Journal of Perinatology www.nature.com/jp

ARTICLE

Household unmet basic needs in the first 1000 days and preterm birth status

Margaret G. Parker [1]✉, Stephanie Ettinger de Cuba [1], Lindsey J. Rateau [2], Megan T. Sandel [1], Deborah A. Frank [1], Diana B. Cutts [3], Timothy C. Heeren [4], Félice Lê-Scherban [5], Maureen M. Black [6,7], Eduardo R. OchoaJr [8] and Arvin Garg [9]

OBJECTIVE: To examine the relationship of individual and composite number of unmet basic needs (housing, energy, food, and healthcare hardships) in the past year with preterm birth status among children aged 0–24 months.
STUDY DESIGN: We examined cross-sectional 2011–18 data of 17,926 families with children aged 0–24 months. We examined children born <31 weeks', 31–33 weeks', and 34–36 weeks' gestation versus term (≥37 weeks) using multivariable multinomial logistic regression.
RESULTS: At least 1 unmet basic need occurred among ≥60% of families with preterm children, compared to 56% of families with term children ($p = 0.007$). Compared to term, children born ≤30 weeks' had increased odds of healthcare hardships (aOR 1.28 [1.04, 1.56]) and children born 34–36 weeks' had increased odds of 1 (aOR 1.19 [1.05, 1.35]) and ≥2 unmet needs (aOR 1.15 [1.01, 1.31]).
CONCLUSION: Unmet basic needs were more common among families with preterm, compared to term children.

Journal of Perinatology; https://doi.org/10.1038/s41372-022-01325-5

INTRODUCTION

Children are the poorest segment of the U.S. population. In 2018, 16% of U.S. children lived within 100% and 38% lived within 200% of the federal poverty level [1]. Families with young children living in poverty are disproportionally families of color [1] who, compared to non-Hispanic white families, experience higher prevalence of adverse social determinants of health (SDH), including unmet basic needs such as housing instability and food insecurity [2, 3]. The "First 1000 Days," that encompasses the time from conception until age 24 months, is a period of rapid growth and a critical time period for programming future neurodevelopment and cardiovascular health [4]. Adverse social determinants of health (SDH) in the first 1000 days are associated with detrimental health consequences throughout the life course [5–8]. For these reasons, the *American Academy of Pediatrics* (AAP) recommends addressing adverse SDH among U.S. families with infants and young children in a multi-faceted manner during clinical encounters, with systematic identification followed by referral to resources as appropriate [9]. Systematic identification and referral of SDH has increased dramatically in the out-patient pediatric clinic setting in the past decade, but remains uncommon in the pediatric in-patient and prenatal setting [10].

Children born preterm, representing 10% of all U.S. births [11], experience increased risk for chronic medical morbidities and developmental disabilities, which often require intensive follow-up and specialty care, particularly in the first two years after discharge from the neonatal intensive care unit (NICU) [12, 13]. Preterm birth occurs disproportionally among families of color with low incomes, who may have increased burden of unmet basic needs [11, 14]. Children born <34 weeks' gestation have substantially longer birth hospitalizations and worse medical and developmental outcomes requiring more follow-up care, compared to children born late preterm (34–36 weeks' gestation), whose outcomes are less optimal than those of infants born at term [15–17]. While socioeconomic factors are associated with neurodevelopmental outcomes among preterm children [18, 19], the mechanisms driving the association are unclear. It is plausible that dealing with urgent unmet basic needs impedes caregivers' ability to engage consistently in follow-up medical and developmental care for preterm children [20]. Additionally, all children, but particularly those born preterm, are vulnerable to the physiologic stresses of poor nutrition, excess cold and heat, and unstable housing, while many of their caregivers additionally struggle with stress and depression that can accompany caring for the increased medical and developmental needs of a preterm child [19, 21–23]. However, currently, the prevalence of unmet basic needs among families with preterm children in the first 2 years of life in the U.S. is unknown.

Further, the relationship between having unmet basic needs during pregnancy and preterm birth itself is not well understood. Homelessness during pregnancy is a risk factor for preterm birth [24], possibly due to stress, limited access to prenatal care, and/or

[1]Department of Pediatrics, Boston Medical Center, Boston University School of Medicine, Boston, MA, USA. [2]Biostatistics and Epidemiology Data Analytics Center, Boston University School of Public Health, Boston, MA, USA. [3]Department of Pediatrics, Hennepin County Medical Center, Boston, MA, USA. [4]Department of Biostatistics, Boston University School of Public Health, Boston, MA, USA. [5]Department of Epidemiology and Biostatistics, Dornsife School of Public Health, Drexel University, Philadelphia, PA, USA. [6]Department of Pediatrics, University of Maryland School of Medicine, Baltimore, MD, USA. [7]RTI International, Research Triangle Park, NC, USA. [8]Department of Pediatrics, University of Arkansas for Medical Sciences, Little Rock, AR, USA. [9]Department of Pediatrics, University of Massachusetts Medical School, Worcester, MA, USA.
✉email: Margaret.parker@bmc.org

Received: 22 March 2021 Revised: 13 September 2021 Accepted: 19 January 2022
Published online: 31 January 2022

to environmental toxic exposures [25]. Food insecurity during pregnancy is also associated with adverse birth outcomes [26]. However, it is unknown whether other unmet basic needs, such as energy insecurity, and the composite number of unmet basic needs in the prenatal period are associated with preterm birth.

The objective of our study was to examine the extent that specific unmet basic needs (housing, energy, food, and healthcare hardships) and composite number of needs (0, 1, ≥2) in the past year are associated with preterm birth status among children in the first 1000 days. We hypothesized that the prevalence of unmet basic needs varies with the degree of prematurity, where children born ≤ 30 weeks' gestation have the greatest risk, followed by children born 31–33 weeks' gestation, 34–36 weeks' gestation (late preterm) and ≥ 37 weeks' gestation (term).

