

## ARTICLE



# Associations of household unmet basic needs and health outcomes among very low birth weight children

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**OBJECTIVE:** We examined associations of past year household hardships (housing, energy, food, and healthcare hardships) with postnatal growth, developmental risk, health status, and hospitalization among children 0–36 months born with very low birth weight (VLBW) and the extent that these relationships differed by receipt of child supplemental security income (SSI).

**STUDY DESIGN:** We examined cross-sectional data from 695 families. Growth was measured as weight-for-age z-score change. Developmental risk was defined as  $\geq 1$  concerns on the “Parents’ Evaluation of Developmental Status” screening tool. Child health status was categorized as excellent/good vs. fair/poor. Hospitalizations excluded birth hospitalizations.

**RESULTS:** Compared to children with no household hardships, odds of developmental risk were greater with 1 hardship (aOR 2.0 [1.26, 3.17]) and  $\geq 2$  hardships (aOR) 1.85 [1.18, 2.91], and odds of fair/poor child health (aOR) 1.59 [1.02, 2.49] and hospitalizations (aOR) 1.49 [1.00, 2.20] were greater among children with  $\geq 2$  hardships. In stratified analysis, associations of hardships and developmental risk were present for households with no child SSI and absent for households with child SSI.

**CONCLUSION:** Household hardships were associated with developmental risk, fair/poor health status, and hospitalizations among VLBW children. Child SSI may be protective against developmental risk among children living in households with hardships.

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## INTRODUCTION

Nearly half of all US children live in households with incomes  $\leq 200\%$  of the US federal poverty level [1]. These households are at increased risk to experience adverse social determinants of health (SDH), including unmet basic needs leading to problems such as housing instability and food insecurity [2, 3]. Adverse SDH negatively impact child health and well-being [4–6]. This relationship is exacerbated among children with chronic medical disease and developmental disabilities, where unmet basic needs are associated with worse health status and increased healthcare utilization [7–9].

Children born with very low birth weight (VLBW;  $\leq 1500$  g) have high risk of poor growth, chronic medical morbidities, and developmental disabilities especially in the first 3 years of life [10–12]. These complications often lead to decreased quality of life [13] and increased healthcare utilization, including hospitalizations [14, 15]. Most interventions geared toward optimizing the long-term health and well-being of VLBW children have focused on optimization of medical and developmental care, and have not considered social care, including identifying and addressing unmet basic needs [16]. Compared to households with higher

incomes, households with low incomes experience greater prevalence of unmet basic needs and are more likely to have infants born preterm, including those with VLBW [17]. The extent to which household unmet basic needs are related to health, development, and healthcare utilization among VLBW children, however, is unclear.

One program that may offset the impact of unmet basic needs for low income families is Supplemental Security Income (SSI). SSI is a federal income supplement designed to provide financial resources to adults and children with disabilities and low incomes [18]. Due to their associated medical and developmental complexity, VLBW children from low income families may be eligible to receive SSI until age 1 year [19]. After 1 year, depending on continued medical, developmental and financial needs, an SSI recertification process is possible. SSI is intended to reduce the financial burdens of caring for these children. However, the extent to which SSI may impact associations of household unmet basic needs and child health and developmental outcomes in children with VLBW is unknown.

Among a cohort of children 0–3 years of age born VLBW living in predominately low income US households, the purposes of this

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study were (1) to examine the association of individual household unmet basic needs (housing, energy, food, and healthcare hardships) in the previous year and a composite variable totaling the number of unmet needs (0, 1,  $\geq 2$ ) with (a) postnatal growth and parental report of children's (b) developmental risk, (c) health status, and (d) post-neonatal hospitalizations; and (2) to examine the extent to which these relationships differ by receipt of child SSI.

