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Beyond income: material hardship and the health and healthcare of premature children

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OBJECTIVES: To estimate national prevalence of household hardships (food insufficiency, financial hardship, and difficulty paying medical bills) among children born term and preterm; and examine associations of household hardships with preterm children's outcomes (health status, emergency room visits, and unmet healthcare needs).

METHODS: We studied 24,026 children aged 0–3 years born term, preterm with moderately low birth weight (1501–2499 grams) and preterm with very low birth weight (VLBW; ≤ 1500 grams). Using propensity score matching to control for correlates of poverty, we examined associations of hardships and child outcomes.

RESULTS: Compared with term, households with preterm VLBW children had >2-fold higher odds of financial hardship (aOR:2.63; 95% CI: 1.26–5.46) and >5-fold higher odds of difficulty paying bills (aOR:5.60; 95% CI: 2.35–10.35). Matching for sociodemographics, special healthcare needs, income and receipt of public benefits, hardships were independently associated with adverse preterm children's outcomes.

CONCLUSIONS: Addressing household hardships is needed to optimize preterm child outcomes.

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INTRODUCTION

Preterm birth (<37 weeks gestation), which accounts for 10% of all United States (US) births, is associated with an array of chronic medical conditions and developmental disabilities [1]. Preterm birth occurs disproportionately among low-income families, and household poverty or near poverty is a well-established social determinant of child health that itself is associated with lifelong adverse health consequences [2]. Therefore, preterm children in low-income households represent a particularly vulnerable pediatric population.

Material hardships, defined as difficulty meeting basic needs such as food, housing or medical care, are common among low-income households [3, 4]. The national prevalence of household material hardships among preterm children in the US, and how this may differ from the term population, is unknown. Understanding this research gap is important, as it can inform interventions to identify and address material hardships in clinical settings comprised of preterm children. Moreover, given the disproportionate burden of preterm birth and material hardships among racial and ethnic minorities [4, 5], these interventions have the potential for advancing child health equity in the US.

In the general pediatric population, material hardships have been linked to detrimental effects on child health and development, even after accounting for the direct effects of income [6]. Material hardships, such as homelessness or food insecurity during pregnancy, have been associated with adverse birth outcomes [7, 8]. The extent that the prolonged neonatal birth hospitalization

that follows preterm birth exacerbates material hardships, increasing the baseline risks for adverse child health and healthcare outcomes among the preterm population, has not been investigated. Further, the extent that certain high-risk groups of preterm children, such as those born with very low birth weight (≤ 1500 grams), may be more vulnerable than other preterm groups to the effects of material hardships is poorly understood [9].

Using a nationally representative sample, we aimed to: (1) determine the prevalence of material hardships among US children born term and preterm during a critical window in their development- age 0 to 3 years; (2) examine the association of household material hardships with high-risk groups of preterm children (moderately low birth weight and very low birth weight); and (3) examine the association of material hardships with adverse health and healthcare outcomes among preterm children.

METHODS

Data source and study population

We combined 2016 to 2019 datasets from the National Survey of Children's Health (NSCH) [10]. This survey was supported by the Maternal and Child Health Bureau and administered by the National Center for Health Statistics. The NSCH provided nationally representative estimates of measures of child health and healthcare, household income, hardships and governmental assistance program participation. Children with special healthcare needs and children 0–5 years old were oversampled. The respondent was an adult parent or primary caregiver who was familiar with

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the child's health and use of health services. Final survey weights were comprised of a base weight accounting for the probability of selection, an adjustment for non-response, and an adjustment to match each state's weighted survey responses to the state's population of non-institutionalized children. Details of the design and implementation of this survey are available elsewhere [11].

In these analyses, we included all children aged 0–3 years with complete information on main study variables. Early childhood years were chosen a priori because this is a period of rapid neurodevelopmental change when children are especially vulnerable to the negative effects of their families' limited resources [12]. We excluded 4.8% of participants from the analytic sample due to missing predictor or outcome variables. The Boston University School of Medicine/Boston Medical Center Institutional Review Board approved this study.