METHODS

Population and setting

We used data collected from Children's HealthWatch, a cross-sectional study of caregivers surveyed in emergency rooms and ambulatory clinics affiliated with academic centers regarding unmet basic needs among families with children 0–4 years of age in five cities in the U.S. (Boston Medical Center, Boston; University of Maryland School of Medicine, Baltimore; Arkansas Children's Hospital, Little Rock; Hennepin Country Medical Center, Minneapolis; and St. Christopher's Hospital for Children, Philadelphia). 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. The analytic sample was limited to mothers with children aged 0 to 24 months, thereby representing unmet basic needs that may have occurred in the first 1000 days of life (conception until age 24 months). Among 28,161 surveys completed during this timeframe, we excluded 8,181 (29.0%) when the child age was >24 months, 1,504 (5.3%) when the respondent was not the biological mother caring for child, 109 (0.4%) when the child was not born in the U.S. (because foreign-born children may not qualify for the same social services as US-born children), and 441 (1.6%) when our main exposure and outcome variables were missing, leaving 17,926 dyads for analysis. Institutional review board approval was obtained before data collection and renewed annually at each site.

Main exposure variable

Our main exposure variable was preterm birth status, defined as birth ≤30 weeks' gestation, 31–33 weeks' gestation, 34–36 weeks' gestation (late preterm) and ≥37 weeks' gestation (term). The child's gestational age at birth was self-reported by mothers. In a prior analysis, we found that maternal report of birth weight and gestational age and children's electronic health record data had high correlation coefficients—birthweight (0.97) and gestational age (0.95) [25].

Main outcome variables

Our main outcome 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 two or more times in the past 12 months, and/or being behind on rent or mortgage in the past 12 months. 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. Household food insecurity was measured according to the 18-item United States Department of Agriculture (USDA) Household Food Security Survey Module [27, 28]. This module includes ten household-specific and eight child-specific questions. Household food insecurity was defined as endorsement of ≥3 of the 10 adult-focused questions, following USDA guidance [28]. Healthcare hardship was defined as 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 [29]. We also examined composite number of unmet basic needs, categorized as 0, 1, or ≥2 needs.

Covariates

We collected maternal socioeconomic and demographic characteristics (age, education, race/ethnicity, nativity, employment, marital status, and primary language) and breastfeeding history and depressive symptoms at the time of the interview. We also collected child characteristics, including gestational age, birth weight, sex assigned at birth, age at time of survey, child health insurance type, a positive screen on the Children with Special Health Care Needs screener, receipt of Supplemental Security Income (SSI) for the index child, and Early Intervention participation. Household characteristics included caregiver employment, and participation in Special Supplemental Nutrition Program for Women, Infants and Children.

Statistical analysis

First, we examined bivariate relationships between maternal, child, and household characteristics and unmet basic needs according to preterm birth status. We used ANOVA for continuous variables and chi-square tests for categorical variables. Next, we performed multivariable multinomial regression models to examine the associations between unmet basic needs and preterm birth status (≤30 weeks' vs. term [reference], ≤31–33 weeks' vs. term [reference] and 34–36 weeks' vs. term [reference]). We examined these categories of preterm birth separately because they have different degrees of medical and developmental vulnerability and we hypothesized that unmet basic needs may be more prevalent among the youngest, most vulnerable infants. We performed a separate model for each unmet basic need of interest and for our composite number of unmet basic needs (0 needs as reference). We included covariates of a priori interest that are known to be associated with our main exposure and outcome, including maternal age, race/ethnicity, education, nativity, marital status, and child insurance [30–34]. We also included study site because access to prenatal care and availability of community services that address unmet basic needs and the health and developmental needs of preterm infants vary by location in the United States. Finally, we performed multivariable multinomial regression models to examine association of preterm birth status and unmet basic needs according to postnatal age. We examined infants (A) < 3 months of age, where unmet basic needs in the past year would predominantly capture pregnancy and the newborn period that occurred exclusively or partly in the hospital setting among preterm infants, (B) 3 to <12 months of age, when many preterm infants would be transitioning to parental care at home and when the frequency of medical and developmental follow-up visits may be most acute, and (C) 12–24 months. We then performed a sensitivity analysis with categories of <6 months, 6 to <12 months of age, and 12–24 months, because of the possibility some infants in the youngest gestational age groups would still be hospitalized when we restricted to <3 months corrected age and would be more likely to be discharged home if we examined <6 months corrected age. We included the same covariates in all models. Analysis was performed using two-sided tests and a significance level of $p < 0.05$, with SAS software (version 9.4); SAS Institute, Inc, Cary, NC.) Code can be accessed by contacting the corresponding author.

RESULTS

Mother–child characteristics according to the child's preterm birth status are shown in Table 1. Among 17,926 dyads, 478 (2.7%) were born ≤30 weeks' gestation, 498 (2.8%) were born 31–33 weeks' gestation, 1604 (9.0%) were late preterm, and 15,346 (86.0%) were term. Mothers with preterm births were less often employed, Hispanic, and foreign-born, compared to mothers with term births. Compared to term children, preterm children had lower birth weights, higher positive screens for special health care needs, and were more likely to receive SSI and participate in Early Intervention. In our overall sample, 27.5% had 1 hardship and 29.6% had ≥2 hardships. For children born ≤30 weeks', 1 and ≥2 hardships occurred among 29.9% and 31.8%, respectively; for children born 31–33 weeks', 1 and ≥2 hardships occurred among 29.3% and 30.3%, respectively; for children born 34–36 weeks' gestation, 1 and ≥2 hardships occurred among 29.7% and 31.2%, respectively; and for children born at term, 1 and ≥2 hardships occurred among 27.1% and 29.3%, respectively ($p = 0.007$).

In Table 2 we present associations of unmet basic needs in the past year and preterm birth status among our entire sample. In adjusted models, families with children born ≤30 weeks' had higher odds of healthcare hardships (1.28 [95% CI 1.04, 1.56]) compared to families with children born at term. Families with late preterm children had higher odds of 1 (1.19 [95% CI 1.05, 1.35]

Table 1. Participant characteristics according to gestational age at birth.