## METHODS

### Population and setting

Data were collected as part of Children's HealthWatch, a cross-sectional study of caregivers surveyed in emergency rooms and primary health clinics affiliated with academic centers, regarding unmet basic needs among families with children aged 0 to 47 months of age in 5 cities in the U.S. (Boston Medical Center, Boston; University of Maryland Medical Center, Baltimore; Arkansas Children's Hospital, Little Rock; Hennepin County Medical Center, Minneapolis; and St. Christopher's Hospital for Children, Philadelphia) [20, 21]. Surveys of caregivers of singletons or multiples were conducted in English, Spanish and Somali (Minneapolis only) between 2011 and 2018 to assess household unmet basic needs in the previous year. We used corrected age in months for this analysis. Among 28,498 surveys of respondents with children with known gestational age and weight at birth, we excluded 2104 (7.4%) non-biologic mothers, 188 (0.7%) children born outside the U.S. (foreign-born children may not qualify for the same social services as US-born children), 4,357 (15.3%) children older than 36 corrected months, and 21,145 (74.2%) children not born  $\leq 1500$  g. We also excluded 142 (0.5%) with missing values for the main exposure or outcome, leaving a sample of 695 dyads for analysis. Institutional review board approval was obtained before data collection and renewed annually at each site.

After giving informed consent, the infant's mother provided information on socio-demographics (age, education, self-identified race/ethnicity, country of birth, employment, marital status, and primary language), any breastfeeding, household income, employment, and child characteristics, including birthweight and gestational age, child health insurance type, receipt of Supplemental Security Income (SSI) for the index child, and participation in Special Supplemental Nutrition Program for Women, Infants and Children (WIC) and Early Intervention. Participants also answered the Children with Special Health Care Needs screener. Children who screened positive for special health care needs included a group classified with an intentionally broad and inclusive range of physical and mental health conditions, based on functional limitations and/or additional needed services, independent of their specific diagnoses [22]. In a prior analysis using the same data set, we found that maternal report of birthweight and gestational age and children's electronic health record data had high correlation coefficients—birthweight (0.97) and gestational age (0.95) [23].

### Exposure variables

The main exposure variables were housing instability, energy insecurity, household food insecurity, and healthcare hardships in the past year. Housing instability was defined as experiencing homelessness during the child's lifetime, moving 2 or more times in the past 12 months, and/or being behind on rent or mortgage in the past 12 months [24]. Energy insecurity was defined as experiencing a threatened or actual shut-off of gas or electricity because of non-payment, one or more unheated or uncooled days in the last year because of non-payment, and/or heating the residence with a cooking stove in the last year [25]. Household food insecurity was measured according to the US Department of Agriculture (USDA) Household Food Security Survey Module [26]. Household food insecurity was defined as endorsement of  $\geq 3$  of 18 household-focused questions per USDA guidance [26]. Healthcare hardship was defined as caregiver's report the child or someone else in the household forgoing needed medical care, dental care, or prescriptions due to inability to pay, and/or difficulty paying for household basic needs as a consequence of medical costs [27]. We also examined composite number of unmet basic needs, categorized as 0, 1, or  $\geq 2$  needs.

### Main outcome measures

Postnatal growth was defined as weight for gestational age z-score change from birth until the survey time point. Therefore, a negative

z-score change represented a decrease in weight gain percentiles and a positive z-score change represented an increase in weight gain percentiles. We derived z-scores using the sex-specific Fenton 2013 growth charts for time points  $< 40$  weeks' gestation [28], World Health Organization growth charts from 40 weeks' gestation until 24 months [29], and Centers for Disease Control from  $> 24$  months until 36 months [30]. To assess developmental risk, we used the Parents' Evaluation of Developmental Status (PEDS) screening tool that meets the standards set by the *American Academy of Pediatrics* for developmental screening tests [31]. This is a validated 10-item questionnaire designed for children aged  $\geq 4$  months to 8 years that elicits parental concerns and has been used to screen multiple populations of children at risk for developmental delay, including ex-preterm infants [32, 33]. Developmental risk was defined as 1 or more concerns regarding fine motor, gross motor, expressive language, receptive language, self-help and socio-emotional skills specifically identified on the PEDS according to corrected age at the time of the assessment and/or report of current early intervention participation. Child health status was characterized by caregiver rating of child health as excellent, good, fair, or poor, using a question from the National Health and Nutrition Examination Survey [34]. Any hospitalizations were defined as  $\geq 1$  hospitalizations in the child's lifetime, excluding the birth hospitalization.