Measures

Groups. Because NSCH does not have data on gestational age besides <37 weeks (preterm) vs. ≥37 weeks (term) and the goal of our study was to examine associations of material hardship on health and healthcare outcomes among preterm children with varying degrees of risk, we created the following categories for analysis: (1) term birth, which was defined as ≥37 weeks gestation and birth weight ≥2500 grams [13]; and preterm birth (< 37 weeks gestation), which was subdivided by birth weight category in: (2) moderately low birth weight (LBW, birth weight 1501–2499 grams), and (3) very low birth weight (VLBW, birth weight ≤1500 grams) [14]. Exclusion of children with low birth weight from the term birth category avoided confounding by growth restriction.

Material hardships. We examined household material hardships available in the NSCH, including food insufficiency, financial hardship and difficulty paying medical bills, using previously published definitions. Food insufficiency was measured by using the question of the US Department of Agriculture: [15] "Which of these statements best described your household's ability to afford the food you needed during the past 12 months?" Response categories included "we could always afford to eat good nutritious meals", "we could always afford enough to eat but not always the kinds of food we should eat", "sometimes we could not afford enough to eat", and "often we could not afford enough to eat." Food insufficiency was defined as "sometimes or often we could not afford enough to eat or we could always afford enough to eat but not always the kinds of food we should eat." [16] Financial hardship was measured by the question: "Since this child was born, how often has it been hard to cover the basics like food or housing on your family's income?" Responses included never, rarely, somewhat often, or very often. A dichotomous variable "never or rarely" vs. "somewhat often or very often," was used [17]. Difficulty paying medical bills was defined as "yes" response to the question, "During the past 12 months, did your family have problems paying for any of the child's medical or healthcare bills?" [18].

Health and healthcare outcomes. Overall child health status was assessed using the caregiver's answer to the question, "in general, how would you describe this child's health?" Responses were dichotomized as "excellent or very good" vs. "good, fair, or poor." [19–21] Emergency room visits were measured by the question: "During the past 12 months, how many times did this child visit a hospital emergency room?" Responses were dichotomized as ≥1 visits vs. no visits [17]. Unmet healthcare needs were measured using the question: "During the past 12 months, was there any time when this child needed healthcare but it was not received?" This survey question defined healthcare as "medical care as well other kinds of care like vision, hearing or dental care." Unmet healthcare needs was defined as "did not receive needed healthcare" vs. "received needed healthcare or did not need healthcare." [17].

Study covariates. Child and caregiver/household sociodemographic characteristics were included as covariates. These variables included child age (months), sex (male vs. female), special health care needs status (yes, no), insurance type (public only, private only, both public and private, uninsured), caregiver education (high school or less vs. more than high school), caregiver employment (working vs. not), primary household language (English vs. not English), family structure (two parent vs. single parent household), household income (low income defined as <200% vs. ≥200% of the federal poverty level), and receipt of public benefit assistance including Supplemental Nutrition Program for Women, Infants and Children (WIC), food stamps, and cash benefits. Race/ethnicity

(Hispanic, non-Hispanic Black, non-Hispanic White, non-Hispanic other) was included as a proxy measure for relevant social, environmental, and structural factors related to racism that underlie racial disparities in health outcomes [22].

Statistical analysis

All statistical analyses were performed using survey procedures in Stata 17 (Stata Corp, College Station, TX). To obtain multi-year estimates, individual-year survey weights were adjusted for according to procedures published by the US Census Bureau [23]. First, we examined child and caregiver characteristics (Table 1), household material hardships and public benefits, and child outcomes (Table 2) among groups. We compared preterm children stratified by birth weight category with term-born children using Chi-square tests.

Next, we fit multivariable logistic regression models to examine the association of preterm birth groups (term as reference) with household material hardships (Table 3). Our covariates of interest included child age, sex, special healthcare needs status, race/ethnicity, insurance type, caregiver education and employment, and household primary language, income and receipt of public assistance benefits. We also accounted for clustering by state, because public benefits and policies differ by state, and included a survey year fixed effect to account for time trends. We tested for multicollinearity using variance inflation factor.