	Total	≤30 weeks	31–33 weeks	34–36 weeks	≥37 weeks	*p* value[a]
Total *N* (%)	17,926 (100%)	478 (2.7%)	498 (2.8%)	1604 (9.0%)	15,346 (86.0%)	
Study Site, *n* (%)						<0.001
Baltimore	3170 (17.7%)	110 (23.0%)	121 (24.3%)	294 (18.3%)	2645 (17.2%)	
Boston	3548 (19.8%)	65 (13.6%)	87 (17.5%)	306 (19.1%)	3090 (20.1%)	
Little Rock	4482 (25.0%)	151 (31.6%)	135 (27.1%)	452 (28.2%)	3744 (24.4%)	
Minneapolis	2803 (15.6%)	69 (14.4%)	51 (10.2%)	186 (11.6%)	2497 (16.3%)	
Philadelphia	3923 (21.9%)	83 (17.4%)	104 (20.9%)	366 (22.8%)	3370 (22.0%)	
Maternal characteristics						
Age, years, mean (SD)	27.0 (5.9)	28.3 (6.4)	27.9 (6.4)	27.3 (6.1)	26.9 (5.9)	<0.001
Education, *n* (%)						0.018
Less than high school diploma	4398 (24.6%)	92 (19.2%)	123 (24.7%)	364 (22.7%)	3819 (24.9%)	
High school diploma	6666 (37.2%)	181 (37.9%)	170 (34.1%)	600 (37.5%)	5715 (37.3%)	
Any college or technical school	6847 (38.2%)	205 (42.9%)	205 (41.2%)	637 (39.8%)	5800 (37.8%)	
Employed, *n* (%)	7469 (41.8%)	175 (36.6%)	174 (34.9%)	661 (41.3%)	6459 (42.2%)	<0.001
Marital status, *n* (%)						0.334
Single	8653 (48.3%)	244 (51.2%)	248 (49.8%)	793 (49.5%)	7368 (48.1%)	
Married/partner/cohabitating	6206 (34.7%)	159 (33.3%)	175 (35.1%)	521 (32.5%)	5351 (34.9%)	
Separated/divorced/widowed	3045 (17.0%)	74 (15.5%)	75 (15.1%)	287 (17.9%)	2609 (17.0%)	
Race/ethnicity, *n* (%)						<0.001
Non-Hispanic white	8233 (46.3%)	275 (58.0%)	273 (55.4%)	765 (48.2%)	6920 (45.5%)	
Non-Hispanic Black	3114 (17.5%)	76 (16.0%)	104 (21.1%)	296 (18.6%)	2638 (17.3%)	
Hispanic any race	5824 (32.8%)	114 (24.1%)	105 (21.3%)	479 (30.2%)	5126 (33.7%)	
Multi-race/ethnicity	346 (1.9%)	4 (0.8%)	5 (1.0%)	28 (1.8%)	309 (2.0%)	
Other	253 (1.4%)	5 (1.1%)	6 (1.2%)	20 (1.3%)	222 (1.5%)	
Nativity, *n* (%)						<0.001
US born	13,527 (75.5%)	376 (78.7%)	420 (84.3%)	1306 (81.4%)	11,425 (74.5%)	
Foreign born	4389 (24.5%)	102 (21.3%)	78 (15.7%)	298 (18.6%)	3911 (25.5%)	
Primary language, *n* (%)						<0.001
English	14,714 (82.1%)	412 (86.2%)	451 (90.6%)	1384 (86.3%)	12,467 (81.2%)	
Spanish	3131 (17.5%)	66 (13.8%)	47 (9.4%)	220 (13.7%)	2798 (18.2%)	
Somali	81 (0.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	81 (0.5%)	
Depressive symptoms, *n* (%)	3763 (21.0%)	119 (24.9%)	119 (23.9%)	414 (25.8%)	3111 (20.3%)	<0.001
Ever breastfed, *n* (%)	12,475 (69.6%)	378 (79.1%)	337 (67.7%)	1077 (67.1%)	10,683 (69.6%)	<0.001
Child characteristics						
Birth weight, grams, mean (SD)	3112 (672)	1066 (484)	1901 (535)	2542 (552)	3274 (491)	<0.001
Age at time of survey, months, mean (SD)	9.4 (6.9)	10.9 (6.1)	10.0 (6.5)	9.7 (6.9)	9.3 (6.9)	<0.001
Corrected age at time of survey, months, mean (SD)	9.2 (6.9)	7.7 (6.0)	8.0 (6.5)	8.6 (6.9)	9.3 (6.9)	<0.001
Health insurance, *n* (%)						0.002
Public	15,550 (86.9%)	442 (92.5%)	447 (89.8%)	1401 (87.5%)	13,260 (86.6%)	
No insurance	844 (4.7%)	9 (1.9%)	14 (2.8%)	71 (4.4%)	750 (4.9%)	
Private insurance	1499 (8.4%)	27 (5.6%)	37 (7.4%)	129 (8.1%)	1306 (8.5%)	
Positive screen for special health care needs, *n* (%)	1409 (12.3%)	189 (64.3%)	89 (28.3%)	190 (17.9%)	941 (9.6%)	<0.001
Supplemental Security Income for child need, *n* (%)	477 (2.7%)	215 (45.3%)	31 (6.3%)	56 (3.5%)	175 (1.2%)	<0.001
WIC participation, *n* (%)	14,002 (78.4%)	388 (81.2%)	402 (81.0%)	1261 (79.1%)	11,951 (78.2%)	0.160
Early intervention participation, *n* (%)						<0.001
Yes, current	1067 (6.1%)	200 (46.4%)	88 (18.9%)	171 (11.2%)	608 (4.1%)	
Yes, in past	219 (1.3%)	22 (5.1%)	30 (6.4%)	40 (2.6%)	127 (0.8%)	
No	16,096 (92.6%)	209 (48.5%)	348 (74.7%)	1312 (86.1%)	14,227 (95.1%)	