### Statistical analysis

First, we examined descriptive statistics of our population of interest. Then we examined bivariate relationships between individual and composite unmet basic needs and outcomes. We used multivariable linear regression to examine postnatal growth and multivariable logistic regression to examine developmental concerns (0 vs.  $\geq 1$ ), child health (excellent/good vs. fair/poor), and post-neonatal hospitalizations (0 vs.  $\geq 1$ ). We performed separate models for each unmet basic need and for composite number of unmet basic needs (0 vs. 1 or  $\geq 2$ ). We included covariates of a priori interest known to be associated with the main exposure and outcome variables, including maternal age, race/ethnicity, education, country of birth, marital status and ever breastfed [10, 20, 24, 25, 35, 36]. We also included study site since availability of community services that address unmet basic needs and the health and developmental needs of VLBW children vary by U.S. location. We included weight for gestational age z-score change in our models examining developmental risk and post neonatal hospitalizations, as weight gain may contribute to these outcomes [37, 38]. To examine the extent that receipt of SSI moderated the relationship of household unmet basic needs and child outcomes, we (1) analyzed the data using an interaction term in our multivariable models and (2) conducted a stratified analysis. Last, we conducted a sensitivity analysis including gestational age at birth into our models, as gestational age at birth is associated with child outcomes among VLBW infants. Analyses were performed using 2-sided tests and a significance level of  $p < 0.05$ , with SAS software (version 9.4; SAS Institute, Inc, Cary, NC).

## RESULTS

Characteristics of the 695 dyads are reported in Table 1. We found that 57% of mothers self-identified as non-Hispanic Black and 56% had a high school education or less. Ninety-one percent of children had public insurance, 63% screened positive for special health care needs and 44% received child SSI. Among the sample, housing instability was reported by 28%, energy insecurity 28%, food insecurity 25%, and healthcare hardships 34%. We found that 31% of mothers reported 1 hardship and 31% of mothers reported 2 or more hardship. The mean (SD) chronological and corrected child age at the time of the survey was 17.4 (10.5) and 14.5 (10.4) months, respectively. Mean (SD) of postnatal growth z-score was 0.33 (1.50), developmental risk occurred among 55%, child health was reported as fair or poor among 25% and  $\geq 1$  post neonatal hospitalization occurred among 52%.

In adjusted analysis (Table 2), compared to children in households not reporting hardships, VLBW children living in households with 1 hardship (aOR 2.00 [1.26, 3.17]) and  $\geq 2$  hardships (aOR 1.85 [1.18, 2.91]) had significantly greater odds of developmental risk. Compared to children in households reporting no hardships, VLBW children living in households with  $\geq 2$  hardships had higher

**Table 1.** Participant characteristics.

Total N (%)	695 (100%)
Study site, n (%)	
Baltimore	157 (22.6%)
Boston	97 (14.0%)
Little Rock	213 (30.6%)
Minneapolis	90 (12.9%)
Philadelphia	138 (19.9%)
Maternal characteristics	
Age, years, mean (SD)	29.0 (6.0)
Education, n (%)	
Less than high school diploma	140 (20.1%)
High school diploma	250 (36.0%)
Any college or technical school	305 (43.9%)
Employed, n (%)	290 (41.7%)
Marital status, n (%)	
Single	337 (48.6%)
Married/partnered/cohabitating	252 (36.4%)
Separated/divorced/widowed	104 (15.0%)
Race/ethnicity, n (%)	
Non-Hispanic White	121 (17.7%)
Non-Hispanic Black	293 (57.4%)
Hispanic any race	153 (22.3%)
Multi-race/ethnicity	11 (1.6%)
Other	7 (1.0%)
Nativity, n (%)	
US born	556 (80.0%)
Foreign born	139 (20.0%)
Primary language, n (%)	
English	610 (87.8%)
Spanish	85 (12.2%)
Depressive symptoms, n (%)	181 (26.0%)
Child characteristics	
Birth weight, grams, mean (SD)	1005 (304)
Age at time of survey, months, mean (SD)	17.4 (10.5)
Corrected age at time of survey, months, mean (SD)	14.5 (10.4)
Gestational age at birth, weeks, mean (SD)	28.2 (3.1)
Health insurance, n (%)	
Public insurance	631 (90.8%)
No insurance	6 (0.9%)
Private insurance	58 (8.3%)
Positive screen for special health care needs, n (%)	276 (62.7%)
Child receipt of Supplemental Security Income, n (%)	302 (43.8%)
WIC participation, n (%)	526 (75.9%)
Early intervention participation, n (%)	
Yes, current	289 (44.6%)
Yes, in past	61 (9.4%)
No	298 (46.0%)
Received any breast milk	544 (78.4%)
Household characteristics	
Monthly household income, n (%)	
<\$1000	155 (31.3%)

