Maternal depression as a risk factor for children's inadequate housing conditions

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Abstract

Depression among mothers with young children is an important public health issue that not only has implications for their own well-being, but can also potentially affect their children's health and developmental trajectories. This study explored the extent to which maternal depression is a risk factor for inadequate housing conditions related to utilities, a noteworthy risk factor for poor child health. Using data on 2965 mothers and children from a national urban cohort of U.S. births in 1998–2000, we estimated multivariate logistic regression models of associations between maternal depression during the postpartum year and a U.S. Department of Housing and Urban Development (HUD) measure of severely inadequate housing due to heating issues, as well as a broader measure of energy insecurity that encompasses various types of utility problems. We also considered outcomes that incorporated housing instability and food insecurity in conjunction with housing inadequacy. Mothers who experienced depression had about 60% higher odds of experiencing severely inadequate housing due to heat (OR: 1.57) and 70% higher odds of experiencing energy insecurity (OR: 1.69) compared to mothers who did not experience depression. Maternal depression was even more strongly associated with multiple hardships in the forms of housing inadequacy plus housing instability and/or food insecurity than it was with housing inadequacy. This study provides robust evidence that maternal depression is a risk factor for inadequate housing and multiple hardships during a critical period of children's development. The findings suggest that policy efforts should not occur in mental health, housing, and food security silos.

1. Introduction

Depression is a major public health issue, particularly among new mothers. According to an expert panel convened by the Center on the Developing Child at Harvard, 10–20 percent of

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mothers experience depression at some time during their lives, over 10 percent of infants have a mother who experiences major depression in their first year of life, and depression among new mothers often goes unidentified and rates of treatment are low (Center on Developing Child, 2009). According to the authors of the report, maternal depression can have potentially far-reaching, adverse effects on parenting and child development (Center on Developing Child, 2009). As such, maternal depression not only affects the mothers' own well-being, but it also potentially affects their children's health and developmental trajectories.

Most studies of the effects of maternal depression on children have focused on mother–child interactions or children's psychological well-being (Hwa-Froelich et al., 2008; Jacob and Johnson, 1997; Conners-Burrow et al., 2014; Cummings and Davies, 1994). Very few studies in developed countries have investigated effects of maternal depression on their children's physical health. One recent exception, which used the Early Childhood Longitudinal Survey—Birth Cohort from the U.S., found that children of mothers who had moderate-to-severe depression during the postpartum period had worse growth trajectories up to age 6 (Surkan et al., 2014). Another study (Casey et al., 2004), using a convenience sample of mothers of very young children (0–2 years), found no associations between maternal depression and child growth but that children of depressed mothers were more likely to be in fair or poor health and to have hospitalizations. Other studies found that young children with depressed mothers are at risk for receiving inadequate preventive healthcare (Chung et al., 2004; Flynn et al., 2004; Logan et al., 2008; Minkovitz et al., 2005), that maternal depression has negative effects on management of childhood asthma (Perry, 2008), and that maternal depression has adverse associations with child safety practices (e.g., putting infants to sleep on their backs) and use of safety devices (e.g., smoke alarms, electrical outlet covers, car seats) (Balbierz et al., 2015; Conners-Burrow et al., 2012; Chung et al., 2004; McLennan and Kotelchuck, 2000).

Studies of the effects of maternal depression on the physical environment in which children live are virtually non-existent, despite the fact that housing situations are associated with an array of exposures that affect health and the reality that mothers' resources, behaviors, and decisions generally dictate those conditions for children. Among the housing exposures that have been linked to poor health of children (and adults as well) are asbestos, lead paint, rodents, dust mites, lack of heat, and dangerous physical structures (e.g., Breysse et al., 2004; Krieger and Higgins, 2002; Jacobs et al., 2009; WHO, 2006). We know of no studies that have examined the effects of maternal depression on household environmental factors other than parental behaviors surrounding child safety.

Cold homes in particular have been linked to circulatory diseases, respiratory conditions, mental ill-health, the common cold and flu, arthritis and rheumatisms, and at the extreme, mortality (Marmot et al., 2011). Children, the elderly, and people with long-term illness are at particular risk, due to both underlying frailty and because they spend more time at home (Marmot et al., 2011). In a systematic review, Liddell and Morris (2010) found that lower-than-recommended indoor air temperatures are adversely related to infants' weight gain and children's hospital admission rates, caregiver-rated developmental status, and severity and frequency of asthmatic symptoms. In a recent review of ambient temperatures and children's

health, Xu et al. (2012) found that very young children, especially those less than 1 year old, are particularly vulnerable to hot and cold temperatures in terms of their risk for infectious diseases, respiratory diseases, pediatric allergic diseases such as eczema, renal disease, and fever and electrolyte imbalance; however, the studies reviewed did not focus on indoor temperature.

