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Heat or Eat: The Low Income Home Energy Assistance Program and Nutritional and Health Risks Among Children Less Than 3 Years of Age

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ABSTRACT

OBJECTIVES. Public funding for the Low Income Home Energy Assistance Program has never been sufficient to serve more than a small minority of income-eligible households. Low Income Home Energy Assistance Program funding has not increased with recent rapidly rising energy costs, harsh winter conditions, or higher child poverty rates. Although a national performance goal for the Low Income Home Energy Assistance Program is to increase the percentage of recipient households having ≥1 member ≤5 years of age, the association of income-eligible households' receipt of the Low Income Home Energy Assistance Program with indicators of well-being in young children has not been evaluated previously. The goal of the current study was to evaluate the association between a family's participation or nonparticipation in the Low Income Home Energy Assistance Program and the anthropometric status and health of their young children.

METHODS. In the ongoing Children's Sentinel Nutrition Assessment Project from June 1998 through December 2004, caregivers with children <3 years of age in 2 emergency departments and 3 primary care clinics in 5 urban sites participated in cross-sectional surveys regarding household demographics, child's lifetime history of hospitalizations, and, for the past 12 months, household public assistance program participation and household food insecurity, measured by the US Food Security Scale. This scale, in accordance with established procedures, classifies households as food insecure if they report that they cannot afford enough nutritious food for all of the members to lead active, healthy lives. On the day of the interview, children's weight, length, and whether the children were admitted acutely to the hospital from the emergency departments were documented. The study sample consisted only of Low Income Home Energy Assistance Program income-eligible renter households without private insurance who also participated in ≥1 other means-tested program.

RESULTS. In this sample of 7074 caregivers, 16% of families received the Low Income Home Energy Assistance Program, similar to the national rate of 17%. Caregivers who received the Low Income Home Energy Assistance Program were more likely

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Key Words
child nutrition, hospitalizations, food security, growth, Low Income Home Energy Assistance Program

Abbreviations
LIHEAP—Low Income Home Energy Assistance Program
ED— emergency department
C-SNAP—Children's Sentinel Nutrition Assessment Project
TANF—Temporary Assistance for Needy Families
SSI—Supplemental Security Income
WIC—Special Supplemental Nutrition Program for Women, Infants, and Children
AOR—adjusted odds ratio
CI— confidence interval

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to be single (63% vs 54%), US born (77% vs 68%), and older (mother's mean age: 28.1 vs 26.7 years) but were less likely to be employed (44% vs 47%). Households who received the Low Income Home Energy Assistance Program were more likely to receive Supplemental Nutrition Program for Women, Infants, and Children (85% vs 80%), Supplemental Security Income (13% vs 9%), Temporary Assistance for Needy Families (38% vs 23%), and food stamps (59% vs 37%) and to live in subsidized housing (38% vs 19%) compared with nonrecipients. Children in families participating in the Low Income Home Energy Assistance Program were older than children in nonparticipating families (13.6 vs 12.5 months), were less likely to be uninsured (5% vs 9%), and were more likely to have had a low birth weight ≤2500 g (17% vs 14%). Families participating in the Low Income Home Energy Assistance Program reported more household food insecurity (24% vs 20%) There were no significant group differences between recipients and nonrecipients in caregiver's education or child's gender. After controlling for these potentially confounding variables, including receipt of other means-tested programs, compared with children in recipient households, those in nonrecipient households had greater adjusted odds of being at aggregate nutritional risk for growth problems, defined as children with weight-for-age below the 5th percentile or weight-for-height below the 10th percentile, with significantly lower mean weight-for-age *z* scores calculated from age- and gender-specific values from the Centers for Disease Control and Prevention 2000 reference data. However, in adjusted analyses, children aged 2 to 3 years in recipient households were not more likely to be overweight (BMI >95th percentile) than those in nonrecipient households. Rates of age-adjusted lifetime hospitalization excluding birth and the day of the interview did not differ between Low Income Home Energy Assistance Program recipient groups. Among the 4445 of 7074 children evaluated in the 2 emergency departments, children from eligible households not receiving the Low Income Home Energy Assistance Program had greater adjusted odds than those in recipient households of acute hospital admission on the day of the interview.