Table 1. continued

	Total	≤30 weeks	31–33 weeks	34–36 weeks	≥37 weeks	*p* value[a]
Household characteristics						
Monthly household income, *n* (%)						0.189
<$1000	4,572 (40.3%)	114 (37.7%)	154 (47.7%)	399 (39.4%)	3905 (40.2%)	
$1000–$1999	3481 (30.7%)	89 (29.5%)	94 (29.1%)	307 (30.3%)	2991 (30.8%)	
$2000–$2999	1627 (14.3%)	53 (17.5%)	35 (10.8%)	152 (15.0%)	1387 (14.3%)	
$3000–$3999	696 (6.1%)	22 (7.3%)	11 (3.4%)	62 (6.1%)	601 (6.2%)	
≥$4000	969 (8.5%)	24 (7.9%)	29 (9.0%)	92 (9.1%)	824 (8.5%)	
Any household employment, *n* (%)	13,923 (78.4%)	354 (74.4%)	349 (70.9%)	1216 (76.3%)	12,004 (78.9%)	<0.001
Unmet basic needs in past year						
Housing instability, *n* (%)	5094 (28.4%)	123 (25.7%)	155 (31.1%)	481 (30.0%)	4335 (28.2%)	0.130
Energy insecurity,[b] *n* (%)	3610 (24.4%)	115 (27.8%)	100 (23.7%)	369 (28.0%)	3026 (24.0%)	0.038
Household food insecurity, *n* (%)	4663 (26.0%)	131 (27.4%)	130 (26.1%)	414 (25.8%)	3988 (26.0%)	0.914
Healthcare hardship, *n* (%)	5424 (30.3%)	173 (36.2%)	153 (30.7%)	520 (32.4%)	4578 (29.8%)	0.005
Number of hardships,[c] *n* (%)						0.007
No hardships	7689 (42.9%)	183 (38.3%)	201 (40.4%)	627 (39.1%)	6678 (43.5%)	
1 hardship	4930 (27.5%)	143 (29.9%)	146 (29.3%)	476 (29.7%)	4165 (27.1%)	
2 or more hardships	5307 (29.6%)	152 (31.8%)	151 (30.3%)	501 (31.2%)	4503 (29.3%)	

[a]*p* values derived from chi-square tests and ANOVA.
[b]Energy insecurity known for 14,781 mother–child dyads only.
[c]Hardships include housing instability, energy insecurity, household food insecurity, healthcare hardships.

and ≥2 unmet basic needs (1.15 [95% CI 1.01, 1.31]), compared to families with children born at term.

In Table 3 we present associations of unmet basic needs in the past year and preterm birth stratified by child age. Among families with children < 3 months of age, families with children born 31–33 weeks' gestation had higher odds of 1 and ≥ 2 unmet basic needs (aOR 2.38 [1.39, 4.08] and 2.13 [1.20, 3.80], respectively), compared to families with children born at term. Among families with children 3 to <12 months of age, families with late preterm children had higher odds of energy insecurity (aOR 1.30 [95% CI 1.07, 1.60] and 1 unmet basic need (aOR 1.34 [95% 1.10, 1.64], compared to families with children born at term. Finally, among children 12 months to 2 years of age, families with children born ≤30 weeks' gestation had higher odds of health care hardships (aOR 1.41 [1.04, 1.90]) and children born late preterm had higher odds of ≥ 2 unmet basic needs (aOR 1.24 [95% 1.01, 1.53]), compared to families with children born at term.

In our sensitivity analysis, we did not find meaningful differences when we examined preterm children in <6 months vs. <3 months corrected age categories; we, therefore, present data with children <3 months corrected age, such that report of hardships in the previous year represents pregnancy and the first chronological months of life spent in the NICU and the early post-discharge time period.

DISCUSSION

In a diverse U.S. cross-sectional sample of households with a high prevalence of poverty, ≥60% of families with preterm children younger than 24 months experienced 1 or more unmet basic needs. Healthcare hardships were the most frequently reported unmet basic need, occurring among ≥30% of families with preterm children. One and ≥2 hardships in the previous year occurred more often among families with preterm children, compared to families with term children. This finding was most pronounced among families with preterm children born 31–33 weeks and <3 months of age at the time of the interview, representing pregnancy and the birth hospitalization time periods.

Unmet basic needs which accompany child poverty can have detrimental influences on child health and development. The neurodevelopmental fragility of preterm infants increases their vulnerability to the effects of household unmet basic needs. Previous studies have shown associations of adverse social circumstances and worse neurodevelopmental outcomes among preterm infants [18, 19]. For example, Lean et al. reported that elevated maternal social risk factors (≤18 years, Black race, no high school degree, public health insurance, and single-parent household) explained 12% of the variance in low cognitive outcomes at 2 and 5 years of age, among a cohort of preterm children born <30 weeks' gestation [19]. A plausible mechanism by which these social risk factors contribute to adverse child development may be in part through unmet basic needs. For example, parents of preterm infants with low incomes or other social risk factors who face challenges of housing or food insecurity, or other unmet basic needs have increased stress and may have limited bandwidth, which can undermine adherence to preterm infant medical and developmental follow-up and contribute to less optimal preterm infant developmental outcomes [35]. Their children may also experience direct physiological effects of poor nutrition, cold or heat stress, and crowded and unsafe housing. The elevated prevalence of unmet basic needs among children less than 24 months supports the importance of addressing adverse SDH during the first 1000 days.

We hypothesized that unmet basic needs may be more prevalent among families with the most medically complex infants, those ≤30 weeks' gestation. Our results did not show any relationship between degree of prematurity and unmet basic needs however. It is possible that infants ≤30 weeks' gestation with longer birth hospitalizations and more out-patient follow-up visits may have had more time to interact with social workers or other staff that may have addressed unmet basic needs. We also had the smallest N for this group and may have lacked statistical power to detect differences.

