Assessing the Role of Health-Related Behaviors in Explaining the Relationship between Poverty and Obesity among Mothers*

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Abstract
The high prevalence of obesity in the U.S. is a significant concern for health and social scientists. Low-income women seem to be at a particularly high risk of becoming obese. One explanation for this phenomenon derives from the gendered division of childrearing responsibilities within American families: When faced with poverty-related constraints on the types and amounts of food they can buy, mothers may develop rationing strategies that benefit their children's health at the expense of their own. Long work hours and high stress levels may be additional factors contributing to obesity among low-income women, especially mothers. In the current study, we use data from the American Time Use Survey and Consumer Expenditure Survey to 1) replicate past findings of a link between the intersection of poverty and motherhood and the risk for obesity, and 2) investigate the extent to which this link is explained by measures of day and nighttime health behaviors, including physical activity, food purchasing patterns, and sleep.

Introduction

The high prevalence of obesity in the U.S. is among the foremost population health issues concerning health scientists today. More than 35% of American adults are obese and at higher risk than their normal-weight peers for conditions such as diabetes, inflammation, and bone and joint problems (U.S. Surgeon General 2007). Among women, comorbid conditions associated with obesity include impaired fecundity, premature birth, and anovulatory infertility (Metwally, Li, & Ledger 2007). Like many health problems, the risk for obesity is generally higher for low-income individuals whose limited budgets constrain their dietary options to energy-dense, nutrient-poor foods (Drewnowski & Specter 2004; Glass & McAtee 2006; Poston & Foreyt 1999). The inverse association between income and obesity is particularly pronounced for women, with the highest risks found among women living under the poverty line (Ogden et al. 2010; McLaren 2007). Conversely, obesity rates tend to be *lower* among very low-income males (Ogden et al. 2010). Few studies have examined the reasons for the gendered association between poverty and obesity.

One explanation for low-income women's higher risk for obesity hinges on the gendered division of childrearing responsibilities within American families. Women are typically viewed as the primary providers of sustenance within the household, shouldering the responsibilities for purchasing, preparing, and feeding household members—especially children (DeVault 1991). When faced with poverty-related constraints on the types and amount of foods they can afford, mothers may ration healthier foods for their children while taking on obesogenic practices for themselves including meal skipping and the consumption of energy-dense diets. One study finds indirect support for this by showing that, compared to childfree women and all men, low-income

mothers were more likely to be overweight or obese and gained more weight over time (Martin & Lippert 2012). However, the specific mechanisms explaining this pattern remain unclear.

In the current study, we utilize two unique data sets that, when combined, include a range of behavioral health measures that are theoretically linked to both poverty and obesity. We seek to accomplish two main aims: (1) using both data sources, we replicate past findings of a link between the intersection of poverty and motherhood and the risk for obesity; (2) we investigate the extent to which this link is explained by several measures of day and nighttime health behaviors including physical activity, food purchasing patterns, and sleep quality. Results from this study provide important clues about the mechanisms through which poverty and motherhood combine to affect obesity. Understanding these mechanisms will help inform policy responses aimed at eliminating the undue obesity risks faced by low-income women.

Background

Previous research has found that in food-insecure homes, mothers adopt a variety of strategies to protect children's access to food. These may include strategies like skipping meals or otherwise consuming insufficient calories (DeVault 1991; Stevens 2010). Such behaviors are linked to a slowing of metabolism and thus a higher likelihood of overweight or obesity (Ledikwe et al. 2006; Ma et al. 2003). There are additional potential mechanisms by which diet in particular may affect overweight and obesity for low-income mothers. First, when households are concerned about individuals within the household going hungry, family members may purchase cheap, energy dense foods, like fast food, for consumption in place of nutrient dense foods such as fruits and vegetables (Dixon, Winkleby, & Radimer 2001; Drewnowski & Specter 2004; Kirkpatrick & Tarasuk 2008). This is because if hunger is a concern, one wants the lowest

per-calorie cost. Consumption of energy dense foods in place of nutrient dense foods may lead to a poorly balanced diet as well as overweight and obesity.