CONCLUSIONS. Even within a low-income renter sample, Low Income Home Energy Assistance Program benefits seem to reach families at the highest social and medical risk with more food insecurity and higher rates of low birth-weight children. Nevertheless, after adjustment for differences in background risk, living in a household receiving the Low Income Home Energy Assistance Program is associated with less anthropometric evidence of undernutrition, no evidence of increased overweight, and lower odds of acute hospitalization from an emergency department visit among young children in low-income renter households compared with children in comparable households not receiving the Low Income Home Energy Assistance Program. The Low Income Home Energy Assistance Program in many states shuts down early each winter when their funding is exhausted. From a clinical perspective, pediatric health providers caring for children from impoverished families should consider encouraging families of these children to apply for the Low Income Home Energy Assistance Program early in the season before funding is depleted. From a public policy perspective, although this cross-sectional study design can only demonstrate associations and not causation, these findings suggest that, particularly as fuel costs and children's poverty rates increase, expanding the Low Income Home Energy Assistance Program funding and meeting the national Low Income Home Energy Assistance Program performance goal of increasing the percentage of recipient households with young children might potentially benefit such children's growth and health.

IN RESPONSE TO the Organization of the Petroleum Exporting Countries Energy Crisis of 1979, in fiscal year 1981, Congress implemented the Low-Income Energy Assistance Program to provide $1.85 billion for home heating, medically necessary home cooling, and weather-related supply shortage emergencies. This program became the Low Income Home Energy Assistance Program (LIHEAP) in 1982 and reached peak funding in the mid-1980s. In fiscal year 2004, the program served nearly 5 million households, of which the average household income was less than $8000 a year.[1] By statute, LIHEAP benefits should be targeted to "vulnerable households with the highest home energy needs" defined as those including an individual with disabilities, a frail elder, or ≥1 member who is a young child.[2] However, the program has never been allocated funds sufficient to serve more than a small minority of income-eligible households.[1–3] Although one national performance goal for LIHEAP is to increase the percentage of LIHEAP recipient households having ≥1 member ≤5 years of age,[2] the association of income-eligible households' receipt of LIHEAP with indicators of improved health and nutrition in their young children has not been evaluated previously in peer-reviewed medical literature.

Convergent evidence suggests that the periodic stress of home heating and cooling costs may adversely impact the health and nutritional status of children and other vulnerable populations. A study of children 6 to 24 months of age in Boston, Massachusetts, found higher proportions of children with weight-for-age below the 5th percentile in the 3 months after the coldest months, compared with all of the other months of the year (8.8% vs 6.6%; $P < .001$).[4] Data from Europe provide evidence of serious health consequences for impoverished elderly

associated with acute seasonal stress on family budgets caused by winter weather. Excess winter mortality among the elderly was found in Great Britain, where the cost of heat is not included in rent, but not in Scandinavia, where it is included.[5]

In addition to these physiologic indicators of the stress of home heating costs, there is also evidence that hunger and food insecurity are associated with high utility costs and cold weather. In the United States, data show that families reporting unheated days or threats of utility turnoff are more likely to report that their children were hungry or at risk for hunger than families without either experience.[4,6] In addition, national data collected from 1995 to 2001 as part of the Current Population Survey Food Security Supplement suggest that rates of food insecurity with hunger increased during the winter and early spring among low-income families in areas with high winter heating costs and during summer in regions with high summer cooling costs.[7] Findings from the Consumer Expenditure Survey and the Third National Health and Nutrition Examination Survey also suggest a "heat or eat" effect in low-income families with children. Although both rich and poor families increased their expenditures on home fuel in unusually cold months, in poor families this expenditure was associated with a decreased expenditure on food. The "winter resource shift" was confirmed by the finding that adults and children in poor households reduced their caloric intake by 10% in the winter months, whereas there was no reduction among members of wealthier families.[8]

One would anticipate that children may be particularly vulnerable to the negative consequences of such inconsistent availability of food during the first 3 years of life when growth of the body and brain is most rapid.[9] Food insecurity, or limited or uncertain access to enough nutritious food, has been linked to nutrient deficiencies, learning and developmental deficits, emotional and behavioral problems, and poor health among children.[10–16]

In light of rapidly rising energy costs,[17–19] forecasts of colder-than-normal winter temperatures,[20] and increasing poverty rates in the United States,[21] there is an urgent need to examine whether LIHEAP may be associated with buffering of the expected heat or eat effect on young children, whose households are targeted by the national performance standards for LIHEAP.