Our study highlights the value of early screening and referral for identified unmet basic needs among families with preterm infants, as recommended among all pediatric populations by the AAP [9].

Table 2. Associations of unmet basic needs in the past year and preterm birth among children age 0 to 24 months.

	REF	Crude OR (95% CI)			Adjusted[a] OR (95% CI)		
	≥37 weeks (n = 15,346)	≤30 weeks (n = 478)	31–33 weeks (n = 498)	34–36 weeks (n = 1604)	≤30 weeks (n = 478)	31–33 weeks (n = 498)	34–36 weeks (n = 1604)
Housing instability	1.00	0.88 (0.71, 1.08)	1.15 (0.95, 1.39)	1.09 (0.97, 1.22)	0.88 (0.71, 1.09)	1.10 (0.90, 1.34)	1.09 (0.97, 1.22)
Energy insecurity[b]	1.00	1.22 (0.98, 1.52)	0.99 (0.78, 1.24)	**1.23 (1.08, 1.40)**	1.11 (0.89, 1.40)	0.85 (0.67, 1.08)	**1.14 (1.00, 1.31)**
Household food insecurity	1.00	1.08 (0.88, 1.32)	1.01 (0.82, 1.23)	0.99 (0.88, 1.11)	1.10 (0.89, 1.35)	1.04 (0.84, 1.29)	1.02 (0.91, 1.16)
Healthcare hardship	1.00	**1.33 (1.10, 1.61)**	1.04 (0.86, 1.27)	**1.13 (1.01, 1.26)**	**1.28 (1.04, 1.56)**	0.96 (0.78, 1.18)	1.07 (0.95, 1.20)
Number of hardships							
1 hardship	1.00	1.25 (1.00, 1.57)	1.17 (0.94, 1.45)	**1.22 (1.07, 1.38)**	1.22 (0.97, 1.53)	1.14 (0.91, 1.42)	**1.19 (1.05, 1.35)**
≥2 hardships	1.00	1.23 (0.99, 1.53)	1.11 (0.90, 1.38)	**1.19 (1.05, 1.34)**	1.18 (0.94, 1.48)	1.02 (0.81, 1.27)	**1.15 (1.01, 1.31)**

[a]Models adjusted for maternal age, race/ethnicity, education, nativity, marital status, child insurance and study site.
[b]Energy insecurity known for 14,781 dyads.
Bold face indicates statistical significance $p < 0.05$

Use of brief screening tools that assess housing, job, food, and energy insecurity, among other unmet basic needs, have been effectively integrated into pediatric settings and translated to increased provision of community resources to U.S. families with limited financial resources [36, 37]. Medicaid managed-care organizations in many states encourage screening and referral for unmet basic needs, and some include screening as a quality measure [38]. However, while screening for unmet basic needs has increased in the past 5–10 years in the out-patient pediatric setting, it remains infrequent in the in-patient setting. Indeed, a recent study reported that providers assessed social needs at substantially lower rates in the inpatient vs. outpatient setting (e.g., 2% vs. 76% for food insecurity) [39]. Many preterm infants spend weeks to months hospitalized in the NICU, with frequent opportunities for families to interact with hospital staff, where delivery of a standardized SDH screening tool and referral of resources would be feasible. Implementation studies that examine optimal strategies for adoption of screening and referral systems into the NICU environment are urgently needed.

After NICU discharge, many preterm children also attend high-risk infant follow-up clinics and receive Early Intervention services where, typically, the sole purpose is to assess, monitor and augment the infant's health and development. Considering the relatively high prevalence of preterm children living in households with unmet basic needs, greater emphasis on identifying and addressing unmet basic needs in these specialty clinic settings and early intervention programs may have substantial benefits. For example, a recent study surveyed 196 parents of preterm children <24 months corrected age in specialty clinics regarding quality of life. Independent of infant medical factors, increased bills, out-of-pocket expenses, financial worries, and feeling unsafe in the home were associated with worse family and parent well-being scores, while receipt of Medicaid insurance and public housing was associated with improved parental well-being [40]. Qualitative data from families with recently discharged infants similarly reported the financial strains they accrued from the NICU hospitalization, which exacerbated underlying stressors [41] and need for information regarding financial assistance programs [42]. These results suggest that there may be an important role for monitoring and intervening on unmet basic needs and other mechanisms of financial stress alongside health and developmental care in high-risk infant follow-up settings.

Finally, the magnitude of the associations between unmet basic needs in the previous year and early preterm birth were largest in our analyses among infants 0 to <3 months born at 31–33 weeks' gestation, thereby capturing pregnancy. These results corroborate previous studies demonstrating associations between unmet basic needs during pregnancy and preterm birth [24, 43, 44]. Etiologies are multifactorial [45]. Regarding homelessness, for instance, women who are homeless during pregnancy have increased risk of co-morbid medical conditions, substance use disorders, mental illness, and intimate partner violence. These risks are independently associated with preterm delivery, either directly or through decreased access to adequate prenatal care [45]. Women with individual or multiple unmet basic needs may have one or more of these conditions and thus be at additional risk for preterm delivery. While we did not measure these factors in our study, our results also highlight the importance of addressing unmet basic needs and their determinants during the prenatal period.

Strengths of our study include examination of a large, diverse U.S. cohort from five cities in different geographic areas and detailed examination of a wide array of unmet basic needs and other socioeconomic factors over multiple years. However, generalizability to the greater U.S. population may be limited because the study sample is not nationally representative. Mothers were interviewed in emergency rooms and primary care clinics in hospitals that primarily served populations with low incomes. The resulting relative socioeconomic homogeneity in our sample likely biased our results *toward*

Table 3. Associations of unmet basic needs in the past year and preterm birth stratified by 0 to 2 year age groups.