**Table 1.** continued

Total N (%)	695 (100%)
\$1000–\$1999	150 (30.3%)
\$2000–\$2999	78 (15.8%)
\$3000–\$3999	32 (6.5%)
≥\$4000	43 (8.5%)
Do not know/refused	38 (7.7%)
Any household employment, n (%)	521 (75.7%)
Unmet basic needs in past year	
Housing instability, n (%)	193 (27.8%)
Energy insecurity, <sup>a</sup> n (%)	165 (27.6%)
Household food insecurity, n (%)	175 (25.2%)
Healthcare hardship, n (%)	237 (34.1%)
Number of hardships, <sup>b</sup> n (%)	
No hardships	268 (38.6%)
1 hardship	215 (30.9%)
2 or more hardships	212 (30.5%)
Outcomes of interest	
Weight for age z-score change from birth until survey, mean (SD)	0.33 (1.50)
Developmental risk <sup>c</sup> (≥1), n (%)	311 (55.3%)
Child health status	
Excellent/Good	523 (75.3%)
Fair/Poor	172 (24.7%)
Lifetime hospitalizations (excluding birth hospitalization) (≥1), n (%)	327 (47.5%)

<sup>a</sup>Energy insecurity known for 597 mother-child dyads only.

<sup>b</sup>Hardships include housing instability, energy insecurity, household food insecurity, healthcare hardships.

<sup>c</sup>Development risk derived from the Parents' Evaluation of Developmental Status (PEDS) screening tool designed for children ≥4 months corrected age to 8 years, therefore this variable includes 562 children ≥4–36 months corrected age.

odds of fair/poor health (aOR 1.59 [1.02, 2.49]) and lifetime post-neonatal hospitalizations (aOR 1.49 [1.00, 2.20]). We found no differences in postnatal growth.

When we introduced interaction terms of SSI receipt into our models of interest, we found significant interactions in models examining the association of housing instability and postnatal growth and the association of energy insecurity and developmental risk. To clarify our findings, we stratified our main associations of interest by SSI receipt (Table 3). Among VLBW children without SSI receipt we found associations of unmet basic needs and postnatal growth and developmental risk; we did not find these associations among VLBW children with SSI receipt. Among VLBW children without SSI receipt, housing instability was associated with faster postnatal growth (0.38 z-score change [0.02, 0.74]), compared to without housing instability; and healthcare hardships (aOR 2.00 [1.09, 3.67]), 1 hardship (aOR 1.96 [1.02, 3.78]), and ≥2 hardships (aOR 2.52 [1.29, 4.92]) were associated with higher odds of developmental risk, compared to without these hardships (Table 3). In our sensitivity analysis including gestational age at birth, we found similar effect estimates and therefore show our models without gestational age.

## DISCUSSION

Among a multi-site racially/ethnically diverse sample of 695 VLBW children from predominantly low income backgrounds, household-level unmet basic needs were common. Unmet basic

**Table 2.** Associations of household unmet basic needs and child health outcomes among vlbw children 0 to 36 months corrected age<sup>a</sup> (*n* = 695).