In this study, we explore whether and to what extent maternal depression is a risk factor for inadequate housing conditions related to utilities—an outcome that is both important in its own right and a noteworthy risk factor for poor child health. We focus on maternal depression during the postpartum year, which allows us to study housing conditions at a critical period for child health and development. For outcomes, we use the U.S. Department of Housing and Urban Development (HUD) measure of severely inadequate housing due to heating issues as well as a broader measure of various types of utility problems. Studies have found evidence linking physical household conditions to adverse mental health outcomes (Evans et al., 2003), but as far as we know effects in the opposite direction have not been explored.

Recent studies found that maternal depression is a risk factor for other hardships among families with young children, including homelessness (Curtis et al., 2014), housing instability (Curtis et al., 2014), and food insecurity (Noonan et al., 2014), all of which have traditionally been considered almost exclusively as causes, rather than consequences, of poor health. However, physical housing conditions are distinct from housing instability and food insecurity, and the different hardships do not necessarily go hand-in-hand. For example, studies found that housing and food costs are competing demands for many low-income families and that tradeoffs are sometimes made (Bhattacharya et al., 2003; Beatty et al., 2013). To bridge and build on this previous research, we not only investigate links between maternal depression and subsequent housing inadequacy, but also between maternal depression and multiple hardships in the realms of housing and food.

The objective of this study is to identify robust independent associations (if there are any) between maternal depression during the postpartum year and subsequent housing conditions as well as multiple hardships. The findings cannot necessarily be interpreted as causal, but the analyses take important steps in that direction, and regardless of causality, information about which types of hardships (and combinations of hardships) children with depressed mothers face has implications for policy approaches.

2. Methods

2.1. Data

Births were randomly selected from birth logs in 75 hospitals in 20 U S. cities with populations greater than 200,000 as part of the Fragile Families and Child Wellbeing (FFCWB) study, a longitudinal birth cohort survey. The research design is described elsewhere (Reichman et al., 2001). Non-marital births were oversampled. A total of 4898 mothers (86% of those eligible) were interviewed while still in the hospital after giving birth, between 1998 and 2000. Response rates were higher among unmarried mothers than among married mothers (87 vs. 82%) (Bendheim-Thoman Center for Research on Child Wellbeing,

2008). Fathers were also interviewed. Additional information was collected from medical records from the birth hospitalization. Institutional Review Board Approval for the current study was not required because the research was based on previously collected de-identified data.

Of the mothers who completed initial (baseline) interviews, 89% were re-interviewed one year later and 86% were re-interviewed when their children were 3 years old. Of the 3684 mothers with available medical record data (needed to create measures of prenatal factors such as housing problems and mental illness), 3024 completed both follow-up surveys. Of the 3024 mothers, 59 were excluded from the analysis because of missing data on key variables, leaving 2965 cases. Comparisons (at baseline) between the 2965 mothers in the analysis sample to the 1933 mothers not in the sample (available upon request) indicated no significant differences by education, relationship status, race/ethnicity, insurance status, or parity, but that mothers in the analysis sample were less likely to be foreign born (15, versus 20%) and slightly more likely to have been employed prior to pregnancy (81, versus 77%). The mean age difference was significant but substantively trivial.

2.2. Measures

2.2.1. Exposure—Depression during the postpartum year, assessed at 1 year, was measured using an indicator for whether the mother met diagnostic criteria for major depression in the past 12 months, according to the Composite International Diagnostic Interview Short Form (CIDI-SF) Version 1.0 November 1998, an instrument widely used in epidemiologic and population research. Our main measure of depression is based on the number of depressive symptoms from 0 to 7, with a major depressive episode defined as the experience of 3 + symptoms of dysphoria or anhedonia (e.g., being sad, feeling blue, losing interest in things) for most of the day for a period of at least 2 weeks. We also used a less stringent measure in supplementary analyses. Both measures have been validated in the literature (Fragile Families and Child Wellbeing Study, 2014).

Although our measures of maternal depression are based on a validated instrument for assessing diagnostic criteria for major depression and pertain to the postpartum year, they do not capture postpartum depression per se, which is the explicit focus of the Edinburgh Postnatal Depression Scale. However, because of the timing of the diagnostic assessments, our measures are likely to pick up many cases of postpartum depression.

2.2.2. Outcomes—Our main outcomes are two measures of inadequate housing conditions related to utilities—a stringent HUD-based measure of severely inadequate housing related to heating and a broader measure of various types of utility problems. We focus on inadequate utilities based on mothers' reports at 3 years (and pertaining to the past year), to ensure that the assessment of maternal depression precedes the reports of inadequate utilities and because the relevant measures are not available at 1 year.

