition (Anderson et al., 2003).

2.2 Stress and health

Stress is an environmental factor that often leads to reduced psychological and physiological health. One of the most common consequences of stress exposure is psychological distress, especially depression (e.g., Brooks et al., 2002; Kort-Butler, 2009; Schilling et al., 2008). Daily hassles and chronic stressors are the typical antecedents to depressive symptoms with stress leading to anxiety and aggression (Evans & English, 2002; Krause et al., 2003; Kort-Butler, 2009).

Physiologically, higher levels of stress have been associated with higher levels of self-reported illness (Gee & Walsemann, 2009; Goodman, 1999; Larson et al., 2008). Early and chronic exposure to stressors has been linked with cardiovascular disease and obesity.

Specifically, the psychosocial stressors that provoke exaggerated cardiovascular reactivity may also trigger overeating (Marniemi et al., 2002; Siervo et al., 2009). Indeed, research has found that stress exposure leads to increased cortisol levels, which enhances appetite and decreases leptin resistance, which increases the risk of obesity (Bjorntorp, 2001; Koch et al., 2008; Siervo et al., 2009).

The effects of economic stressors on health and well-being have been examined under a range of headings including economic stress, financial stress, economic hardship, economic strain, economic pressure, and material hardship (e.g., Fletcher et al., 2005; Kim & Garman, 2003; Kim et al., 2006). Lower income children are at an elevated risk of exposure to varied forms of these stressors (Gershoff et al., 2007; Pearlin et al., 2005; Wickrama et al., 2007) and may have more severe health consequences stemming from stress due to their greater exposure and vulnerability (Sampson et al., 1997; Spencer, 2001). Recently, scholars have shown an association between household- and individual-level indicators of stress and childhood obesity (Garasky et al., 2009; Gundersen et al., 2008; Lohman et al., 2009).

2.3 Stress and childhood obesity

Recent evidence suggests that stress faced by family members may lead to childhood obesity. Gundersen et al. (2008) found using data from the National Health and Nutrition Examination Survey (NHANES) that higher values of an index measuring cumulative stress exposure led to higher probabilities of obesity for food secure children in comparison to food insecure children. This result held for younger children, but the effect was statistically insignificant for older children. Lohman et al. (2009) found using data from the Three-City Study that higher levels of individual stress experienced by a child between the ages of 10 and 15 were statistically significantly associated with higher probabilities of childhood obesity. In contrast to Gundersen et al. (2008), they found that food insecure children with higher levels of maternal stress had higher probabilities of childhood obesity in comparison to food secure children. It should be noted that Gundersen et al. (2008) and Lohman et al. (2009) examined data from different surveys and employed different protocols for measuring food insecurity and stress which may have led to their finding somewhat conflicting results. Garasky et al. (2009) found using data from the PSID that stress was associated with childhood obesity, but the type of stress had differential effects for younger and older children. For younger children, lack of cognitive stimulation and emotional support in the household were associated with higher probabilities of obesity. However, for older children, mental and physical health problems and financial strain in the household were associated with higher probabilities of obesity. Finally, van Jaarsveld et al. (2009) conjectured that perceived stress in pre-adolescence may set adiposity trajectories, with no accentuation of differences due to perceived stress in adolescence, when they did not find an association between perceived stress and weight gain among British adolescents.

Important to this research, few studies have investigated whether associations between stressor exposure and weight status differ between females and males, nor have they examined whether the associations differ by gender within age groups (an exception being van Jaarsveld et al. (2009) who examined potential differences among adolescents by gender). Among adolescents, boys and girls have the same likelihood of being overweight (Anderson et al., 2003) with no differences in the effect of perceived stress on weight gain (van Jaarsveld et al., 2009). However, some research indicates that girls and boys cope with

stress differently (e.g., Frydenberg & Lewis, 2004; Rudolph, 2002), although others have found no gender differences in adolescent coping (Wadsworth & Compas, 2002). Different coping styles for boys and girls may affect their risks of obesity. For example, eating-related responses to stress differ for boys and girls (Mikolajczyk et al., 2009) with adolescent girls being more likely than boys to suffer from disordered eating (Hepworth, 2004). Additionally, greater consumption of sweets and fast food consistent with higher rates of “emotional eating” has been found among women relative to men (Larsen et al., 2006).

The current study expanded on previous work by considering three types of economic stressors most commonly examined in the literature and most relevant to the home environments of children – housing, financial and neighborhood stressors – within a fixed effects framework. We examined separate groups of younger and older children and, given the mixed results by age and gender discussed above, compared the relationship between stress and obesity for girls versus boys within each age group. Previous studies did not systematically examine the potential effects of these economic factors on a child’s propensity to be obese in this way. Additionally, previous work concentrated on binary measures of obesity (an exception being van Jaarsveld et al. (2009)). We utilized the obesity gap (Garasky et al., 2009; Jolliffe, 2004) to depict the extent of a child’s obesity. A central advantage to using the gap measure is that it addresses a key disadvantage associated with binary measures of child weight status. A binary measure of obesity treats all children with a body mass index (BMI) $\geq 95^{\text{th}}$ percentile for age and sex the same. With the obesity gap, these children are treated differently within the context of the models. From a policy perspective, these additional analyses are important as one may be especially interested in children with relatively high levels of obesity (US/Office of the President, 2010).