Then, we examined associations of household material hardships with child health and healthcare within the preterm population. To preserve comparability between groups with different degrees of medical and developmental risk, models were built separately for preterm children with LBW and VLBW. We used propensity score matching because of large observable differences in baseline characteristics between households with and without each material hardship. Propensity score matching is a method to minimize selection bias by controlling for such imbalance in observable confounding factors that may not be adequately adjusted for in multivariable regression [24]. The following characteristics were included in our propensity score regression models: child age, sex, race and ethnicity, special healthcare need status, insurance type, caregiver education and employment, household income, primary language, family structure, and receipt of food and cash assistance. Using these variables, a propensity score was generated for each child. We used a 1:1 matching macro to match preterm children in households with and without each material hardship.

Finally, given national estimates of stark racial disparities in rates of material hardship among US children [4], we tested for effect modification by race and ethnicity (non-Hispanic White vs. non-Hispanic Black and Hispanic vs. non-Hispanic). To do this, we built separate multivariable logistic models and introduced an interaction term for race/ethnicity in the associations between preterm birth groups and household material hardships. Significance level was set at 0.05 for all analyses.

RESULTS

From 2016 to 2019 there were 24,026 children in the sample who were 0–3 years of age representing 13.5 million US children (Table 1). Overall, 93.4% were term, 5.1% were preterm with LBW, and 1.5% were preterm with VLBW. Those in the preterm LBW group were more likely to have special healthcare needs compared to term-born children. Those in the preterm VLBW group were more likely than their term counterparts to be non-White, have public insurance and reside in low-income households with caregivers who had lower educational attainment or were unemployed in the previous year (Table 1). Compared to term children, preterm children with VLBW were more likely to reside in households that experienced food insufficiency (28.5% vs. 41.5%) or difficulty paying medical bills (14.0% vs. 47.9%) and with caregivers who reported being somewhat or very often unable to cover basics like food or housing on their household's income (18.8% vs. 40.5%) (Table 2). Caregivers of preterm VLBW children were also more likely than term children to be enrolled in WIC and to receive food stamps and cash benefits (Table 2). Compared with term children, both preterm children groups had reported worse overall health and those with VLBW were more likely to have visited the emergency room and more likely to have reported unmet healthcare needs over the previous year.

Table 1. Descriptive Characteristics of Children 0–3 years of age and their Caregivers/Households comparing Preterm Children Groups to Term Children.

	Term Weighted <i>n</i> (%)	Preterm		<i>P</i>	<i>P</i>
		Moderately Low Birth Weight Weighted <i>n</i> (%)	Very Low Birth Weight Weighted <i>n</i> (%)		
Total	12,639,984 (93.4)	636,233 (5.1)	182,524 (1.5)		
Children					
Age				0.34	0.03
<12 mo	6,196,994 (49.0)	309,876 (48.7)	86,093 (47.2)		
12–23 mo	3,266,265 (25.8)	187,010 (29.4)	50,855 (27.8)		
24–36 mo	3,176,724 (25.1)	139,346 (21.9)	45,575 (25.0)		
Sex				0.67	0.99
Male	6,492,934 (51.4)	337,022 (53.0)	93,746 (51.4)		
Female	6,147,050 (48.6)	299,210 (47.0)	88,777 (48.6)		
CSHCN				<0.001	<0.001
Yes	910,596 (7.2)	105,996 (16.7)	76,582 (42.0)		
No	11,729,388 (92.8)	530,236 (83.3)	105,941 (58.0)		
Race and ethnicity				0.14	0.04
Hispanic	2,806,954 (22.2)	149,857 (23.6)	37,350 (20.5)		
Non-Hispanic White	7,009,573 (55.5)	297,862 (46.8)	71,209 (39.0)		
Non-Hispanic Black	1,234,946 (9.8)	83,879 (13.2)	34,481 (18.9)		
Multiracial/Other non-Hispanic	1,588,510 (12.6)	104,634 (16.4)	39,482 (21.6)		
Insurance type				0.81	<0.001
Public only	3,906,494 (31.4)	213,140 (33.8)	97,374 (54.4)		
Private only	7,400,117 (59.4)	352,082 (55.8)	50,754 (28.4)		
Combination public and private	525,633 (4.2)	30,380 (4.8)	20,799 (11.6)		
Uninsured	617,766 (5.0)	35,309 (5.6)	9968 (5.6)		
Caregivers/Households					
Highest educational attainment				0.31	0.007
High school or less	2,761,560 (21.9)	162,254 (25.5)	71,334 (39.1)		
Some college or more	9,841,994 (78.1)	473,020 (74.5)	110,988 (60.9)		
Any caregiver employed				0.66	0.001
Yes	11,195,941 (88.6)	556,708 (87.5)	128,640 (70.5)		
No	1,444,043 (11.4)	79,524 (12.5)	53,883 (29.5)		
Primary household language				0.66	0.39
English	10,745,758 (85.7)	551,446 (87.2)	138,661 (79.2)		
Non-English	1,793,006 (14.3)	80,970 (12.8)	36,322 (20.8)		
Family structure				0.26	0.08
Two parent household	9,956,494 (80.5)	461,039 (75.6)	129,928 (75.0)		
Single parent household	1,721,698 (13.9)	104,701 (17.2)	20,878 (12.0)		
Others	695,352 (5.6)	44,515 (7.3)	22,526 (13.0)		
Income				0.14	0.04
<200 FPL	4,874,908 (38.6)	280,882 (44.1)	84,148 (47.1)		
≥200 FPL	7,765,076 (61.4)	355,350 (55.9)	98,375 (52.9)		