Recent winters in the United States, especially for the years 2001–2002 and 2003–2004, have had colder temperatures than normal in many states, meaning that families in these states have had to spend more to heat their homes.[20] Simultaneously, poverty rates for children <6 years of age in the United States increased from 17.8% in 2000 to 19.9% in 2004. [21] Concurrently, looking at winter fuel costs only from the winter of 1999–2000 through the winter of 2004–2005, prices of natural gas increased 63.5%, of heating oil increased 54.8%, and of propane increased 51.8%.[19] Given the evolution of these trends from the late 1990s until 2004 and previous research on the heat or eat effect, the goal of this analysis was to assess whether, in that period, a family's receipt of LIHEAP, with potentially confounding variables controlled statistically, was related among young children <3 years of age to anthropometric indicators of a child's nutritional risk and risk of lifetime hospitalizations ascertained either in primary care clinics or emergency departments (EDs) or to acute hospitalization on the day of the interview from EDs only.

METHODS

Participants: The Children's Sentinel Nutrition Assessment Project

From 1998 to 2004, the ongoing Children's Sentinel Nutrition Assessment Project (C-SNAP)[10] conducted household-level surveys and medical chart audits at 6 central-city medical centers in Baltimore, Maryland; Boston; Little Rock, Arkansas; Los Angeles, California; Minneapolis, Minnesota; and Washington, DC. Institutional review board approval was obtained at each site before beginning data collection in 1998 and has been renewed yearly. This is a repeat cross-sectional survey. Trained interviewers scheduled during peak patient-flow times interview in private settings adult caregivers accompanying children <3 years of age at acute/primary care clinics and hospital EDs. Caregivers of critically ill or injured children are not approached. Potential respondents are excluded if: (1) they do not speak English, Spanish, or (in Minneapolis only) Somali; (2) they are not knowledgeable about the child's household; (3) they have been interviewed within the previous 6 months; (4) they live out of state; or (5) they refuse consent for any reason.

The C-SNAP survey instrument is composed of questions on household characteristics, children's health and hospitalization history, maternal health, participation in federal assistance programs (including LIHEAP), and change in benefit levels. In addition, the C-SNAP interview includes the US Food Security Scale, which, in accordance with established procedures,[22,23]classifies households as food insecure if they report that they can not afford enough nutritious food for all of the members to lead active, healthy lives.[22–24]

Study staff members also collect anthropometric data. Each child's weight is obtained either by project staff members or from medical chart reviews conducted on the same day as the caregiver interview. Each child's length or height is also obtained when possible (for simplicity, both length and height are referred to in the discussions that follow as height). To ensure that weights and heights are recorded in the same manner at all of the sites, we purchased standard equipment and conducted training sessions at each site.

Sample Selection

Because Southern California does not experience wide temperature shifts and because preliminary inspection of the data showed that LIHEAP participation at that site was negligible, data from that site were not included in the analysis. Data collected at the other 5 sites between June 1998 and December 2004 comprise the basis of this report. Figure 1 shows how the analytic sample of 7074 caregivers and children was selected.

Of those caregivers who were approached at the 5 sites between June 1998 and December 2004 (N = 21 157), 11% were found to be ineligible. Reasons for ineligibility were: language of interviewer and caregiver were different (76%), the caregiver was interviewed in the previous 6 months (14%), the caregiver was not knowledgeable about the household (9%), or the household was from out of state (2%). Among eligible respondents, 10% refused consent to participate or did not complete the interview.

For this analysis, the remaining sample of interviews (N = 16 968) was restricted to low-income, LIHEAP-eligible families. Because of respondents' inability or unwillingness to furnish specific, credible data on household income to research staff, the absence of private insurance was used as a proxy for low-income families. All of the families who received private insurance were excluded from the analysis sample. In addition, participation in ≥1 other means-tested assistance program was also used as a proxy for LIHEAP income eligibility. In states represented in this research, the cutoff for income eligibility for receipt of LIHEAP is 150% of the federal poverty level in Arkansas, Maryland, and Washington, DC, and 200% of the federal poverty level in Massachusetts. In Minnesota, the income cutoff is 50% of the state median income. Because the income eligibility requirements for Temporary Assistance for Needy Families (TANF), food stamps, Supplemental Security Income (SSI) disability, and subsidized housing are similar to those for LIHEAP, receipt of ≥1 of those programs was used as an indicator of LIHEAP eligibility at all of the study sites. In addition, at the Boston site, families receiving benefits from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), but no other benefits, were also included, because the higher