	Postnatal growth <sup>b</sup>		Beta (95% CI)	Adjusted <sup>a</sup> Beta (95% CI)
	Hardship Absent mean (SD)	Hardship Present mean (SD)		
Housing instability	0.29 (1.53)	0.43 (1.4)	0.14 (−0.11, 0.40)	0.10 (−0.17, 0.36)
Energy insecurity	0.27 (1.47)	0.47 (1.56)	0.21 (−0.07, 0.48)	0.07 (−0.22, 0.36)
Household food insecurity	0.33 (1.5)	0.34 (1.49)	0.01 (−0.25, 0.27)	−0.08 (−0.35, 0.19)
Healthcare hardship	0.31 (1.57)	0.36 (1.35)	0.05 (−0.19, 0.29)	0.13 (−0.13, 0.38)
Number of hardships				
0 Hardships	0.23 (1.57)		Ref	Ref
1 hardship		0.36 (1.47)	0.13 (−0.14, 0.41)	0.15 (−0.14, 0.43)
≥2 hardships		0.41 (1.44)	0.18 (−0.10, 0.46)	0.11 (−0.17, 0.39)
	Developmental risk		OR of ≥1 Concern (95% CI)	aOR <sup>a</sup> of ≥1 Concern (95% CI)
	No Concerns n (%)	≥1 Concern n (%)		
Housing instability	67 (26.7%)	95 (30.5%)	1.21 (0.83, 1.75)	1.26 (0.83, 1.92)
Energy insecurity	56 (26.3%)	79 (29.2%)	1.15 (0.77, 1.73)	1.08 (0.68, 1.70)
Household food insecurity	64 (25.5%)	79 (25.4%)	0.99 (0.68, 1.46)	1.13 (0.73, 1.73)
Healthcare hardship	62 (24.7%)	133 (42.8%)	<b>2.28 (1.58, 3.29)</b>	<b>1.91 (1.28, 2.85)</b>
Number of hardships				
0 hardships			Ref	Ref
1 hardship	66 (26.3%)	103 (33.1%)	<b>1.81 (1.20, 2.72)</b>	<b>2.00 (1.26, 3.17)</b>
≥2 hardships	69 (27.5%)	108 (34.7%)	<b>1.82 (1.21, 2.72)</b>	<b>1.85 (1.18, 2.91)</b>
	Child health status		OR of Fair/Poor (95% CI)	aOR <sup>a</sup> of Fair/Poor (95% CI)
	Excellent/Good n (%)	Fair/Poor n (%)		
Housing instability	140 (26.8%)	53 (30.8%)	1.22 (0.84, 1.78)	1.24 (0.83, 1.87)
Energy insecurity	118 (26.6%)	47 (30.7%)	1.22 (0.82, 1.83)	1.16 (0.75, 1.81)
Household food insecurity	120 (22.9%)	55 (31.9%)	<b>1.58 (1.08, 2.31)</b>	<b>1.61 (1.07, 2.42)</b>
Healthcare hardship	167 (31.9%)	70 (40.7%)	<b>1.46 (1.03, 2.09)</b>	1.43 (0.97, 2.11)
Number of hardships				
0 hardships			Ref	Ref
1 hardship	159 (30.4%)	56 (32.6%)	1.40 (0.91, 2.14)	1.35 (0.85, 2.13)
≥2 hardships	150 (28.7%)	62 (36.1%)	<b>1.64 (1.08, 2.49)</b>	<b>1.59 (1.02, 2.49)</b>
	Hospitalizations <sup>c</sup>		OR of ≥1 hospitalization (95% CI)	aOR <sup>a</sup> of ≥1 hospitalization (95% CI)
	None n (%)	≥1 hospitalization n (%)		
Housing instability	89 (24.7%)	101 (30.9%)	1.37 (0.98, 1.91)	<b>1.57 (1.09, 2.27)</b>
Energy insecurity	78 (25.2%)	85 (30.1%)	1.28 (0.89, 1.83)	1.19 (0.80, 1.78)
Household food insecurity	85 (23.5%)	88 (26.9%)	1.20 (0.85, 1.69)	1.28 (0.88, 1.85)
Healthcare hardship	109 (30.2%)	125 (38.2%)	<b>1.43 (1.04, 1.96)</b>	1.27 (0.90, 1.79)
Number of hardships				
0 hardships			Ref	Ref
1 hardship	111 (30.7%)	102 (31.2%)	1.23 (0.85, 1.76)	1.12 (0.76, 1.66)
≥2 hardships	98 (27.1%)	111 (33.9%)	<b>1.51 (1.05, 2.17)</b>	<b>1.49 (1.00, 2.20)</b>