Term: ≥37 weeks gestation and birth weight ≥2500 grams; preterm with moderately low birth weight: <37 weeks gestation and birth weight 1501–2499 grams; preterm with very low birth weight: <37 weeks gestation and birth weight ≤1500 grams.

CSHCN children with special healthcare needs, FPL federal poverty level.

Bold indicates $P < 0.05$, Chi-square test comparing preterm children stratified by birth weight with term-born children.

Table 2. Household Material Hardships, Public Benefits and Child Main Outcomes comparing Preterm Children Groups to Term Children.

	Term Weighted <i>n</i> (%)	Preterm		<i>P</i>	<i>P</i>
		Moderately Low Birth Weight Weighted <i>n</i> (%)	Very Low Birth Weight Weighted <i>n</i> (%)		
Household Material Hardships					
Food insufficiency				0.94	0.025
Yes	3,514,077 (28.5)	173,220 (28.3)	72,920 (41.5)		
No	8,826,112 (71.5)	439,968 (71.8)	102,813 (58.5)		
Financial hardship				0.80	<0.001
Somewhat/very often	2,325,310 (18.8)	120,376 (19.6)	70,026 (40.5)		
Never/rarely	10,034,717 (81.2)	494,385 (80.4)	103,070 (59.5)		
Difficulty paying medical bills ^a				0.24	<0.001
Yes	1,085,600 (14.0)	71,863 (17.9)	40,722 (47.9)		
No	6,685,605 (86.0)	329,190 (82.1)	44,384 (52.1)		
Household Public Benefits					
WIC				0.23	<0.001
Yes	3,149,364 (25.6)	181,583 (29.6)	86,326 (50.1)		
No	9,166,665 (74.4)	430,746 (70.4)	85,976 (49.9)		
Food stamps				0.39	0.003
Yes	2,461,021 (20.0)	140,000 (22.9)	69,636 (39.6)		
No	9,837,823 (80.0)	470,951 (77.1)	106,293 (60.4)		
Cash assistance from government				0.97	0.045
Yes	443,008 (3.6)	22,089 (3.6)	18,062 (10.6)		
No	11,858,396 (96.4)	585,090 (96.4)	151,642 (89.4)		
Outcomes					
Health status				<0.001	<0.001
Excellent or very good	12,060,783 (95.6)	562,846 (88.6)	130,002 (71.2)		
Good	444,323 (3.5)	64,508 (10.2)	46,480 (25.5)		
Fair or poor	107,465 (0.9)	7836 (1.2)	6041 (3.3)		
Any emergency room visits				0.30	0.007
Yes	3,244,275 (25.7)	185,557 (29.2)	78,555 (43.0)		
No	9,355,608 (74.3)	450,365 (70.8)	103,968 (57.0)		
Unmet healthcare need				0.23	0.04
Yes	123,562 (1.1)	10,222 (1.9)	12,686 (6.7)		
No	12,450,344 (98.9)	624,978 (98.1)	169,838 (93.3)		

Term: ≥ 37 weeks gestation and birth weight ≥ 2500 grams; preterm with moderately low birth weight: < 37 weeks gestation and birth weight 1501–2499 grams; preterm with very low birth weight: < 37 weeks gestation and birth weight ≤ 1500 grams.