	REF	Crude OR (95% CI)			Adjusted[a] OR (95% CI)		
	≥37 weeks	≤30 weeks	31–33 weeks	34–36 weeks	≤30 weeks	31–33 weeks	34–36 weeks
Children < 3 months	$n = 3839$	$n = 45$	$n = 85$	$n = 359$	$n = 45$	$n = 85$	$n = 359$
Housing instability	1.00	0.78 (0.36, 1.69)	**1.69 (1.06, 2.68)**	1.18 (0.91, 1.51)	0.82 (0.37, 1.80)	1.63 (0.99, 2.68)	1.19 (0.92, 1.55)
Energy insecurity[b]	1.00	1.75 (0.83, 3.68)	**1.76 (1.05, 2.96)**	1.04 (0.76, 1.41)	1.62 (0.75, 3.53)	1.60 (0.93, 2.75)	0.95 (0.69, 1.32)
Household food insecurity	1.00	1.13 (0.59, 2.16)	1.30 (0.82, 2.06)	0.80 (0.62, 1.03)	1.18 (0.60, 2.31)	1.53 (0.94, 2.50)	0.84 (0.64, 1.10)
Healthcare hardship	1.00	0.87 (0.42, 1.82)	**1.90 (1.21, 2.99)**	0.95 (0.73, 1.24)	0.96 (0.44, 2.10)	1.61 (0.99, 2.60)	0.92 (0.70, 1.21)
Number of hardships							
1 hardship	1.00	1.75 (0.90, 3.41)	**2.13 (1.26, 3.58)**	0.93 (0.72, 1.21)	1.84 (0.94, 3.62)	**2.38 (1.39, 4.08)**	0.94 (0.72, 1.23)
≥2 hardships	1.00	1.24 (0.57, 2.70)	**2.23 (1.30, 3.82)**	1.02 (0.78, 1.34)	1.35 (0.60, 3.04)	**2.13 (1.20, 3.80)**	1.02 (0.77, 1.36)
Children 3 to < 12 months	$n = 6,115$	$n = 232$	$n = 232$	$n = 650$	$n = 232$	$n = 232$	$n = 650$
Housing instability	1.00	0.84 (0.62, 1.13)	1.00 (0.75, 1.33)	1.05 (0.88, 1.26)	0.81 (0.59, 1.10)	0.98 (0.73, 1.32)	1.05 (0.88, 1.26)
Energy insecurity[b]	1.00	1.20 (0.88, 1.64)	0.79 (0.55, 1.13)	**1.40 (1.15, 1.70)**	1.18 (0.85, 1.64)	0.71 (0.49, 1.02)	**1.30 (1.07, 1.60)**
Household food insecurity	1.00	0.93 (0.69, 1.27)	1.02 (0.76, 1.38)	0.96 (0.79, 1.16)	0.85 (0.62, 1.16)	1.05 (0.77, 1.43)	0.98 (0.81, 1.19)
Healthcare hardship	1.00	1.13 (0.86, 1.49)	0.75 (0.55, 1.01)	1.16 (0.98, 1.38)	1.12 (0.83, 1.50)	0.75 (0.55, 1.03)	1.06 (0.89, 1.27)
Number of hardships							
1 hardship	1.00	1.03 (0.74, 1.42)	0.91 (0.66, 1.25)	**1.41 (1.16, 1.71)**	0.95 (0.68, 1.31)	0.87 (0.62, 1.20)	**1.34 (1.10, 1.64)**
≥2 hardships	1.00	1.01 (0.74, 1.37)	0.83 (0.61, 1.14)	1.19 (0.98, 1.45)	0.93 (0.67, 1.29)	0.79 (0.57, 1.10)	1.14 (0.93, 1.40)
Children 12 months to 2nd Birthday	$n = 5392$	$n = 201$	$n = 181$	$n = 595$	$N = 201$	$n = 181$	$n = 595$
Housing instability	1.00	0.81 (0.59, 1.11)	1.07 (0.78, 1.47)	1.05 (0.88, 1.26)	0.88 (0.64, 1.22)	1.02 (0.74, 1.41)	1.07 (0.89, 1.29)
Energy insecurity[b]	1.00	1.04 (0.75, 1.46)	0.93 (0.65, 1.34)	1.13 (0.93, 1.39)	0.93 (0.65, 1.31)	0.79 (0.54, 1.15)	1.07 (0.87, 1.32)
Household food insecurity	1.00	1.25 (0.92, 1.70)	0.87 (0.62, 1.24)	1.16 (0.96, 1.40)	1.37 (0.99, 1.90)	0.84 (0.59, 1.21)	1.19 (0.98, 1.44)
Healthcare hardship	1.00	**1.45 (1.09, 1.93)**	1.08 (0.80, 1.48)	1.15 (0.96, 1.37)	**1.41 (1.04, 1.90)**	1.02 (0.74, 1.41)	1.12 (0.93, 1.35)
Number of hardships							
1 hardship	1.00	1.35 (0.95, 1.92)	1.16 (0.80, 1.67)	1.22 (0.98, 1.50)	1.38 (0.96, 1.97)	1.12 (0.77, 1.62)	1.20 (0.97, 1.49)
≥2 hardships	1.00	1.29 (0.92, 1.81)	1.09 (0.77, 1.55)	**1.25 (1.02, 1.53)**	1.31 (0.92, 1.87)	0.98 (0.68, 1.41)	**1.24 (1.01, 1.53)**

[a]Models adjusted for maternal age, race/ethnicity, education, nativity, marital status, child insurance and study site.
[b]Energy insecurity known for 3405 dyads <3 months, 5993 dyads 3m-<12 months, and 5383 dyads 12–24 months.
Bold face indicates statistical significance $p < 0.05$.

the null hypothesis, such that there would be no difference in unmet basic needs among term vs. preterm children. Because parents were interviewed in emergency rooms rather than NICUs or other settings, this limited the numbers of preterm children ≤30 weeks' and 31–33 weeks in our stratified analysis of child age <3 months. Because the NICU hospitalization lasts weeks to months for children born at these gestational ages, many were likely still admitted to the NICU at <3 months of age. Another limitation is that our study was cross-sectional by design, therefore we are unable to ascertain whether unmet basic needs changed over time among families experiencing preterm birth. Further, we are unable to determine causality, only associations of preterm birth status and household unmet basic needs. We also obtained our primary exposure variable, gestational age, through self-report and not medical records. Although we confirmed that maternal report and electronic health record data are highly correlated, we cannot eliminate the possibility of reporting errors. Finally, while we adjusted for multiple confounding variables known to impact unmet basic needs and preterm birth, other unmeasured confounders, including those that occurred during and after pregnancy, were not included in our study.