3. Methods

We controlled for time invariant unobserved factors through the following fixed effects model:

$$OB_{it}^{\alpha} = \gamma I_{it} + \lambda Y_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where i denotes a child, t denotes the interview wave ($t=1$ or 2), OB_{it}^{α} denotes the measures of the weight status of the child (in manners described below), I is a vector of the three economic stressor indices described below, Y is a vector of time varying covariates, μ is a child-specific fixed effect, and ε is an error term. We estimated logit fixed effects models for the binary specification of weight status and linear regression fixed effects models for our continuous (i.e., gap) measure. With respect to the direction of the influence of the economic stressors on childhood obesity, these models implicitly assumed that the stressors affected weight status. While in theory the relationship between the economic stressors and weight status could be bidirectional, our model was consistent with the vast majority of research in this area and every study discussed above.

3.1 Data

Our analyses were conducted with data from the first two waves of the Child Development Supplement (CDS-I and CDS-II) of the PSID. The PSID, begun in 1968, is a longitudinal study of a nationally representative sample of U.S. individuals and the families in which they reside. In 1997, a refresher sample of post-1968 immigrant families and their adult children was introduced to keep the study representative of the U.S. population (PSID, 2005). Currently, PSID interview waves are conducted biannually.

The CDS, a research component of the PSID focusing on children age 0-12 years in PSID families was introduced in 1997. The CDS examines a range of developmental outcomes within the context of family, neighborhood, and school environments. Assessments of cognition, behavior, and health status are obtained from a variety of sources including the child and the child's primary caregiver. The multi-method CDS survey design includes computer-assisted personal interviews (CAPI) and audio computer-assisted self-interviews (ACASI) (PSID, 2008b). Trained personnel measure the child's height without shoes using a rafter's square and tape measure. The child's weight is measured using a digital scale (PSID, 2008a). In 2002-2003, interviewers recontacted families that participated in CDS-I and remained active in the PSID as of 2001. Of those families, 91% were successfully reinterviewed (PSID, 2008b).

Information from CDS-I and CDS-II constituted the basis of our study. We supplemented these data with income and household composition data from contemporaneous PSID interview waves. Together, these data were well-suited for this analysis as they provided a large sample of households and detailed longitudinal information on child characteristics, family stressors, and relevant covariates. This data set had other strengths as well. In particular, the use of directly measured child height and weight strengthened this study as other large, national studies (e.g., Youth Risk Behavior Survey; National Longitudinal Survey of Youth) tend to rely on less reliable self-report or parental-report methods.

Our analytic sample consisted of 1,263 youths who at the time of the CDS-I interview were between 2 and 14 years of age. This research examined the full analytic sample, as well as two age-based subsamples. Consistent with other research, the full sample was split at age 8 years at the time of the CDS-I interview. Children less than 8 years of age (i.e., 24-95 months of age) at the time of the CDS-I interview were the younger sample ($n = 677$ children). Children at least 8 years of age (i.e., 90-167 months of age) at the time of the CDS-I interview comprised the older sample ($n = 586$ children). Youths under age 2 years (less than 24 months) at the time of the CDS-I interview and over age 18 years (over 228 months) at the time of the CDS-II interview were removed. Also, youths classified as underweight (body mass index $< 5^{\text{th}}$ percentile for age and gender as defined below) at either their CDS-I or CDS-II interview were removed from the sample since underweight children were not the focus of the referent group (i.e., normal weight youth).

3.2 Variables and descriptive statistics

3.2.1 Dependent variables

The measures used to delineate child weight status began with the calculation of a child's body mass index (BMI, kg/m^2). The BMI for each child was then mapped into a percentile based on age (in months) and gender using the Centers for Disease Control and Prevention (CDC) growth charts for the United States (e.g., Kuczmarski et al., 2002; Ogden et al., 2002). Our measures of obesity (OB^{BIN} and OB^{GAP}) were derived from these BMI percentiles and employed the definitions of the American Academy of Pediatrics (Barlow, 2007). That is, we set the obesity cutoff at the 95th percentile for age and gender.

Our binary measure of child weight status (OB^{BIN}) was defined as follows:

$$\begin{aligned}\text{OB}^{\text{BIN}} &= 1 \text{ if } \text{BMIPER} \geq 95 \\ \text{OB}^{\text{BIN}} &= 0 \text{ otherwise}\end{aligned}\tag{2}$$

where BMIPER was the child’s BMI percentile for age and gender.

Our measure of obesity severity (OB^{GAP} , the obesity gap measure) was defined as follows:

$$OB^{GAP} = [(BMIPER - 95) / 5] \text{ if } BMIPER \geq 95$$
$$OB^{GAP} = 0 \text{ otherwise}$$

(3)

To better understand how OB^{BIN} and OB^{GAP} were defined, consider three children who have BMI percentiles for age and gender of 50, 96 and 99, respectively. Regarding OB^{BIN} , the first child, and any child with a BMIPER below the 95th percentile, will have OB^{BIN} set equal to 0. For the second and third child, and any child with $BMIPER \geq 95^{th}$ percentile, OB^{BIN} will equal 1. As for OB^{GAP} , the first child, and any child with a BMIPER below the 95th percentile, OB^{GAP} will be set to 0 as well. Key to these analyses is that the second and third children, both of whom are classified as obese, will have different values for OB^{GAP} . OB^{GAP} will equal 0.2 for the second child, while OB^{GAP} will equal 0.8 for the third child. That is, children with more severe obesity (higher BMI percentiles for age and gender) will have higher obesity gap scores.