Second, low-income individuals often work long hours. Particularly for low-income mothers, this means that they may have little time to prepare food for themselves and their children (Dubowitz et al. 2007, Glanz et al. 1998), and this may lead to a reliance on convenience foods, which typically have significant amounts of added fats, sugars, and salt (Darmon and Drewnowski 2008, Drewnowski 2004, Turrell et al. 2002).

Third, low-income mothers may experience particularly high levels of stress associated with balancing paid labor, housework, and childrearing responsibilities with limited time and economic resources. Research indicates that under conditions of stress, individuals are more likely to consume high-calorie sweet and fatty foods, and to concurrently reduce consumption of healthy low-fat foods, such as fruits and vegetables (Oliver and Wardle 1999, Zellner et al. 2006).

Along with dietary patterns, physical activity levels and time in sleep may play a role in driving the obesity risks of low-income women. Engagement in physical activity, whether in the forms of strenuous physical labor or leisure-time activities such as running or playing sports, is considered one important strategy for maintaining healthy weight and losing weight among those who are overweight or obese. As stated with regard to diet, low-income mothers may experience a time crunch between their time in paid labor and the demands of the home. Because evidence suggests that mothers faced with time trade-offs put their children ahead of themselves, we expect that lack of physical activity would be another mechanism through which poverty relates to obesity.

Finally, we are interested in the role that sleep may play in the relationship between poverty and obesity. Inadequate sleep can lead to elevated cortisol levels (stress hormones), which can slow metabolism, resulting in weight gain if dietary modifications are not made. Increased stress levels are linked to obesity, particularly central adiposity (De Vriendt, Moreno and De Henauw 2009). Single mothers may be particularly vulnerable to inadequate sleep. Outside of paid labor hours, single mothers may spend many additional hours on housework and childcare activities; the need to complete these tasks may reduce the amount of time available for sleep. Also, as indicated previously, single mothers often experience high levels of stress related to balancing their responsibilities, and this condition is likely to be greater among low-income single mothers. High levels of stress may be associated with low-quality sleep.

To investigate the role of sleep, physical activity, and diet as potential mechanisms in the relationship between income and obesity for mothers, we use data from the American Time Use Survey (ATUS) and the Consumer Expenditure Survey (CEX).

Data

ATUS

The ATUS is a nationally representative time diary study funded by the U.S. Bureau of Labor Statistics (BLS) and fielded by the U.S. Census Bureau. The sample is drawn from the outgoing rotation of the Current Population Survey. The ATUS is ideal for studying issues related to the allocation of time and allows us to study time in sleep and time in physical activity (BLS 2013a). Along with time-use data, the survey collects demographic and other information (BLS 2013b). We use the ATUS years 2006-2008 because they coincide with the fielding of the special Eating and Health module, which collected data on respondents' health and body mass index (BMI).

This allows us to study obesity, which we cannot do in other years. The ATUS data were extracted from ATUS-X, a project of the Maryland Population Research Center and the Minnesota Population Center.

We restrict the sample to female respondents between the ages of 18 and 55 who were not foreign born. These sample restrictions allow us to compare our results to previous studies, including the Martin and Lippert (2012) study discussed earlier. Women who were pregnant at the time of the survey are excluded because BMI values do not exist for pregnant women in the data, given pregnancy's strong relationship with weight. Our final analytic sample includes 10,982 women, of whom 6,429 are partnered and 4,553 are single.

CEX

The CEX is a survey conducted by the BLS to collect data on the purchasing habits of American consumers. We use the Diary component of the survey, which is a cross-sectional survey in which consumer units (usually equivalent to a household) record expenditures on small, frequently purchased items that are bought on a weekly or daily basis. The consumer unit completes the survey for two consecutive weeks. For comparability to the ATUS, we limit the survey years to 2006-2008. The Diary survey allows us to examine food purchases made by women's households. We categorize food purchases into three categories: foods that should be consumed infrequently, foods that should be consumed frequently, and other foods. This categorization scheme was initially used by researchers at Mathematica who were studying diet quality and food expenditures among low-income households (Mabli et al. 2010). Because BMI is not available in this data set, we predict BMI using the ATUS data. The procedure involves estimating BMI in the ATUS data and applying the coefficients from the ATUS model to the

corresponding CEX variables. To our knowledge this strategy has not been used previously for studying overweight and obesity, and a recent example of its use predicting permanent income can be seen in Killewald (2014).