CONCLUSION

While the focus on addressing adverse SDH in pediatric primary care is a national priority, relatively little attention has been paid to investigating pathways to address SDH as part of prenatal or neonatal subspecialty care [46]. This study demonstrates that unmet basic needs are extremely common among families of preterm children who are low income. These factors significantly impact the future health and well-being of this vulnerable population. Integration of robust processes to identify and address unmet social needs of families should optimally begin during the prenatal course and be continued during the newborn hospitalization and in specialty follow-up as well as primary care focused on this population.

REFERENCES

1. US Census Bureau. Income and Poverty in the United States: 2018. The United States Census Bureau. https://www.census.gov/data/tables/2019/demo/income-poverty/p60-266.html. Accessed 20 Mar 2021.
2. Marmot M. Social determinants of health inequalities. Lancet. 2005;365:1099–104.
3. Braveman P, Egerter S, Williams DR. The social determinants of health: coming of age. Annu Rev Public Health. 2011;32:381–98. https://doi.org/10.1146/annurev-publhealth-031210-101218
4. Schwarzenberg SJ, Georgieff MK, Nutrition CO. Advocacy for improving nutrition in the first 1000 days to support childhood development and adult health. *Pediatrics*. 2018;141. https://doi.org/10.1542/peds.2017-3716
5. Miller GE, Chen E. The biological residue of childhood poverty. Child Dev Perspect. 2013;7:67–73.
6. Hoynes H, Schanzenbach DW, Almond D. Long-run impacts of childhood access to the safety net. Am Economic Rev. 2016;106:903–34.
7. Metallinos-Katsaras E, Must A, Gorman K. A longitudinal study of food insecurity on obesity in preschool children. J Acad Nutr Diet. 2012;112:1949–58.
8. Woo Baidal JA, Locks LM, Cheng ER, Blake-Lamb TL, Perkins ME, Taveras EM. Risk factors for childhood obesity in the first 1000 days: a systematic review. Am J Prev Med. 2016;50:761–79.
9. Council on Community Pediatrics. Poverty and child health in the United States. *Pediatrics*. 2016;137. https://doi.org/10.1542/peds.2016-0339
10. Fritz CQ, Thomas J, Gambino J, Torok M, Brittan MS. Prevalence of social risks on inpatient screening and their impact on pediatric care use. Hosp Pediatr. 2020;10:859–66.
11. Martin JA. Births in the United States, 2018. 2019. p. 8. https://www.cdc.gov/nchs/data/databriefs/db318.pdf. Accessed 1 Sept 2021.
12. Institute of Medicine (US) Committee on understanding premature birth and assuring healthy outcomes. *Preterm birth: causes, consequences, and prevention*. (Behrman RE, Butler AS, eds.). National Academies Press (US); 2007. http://www.ncbi.nlm.nih.gov/books/NBK11362/. Accessed 20 Mar 2021.
13. Allotey J, Zamora J, Cheong-See F, Kalidindi M, Arroyo-Manzano D, Asztalos E, et al. Cognitive, motor, behavioural and academic performances of children born preterm: a meta-analysis and systematic review involving 64 061 children. BJOG. 2018;125:16–25.
14. Wallace ME, Mendola P, Chen Z, Hwang BS, Grantz KL. Preterm birth in the context of increasing income inequality. Matern Child Health J. 2016;20:164–71.
15. Shah P, Kaciroti N, Richards B, Oh W, Lumeng JC. Developmental outcomes of late preterm infants from infancy to kindergarten. *Pediatrics*. 2016;138. https://doi.org/10.1542/peds.2015-3496
16. Woythaler M. Neurodevelopmental outcomes of the late preterm infant. Semin Fetal Neonatal Med. 2019;24:54–59.
17. Yaari M, Mankuta D, Harel-Gadassi A, Friedlander E, Bar-Oz B, Eventov-Friedman S, et al. Early developmental trajectories of preterm infants. Res Dev Disabil. 2018;81:12–23.
18. Joseph RM, O'Shea TM, Allred EN, Heeren T, Kuban KK. Maternal educational status at birth, maternal educational advancement, and neurocognitive outcomes at age 10 years among children born extremely preterm. Pediatr Res. 2018;83:767–77.
19. Lean RE, Paul RA, Smyser TA, Smyser CD, Rogers CE. Social adversity and cognitive, language, and motor development of very preterm children from 2 to 5 years of age. J Pediatr. 2018;203:177–184.e1.
20. Mani A, Mullainathan S, Shafir E, Zhao J. Poverty impedes cognitive function. Science. 2013;341:976–80.
21. Treyvaud K, Lee KJ, Doyle LW, Anderson PJ. Very preterm birth influences parental mental health and family outcomes seven years after birth. J Pediatr. 2014;164:515–21.
22. Sandel M, Sheward R, de Cuba SE, Coleman SM, Frank DA, Childton M, et al. Unstable housing and caregiver and child health in renter families. *Pediatrics*. 2018;141. https://doi.org/10.1542/peds.2017-2199.
23. Cook JT, Frank DA, Casey PH, Rose-Jacobs R, Black MM, Chilton M, et al. A brief indicator of household energy security: associations with food security, child health, and child development in US infants and toddlers. Pediatrics. 2008;122:e867–75.
24. Cutts DB, Coleman S, Black MM, Chilton MM, Cook JT, Ettinger de Cuba S, et al. Homelessness during pregnancy: a unique, time-dependent risk factor of birth outcomes. Matern Child Health J. 2015;19:1276–83.
25. Rhee J, Fabian MP, Ettinger de Cuba S, Coleman S, Sandel M, James Lane K, et al. Effects of maternal homelessness, supplemental nutrition programs, and prenatal PM2.5 on birthweight. *Int J Environ Res Public Health*. 2019;16. https://doi.org/10.3390/ijerph16214154
26. Mousa A, Naqash A, Lim S. Macronutrient and micronutrient intake during pregnancy: an overview of recent evidence. *Nutrients*. 2019;11. https://doi.org/10.3390/nu11020443
27. Coleman-Jensen A, Rabbitt MP, Gregory CA, Singh A. Household food security in the United States in 2017. Economic Research Report No. (ERR-256). 2017. p. 44. https://www.ers.usda.gov/publications/pub-details/?pubid=90022. Accessed 1 Sep 2021.
28. United States Department of Agriculture. Guide to measuring household food security. 2000. https://naldc.nal.usda.gov/download/38369/PDF. Accessed 1 Sep 2021.
29. Ettinger de Cuba SMD, Fix G, Raifman J, Cutts D, Bovell-Ammon A, Coleman S, et al. Health care hardship among young US-born children of us-born and immigrant mothers may put children at risk. Published online July 2020.
30. Schaaf JM, Liem SMS, Mol BWJ, Abu-Hanna A, Ravelli ACJ. Ethnic and racial disparities in the risk of preterm birth: a systematic review and meta-analysis. Am J Perinatol. 2013;30:433–50.
31. Schempf AH, Branum AM, Lukacs SL, Schoendorf KC. Maternal age and parity-associated risks of preterm birth: differences by race/ethnicity. Paediatr Perinat Epidemiol. 2007;21:34–43.
32. El-Sayed AM, Galea S. Temporal changes in socioeconomic influences on health: maternal education and preterm birth. Am J Public Health. 2012;102:1715–21.
33. El-Sayed AM, Tracy M, Galea S. Life course variation in the relation between maternal marital status and preterm birth. Ann Epidemiol. 2012;22:168–74.
34. Frank DA, Casey PH, Black MM, Rose-Jacobs R, Chilton M, Cutts D, et al. Cumulative hardship and wellness of low-income, young children: multisite surveillance study. Pediatrics. 2010;125:e1115–23.
35. Swearingen C, Simpson P, Cabacungan E, Cohen S. Social disparities negatively impact neonatal follow-up clinic attendance of premature infants discharged from the neonatal intensive care unit. J Perinatol. 2020;40:790–7.
36. Garg A, Butz AM, Dworkin PH, Lewis RA, Thompson RE, Serwint JR. Improving the management of family psychosocial problems at low-income children's well-child care visits: the WE CARE Project. Pediatrics. 2007;120:547–58.
37. Garg A, Toy S, Tripodis Y, Silverstein M, Freeman E. Addressing social determinants of health at well child care visits: a cluster RCT. Pediatrics. 2015;135:e296–304.
38. Garg A, Homer CJ, Dworkin PH. Addressing social determinants of health: challenges and opportunities in a value-based model. *Pediatrics*. 2019;143. https://doi.org/10.1542/peds.2018-2355
39. Vasan A, Kenyon CC, Palakshappa D. Differences in pediatric residents' social needs screening practices across health care settings. Hosp Pediatr. 2020;10:443–6.
40. Lakshmanan A, Agni M, Lieu T, Fleegler E, Kipke M, Friedlich PS, et al. The impact of preterm birth <37 weeks on parents and families: a cross-sectional study in the