For the more stringent measure, we consider whether the mother reported that her home was uncomfortably cold for a period of 48 h due to inadequate heating capacity or insulation, equipment breakdown, or the super or landlord keeping the heat too low. This measure conforms to a measure of severely inadequate housing (U.S. HUD, 2013), which is relatively

rare in the U.S. For example, in 2005 (the year for which data exist that is closest to the observation window in our study), 4.1% of low-income renters in the U.S. had severely inadequate housing due to physical problems related to heating, plumbing, electric, public spaces, or maintenance (U.S. HUD, 2005). Our measure is quite stringent because it only includes conditions related to heat; that is, mothers could be coded as having adequate housing based on this measure but in actuality have experienced structural problems related to plumbing, electric, public spaces, or maintenance. In addition, it does not capture other types of heating hardships, such as utility shutoffs because of inability to pay. For shorthand, we refer to this measure as "HUD inadequate housing."

For the broader measure, we consider a household to have had inadequate utilities if the mother responded affirmatively to any of the following questions: "In the past 12 months, has your home ever been uncomfortably cold for a period of 48 h or more?" In the past 12 months, was your electricity ever turned off by the utility company because there wasn't enough money to pay bills?" "In the past 12 months, was service ever turned off by the gas company, or did the heating oil company not deliver oil because there wasn't enough money to pay the bill?" "In the past 12 months, did you ever have no running water for a period of 48 h?" This indicator is similar to a measure of "severe energy insecurity" developed and applied by Cook et al. (2008), for which one criterion was that the household went at least one day in the past year with no heat or cooling. We thus refer to this measure as "energy insecurity." By definition, everyone who experienced the more stringent measure defined above was coded as experiencing energy insecurity.

In auxiliary analyses, we consider multiple hardships, incorporating two other forms of hardship that have been studied as consequences of maternal depression—residential instability and food insecurity. Following Curtis et al. (2013), we coded the mother as experiencing housing instability if she reported in the 3-year interview that she was currently homeless or living in a temporary shelter; that in the past 12 months she had been homeless or stayed in a shelter, abandoned building, automobile, or any other place not meant for regular housing; or that she had been evicted, moved 3 or more times in the past 2 years, or was living with friends or relatives without paying rent. Following Noonan et al. (2014), we coded the household as being food insecure if the mother responded affirmatively to 3 or more of the questions from the USDA Core Food Security Module, which was embedded in the mother's 3-year survey and consists of 18 different questions about food hardship during the past year.

2.2.3. Covariates—To clearly situate this study in the literature, particularly the recent study by Curtis et al. (2014) that explored associations between maternal depression and residential instability, we included the same set of covariates in our main models that were included in the main models in that paper. Maternal characteristics included age, race/ethnicity, nativity, education, health insurance type, employment before pregnancy, relationship status with the father of the child, and parity, all measured at baseline (see Table 1 for race/ethnic, education, and relationship status categories), as well as indicators for whether there was any documentation in the mother's prenatal medical record of any diagnosed mental illness (excluding substance abuse diagnoses), any pre-existing physical health condition, and any prenatal illicit drug use (which was augmented with maternal self-

reports of prenatal drug use in the baseline survey). Child characteristics included poor infant health, sex, multiple birth, and age (in months) at the time of the 3-year interview. For poor infant health we used a measure based primarily on information from the newborn's medical record and designed to capture severe conditions considered random by the medical community [Supplementary Table 1]. This measure has been used previously to study the effects of unexpected infant health conditions on housing conditions (Curtis et al., 2010) and homelessness (Curtis et al., 2013). Paternal characteristics, measured at baseline directly from the father, included education (relative to that of the mother), risk for depression based on a short version of the Center for Epidemiologic Studies Depression Scale (CES-D), suboptimal self-rated health (good, fair, or poor, versus excellent or very good), and non-completion of baseline interview (see Table 1 notes for more information about coding of the paternal variables). City indicators (sometimes referred to as "city fixed effects") controlled for aspects of cities or states that may be associated with both maternal depression and housing inadequacy.

We controlled for the mother's housing conditions and living situation prior to the birth. The first measure captures housing problems based on information in the mother's prenatal medical record. The abstractors were instructed to record any mention (in progress notes or elsewhere) of "homelessness or threatened eviction" or "inadequate heat, electricity, or running water or other poor housing/living condition." These were combined to create a baseline measure of housing problems. The second is whether the mother lived with any adult other than the baby's father during the pregnancy. To capture the mother's family-related (genetic or environmental) predisposition for depression we included measures of the child's maternal grandmother's and grandfather's histories of depressive symptoms based on positive responses to the following question in the mother's 3-year interview: "Did your biological mother/father ever have periods lasting two weeks or more when she/he was depressed, blue, or down in the dumps most of the time?" We also used indicators for missing data on these measures.