Variables	All Children 2 to 14 yrs		Younger Children 2 to <8 yrs		Older Children 8 to 14 yrs	
	CDS-I	CDS-II	CDS-I	CDS-II	CDS-I	CDS-II
<i>Dependent Variables</i>						
Obese	0.200	0.210	0.241	0.230	0.154	0.186
Obesity gap	0.130 (0.291)	0.120 (0.268)	0.170 (0.330)	0.136 (0.283)	0.084 (0.228)	0.101 (0.249)
<i>Stressor Indices</i>						
Housing stressors (range = 0-4)	0.245 (0.514)	0.196 (0.484)	0.270 (0.554)	0.225 (0.507)	0.217 (0.463)	0.164 (0.453)
Financial stressors (range = 0-10)	1.451 (1.529)	1.182 (1.496)	1.539 (1.530)	1.205 (1.513)	1.348 (1.522)	1.155 (1.479)
Neighborhood stressors (range = 0-2)	0.299 (0.584)	0.295 (0.592)	0.298 (0.575)	0.301 (0.609)	0.300 (0.595)	0.289 (0.573)
<i>Control Variables</i>						
Number of persons in household	4.154 (1.200)	4.064 (1.217)	4.049 (1.216)	4.165 (1.133)	4.275 (1.171)	3.947 (1.299)
Annual total family income (\$1000)	50.565 (54.930)	70.725 (106.238)	47.144 (44.570)	65.316 (71.196)	54.516 (64.687)	76.974 (135.712)
Number of respondents	1263		677		586	

^a Percent of sample reported for categorical measures. Means with standard errors reported in parentheses for continuous measures. Children are classified as ‘younger’ or ‘older’ based on their age at the time of the CDS-I interview. Obese (BMI ≥ 95th percentile).

Table 1. Summary statistics: Variables in multivariate regressions.^a

Summary statistics for the variables in the multiple regressions for each wave are reported in Table 1 with changes in the variables across interviews reported in Table 2. About one-fifth of the analytic sample was categorized as obese in each wave. The group of younger children had a higher proportion that was obese compared to the older children. About one-fourth (22.7%) of all of the children experienced a change in weight status between interviews with a higher percentage of younger children (28.5%) experiencing change compared to the older children (15.9%). Older children, however, were more likely to become obese (9.6%) between interviews than to no longer be obese (6.3%) at the second interview. Younger children slightly more frequently became non-obese between waves (13.7% became obese, 14.8% were no longer obese at CDS-II). By definition, there was more change in weight status when status was assessed via the obesity gap (31.8% for all children, 37.8% for younger children, and 24.9% for older children) than when obesity was assessed through the standard binary measure.

Variables	All Children 2 to 14 yrs		Younger Children 2 to <8 yrs		Older Children 8 to 14 yrs	
	Increase	Decrease	Increase	Decrease	Increase	Decrease
<i>Dependent Variables</i>						
Obese ^a	11.8	10.9	13.7	14.8	9.6	6.3
Obesity gap	17.0	14.8	18.0	19.8	15.9	9.0
<i>Stressor Indices</i>						
Housing stressors	10.4	15.5	11.7	15.8	8.9	15.0
Financial stressors	25.7	36.9	25.4	39.3	26.1	34.1
Neighborhood stressors	13.3	13.1	12.9	12.9	13.8	13.5
<i>Control Variables</i>						
Number of persons in household	22.3	28.9	29.8	21.0	13.7	38.1
Annual total family income (\$1000)	78.4	21.1	77.7	21.9	79.2	20.3
Number of respondents	1263		677		586	

Children are classified by their age at the time of the CDS-I interview. Obese (BMI ≥ 95th percentile).
^a Increase defined as becoming obese between CDS-I and CDS-II interviews. Decrease defined as no longer being obese at CDS-II interview.

Table 2. Summary statistics: Change in variables in multivariate regressions from CDS-I to CDS-II (% of children).

3.2.2 Economic stressors

Stress is a difficult concept to measure. Both subjective (i.e., directly asking individuals how much stress they feel from a given stressor) and objective (i.e., observing stressors within an individual's environment or assessing physiologic markers such as cortisol) assessments of stress have been used in research. For example, Gottholmseder et al. (2009) examined the effect of commuting on perceived stress via a survey question asking "How do you feel when you arrive at your place of work (under normal traffic conditions)?" van Jaarsveld et al. (2009) when examining the link between stress and weight gain among adolescents assessed perceived stress with four questions that focused on stress and coping over the preceding month (e.g., "How often have you felt that you could not control the important things in your life?"). On the other hand, Kim et al. (2006) linked the stress caused by excessive debt (an objective financial stressor) to a higher likelihood of workplace absenteeism.

This study employed objective measures of stress for three categories of economic stressors (housing, financial and neighborhood). Consistent with individuals experiencing "stress pile-up" as a result of dealing with multiple stressors at once (McGuigan, 1999; White & Klein, 2002) and aggregate economic risk being a more important correlate than any single economic risk (MacFadyen et al., 1996), a stressor index was calculated for each category by summing the dichotomous response values for the variables in the category.

Housing stressors. Economic stressors related to housing were measured via four variables. CDS respondents when asked about economic problems in the last 12 months were asked three questions about housing experiences. "Did they move to cheaper living quarters?" "Did they move in with other people?" "Did they send one or more of the children to live with someone else?" A 'yes' response to any of these items was considered an indicator of housing-related economic stress. The last housing indicator regarded mortgage and rent expenditures. Respondents were queried about monthly first mortgage, second mortgage and rent payments. An indicator of economic stress was calculated by summing these payments and multiplying by 12 to arrive at an annual housing expenditure. The annual housing expenditure was divided by annual family income to determine the share of annual income spent on housing. If the share of income spent on housing was greater than 30 percent, an amount commonly considered to represent a household that is housing cost burdened (US/HUD, 2007), we considered this to be an indicator of economic stress. The housing stressors index ranged in value from 0 to 4.