We restrict the sample to female respondents or partners (including married and unmarried partners) between the ages of 18 and 55. We are not able to exclude pregnant women, but because BMI is estimated in this data set, we do not expect this to be problematic. Our final analytic sample includes 13,821 women, of whom 7,016 are partnered, and 6,805 are single.

Methods

To gain insight into the potential mechanisms of physical activity, sleep, and food quality, we estimate ordered logit models. Our outcome variable of interest is a categorical measure of weight. Specifically, category 1 is underweight/normal weight, category 2 is overweight, and category 3 is obese. We use the standard cutoffs of BMI of 25 for overweight, and BMI of 30 for obese.

We initially estimate models designed to replicate, as closely as possible in ATUS and CEX, the models estimated by Martin and Lippert (2012). They used the Panel Study of Income Dynamics. Model 1 estimates the association between having children and weight, and poverty and weight, net of controls. Model 2 adds an interaction between having children and poverty to assess whether the relationship between poverty and obesity is different for mothers than non-mothers. The indicator variable for children simply takes a value of 1 if children are reported in the household and 0 otherwise. The measure of poverty we use is an indicator of whether the household income is below 130% of the poverty line for the survey year. This is a substantively interesting cutoff because having gross income at or below 130% of the poverty line qualifies

one for a number of social welfare programs, including the Supplemental Nutrition Assistance Program (SNAP) and free school lunch for children.[1]

We include the following control variables in our models: age, partnership status, education, fair or poor self-rated health (ATUS only), race/ethnicity, and urban residence. We include age as a continuous variable. Partnership status is an indicator variable distinguishing those living in cohabiting or marital unions from single women. Education is a categorical variable taking the following values: less than high school, high school diploma, some college, college degree or higher. In the ATUS we are able to include self-rated health as a predictor. We distinguish those reporting fair or poor self-rated health from those reporting better health. Race/ethnicity is a categorical variable taking the following values: non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic other racial group. Finally, urban residence is included as an indicator variable.

After estimating models 1 and 2, we then examine whether time in physical activity, time in sleep, or food quality mediates the relationship between motherhood, poverty, and obesity. Time in physical activity and time in sleep are continuous measures taken from the time diary portion of the ATUS. They are topcoded to the 99th percentile. To study food quality, we use the coding scheme developed by Mathematica (Mabli et al. 2010), delineating food items as those that should be frequently consumed, infrequently consumed, or other. Foods in the other category are those for which scientific evidence does not provide a determination for whether they should be consumed on a frequent or infrequent basis. Foods in the "frequent foods" category include fruit and fruit products (not juice), vegetables, and legumes. Foods in the

[1] We also examined models with an indicator of household income below 185% of the poverty line. While results are similar, we choose to focus on the lower-income women because of their greater risk of economic insecurity and their eligibility for program participation.

"infrequent foods" category include sweetened drinks, fats, bakery products, sugar-based products, high-fat dairy, snacks, processed meat, and alcohol. Foods in the "other" category include grains, meat, fish, dairy, and unsweetened drinks. We estimate models using the proportion of total food spending allocated to the different categories. In our next iteration of the analysis, we will be incorporating all three potential mechanisms (physical activity, food quality, and sleep) into the models to examine their contribution to the relationship. The current models include each measure separately.

Results

Table 1 provides weighted descriptive statistics for the two samples. The descriptive statistics suggest a number of similarities across the two samples and a few differences. Average BMI (estimated for CEX) is just under 27 in both samples. A little less than one-fifth of the samples have family incomes below 130% of the poverty line. The statistics also indicate that roughly half of the samples have children in the household, and the average age of women is around 38. There are a few noticeable differences between the samples. About 10% more women are partnered in the ATUS than the CEX, and about 10% more women in the CEX live in urban areas than women in the ATUS. On average, the CEX sample has slightly lower levels of education, and women in the sample are more likely to be racial or ethnic minorities. Thus, the samples have a number of similarities, but any differences we see in results will require further investigation to determine whether they are being driven by differences in demographics between the samples.