2.3. Analyses

As indicated earlier, the goal of this study is to identify robust independent associations (if there are any) between maternal depression during the postpartum year and subsequent housing conditions—estimates that are plausibly causal. The two key methodological challenges to identifying causal effects in this context are reverse causality, as discussed by Evans et al. (2003), and confounding from unobserved factors (omitted variables bias). With the rich, longitudinal FFCWB data, we are able to take several steps to address these issues, at least to some extent. We focus on maternal depression during the postpartum year, which as discussed earlier is likely to capture many cases of postpartum depression, which according to the medical community is often an unexpected event (O'Hara and Swain, 1996). We also capitalize on our ability to observe households over time by controlling for detailed information at the time of the birth (before the focal child was born and before depression during the postpartum year could have occurred), including prenatal housing problems and history of mental and physical illness. Thus, we are able to do a good job of establishing the temporal ordering of events. Finally, we conduct "placebo" tests by estimating models predicting prenatal housing problems as a function of maternal depression

during the postpartum year, as well as models predicting prenatal mental illness as a function of postnatal hardships. Finding no associations in these models would provide suggestive evidence that at least some of our estimated effects of maternal depression on housing outcomes are causal.

In our first set of analyses, we compared mothers who experienced and who did not experience depression during the postpartum year. Statistically significant differences were ascertained using 2-tailed t tests for comparisons of means and χ^2 tests for categorical variables. We then estimated logistic regression models of the effects of depression during the postpartum year on housing inadequacy and multiple hardship outcomes that controlled for the maternal, child, paternal, and family characteristics described in the previous section as well as the mother's city of residence (in some models, as noted), and assessed sensitivity of the estimates to a number of alternate model specifications and sample restrictions. Odds ratios (OR) and 95% confidence intervals (CI) are presented for the logistic regression models. Throughout, we refer to values outside 95% CIs as statistically significant. All analyses were conducted using Stata Version 13.1 statistical software (Stata CorpLP, College Station, Tex).

3. Results

Thirteen percent (373/2965) of mothers experienced depression during the postpartum year (Table 1). Although statistically different, the mean ages were similar for mothers with and without depression during the postpartum year. The median age was 24 years, with over three-quarters < 30 and fewer than 5% < 18 years old (not shown). Mothers with depression were less likely than those without depression to be foreign born. There were significant differences in terms of relationship status but not by maternal race/ethnicity, education, or physical health or by child or paternal characteristics. Importantly, mothers who experienced depression during the postpartum year were more likely to have a prior diagnosed mental illness (24% vs. 11%) and to have parents with histories of depressive symptoms. They were also more likely to have used illicit drugs during the pregnancy (14% vs. 10%).

Approximately 7 and 14% of the sample experienced HUD inadequate housing and energy insecurity, respectively (Table 2). Mothers with depression were about twice as likely as those who did not have depression to experience each of the two outcomes. About 12% of mothers experienced housing instability and over 17% experienced food insecurity (see table notes). About 39% of those who experienced HUD inadequate housing also experienced housing instability and/or food insecurity, and about 42% of those who experienced energy insecurity also experienced one or both of those other hardships results not shown. Experiencing all three types of hardship was rare (0.5% of mothers for HUD inadequate housing and 1% for energy insecurity). Mothers with depression were much more likely as those without depression to experience all combinations of hardships.

Table 3 presents logistic regression results for the two main outcomes—HUD inadequate housing and energy insecurity. These models include all characteristics from Table 1, plus a quadratic term for age and city indicators (estimates not shown). Mothers who experienced depression during the postpartum year had about 60% higher odds of experiencing severely

inadequate housing due to heat (OR: 1.57) and 70% higher odds of experiencing energy insecurity (OR: 1.69) compared to mothers who did not experience depression. Few covariates are statistically significant. Families with older mothers, with more children, and with non-coresident parents were more likely to experience inadequate housing (using either measure). Prenatal drug use is a strong predictor of HUD inadequate housing even controlling for prenatal mental illness, while grandparents' histories of depression are strong independent predictors of energy insecurity.

Table 4 presents results from models of inadequate housing combined with other material hardships—housing instability and food insecurity. The adjusted models include all covariates in the models in Table 3 except for severe infant health condition, multiple birth, prenatal housing problems, and city indicators, which were not included because of small cell sizes. A comparison of the estimates from the adjusted models in this table to those from Table 3 indicates that dropping these variables was not consequential. The outcomes consisting of two hardships were coded as "yes" if both hardships were experienced, whether or not the third was experienced; e.g., "energy insecurity and food insecurity" was coded as yes if the family experienced both energy insecurity and food insecurity, whether or not that family also experienced housing instability. The outcomes consisting of all three hardships are coded as no if the family experienced fewer than three hardships. The most striking finding is that the odds ratios are uniformly higher for multiple hardships than for single hardships. Although the number of mothers experiencing all three types of material hardship is small, it is noteworthy that maternal depression appears to particularly increase the odds of those extreme situations.