Financial stressors. Economic stressors related to finances were measured via ten variables. Respondents were asked a series of questions regarding possible financial problems they may have experienced in the past 12 months. Specifically, respondents were asked: Have you done any of the following or have any of the following happened as a result of economic problems in the last 12 months?: (1) Sold possessions or cashed in life insurance; (2) Postponed major purchases; (3) Postponed medical care; (4) Borrowed money from friends or relatives; (5) Filed for or taken bankruptcy; (6) Fallen behind in paying bills; (7) Had a creditor call or come to see you to demand payment; (8) Had your wages attached or garnished by a creditor; (9) Had a lien filed against your property because you could not pay a bill; and (10) Had your home, car or other property repossessed. For each question, a

‘yes’ response was considered an indicator of economic stress. The financial stressors index ranged in value from 0 to 10.

Neighborhood stressors. Economic stressors related to the household’s neighborhood were measured via two variables. Respondents were asked to rate their neighborhood as a place to raise children on a five-point scale ranging from ‘excellent’ to ‘poor.’ Families residing in neighborhoods self-assessed as being a ‘fair’ or ‘poor’ place to raise children were considered to be experiencing neighborhood-related economic stress. Respondents also were asked how safe it was to walk around alone in their neighborhood after dark. Responses ranged from ‘completely safe’ to ‘extremely dangerous.’ Families residing in neighborhoods self-assessed as being ‘somewhat dangerous’ or ‘extremely dangerous’ also were considered to be experiencing neighborhood-related economic stress. The neighborhood stressors index ranged in value from 0 to 2.

One-third (31.20%) of the respondents reported they had experienced some aspect of housing stress (had an index value > 0) at one or both CDS interviews. Similarly, about one-third (33.57%) reported experiencing some facet of neighborhood stress during the study. It was more common to experience an aspect of financial stress. Three-fourths (74.43%) of the respondents indicated they had experienced an element of financial stress during one or both of the CDS interviews. As seen in Table 1, the mean values for each of the three stressor indices decreased from CDS-I to CDS-II for all children. Housing fell from 0.245 (out of 4) to 0.196; financial decreased from 1.451 (out of 10) to 1.182; neighborhood declined from 0.299 (out of 2) to 0.295. Index values declined across age groups as well, except for neighborhood stressors increasing between interviews from 0.298 to 0.301 for younger children. As seen in Table 2, some children experienced change in these measures. The most change occurred with financial stressors with over 60 percent of the sample experiencing a change. In contrast, about one-fourth of all children in the analytic sample experienced a change in their level of housing or neighborhood stressors.

3.2.3 Time varying covariates

Two time varying covariates were included in these analyses. These were the number of persons in the household and annual total family income. As seen in Table 1, there were about four members on average in each household. The slight mean decrease in household size between waves stemmed from three times as many of the households of older children experiencing a decrease in size versus an increase in size (38.1% and 13.7%, respectively). Mean annual income increased from \$50,565 at CDS-I to \$70,725 at CDS-II with approximately three-fourths of the sample gaining income between waves.

4. Results

Results from our estimation of equation (1) on the samples of all children, younger children and older children are displayed in Table 3. The columns in each table reflect results for the full analytic sample (columns 1-2), the younger children (columns 3-4) and the older children (columns 5-6) for the various specifications of weight status (OB). In columns (1), (3) and (5), we set $\alpha=0$ in equation (1) (i.e., the binary measure of obesity) and estimated logit fixed effects models. In columns (2), (4) and (6), we set $\alpha=1$ (i.e., the obesity gap). We estimated linear regression fixed effects models for the obesity gap analyses.

	All Children 2 to 14 yrs		Younger Children 2 to 8 yrs		Older Children 8 to 14 yrs	
	Obese	Obesity Gap	Obese	Obesity Gap	Obese	Obesity Gap
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Stressor Indices</i>						
Housing stressors	0.4618** (0.1999)	0.0407*** (0.0144)	0.4308* (0.2213)	0.0563** (0.0218)	0.8376* (0.5021)	0.0171 (0.0173)
Financial stressors	-0.0165 (0.0786)	-0.0051 (0.0057)	-0.0929 (0.0902)	-0.0069 (0.0089)	-0.1842 (0.1633)	-0.0023 (0.0066)
Neighborhood stressors	-0.0058 (0.1819)	-0.0042 (0.0143)	0.0557 (0.2115)	0.0118 (0.0232)	-0.2718 (0.3730)	-0.0189 (0.0158)
<i>Control Variables</i>						
Number of household members	-0.1442 (0.1041)	-0.0049 (0.0081)	0.0198 (0.1295)	0.0039 (0.0131)	-0.4937** (0.1991)	-0.0131 (0.0091)
Annual total family income (\$1000)	-0.0022 (0.0023)	-0.0001 (0.0001)	-0.0025 (0.0034)	-0.0003 (0.0003)	-0.0022 (0.0033)	-0.0001 (0.0001)
Constant		0.1500*** (0.0355)		0.1480** (0.0582)		0.1550*** (0.0389)
Number of observations/ respondents	2526 / 1263		1354 / 677		1172 / 586	

Estimated coefficients with standard errors in parentheses. Obese (BMI ≥ 95th percentile). Superscripts of *, **, and *** indicate that the p-value of the coefficient is less than 0.10, 0.05, or 0.01, respectively.