[Table 1 about here]

Table 2 provides results from four ordinal logistic regression models estimating the odds of experiencing higher-order obesity outcomes among women only. Model 1 in Panel A (using ATUS data) shows that the main effect for the presence of children in the household is non-significant, while the effect of household poverty is only marginally significant. In Model 2, the additional interaction term between the presence of children and poverty is positive and significant—consistent with past findings from other data sources. Interpreting this coefficient suggests that impoverished women with children in the household are more likely to be overweight or obese than their childfree counterparts.

[Table 2 about here]

Panel B presents results using the CEX data. In Model 1, we find a significant and negative effect of the presence of children on women's odds of being overweight or obese. Consistent with results from Panel A, we find that the interaction term between poverty and the presence of children is also positive and significant in the CEX data. These findings lend additional credibility to prior work using different data sources that established a link between the intersection of poverty and motherhood and the risk for being overweight or obese.

Table 3 explores the extent to which behavioral factors mediate the additional obesity risks faced by low-income mothers. These models represent an initial examination of mediating factors, and a planned expansion of the models is discussed in the next section.

[Table 3 about here]

Panels 1 and 2 relate to results from the ATUS data while Panel 3 focuses on results from the CEX data. In Panel 1, we find that the coefficient for the interaction between poverty and children in the household is not attenuated by the addition of our measure of physical activity, though the effect of physical activity on the outcome is in the expected direction. Results from

Panel 2 show that sleep quality also does not explain the higher risk for overweight or obesity among low-income mothers. In Panel 3, which adds our measure of food quality furnished in the household, we find that the coefficient for the interaction between poverty and the presence of children is attenuated slightly—from 0.64 in Table 2 to 0.60 in Table 3.

Next Steps

As mentioned in the methods section, the next iteration of the analysis will incorporate all three potential mechanisms into the models. Currently we are limited to looking at the contribution of each mechanism separately. One of the other potential limitations of the analysis is the need to rely on multiple data sets. On the one hand, congruence in results across data sets will strengthen our claims. On the other hand, there are drawbacks to using estimated measures of BMI in the CEX and food quality (in the next iteration) in the ATUS. For example, the estimated measures of BMI in the current analysis appear to suffer from ceiling effects, with a larger-than-expected percentage of individuals categorized as overweight and a smaller-than-expected percentage of individuals categorized as obese. In addition, the coefficients on the poverty measures in the CEX models are unexpectedly large. While these coefficients may reflect a true relationship, given that the CEX sample is more heavily minority and somewhat lower educated (both factors related to overweight and obesity), we will explore this measure and the predicted values of BMI further. Refinement of the prediction model in subsequent analyses may reduce the issues identified above.

Our "next steps" also include exploring the robustness of our results when differing poverty thresholds are used, utilizing additional food expenditure data available in the CEX, utilizing food-related time use measures available in the ATUS, and examining non-linear forms

of the sleep and physical activity variables. Physical activity time in the ATUS is highly skewed, so examining different non-linear forms of the variable may provide more information than the linear form of the variable. The ATUS also contains data on time spent eating and drinking, along with time spent preparing and purchasing food and drink. By incorporating these food-related time measures, we hope to provide a more complete picture of food consumption patterns that may relate to obesity, particularly for low-income mothers.

We will also examine how age of the children present in the household modifies the interaction term between poverty and the presence of children. Based on prior research, we anticipate that low-income mothers of younger children may have higher obesity risks than mothers of older children. This is because younger children are more dependent upon their parents (especially mothers) for providing nourishment, whereas older youth may be encouraged to meet their needs for sustenance independently. Using the demographic information on householders present in both data files, we will examine how the age of children under a mother's care modifies the link between poverty and obesity.

Finally, we will also incorporate male respondents from both the ATUS and CEX samples into the analysis. This step will allow us to expand more thoughtfully on the gendered relationship between poverty and obesity in America.