We estimated supplementary models to assess sensitivity and patterns. First, we assessed patterns of estimates in models with different sets of covariates and found that the estimated effects of maternal depression were insensitive to the inclusion of the city indicators, but that the other covariates, particularly grandparents' history of depressive symptoms, reduced the odds ratios substantially (see Table 4 for unadjusted estimates as well as estimates from models that did not include city indicators and certain other covariates, as noted above).

Second, models using a broader validated measure of depression during the postpartum year, which characterizes respondents who reported experiencing symptoms for at least half the day (instead of most of the day) for a period of 2 + weeks in the past 12 months, produced ORs for depression during the postpartum year that were very similar to those using the stricter measure for both outcomes [Supplementary table 2, PANEL A, MODEL 1], suggesting that even maternal depression that is not severe may compromise children's health environments.

Third, we estimated models with the only measure of housing hardship available at 1 year, having utilities turned off in the past 12 months due to non-payment, as the outcome. We include this specification because the outcome is measured closer in time to when we capture depression; a key disadvantage is that we cannot be sure that the depression preceded the utility shut-off. That said, we found that mothers who experienced depression during the postpartum year had more than twice the odds of having their utilities shut off in the first year after the birth of their child (OR: 2.34) [Appendix table 2, PANEL B].

Fourth, we estimated models for a subsample of mothers for whom depression during the postpartum year should come as a particular shock. That is, we considered only mothers who had no prenatal mental illness, no parent (child's grandparent) with a history of depressive symptoms, and no indication of housing problems at baseline—in other words, with no own or family history of depression or prenatal housing problems. Maternal depression during the postpartum year was predictive of housing outcomes even in this sample of 1803 mothers (although the estimate for HUD inadequate housing was imprecisely estimated), suggesting that at least part of the effects may be causal [Appendix table 2, PANEL A, MODEL 2].

Fifth, as discussed earlier, we conducted several "placebo" tests [Appendix table 2, PANEL C]. The first model predicted prenatal housing problems as a function of maternal depression during the postpartum year and we found no significant or substantive association. Another set of models predicted prenatal mental illness as a function of housing/food hardships at follow-up. The estimated effects of each 3-year hardship (HUD inadequate housing, energy insecurity, and food insecurity) in isolation were statistically insignificant, and except for HUD inadequate housing, small in magnitude. Similarly, the estimated effect of having utilities turned off in the past 12 months due to non-payment (assessed at 1 year) on prenatal mental illness was insignificant and small in magnitude. Overall, these results provide additional suggestive evidence that we may have isolated causal effects of maternal depression on housing inadequacy, particularly energy insecurity.

4. Discussion

In a national sample of childbearing women in large U.S. cities, we found robust associations between maternal depression during the postpartum year and both severely inadequate housing and energy insecurity 2–3 years later. By exploiting data that observes families over time, focusing on a mental illness with clear timing of onset, including relevant covariates, producing results that are robust across specifications and subsamples, and "passing" placebo tests, we have come close to establishing directionality and a plausibly causal connection. Of course, our findings do not preclude the possibility that housing inadequacy has deleterious effects on mental health.

We considered two policy-relevant measures of inadequate housing—a measure of severely inadequate housing based on HUD criteria and a measure of energy insecurity. The distinctions between the two measures are important because interventions to attend to the housing stock would likely be different from those targeting the affordability of utilities. Our measure of severely inadequate housing is one of the elements HUD uses to characterize the overall adequacy of the rental housing stock as well as to set the criteria for evaluating units covered by its Housing Choice Voucher Program (HCV). The HCV program requires an annual inspection of subsidized units to ensure recipients rent adequate housing. The inspection considers the adequacy of the heating and cooling system in the unit (U.S. HUD, 2014).

HUD's office of Policy Development and Research also considers a slightly broader measure of inadequate housing based on data from the American Housing Survey that

incorporates questions about whether renters were uncomfortably cold because of difficulty affording fuel; these data are used to produce the "Worst Case Housing Needs' reports to Congress (U.S. HUD, 2013). Our measure of energy insecurity is akin to the Worst Case Housing Needs measure.

While the issue of energy insecurity has attracted a fair amount of attention in the UK, Europe, and other countries including New Zealand (see, e.g., Marmot et al., 2011), it has not been at the forefront of research or policy discussions in the U.S. despite its prevalence, potential health consequences, and amenability to intervention. According to Hernández et al. (2014), although energy insecurity is a pervasive and generally overlooked problem among low-income families in the U.S., there currently exists no standard or widely-used definition. In terms of research, few studies have explored determinants of energy insecurity, particularly in the U.S. where income inequality is high. In contrast, food insecurity has received substantial research and policy attention in the U.S. As such, we view our focus on the problem of energy insecurity as a contribution of our study.