Table 3. Effects of stressor indices and time varying covariates on weight status and gap measures.

The housing stressors index was significantly, positively related to the likelihood of being obese across both specifications of weight status for all children. With respect to the magnitude of the relationship, a one unit increase from the average value of the housing stressors index across both interview waves (from 0.221 to 1.221) led to a 10.7 percentage point increase in the probability of being obese from a mean probability of 20% at CDS-I, and 32.6% increase in the depth (obesity gap) of obesity for those who were obese. (Derived from Tables 1 and 3.) We found no evidence of a relationship between the other forms of economic stressors –financial and neighborhood stressors – and child weight status.

	Obese	Obesity Gap	Obese	Obesity Gap
	(1)	(2)	(3)	(4)
Younger Children: 2 to 8 yrs				
	Females		Males	
Housing stressors	0.8029** (0.3983)	0.0810*** (0.0279)	0.1895 (0.2949)	0.0245 (0.0346)
Financial stressors	-0.1547 (0.1534)	-0.0038 (0.0125)	-0.0559 (0.1154)	-0.0094 (0.0128)
Neighborhood stressors	0.0034 (0.3349)	0.0055 (0.0351)	0.0787 (0.2899)	0.0105 (0.0314)
Number of observations/ respondents	628 / 314		726 / 363	
Older Children: 8 to 14 yrs				
	Females		Males	
Housing stressors	20.0090 (4476.3590)	0.0231 (0.0217)	0.3925 (0.5196)	0.0120 (0.0271)
Financial stressors	-0.3554 (0.2932)	-0.0053 (0.0077)	-0.1170 (0.2217)	0.0008 (0.0112)
Neighborhood stressors	-1.1994 (0.7814)	-0.0392** (0.0194)	0.2019 (0.5651)	0.0008 (0.0251)
Number of observations/ respondents	590 / 295		582 / 291	

Estimated coefficients with standard errors in parentheses. Obese (BMI ≥ 95th percentile). Superscripts of *, **, and *** indicate that the p-value of the coefficient is less than 0.10, 0.05, or 0.01, respectively. The coefficients on the time varying covariates are suppressed for brevity.

Table 4. Effects of stressor indices and time varying covariates on weight status and gap measures, by age group and gender.

The relationships between economic stressors and child weight status were considered for younger (age 2 to 8 years at the CDS-I interview) and older (age 8 to 14 years) children separately and are reported in Table 3, as well. For younger children, exposure to housing stressors was positively and significantly related to obesity. Examining the magnitude of the relationships as above, a one unit increase in the housing stressors index led to a 10.7 percentage point increase in the probability of being obese. The percent increase for the obesity gap measure was 36.9%. While the percentage point increases in the probability of being obese were the same for all children and only the younger children, the magnitude of the association for the depth of obesity for those who were obese was larger for the sample of younger children than for all children. Unlike younger children, for older children the housing stressors index was significantly positively associated with weight status for only

the binary obesity measure. This result indicated that a one unit increase in the housing stressor index was associated with a 9.5 percentage point increase in the likelihood of being obese for older children. The other two measures of economic stress were statistically insignificant for both age groups.

Table 4 provides additional depth to the age-based analyses by examining the relationships between the three economic stressors and weight status by the gender of the child. These analyses revealed that the significant relationship between housing stressors and weight status for younger children was confined to females. For younger females, a one unit increase in the housing stressors index increased the likelihood that a younger female was obese by 19.3 percentage points. The percentage increases in the depth (obesity gap) of obesity for those young females who were obese stemming from a unit increase in the housing stressor index was 57.9. The relationship between housing stressors and weight status for younger males was statistically insignificant. The remaining results were generally consistent with those reported in Table 3. Financial and neighborhood stressors were not related to weight status for younger females or males. For older females and males, none of the stressor indices were related to weight status except for exposure to neighborhood stressors unexpectedly being negatively associated with weight status for older females in the obesity gap examinations.

5. Conclusions

Although efforts to prevent and treat obesity have traditionally emphasized physical activity and diet, it is now becoming more widely recognized that the causes of childhood obesity are complex and multifactorial (Dietz & Robinson, 2008; Eisenmann, 2006). In this paper, we considered the impacts of economic stressors on childhood obesity. Employing an ecological theoretical framework (Bronfenbrenner & Morris, 1998), we considered factors within the microsystem and mesosystem associated with childhood obesity. Specifically, we examined the relationships between economic stress and obesity during childhood and adolescence. In contrast to previous work on this topic, we explicitly controlled for the effects of time invariant unobserved factors (e.g., a child's ability to cope with adverse conditions) which may be correlated with stress through the estimation of fixed effects models. Additionally, we included measures that portray the incidence of obesity. After controlling for these factors, we found statistically significant effects of economic stress on childhood obesity. Consistent with others (e.g., Garasky et al. (2009)), we found that the relationships between economic stressors and child weight status differed across age groups. More specifically, experiencing housing stress was significantly positively associated with a younger girl's probability of being obese, and the depth of her obesity.

The differing associations between stressors and child weight by age groups can be considered within either a developmental family process framework or a developmental neuropsychosocial perspective (i.e., maturation of the stress systems). Younger children are more dependent on their caregivers. Middle childhood youth and early adolescents (ages 8 to 14 years in this study) may have additional/alternative sources of support such as peers, coaches, teachers and romantic partners to whom they may turn in times of stress. Additionally, we conjecture that housing stressors may be more apparent to younger children than other stressors. Compared to the other sources of economic stress considered here (financial and neighborhood stressors), housing-related stress may have the most

serious ramifications in terms of altering a child's day-to-day routine. There is evidence, for example, showing that frequent moves are negatively related to the well-being of children (Astone & McLanahan, 1994; Tucker et al., 1998). Children and families experiencing the types of housing stress examined here may have less control over their food choices and physical activities. Girls in particular are less physically active (Sallis et al., 2000), are more susceptible to stress (Rudolph, 2002), and are more likely to use food as a coping mechanism (Larsen et al., 2006.)