All questions refer to the past 12 months. WIC: Special Supplemental Nutrition Program for Women, Infants and Children.

^aAmong those with medical or health-related expenses.

Bold indicates $P < 0.05$, Chi-square test comparing preterm children stratified by birth weight with term-born children.

Table 3. Associations of Preterm Children's Groups with Household Material Hardships (Term births as reference).

Household Material Hardships	Preterm			
	Moderately Low Birth Weight		Very Low Birth Weight	
	OR (95% CI)	aOR ^a (95% CI)	OR (95% CI)	aOR ^a (95% CI)
Food insufficiency	0.99 (0.73–1.35)	0.82 (0.57–1.17)	1.78 (1.00–3.36)	1.72 (0.95–3.60)
Financial hardship	1.05 (0.71–1.55)	0.93 (0.58–1.51)	2.93 (1.52–5.65)	2.63 (1.26–5.46)
Difficulty paying medical bills	1.01 (0.66–1.53)	1.00 (0.65–1.56)	5.65 (2.39–10.36)	5.60 (2.35–10.35)

Bold values indicate statistical significance $p < 0.05$.

Term: ≥ 37 weeks gestation and birth weight ≥ 2500 grams; preterm with moderately low birth weight: < 37 weeks gestation and birth weight 1501–2499 grams; preterm with very low birth weight: < 37 weeks gestation and birth weight ≤ 1500 grams.

^aAdjusted Odds Ratio; adjusted for child age, sex, special health care needs status, race and ethnicity, insurance type, caregiver education and employment status, household income, household primary language, family structure and food and cash assistance. We accounted for cluster by state.

Table 4. Association of Household Material Hardships and Child Health and Healthcare Among Preterm Children Groups Using Propensity Score Matching^b.

Household Material Hardships ^a	Preterm with Moderately Low Birth Weight		
	Fair/poor health	Emergency room visits	Unmet healthcare need
	RR (95% CI)	RR (95% CI)	RR (95% CI)
Food insufficiency	1.06 (1.03–1.08)	1.01 (0.98–1.04)	1.02 (0.99–1.05)
Financial hardship	1.05 (1.02–1.08)	1.15 (1.10–1.20)	1.06 (1.04–1.09)
Difficulty paying medical bills	1.07 (1.04–1.09)	1.03 (0.99–1.07)	1.04 (1.02–1.10)
Household Material Hardships ^a	Preterm with Very Low Birth Weight		
	Fair/poor health	Emergency room visits	Unmet healthcare need
	RR (95% CI)	RR (95% CI)	RR (95% CI)
Food insufficiency	1.08 (1.04–1.13)	1.10 (1.05–1.19)	1.09 (1.03–1.15)
Financial hardship	1.15 (1.10–1.25)	1.18 (1.12–1.24)	1.16 (1.08–1.30)
Difficulty paying medical bills	1.14 (1.09–1.22)	1.12 (1.08–1.18)	1.10 (1.04–1.27)

Bold values indicate statistical significance $p < 0.05$.

Preterm with moderately low birth weight: <37 weeks gestation and birth weight 1501–2499 grams; preterm with very low birth weight: <37 weeks gestation and birth weight ≤ 1500 grams.

^aReference group is lack of household material hardships

^bCovariates included in the propensity score regression model were child age, sex, special health care need status, race and ethnicity, insurance type, caregiver education and employment, household income, primary language, family structure, food and cash assistance. Matched 1:1.

In models adjusted for income, public benefits and other confounders (Table 3), we did not find associations between preterm birth and household material hardships for children with LBW. In contrast, households of preterm children with VLBW, experienced more than double the odds of financial hardship (aOR: 2.63; 95% CI: 1.26–5.46) and more than 5 times the odds of difficulty paying medical bills (aOR: 5.60; 95% CI: 2.35–10.35) compared to their term counterparts.