This study establishes that maternal depression during the postpartum year is a significant risk factor for inadequate childhood living conditions and builds upon recent work that found that maternal depression during the postpartum year is a strong risk factor for homelessness and risk for homelessness (Curtis et al., 2014) and food insecurity (Noonan et al., 2014) among families with young children. We found that maternal depression is also a risk factor for inadequate housing conditions, and moreover, it is associated with multiple hardships in the domains of housing inadequacy, housing instability, and food insecurity. Our findings suggest that some families respond to increases in constraints (in this case, those that may be imposed by maternal depression) by trading off between food and housing needs, but that others are driven into situations of multiple hardship. Either way, the implication is that policy interventions should not occur in mental health, housing, and food security silos.

The two main policies that address utility and heating issues in the U.S. are the Low-Income Home Energy Assistance Program (LIHEAP), which provides funding to utilities to defray the costs of energy bills for households defined as low income, and the Weatherization Assistance Program (WAP), which subsidizes structural modifications that increase energy efficiency (and thus decrease heating/cooling costs) (US Dept. of Energy (2014)). Both the LIHEAP and WAP programs serve far fewer households than are eligible (Hernández et al., 2014) and few studies have evaluated the impact of these programs on energy security or broader measures of well-being. One recent study used policy simulations to assess the impact of LIHEAP on energy security and found that eliminating this program would reduce the number of energy secure low-income households by at least 17% (Murray and Mills, 2014). Another study found that LIHEAP is associated with better nutrition among young children in low-income renter households (Frank et al., 2006), underscoring the interdependent nature of hardships involving basic needs.

The findings from this study are quite robust but are subject to certain limitations. Findings vis-à-vis mothers giving birth in urban areas may not generalize to all women giving birth in the U.S. or to mothers with older children. We did not focus on aspects of housing

inadequacy other than utilities. Our measure of prenatal housing problems was limited. Our measure of prenatal mental illness was limited to documented and diagnosed cases and not specific to depression. Grandparents' depressive symptoms were reported by the mother at 3 years and pertained to "ever," so we cannot be sure that they preceded the mother's depression. Hospitals not making medical records data available and attrition from the longitudinal study represent potential sources of bias. We were not able to explore the potential buffering effects of treatment for depression with our data. Finally, despite our attempts to isolate causal effects, it is possible that the observed associations reflect unobserved factors. That said, we obtained robust estimates that are possibly causal. Moreover, knowing about which types of hardships (and combinations of hardships) children with depressed mothers face has implications for policy approaches and targeting of interventions (e.g., making appropriate referrals after screening mothers at pediatric visits).

Overall, the findings from this study add to the emerging evidence that mental illness leads to material hardship and highlight the importance of maternal depression for children's well-being. The finding that maternal depression among mothers with young children is associated with, and appears to lead to, multiple hardships involving housing and food underscores the need for broad-based and integrated interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2015.11.054.

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Table 1

Sample characteristics.

	Full sample (N = 2965)	Not depressed during postpartum year (N = 2592)	Depressed during postpartum year (N = 373)
Maternal characteristics			
Age, mean in years [**]	25.03 (6.05)	25.11 (6.08)	24.41 (5.80)
Race/ethnicity			
Non-hispanic white (%)	0.208	0.209	0.198
Non-hispanic black (%)	0.483	0.479	0.522
Hispanic (%)	0.270	0.274	0.247
Other (%)	0.038	0.039	0.032
Foreign-born (%) [***]	0.148	0.155	0.097
Education			
<high school graduate (%)	0.344	0.344	0.346
High school graduate (%)	0.306	0.304	0.314
Any college (%)	0.350	0.352	0.340
Medicaid birth (%) [**]	0.646	0.640	0.692
Employed during 2 years before the birth (%)	0.808	0.804	0.831
Relationship status [***]			
Married (%)	0.234	0.242	0.180
Cohabiting (%)	0.367	0.368	0.357
Neither married nor cohabiting (%)	0.399	0.390	0.464
Number of children, mean	1.15 (1.35)	1.14 (1.35)	1.22 (1.30)
Prenatal diagnosed mental illness (%) [***]	0.126	0.109	0.241
Prenatal physical health condition (%)	0.204	0.203	0.206
Prenatal illicit drug use (%) [**]	0.103	0.098	0.137
Child characteristics			
Severe infant health condition (%)	0.018	0.018	0.019
Male (%)	0.519	0.519	0.520
Multiple birth (%)	0.019	0.018	0.021
Child's age when outcome was measured, mean in months	35.69 (2.44)	35.67 (2.44)	35.79 (2.41)
Paternal characteristics			
Father higher education category than mother (%)	0.236	0.238	0.228
Paternal depression (CES-D), mean score	1.24 (1.18)	1.24 (1.19)	1.26 (1.13)
Paternal suboptimal physical health (%)	0.410	0.405	0.440
Father did not complete initial interview (%)	0.179	0.179	0.185
Prenatal housing situation			
Housing problems (%)	0.020	0.019	0.027
Lived with adult (not including child's father) (%)	0.333	0.332	0.343
Maternal grandparents' mental Illness			
Grandmother had history of depressive symptoms (%) [***]	0.256	0.227	0.461