We offer five recommendations for future research based on the results of this study. First, other indicators of economic stress should be considered. For example, families often contend with finding adequate and affordable child care which may impact the health and well being of their children, especially their younger children. Second, although examining the mechanisms underlying the relationship between economic stressors and obesity was outside the scope of this study, several potential pathways could be examined. One possibility is parenting. Several studies suggest that economic pressure is associated with lower marital quality, lower parenting quality, and higher levels of depression in children's caretakers, each of which is associated with worse child outcomes (e.g., Kalil & Dunifon, 2007; Robila & Krishnakumar, 2006). Third, our models implicitly assumed that exposure to economic stressors affected child weight status, but that child weight status did not affect the economic stress experienced in the child's household. While the consensus in the literature is that our models reflect the appropriate direction of the relationship when considering economic stressors, future research may want to consider whether the direction of the relationship is reversed when examining non-economic stressors. For example, parents with overweight children may become stressed due to the stigmatization and discrimination associated with weight in our society (e.g., Puhl & Brownell, 2006) or may experience stress as a result of negative perceptions of their appearance (Kraig & Keel, 2001). Fourth, researchers may wish to investigate the effects of longer-term economic shifts within families on child weight status using the longitudinal study design employed here. For example, the effects of income volatility, changes in family structure, and job loss could be considered. Similarly, longer term exposure to stressors could be examined. Lastly, while this article has not examined the effect of the social safety net on childhood obesity, future research may wish to consider how the numerous assistance programs in the U.S. interact to help families mitigate economic challenges and stress.

Dietz and Robinson (2008) contend that it is unlikely that the problem of obesity will respond to a single intervention. A clear policy implication from this research is the identification of a new avenue for reducing the likelihood that a child will be obese. Based on our findings, reductions in housing stress will lead to reductions in the extent and depth of childhood obesity. From a policy perspective, efforts to address housing stress such as the provision of rent vouchers and current programs targeting families facing foreclosure may have a potential added benefit of reducing childhood obesity and associated health care costs to U.S. government programs such as Medicaid and State Child Health Insurance Programs.

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7. References

- Allison, P. (2005). *Fixed Effects Regression Methods for Longitudinal Data Using SAS*. SAS Institute: Cary, NC.
- Anderson, P., & Butcher, K. (2006). Childhood obesity: trends and potential causes. *The Future of Children*, 16, 19-45.
- Anderson, P., Butcher, K., & Levine, P. (2003). Economic perspectives on childhood obesity. *Economic Perspectives*, 27, 30-48.
- Aneshensel, C. (1992). Social stress: Theory and research. *Annual Review of Sociology*, 18, 15-38.
- Astone, N., & McLanahan, S. (1994). Family structure, residential mobility, and school dropout: A research note. *Demography*, 31, 575-584.
- Barlow, S. (2007). Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*, 120, S164-S192.
- Bjorntorp, P. (2001). Do stress reactions cause abdominal obesity and comorbidities? *Obesity Reviews*, 2, 73-86.
- Boss, P. (1998). *Family Stress Management*. Newbury Park, CA: Sage.
- Bronfenbrenner, U., & Morris, P. A. (1998). The ecology of developmental processes. In R. M. Lerner (Ed.), *Handbook of child psychology theory* (5th ed., Vol. 1, pp. 993-1028). New York: Wiley.
- Brooks, T., Harris, S., Thrall, J., & Woods, E. (2002). Association of adolescent risk behaviors with mental health symptoms in high school students. *Journal of Adolescent Health*, 31, 240-246.
- Chrousos, G., & Gold, P. (1992). The concepts of stress and stress system disorders: Overview of physical and behavioral homeostasis. *Journal of the American Medical Association*, 267, 1244-52.
- Crossman, A., Deborah, A., & Benin, M. (2006). The family environment and American adolescents' risk of obesity as young adults. *Social Science & Medicine*, 63, 2255-2267.
- Cutler, D., Glaeser, E., & Shapiro, J. (2003). Why have Americans become more obese? *Journal of Economic Perspectives*, 17, 93-118.
- Dearing, E., McCartney, K., & Taylor, B. (2006). Within-child associations between family income and externalizing and internalizing problems. *Developmental Psychology*, 42, 237-252.
- Dietz, W., & Robinson, T. (2008). What can we do to control childhood obesity? *The Annals of the American Academy of Political and Social Science*, 615, 222-224.
- Dowda, M., Ainsworth, B., Addy, C., Saunders, R., & Riner, W. (2001). Environmental influences, physical activity, and weight status in 8- to 16-year olds. *Archives of Pediatrics & Adolescent Medicine*, 155, 711-717.
- Eisenmann, J. (2006). Insight into the causes of the recent secular trend in pediatric obesity: common sense does not always prevail for complex, multi-factorial phenotypes. *Preventive Medicine*, 42, 329-335.
- Evans, G., & English, K. (2002). The environment of poverty: multiple stressor exposure, psychophysiological stress, and socioemotional adjustment. *Child Development*, 73, 1238-1248.
- Fletcher, C., Garasky, S., & Nielsen, R. (2005). Transportation hardship: are you better off with a car? *Journal of Family and Economic Issues*, 26, 323-343.