Table 4 shows associations of household material hardships (lack of material hardship as reference) and child health and healthcare among preterm children using propensity score matching. After risk adjustment, household food insufficiency, financial hardship and difficulty paying medical bills were each independently associated with worse child health and healthcare utilization outcomes in the preterm population. For instance, both preterm children groups in households with (vs. without) financial hardship were significantly more likely to have ≥ 1 emergency room visit over the previous year (preterm LBW children RR: 1.15; 95% CI: 1.10–1.20, and preterm VLBW children RR: 1.18; 95% CI: 1.12–1.24). Compared with preterm children residing in households without financial hardship, preterm children in households with financial hardship were also more likely to have any unmet health care need over the previous year (preterm LBW children RR: 1.06; 95% CI: 1.04–1.09, preterm VLBW children RR: 1.16; 95% CI: 1.08–1.30).

In analyses of effect modification, we found that race was a significant effect modifier for the association of preterm VLBW birth and household financial hardship. The increased odds of residing in a household with financial hardship was 2.8 times greater for Black VLBW children (OR 4.35; 95% CI: 2.36–6.57) compared to their White counterparts (OR 1.52; 95% CI: 1.01–2.30). We also identified Black-White disparities in difficulties paying medical bills, whereby the association between preterm VLBW birth and difficulty paying medical bills was only significant among Black VLBW children (OR 6.12; 95% CI: 3.24–14.82) and not among White VLBW children (OR 1.32; 95% CI: 0.94–3.22). We did not find evidence of effect modification by ethnicity in the associations of preterm VLBW birth and household hardships.

DISCUSSION

This study provides national, contemporary estimates of the prevalence of material hardships in the term and preterm population and examines the extent that material hardships

affect preterm health and healthcare utilization during the critical period of early childhood. We found that material hardships were exceptionally common among US preterm children, where 41–48% of preterm VLBW children and 20–28% of preterm LBW children lived in households with food insufficiency, financial hardships, or difficulty paying medical bills. Material hardships occurred more often among households with preterm VLBW vs. term children, even after adjustment for income and receipt of public assistance benefits such as WIC, food stamps and cash benefits. Material hardships were independently associated with worse health and healthcare utilization among both preterm groups. Overall, our study highlights the importance of identifying and addressing material hardships in settings caring for children born preterm during early childhood to potentially improve preterm children's health outcomes.

We found that the burden of material hardships in the preterm vs. term population was out of proportion to the observed differences in income. For instance, while prevalence of low-income was 8% higher in households of preterm VLBW infants compared to households of term infants, the rates of food insufficiency and financial hardship were nearly double, and the rates of difficulty paying medical bills were more than triple for the preterm VLBW group compared to the term group. Reasons for these findings are likely multifactorial. First, financial stressors during the birth hospitalization, which often lasts months for VLBW infants, may contribute to material hardships. During this time, many caregivers experience unforeseen costs from frequent transportation and parking, meals, and childcare needs, as well as forgone income from lost time at work [25]. This substantial financial strain may exacerbate the stress and anxiety that is already high for parents of hospitalized preterm infants [26], limiting caregiver's bandwidth to seek out resources. After the neonatal intensive care unit (NICU) period, preterm children, particularly those with VLBW, continue to incur high resource utilization including frequent primary care visits and multi-specialty care as well as increased emergency room visits and hospitalizations [27]. The costs associated with chronic care management needs increase households' financial burden [28] and may contribute to perpetuating, or exacerbating, material hardships even after the NICU period [29, 30].

The constructs of material hardship examined in this study relate to caregivers' inability to meet basic needs such as food or

housing, or to pay for the medical care of their children. The extant literature on material hardships and child health outcomes has focused on low-income pediatric populations in *outpatient* pediatric healthcare settings. Among low-income children, limited or uncertain access to enough nutritious food has been associated with poor overall health, increased hospitalizations and developmental risk [31–34]. Food budgets are those often forgone to meet other basic needs in low-income families [35]. Similarly, low-income children in households experiencing various forms of housing insecurity such as crowding or residential instability have been found to have lower weight and poorer overall health than securely housed children [36, 37]. For the subgroup of low-income children with special healthcare needs, material hardships have been associated with especially high utilization of acute care services [17, 38]. Our study adds a population-based perspective on the prevalence of material hardships and their relationship with adverse health and healthcare in the general preterm population during the first three years of life. During this period, families of children born preterm have multiple touch-points with the healthcare system through the medical home, subspecialty care, high-risk infant follow-up programs, and early intervention services. Therefore, opportunities for intervention in the preterm population span the birth hospitalization as well as outpatient and community settings caring for children born preterm during early childhood years.