	Full sample (N = 2965)	Not depressed during postpartum year (N = 2592)	Depressed during postpartum year (N = 373)
Grandfather had history of depressive symptoms (%) [***]	0.119	0.106	0.206
Grandmother's depressive symptoms missing (%) [**]	0.075	0.070	0.105
Grandfather's depressive symptoms missing (%) [***]	0.284	0.274	0.349

Notes:

[***] p < 0.01;

[**] p < 0.05;

[*] p < 0.10 for significant differences between mothers who experienced depression during the postpartum year and those who did not, based on two-tailed t tests for comparison of means for binary variables or χ^2 tests for categorical variables. All figures are proportions unless indicated otherwise. Standard deviations are in parentheses. Other than child's age (which is measured concurrently with the outcomes), all variables classified above as maternal, child, paternal, and prenatal housing characteristics are measured at or before the birth of the focal child. For fathers who did not complete baseline interviews, paternal suboptimal physical health was set equal to 1 and CES-D was set equal to the mean score for the cases with father data. Mothers' reports of fathers' education were used when fathers' reports were not available.

Table 2

Outcomes at 2–3 years.

	Full sample (N = 2965)	Not depressed during postpartum year (N = 2592)	Depressed during postpartum year (N = 373)
Main outcomes			
Severely inadequate housing due to lack of heat ("HUD inadequate housing") ***	0.072	0.064	0.123
Energy insecurity ***	0.140	0.126	0.239
Auxiliary outcomes			
HUD inadequate housing and housing instability ***	0.012	0.009	0.029
HUD inadequate housing and food insecurity **	0.022	0.018	0.049
HUD inadequate housing, housing instability, and food insecurity ***	0.005	0.003	0.013
Energy insecurity and housing instability ***	0.023	0.019	0.056
Energy insecurity and food insecurity ***	0.048	0.039	0.107
Energy insecurity, housing instability, and food insecurity ***	0.010	0.007	0.029

Notes:

***
p < 0.01;

**
p < 0.05;

*
p < 0.10 for significant differences between mothers who experienced depression during the postpartum year and those who did not, based on two-tailed *t* tests for comparison of means for binary variables. All figures are proportions. The outcomes consisting of two hardships were coded as "yes" if both hardships were experienced, whether or not the third was experienced. For example, "energy insecurity and food insecurity" was coded as yes if family experienced both energy insecurity and food insecurity, whether or not that family also experienced housing instability. The outcomes consisting of all three hardships were coded as no if the family experienced no, 1, or 2 hardships. N = 2373 for all outcomes that include food insecurity because the food insecurity questions were asked in an in–home module at three years, which had a lower response rate than the core 3-year survey. Proportions that experienced food insecurity were: 0.174 (full sample), 0.159 (sample that did not experience depression), and 0.275 (sample that experienced depression). Proportions that experienced housing instability were: 0.121 (full sample), 0.111 (sample that did not experience depression), and 0.190 (sample that experienced depression).

Table 3

Logistic regression estimates of effects of depression during postpartum year and covariates on inadequate housing at 2–3 years (N = 2965).

	Severely inadequate housing due to Lack of heat ("HUD inadequate housing)			Energy insecurity		
	Or	CI	P	Or	CI	P
Depressed during postpartum year	1.57	[1.11,2.22]	0.01	1.69	[1.24,2.30]	0.00
Other maternal characteristics						
Age, years	1.23	[1.03,1.48]	0.02	1.16	[1.02,1.32]	0.03
Non-Hispanic Black	1.13	[0.62,2.04]	0.69	1.27	[0.83,1.94]	0.27
Hispanic	0.96	[0.48,1.92]	0.91	1.25	[0.90,1.73]	0.18
Other non-white	1.85	[0.66,5.22]	0.24	2.09	[1.10,3.97]	0.02
Foreign born	1.32	[0.81,2.18]	0.27	0.95	[0.56,1.62]	0.86
High school graduate	0.91	[0.66,1.23]	0.53	0.95	[0.70,1.29]	0.74
Any college	0.81	[0.54,1.22]	0.31	0.95	[0.67,1.34]	0.75
Medicaid birth	0.95	[0.64,1.40]	0.78	1.03	[0.82,1.29]	0.78
Employed	1.12	[0.82,1.54]	0.48	1.13	[0.85,1.50]	0.38
Married	0.45	[0.29,0.69]	0.00	0.55	[0.42,0.71]	0.00
Cohabiting	0.71	[0.48,1.05]	0.09	0.85	[0.68,1.07]	0.17
Number of children	1.23	[1.13,1.35]	0.00	1.19	[1.07,1.32]	0.00
Prenatal diagnosed mental illness	1.35	[0.91,2.01]	0.13	1.04	[0.76,1.42]	0.80
Prenatal physical health condition	1.20	[0.85,1.69]	0.29	1.11	[0.86,1.45]	0.42
Prenatal illicit drug use	1.53	[1.01,2.32]	0.04	1.30	[0.86,1.95]	0.21
Child characteristics						
Severe infant health condition	0.85	[0.33,2.19]	0.74	1.57	[0.82,2.99]	0.17
Male child	0.86	[0.64,1.17]	0.35	0.78	[0.58,1.05]	0.10
Multiple birth	0.43	[0.09,2.06]	0.29	0.85	[0.43,1.71]	0.65
Child's age when outcome was measured, months	0.87	[0.79,0.95]	0.00	0.98	[0.92,1.04]	0.44
Paternal characteristics						
Father higher education category than mother	0.74	[0.49,1.12]	0.16	0.88	[0.62,1.26]	0.49
Paternal depression (CES-D), score	0.96	[0.84,1.08]	0.47	0.98	[0.88,1.10]	0.78
Paternal suboptimal physical health	1.42	[0.93,2.18]	0.11	1.14	[0.81,1.60]	0.46
Father did not complete interview	0.80	[0.52,1.22]	0.30	0.95	[0.66,1.36]	0.76