2 years after discharge from the neonatal intensive care unit. *Health Qual Life Outcomes*. 2017;15. https://doi.org/10.1186/s12955-017-0602-3
41. Berman L, Raval MV, Ottosen M, Mackow AK, Cho M, Goldin AB. Parent perspectives on readiness for discharge home after neonatal intensive care unit admission. J Pediatr. 2019;205:e4
42. Lakshmanan A, Kubicek K, Williams R, Robles M, Vanderbilt DL, Mirzaian CB, et al. Viewpoints from families for improving transition from NICU-to-home for infants with medical complexity at a safety net hospital: a qualitative study. BMC Pediatr. 2019;19:223
43. Clark RE, Weinreb L, Flahive JM, Seifert RW. Homelessness contributes to pregnancy complications. Health Aff. 2019;38:139–46.
44. Dolatian M, Sharifi N, Mahmoodi Z. Relationship of socioeconomic status, psychosocial factors, and food insecurity with preterm labor: a longitudinal study. Int J Reprod Biomed. 2018;16:563–70.
45. Gadson A, Akpovi E, Mehta PK. Exploring the social determinants of racial/ethnic disparities in prenatal care utilization and maternal outcome. Semin Perinatol. 2017;41:308–17.
46. Beck AF, Edwards EM, Horbar JD, Howell EA, McCormick MC, Pursley DM. The color of health: how racism, segregation, and inequality affect the health and well-being of preterm infants and their families. Pediatr Res. 2020;87:227–34.

ACKNOWLEDGEMENTS

We thank the families who participated in the Children's HealthWatch survey and shared their experiences with us. This study was funded in part by the grant R01MD007793 from the National Institute on Minority Health and Health Disparities (NIMMD) and supporters of the Children's HealthWatch https://childrenshealthwatch.org/giving/supporters/

AUTHOR CONTRIBUTIONS

Parker conceptualized and designed the study, interpreted the data, drafted the initial manuscript, and reviewed and revised the manuscript. Ms. Rateau conducted the analysis, interpreted the data, and critically revised the manuscript for important intellectual content. Garg, Sandel, Cutts, Frank, Lê-Scherban, Ochoa, and Black interpreted the data and critically revised the manuscript for important intellectual content. Ettinger de Cuba and Heeren 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.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

Correspondence and requests for materials should be addressed to Margaret G. Parker.