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Table 1. Descriptive Statistics—Sample Means and Percentages, ATUS and CEX, Sample Weighted

	ATUS	**CEX**
BMI (est. for CEX)	26.73	26.69
Hhold income <=130% poverty	17%	19%
Children present in household	53%	54%
Number of children in hhold	0.99	1.03
Age	37.34	38.77
Partnered (married/cohabiting)	61%	50%
Fair or poor self-reported health	12%	---
Urban residence	82%	92%
Education		
Less than high school	9%	11%
High school diploma	28%	24%
Some college	31%	35%
College or more	32%	29%
Race/ethnicity		
Non-Hispanic white	72%	66%
Non-Hispanic black	14%	16%
Hispanic	10%	14%
Non-Hispanic, other race	5%	5%
Minutes/day in physical activity	10.39	---
Minutes/day sleeping	507.20	---
Percent budget—infrequent foods		25%
Percent budget—frequent foods		11%
N	10982	13821

Table 2. Coefficients from Ordinal Logistic Regression Models Predicting Heavier Weight Classification

	Panel A. ATUS		Panel B. CEX	
	Model 1	**Model 2**	**Model 1**	**Model 2**
Kids in household	0.04 (0.06)	-0.02 (0.06)	-0.42 (0.07)***	-0.55 (0.08)***
<130% poverty	0.15 (0.08)$^{+}$	-0.10 (0.13)	2.61 (0.09)***	2.23 (0.13)***
Kids X <130% poverty		0.40 (0.15)**		0.64 (0.15)***
Age	0.03 (0.003)***	0.03 (0.003)***	0.15 (0.004)***	0.15 (0.004)***
Partnered	0.09 (0.06)	0.09 (0.06)	-0.42 (0.07)***	-0.41 (0.07)***
Education (less than high school omitted)				
High school diploma	0.11 (0.10)	0.10 (0.10)	1.15 (0.11)***	1.16 (0.11)***
Some college	0.04 (0.10)	0.04 (0.10)	1.42 (0.11)***	1.43 (0.11)***
College or more	-0.54 (0.10)***	-0.54 (0.10)***	-5.07 (0.14)***	-5.09 (0.14)***
Fair/poor health	0.80 (0.09)***	0.82 (0.09)***		
Race/ethnicity (non-Hispanic white omitted)				
Non-Hispanic black	0.87 (0.07)***	0.86 (0.07)***	5.27 (0.12)***	5.25 (0.12)***
Hispanic	0.55 (0.09)***	0.54 (0.09)***	2.92 (0.11)***	2.89 (0.11)***
Non-Hispanic, other race	-0.27 (0.14)$^{+}$	-0.27 (0.14)$^{+}$	-1.17 (0.17)***	-1.17 (0.17)***
Urban residence	-0.21 (0.07)**	-0.21 (0.07)**	-1.17 (0.16)***	-1.15 (0.16)***

Notes: Models are weighted.
*p<.05; **p<.01; ***p<.001

Table 3. Key Coefficients from Ordinal Logistic Regression Models Predicting Heavier Weight Classification, with Mediating Variables of Physical Activity Time, Sleep Time, and Food Quality

	ATUS	CEX
Panel 1. Physical Activity		
Kids in household	-0.03 (0.06)	
<130% poverty	-0.11 (0.13)	
Kids X <130% poverty	0.40 (0.15)**	
Minutes in physical activity	-0.01 (0.001)***	
Panel 2. Sleep		
Kids in household	-0.02 (0.06)	
<130% poverty	-0.09 (0.13)	
Kids X <130% poverty	0.40 (0.15)**	
Minutes in sleep	-0.0002 (0.0002)	
Panel 3. Food Quality--proportion		
Kids in household		-0.48 (0.08)***
<130% poverty		2.29 (0.14)***
Kids X <130% poverty		0.60 (0.16)***
Proportion budget—infrequent foods		0.04 (0.07)
Proportion budget—frequent foods		0.19 (0.30)

Notes: Models include the following controls: respondent age, partnership status, education, race/ethnicity, urban residence, and fair/poor health (ATUS only). Models are weighted.
,*p<.05; **p<.01; ***p<.001