<sup>a</sup>Adjusted for site, maternal age, race/ethnicity, education level, country of birth, marital status, received any breast milk; models examining developmental risk and hospitalizations are also adjusted for weight for gestational age z-score change from birth until time of survey.

<sup>b</sup>Postnatal growth is weight-for-age z-score change from birth until the time of survey.

<sup>c</sup>Excludes the birth hospitalization.

Boldface indicates *p* < 0.05.

**Table 3.** Associations of household unmet basic needs and child health outcomes among VLBW children 0 to 36 months corrected age stratified by child receipt of supplemental security incomea (*n* = 695).

Postnatal growth	No supplemental security income		Supplemental security income	
	Beta (95% CI)	Adjusted <sup>a</sup> Beta (95% CI)	Beta (95% CI)	Adjusted <sup>a</sup> Beta (95% CI)
Housing instability <sup>b</sup>	<b>0.41 (0.07, 0.75)</b>	<b>0.38 (0.02, 0.74)</b>	-0.15 (-0.54, 0.23)	-0.19 (-0.60, 0.21)
Energy insecurity	0.28 (-0.11, 0.66)	0.19 (-0.22, 0.61)	0.18 (-0.22, 0.59)	-0.02 (-0.44, 0.41)
Household food insecurity	0.13 (-0.23, 0.50)	0.04 (-0.35, 0.42)	-0.05 (-0.43, 0.33)	-0.11 (-0.50, 0.29)
Healthcare hardship	0.25 (-0.09, 0.59)	0.28 (-0.08, 0.64)	-0.07 (-0.43, 0.29)	0.03 (-0.34, 0.40)
Number of hardships				
1 hardship	0.19 (-0.16, 0.55)	0.15 (-0.23, 0.53)	0.11 (-0.34, 0.56)	0.24 (-0.22, 0.70)
≥2 hardships	0.36 (-0.01, 0.74)	0.30 (-0.09, 0.69)	0.08 (-0.37, 0.52)	0.03 (-0.42, 0.48)
<b>Developmental Risk (ref = no concerns)</b>				
	<b>OR of ≥1 Concern (95% CI)</b>	<b>aOR<sup>a</sup> of ≥1 Concern (95% CI)</b>	<b>OR of ≥1 Concern (95% CI)</b>	<b>aOR<sup>a</sup> of ≥1 Concern (95% CI)</b>
Housing instability	1.64 (0.98, 2.73)	1.60 (0.88, 2.93)	0.82 (0.46, 1.46)	0.96 (0.49, 1.85)
Energy insecurity <sup>b</sup>	1.61 (0.90, 2.88)	1.66 (0.84, 3.28)	0.69 (0.38, 1.24)	0.69 (0.35, 1.37)
Household food insecurity	0.97 (0.55, 1.71)	1.19 (0.60, 2.34)	0.71 (0.41, 1.25)	0.66 (0.36, 1.24)
Healthcare hardship	<b>2.23 (1.33, 3.75)</b>	<b>2.00 (1.09, 3.67)</b>	1.66 (0.96, 2.87)	1.34 (0.73, 2.46)
Number of hardships				
1 hardship	1.75 (0.99, 3.07)	<b>1.96 (1.02, 3.78)</b>	1.23 (0.63, 2.42)	1.28 (0.60, 2.74)
≥2 hardships	<b>2.24 (1.27, 3.97)</b>	<b>2.52 (1.29, 4.92)</b>	0.93 (0.49, 1.77)	0.89 (0.43, 1.81)
<b>Child Health Status (ref = excellent/good)</b>				
	<b>OR of Fair/Poor (95% CI)</b>	<b>aOR<sup>a</sup> of Fair/Poor (95% CI)</b>	<b>OR of Fair/Poor (95% CI)</b>	<b>aOR<sup>a</sup> of Fair/Poor (95% CI)</b>