- Freedman, D., Mei, Z., Srinivasan, S., Berenson, G., & Dietz, W. (2007). Cardiovascular risk factors and excess adiposity among overweight children and adolescents: the Bogalusa Heart Study. *Journal of Pediatrics*, 150, 12-17.
- Frydenberg, E., & Lewis, R. (2004). Adolescent coping: the different ways in which boys and girls cope. *Journal of Adolescence*, 14, 119-133.
- Garasky, S., Stewart, S., Lohman, B., Gundersen, C., & Eisenmann, J. (2009). Family stressors and childhood obesity. *Social Science Research*, 38, 755-766.
- Gee, G., & Walsemann, K. (2009). Does health predict the reporting of racial discrimination or do reports of discrimination predict health? findings from the National Longitudinal Study of Youth. *Social Science & Medicine*, 68, 1676-1684.
- Gershoff, E., Aber, J., Raver, C., & Lennon, M. (2007). Income is not enough: Incorporating material hardship into models of income associations with parenting and child development. *Child Development*, 78, 70-95.
- Gibson, L., Byrne, S., Davis, E., Blair, E., Jacoby, P., & Zubrick, S. (2007). The role of family and maternal factors in childhood obesity. *Medical Journal of Australia*, 186, 591-595.
- Goodman, E. (1999). The role of socioeconomic status gradients in explaining differences in US adolescents' health. *American Journal of Public Health*, 89, 1522-1528.
- Gottholmseder, G., Nowotny, K., Pruckner, G., & Theurl, E. (2009). Stress perception and commuting. *Health Economics*, 18, 559-576.
- Gundersen, C., Lohman, B., Garasky, S., Stewart, S., & Eisenmann, J. (2008). Food security, maternal stressors, and overweight among low-income U.S. children: results from National Health and Nutrition Examination Survey (1999-2002). *Pediatrics*, 122, e529-e540.
- Hepworth, J. (2004). The social construction of eating disorders. In J. Germov & L. Williams (Eds.), *A Sociology of Food and Nutrition 2nd ed.* (pp. 368-382). Oxford University Press: South Melbourne, Australia.
- Jolliffe, D. (2004). Continuous and robust measures of the overweight epidemic: 1971-2000. *Demography*, 41, 303-314.
- Kalil, A., & Dunifon, R. (2007). Maternal work and welfare use and child well-being: evidence from 6 years of data from the Women's Employment Study. *Children and Youth Services Review*, 29, 742-761.
- Kim, J., & Garman, E. (2003). Financial stress and absenteeism: an empirically derived research model. *Financial Counseling and Planning*, 14, 31-42.
- Kim, J., Sorhaindo, B., & Garman, E. (2006). Relationship between financial stress and workplace absenteeism of credit counseling clients. *Journal of Family and Economic Issues*, 27, 458-478.
- Koch, F., Sepa, A., & Ludvigsson, J. (2008). Psychological stress and obesity. *Journal of Pediatrics*, 153, 839-844.
- Kort-Butler, L. (2009). Coping styles and sex differences in depressive symptoms and delinquent behavior. *Journal of Youth and Adolescence*, 38, 122-136.
- Kraig, K., & Keel, P. (2001). Weight-based stigmatization in children. *International Journal of Obesity*, 25, 1661-1666.
- Krause, E., Mendelson, T., & Lynch, T. (2003). Childhood emotional invalidation and adult psychological distress: the mediating role of emotional inhibition. *Child Abuse & Neglect*, 27, 199-213.

- Kuczmarski, R., Ogden, C., Guo, S., Grummer-Strawn, L., Flegal, K., Mei, Z., Wei, R., Curtin, L., Roche, A., & Johnson, C. (2002). 2000 CDC growth charts for the United States: methods and development. *Vital Health Statistics*, 11, 1-190.
- Kumanyika, S., & Grier, S. (2006). Targeting interventions for ethnic minority and low-income populations. *The Future of Children*, 16, 187-207.
- Larsen, J., van Strien, T., Eisinga, R., & Engles, R. (2006). Gender differences in the association between alexithymia and emotional eating in obese individuals. *Journal of Psychosomatic Research*, 60, 237-243.
- Larson, K., Russ, S., Crall, J., & Halfon, N. (2008). Influence of multiple social risks on children's health. *Pediatrics*, 121, 337-344.
- Lohman, B., Stewart, S., Gundersen, C., Garasky, S., & Eisenmann, J. (2009). Adolescent overweight and obesity: links to food insecurity and individual, maternal, and family stressors. *Journal of Adolescent Health*, 45, 230-237.
- Loureiro, M., & Nayga, R. (2005). International dimensions of obesity and overweight related problems: an economic perspective. *American Journal of Agricultural Economics*, 87, 1147-1153.
- MacFadyen, A., MacFadyen, H., & Prince, N. (1996). Economic stress and psychological well-being: an economic psychology framework. *Journal of Economic Psychology*, 17, 291-311.
- Marder, W., & Chang, S. (2006). *Childhood Obesity: Costs, Treatment Patterns, Disparities in Care, and Prevalent Medical Conditions*. Thomson: Stamford, CT.
- Marniemi, J., Kronholm, E., Aunola, S., Toikka, T., Mattlar, C., Koskenvuo, M., & Rönnemaa, T. (2002). Visceral fat and psychosocial stress in identical twins discordant for obesity. *Journal of Internal Medicine*, 251, 35-43.
- McGuigan, F. (1999). *Encyclopedia of Stress*. Allyn and Bacon: Boston.
- Mikolajczyk, R., Ansari, W., & Maxwell, A. (2009). Food consumption frequency and perceived stress and depressive symptoms among students in three European countries. *Nutrition Journal*, 8, 31-39.
- Ogden, C., Carroll, M., Curtin, L., Lamb, M., & Flegal, K. (2010). Prevalence of high body mass index in US children and adolescents, 2007-2008. *Journal of the American Medical Association*, 303, 242-249.
- Ogden, C., Kuczmarski, R., Flegal, K., Mei, Z., Guo, S., Wei, R., Grummer-Strawn, L., Curtin, L., Roche, A., & Johnson, C. (2002). Centers for Disease Control and Prevention 2000 growth charts for the United States: improvements to the 1977 National Center for Health Statistics Version. *Pediatrics*, 109, 45-60.
- Pearlin, L., Menaghan, E., Lieberman, M., & Mullan, J. (1981). The stress process. *Journal of Health and Social Behavior*, 22, 337-356.
- Pearlin, L., Schieman, S., Fazio, E., & Meersman, S. (2005). Stress, health, and the life course: Some conceptual perspectives. *Journal of Health and Social Behavior*, 46, 205-219.
- PSID (Panel Study of Income Dynamics). 2005. *An Overview of the Panel Study of Income Dynamics*. <http://psidonline.isr.umich.edu/Guide/Overview.html> [13 May 2005].
- PSID (Panel Study of Income Dynamics). 2008a. *The PSID-CDS Design at-a-Glance*. <http://psidonline.isr.umich.edu/CDS/questionnaires/cdsover.pdf> [21 September 2008].
- PSID (Panel Study of Income Dynamics). 2008b. *What is the CDS?* <http://psidonline.isr.umich.edu/CDS/researchdesign.html> [21 September 2008].