	Severely inadequate housing due to Lack of heat ("HUD inadequate housing)			Energy insecurity		
	Or	CI	P	Or	CI	P
Prenatal housing situation						
Housing problems	0.78	[0.43,1.43]	0.42	1.05	[0.65,1.69]	0.86
Lived with adult (not including child's father)	1.08	[0.81,1.45]	0.58	1.13	[0.92,1.39]	0.26
Maternal grandparents' mental illness						
Grandmother had history of depressive symptoms	1.54	[0.98,2.42]	0.06	1.72	[1.30,2.28]	0.00
Grandfather had history of depressive symptoms	1.40	[0.86,2.27]	0.17	1.64	[1.38,1.95]	0.00
Grandmother's depressive symptoms missing	1.76	[1.03,3.01]	0.04	1.70	[1.24,2.33]	0.00
Grandfather's depressive symptoms missing	1.20	[0.93,1.55]	0.17	1.21	[0.96,1.53]	0.10

Notes: OR = odds ratio. CI = 95% confidence interval. Models include a quadratic term for age plus indicators for the mother's city of residence at baseline, with cities with fewer than 100 observations grouped together (estimates not shown). Other than child's age (which is measured concurrently with the outcomes), all variables classified above as maternal, child, paternal, and prenatal housing characteristics are measured at or before the birth of the focal child. Marginal effects of depression during the postpartum year from alternative specifications using linear probability models were 0.04 for "HUD inadequate housing" and 0.08 for energy insecurity, compared to marginal effects from the logistic regressions shown here of 0.02 and 0.06, respectively (figures not shown).

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Table 4

Logistic regression estimates of effects of depression during postpartum year on inadequate housing and multiple material hardships at 2–3 years (N = 2965).

	Unadjusted			Adjusted		
	Or	CI	P	Or	CI	P
Main outcomes:						
Severely inadequate housing due to lack of heat ("HUD inadequate housing)	2.06	[1.45,2.92]	0.00	1.64	[1.17,2.31]	0.00
Energy insecurity	2.19	[1.61,2.96]	0.00	1.71	[1.27,2.31]	0.00
Multiple hardships:						
HUD inadequate housing and housing instability	3.25	[1.71,6.17]	0.00	2.11	[0.97,4.58]	0.06
HUD inadequate housing and food insecurity	2.80	[1.52,5.15]	0.00	2.40	[1.21,4.77]	0.01
HUD inadequate housing, housing instability, and food insecurity	3.85	[1.34,11.11]	0.01	N/A	N/A	N/A
Energy insecurity and housing instability	3.16	[2.20,4.53]	0.00	2.26	[1.50,3.42]	0.00
Energy insecurity and food insecurity	2.93	[1.94,4.42]	0.00	2.30	[1.35,3.92]	0.00
Energy insecurity, housing instability, and food insecurity	4.39	[2.22,8.71]	0.00	3.60	[1.57,8.28]	0.00

Notes: OR = odds ratio. CI = 95% confidence interval. N/A = Outcome too rare for meaningful analysis. Adjusted models include the same covariates as in the models in Table 3 other than severe infant health condition, multiple birth, prenatal housing problems, and city indicators (these factors were not included due to small cell sizes). The outcomes consisting of two hardships were coded as "yes" if both hardships were experienced, whether or not the third was experienced. For example, "energy insecurity and food insecurity" was coded as yes if family experienced both energy insecurity and food insecurity, whether or not that family also experienced housing instability. The outcomes consisting of all three hardships were coded as no if the family experienced no, 1, or 2 hardships. N = 2373 for all models that include food insecurity because the food insecurity questions were asked in an in–home module at three years, which had a lower response rate than the core 3-year survey.