Housing instability	1.59 (0.93, 2.72)	1.55 (0.85, 2.82)	0.93 (0.54, 1.59)	0.91 (0.50, 1.65)
Energy insecurity	1.59 (0.89, 2.86)	1.46 (0.76, 2.79)	0.92 (0.53, 1.62)	0.87 (0.46, 1.63)
Household food insecurity	1.38 (0.78, 2.47)	1.37 (0.72, 2.61)	1.57 (0.94, 2.64)	1.48 (0.85, 2.59)
Healthcare hardship	1.40 (0.81, 2.40)	1.38 (0.75, 2.54)	1.27 (0.78, 2.06)	1.27 (0.74, 2.18)
Number of hardships				
1 hardship	1.23 (0.66, 2.30)	1.10 (0.55, 2.19)	1.28 (0.69, 2.37)	1.25 (0.63, 2.47)
≥2 hardships	<b>1.93 (1.06, 3.51)</b>	1.87 (0.97, 3.59)	1.18 (0.64, 2.17)	1.10 (0.57, 2.14)
<b>Lifetime Hospitalizations (ref = no hospitalizations except at birth)</b>				
	<b>OR of ≥1 hospitalization (95% CI)</b>	<b>aOR<sup>a</sup> of ≥1 hospitalization (95% CI)</b>	<b>OR of ≥1 hospitalization (95% CI)</b>	<b>aOR<sup>a</sup> of ≥1 hospitalization (95% CI)</b>
Housing instability	1.18 (0.74, 1.88)	1.19 (0.70, 2.00)	1.64 (0.97, 2.77)	<b>1.94 (1.07, 3.52)</b>
Energy insecurity	1.18 (0.70, 1.99)	1.07 (0.59, 1.93)	1.23 (0.72, 2.10)	1.17 (0.64, 2.13)
Household food insecurity	1.01 (0.61, 1.67)	0.98 (0.55, 1.73)	1.17 (0.70, 1.94)	1.28 (0.74, 2.22)
Healthcare hardship	1.35 (0.85, 2.13)	1.29 (0.77, 2.17)	1.15 (0.72, 1.85)	0.92 (0.55, 1.55)
Number of hardships				
1 hardship	1.23 (0.75, 2.01)	1.02 (0.59, 1.77)	0.98 (0.55, 1.74)	0.97 (0.51, 1.84)
≥2 hardships	1.27 (0.76, 2.11)	1.20 (0.68, 2.11)	1.38 (0.77, 2.47)	1.35 (0.72, 2.53)

<sup>a</sup>Adjusted for site, maternal age, race/ethnicity, education level, country of birth, marital status, any breastfeeding; models examining developmental risk and hospitalizations are also adjusted for weight for gestational age z-score change from birth until time of survey.

<sup>b</sup>Significant interaction term ( $p < 0.05$ ) found in these models.

Boldface indicates  $p < 0.05$

needs were associated with increased report of children's developmental risk, fair or poor health, and post-neonatal hospitalizations. These results highlight the importance of identifying and addressing unmet basic needs in the VLBW

population who have many touch points with social and medical services in the first three years of life. In stratified analysis, we found that associations of hardships with developmental risk were present for households whose children did not receive SSI and

were absent among households with SSI, suggesting a possible protective effect of SSI.