- Puhl, R., & Brownell, K. (2006). Confronting and coping with weight stigma: an investigation of overweight and obese adults. *Obesity, 14*, 1802-1815.
- Puhl, R., & Latner, J. (2007). Stigma, obesity, and the health of the nation's children. *Psychological Bulletin, 133*, 557-580.
- Raman, R. (2002). Obesity and health risks. *Journal of the American College of Nutrition, 21*, 134S-139S.
- Robila, M., & Krishnakumar, A. (2006). Economic pressure and children's psychological functioning. *Journal of Child and Family Studies, 15*, 435-443.
- Rudolph, K. (2002). Gender differences in emotional responses to interpersonal stress during adolescence. *Journal of Adolescent Health, 30*, 3-13.
- Sallis, J., Prochaska, J., & Taylor, W. (2000). A review of correlates of physical activity of children and adolescents. *Medicine & Science in Sports & Exercise, 32*, 963-975.
- Sampson, R., Raudenbush, S., & Earls, F. (1997). Neighborhoods and violent crimes: A multilevel study of collective efficacy. *Science, 277*, 918-924.
- Schilling, E., Aseltine, R., & Gore, S. (2008). The impact of cumulative childhood adversity on young adult mental health: measures, models, and interpretations. *Social Science & Medicine, 66*, 1140-1151.
- Siervo, M., Wells, J., & Cizza, G. (2009). The contribution of psychosocial stress to the obesity epidemic: an evolutionary approach. *Hormone and Metabolic Research, 41*, 261-270.
- Skinner, A., Mayer, M., Flower, K., & Weinberger, M. (2008). Health status and health care expenditures in a nationally representative sample: how do overweight and healthy-weight children compare? *Pediatrics, 121*, e269-e277.
- Spencer, M. (2001). Resiliency and fragility factors associated with the contextual experiences of low-resource urban African-American male youth and families. In *Does it Take a Village? Community Effects on Children, Adolescents, and Families*, edited by A. Booth and A.C. Crouter. Mahwah, N.J.: Lawrence Erlbaum Associates, Inc.
- Strauss, R. (1999). Childhood obesity. *Current Problems in Pediatrics, 29*, 5-29.
- Tucker, C., Marx, J., & Long L. (1998). Moving on: resident mobility and children's school lives. *Sociology of Education, 71*, 111-129.
- US/DHHS (U.S. Department of Health and Human Services). (2000). *Healthy People 2010, 2nd ed; With Understanding and Improving Health and Objectives for Improving Health*. 2 vols. U.S. Government Printing Office: Washington, DC.
- US/HUD (U.S. Department of Housing and Urban Development). (2007). *Affordable Housing*. <http://www.hud.gov/offices/cpd/affordablehousing/index.cfm> [16 October 2007].
- US/Office of the President. (2010). *Solving the Problem of Childhood Obesity within a Generation: Report to the President*. White House Task Force on Childhood Obesity: Washington, DC.
- van Jaarsveld, C., Fidler, J., Steptoe, A., Boniface, D., & Wardle, J. (2009). Perceived stress and weight gain in adolescence: a longitudinal analysis. *Obesity, 17*, 2155-2161.
- Wadsworth, M., & Compas, B. (2002). Coping with family conflict and economic strain: the adolescent perspective. *Journal of Research on Adolescence, 12*, 243-274.
- Wang, Y., & Zhang, Q. (2006). Are American children and adolescents of low socioeconomic status at increased risk of obesity? Changes in the association between overweight

and family income between 1971 and 2002. *The American Journal of Clinical Nutrition*, 84, 707-716.

White, J., & Klein, D. (2002). *Family Theories*, 2nd ed. Sage: Thousand Oaks, CA.

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