Child health is embedded in the household conditions in which children live. We speculate that material hardships may be associated with preterm child health outcomes through several mechanisms, acting alone or in concert, including reduced adherence to health-promoting behaviors (i.e. breastfeeding discontinuation) [39] or adverse caregiver mental health such as stress, anxiety or depression [40]. It is possible that the associations of material hardships with caregivers' perception of poorer overall child health reflect their general worry of their living situation and the perceived fragility of their preterm children. The associations with increased emergency room visits may be a more concrete reflection of preterm children's medical needs, but it may also indicate barriers to accessing primary care. Material hardships may also exert their detrimental effects on health through exposure to adverse environmental conditions among medically vulnerable preterm children. For instance, housing insecurity may force families to move to substandard housing, increasing exposure to second-hand smoke or infectious agents that can land preterm children with bronchopulmonary dysplasia in the emergency room [41].

Preterm children are disproportionately born to Black mothers [1]; and Black children younger than 3 years of age are disproportionately low income or poor compared to young White children [42]. In this study, among preterm children with VLBW, the association of prematurity with the likelihood of residing in a household experiencing material hardships was greater for Black than for White children. These stacking health inequities occur for a myriad of reasons, including systemic social injustices such as structural racism and institutionalized discrimination that have shaped the living conditions of racial minorities in the US [43, 44]. Given the disproportionate burden of preterm birth among low-income, racial/ethnic minority populations, addressing material hardships in settings caring for high-risk preterm infants constitute a public health priority to promote child health equity in the US.

Our findings have important implications for addressing modifiable household material hardships in clinical settings focused on preterm children. During the birth hospitalization in the NICU, for example, interventions may include universal programs for short-term needs (e.g. transportation, parking vouchers, meal delivery), standardized screening tools coupled with strong referral systems for short and longer-term needs (e.g. medical-legal partnerships), or enhanced care-coordination or family navigation support to assist families with connections to community resources and social services [45]. While integrating social risk screening and referral interventions in clinical settings is

recommended by the American Academy of Pediatrics, recent evidence suggests this practice is substantially underutilized in NICU settings [46]. After discharge from the NICU, high-risk infant follow-up settings should continue to track material hardships identified and resources provided during the NICU hospitalization, as well as identify and address material hardships that may emerge over time [47].

This study has several strengths including the use of a large nationally representative data set permitting examination of prevalence, and inclusion of a robust array of sociodemographic characteristics. We also had a large enough sample size to use propensity score matching which enabled better balancing of the baseline differences between groups with and without material hardships. However, unmeasured confounding remains a possibility. Another limitation of this study was that cross-sectional data limited our ability to infer the direction of the associations. Given NSCH's lack of more granular measures of gestational age, we relied on birth weight categories as a proxy for degree of prematurity. In addition, we were limited by the measures of material hardships and child health outcomes available in the NSCH data set, which lacked a broader array of material hardships and important outcomes for the preterm population such as developmental outcomes and prematurity-related morbidities.

CONCLUSIONS

This population-based study found that household material hardships- specifically food insufficiency, financial hardship, and difficulty paying medical bills- were highly prevalent and related to adverse child health and healthcare utilization outcomes among preterm children. Households of preterm VLBW children were at particularly high risk of experiencing material hardships. These findings underscore the need to examine how interventions during the prolonged NICU hospitalization to buffer the effects of material hardships and its health consequences may improve preterm infant outcomes and promote child health equity.

DATA AVAILABILITY

Dataset and codebooks for the National Survey of Children's Health are publicly available in the Data Resource Center for Child & Adolescent Health at <https://www.childhealthdata.org/>.

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AUTHOR CONTRIBUTIONS

ECR and MGP contributed to conceptualization and design, analysis, and drafted and edited the manuscript. YT contribute to design and data analysis. AB, AG and YT contributed to data interpretation, and reviewed and edited the manuscript. All authors approved the final manuscript.

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COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

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