These findings provide additional evidence that the relation between social factors and children's health and development extend to children born VLBW [39, 40]. Previous findings have reported associations of maternal factors such as age  $\leq 18$ , Black race/ethnicity, no high school degree, public health insurance, and single parent household with lower cognition among preterm preschoolers born <30 weeks gestation [39]. These maternal factors represent those that are not easily modifiable. In contrast, household unmet basic needs could be modified as a strategy to alleviate risks for adverse child health, development and hospitalizations. In addition, the challenges of unmet basic needs, such as housing instability and food insecurity, may further act as physiologic stressors to the infant and trigger parental psychological stress, which may limit parents' adherence to high-risk developmental and medical follow-up care [41].

These results corroborate studies examining unmet basic needs and child health among children with special health care needs [21]. Many VLBW children have special health care needs. Professional organizations, such as the *American Academy of Pediatrics*, have recommended screening and referral for household unmet basic needs during clinical encounters, particularly in medical home models of care where coordinated care for children with special health care needs occurs [1]. Although screening and referral for unmet basic needs has increased in medical homes in the past decade, such screening and referral has not yet come to scale among clinical venues tailored to VLBW children, including neonatal intensive care units (NICUs) or high-risk developmental follow-up clinics. This represents a missed opportunity [16]. Further studies focused on integration of screening and referral in the NICU and in high-risk preterm infant follow-up settings are urgently needed to devise best strategies for widespread adoption.

SSI represents one of the few income benefits routinely available to households with limited financial assets and a household member with significant medical or developmental impairments [18]. This benefit may help families alleviate out-of-pocket medical expenses, lost wages, or other basic needs related to child care, such as food or formula. SSI may also provide money to assist with food, energy, and housing related expenses as well as child medical expenses that may reduce the severity of unmet basic needs. Our results suggest a possible protective effect of SSI on child outcomes among families with hardships, yet less than half of our sample received SSI. Further examination of the prevalence of and barriers to uptake of SSI among households with VLBW children that qualify as well as the role of SSI in alleviating the impacts of poverty on child health are greatly needed. As with other aspects of social care provided in clinical settings, assistance to families in completion of the SSI application process likely varies widely. The SSI application itself is complex and can be particularly difficult for low income families that have recently experienced the birth of an ill infant who had a prolonged hospitalization. Future studies should consider best approaches to supporting families in the SSI application process beginning in the NICU period.

Strengths of this study are inclusion of a racially/ethnically diverse US cohort of mothers and young children from predominately low income communities in 5 cities and detailed examination of a wide range of unmet basic needs in the VLBW population, a medically and developmentally complex group. However, this is a sentinel, not nationally representative, sample which may limit generalizability. We also limited our analysis to biological mothers because important covariates were not collected on non-biological mothers. Therefore, our findings may not be generalizable to VLBW children living in households without biological mothers. Further, the cross-sectional design limits the ability to ascertain longitudinal changes in unmet basic needs, initiation and continuation of receipt of SSI and other public benefits and associations of children's health and

development. The measures of hardships as well as the measures of children's health and development were based on maternal report, thereby possibly raising concerns about respondent bias. However, we used validated measures of developmental risk [31] and child health status [34]. Finally, although we adjusted for many potential confounding variables, there may be unmeasured confounding.

## CONCLUSION

This study represents one of the first steps toward understanding the relationships between household unmet basic needs and health, development, and healthcare utilization among VLBW children, a highly medically and socially vulnerable pediatric population. Providers and health systems that care for families with VLBW children urgently need to address unmet basic needs which can threaten children's health and provide information and assistance relative to enrollment in SSI and other public benefits which mitigate hardships. SSI represents a public benefit which may have crucially important implications for VLBW child health and development.

## DATA AVAILABILITY

Data will be made available upon request to the corresponding author.

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## AUTHOR CONTRIBUTIONS

MGP conceptualized and designed the study, interpreted the data, drafted the initial manuscript and reviewed and revised the manuscript. LJR and MS conducted the analysis, interpreted the data, and critically revised the manuscript for important intellectual content. AG, MS, DBC, DAF, FL-S, ERO, MMB, and RR-J interpreted the data and critically revised the manuscript for important intellectual content. SEdeC and TH conceptualized and designed the study, interpreted the data, and reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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## COMPETING INTERESTS

The authors declare no competing interests.

## ADDITIONAL INFORMATION

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