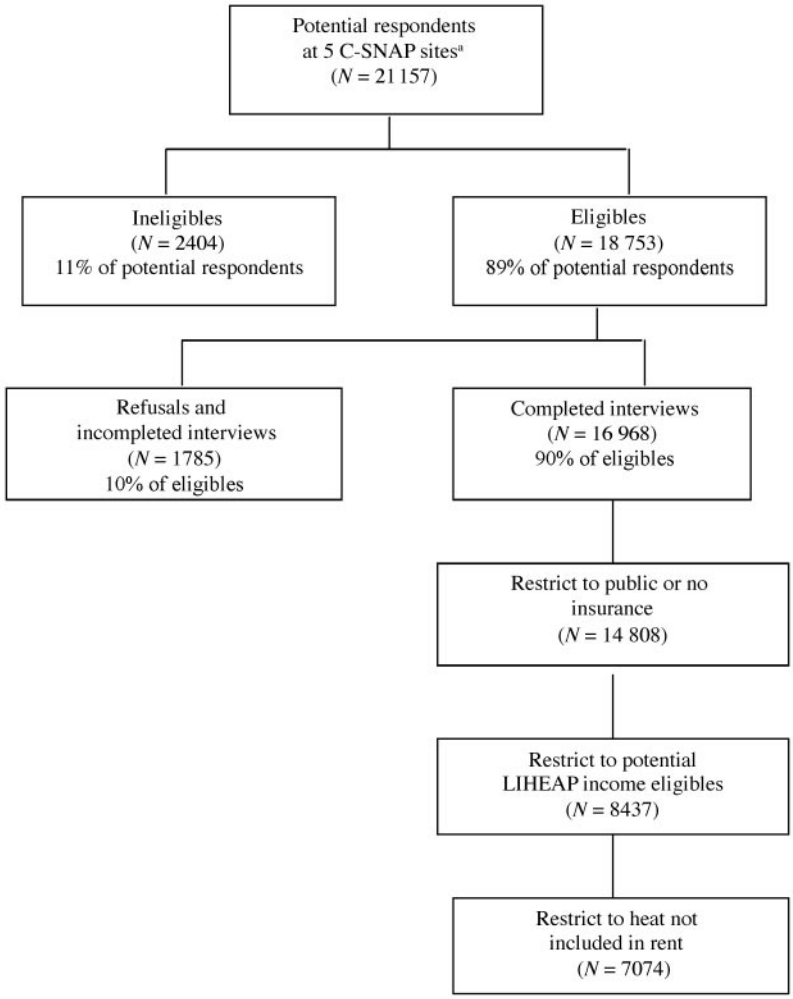

FIGURE 1
Sample selection. [a] Data from California site are not included because of negligible LIHEAP participation at that site.

cutoff for LIHEAP eligibility in Boston is comparable to the cutoff for WIC benefits.

Because previous findings suggest that families whose rent does not include the cost of heat are particularly susceptible to the acute seasonal impact of energy costs,[5] the analysis sample was further restricted to only those families whose rent did not include the cost of heat. This criterion resulted in a final analytic sample of 7074.

Because of funding and logistic constraints, data collection began and ended at different times in different study sites but spanned ≥2 full years in all of the sites. Data collection was continuous over all 6 years in Boston, Little Rock, and Minneapolis, as shown in Table 1. In Boston and Little Rock, data collection took place solely in pediatric EDs, whereas the other sites (Minneapolis, Baltimore, and Washington, DC) collected data primarily in pediatric outpatient clinics.

Predictor Variable

The primary predictor variable in this study was receipt of LIHEAP benefits within the previous year. Two mutually exclusive groups were formed based on caregiver report of whether households did or did not receive home energy assistance within the past 12 months.

Outcome Variables

The first outcome variable was nutritional risk operationalized in 2 ways. Weight-for-age expressed in *z* scores using age- and gender-specific values from the Centers for Disease Control and Prevention 2000 reference data[25] was first calculated as a continuous variable to examine mean differences in nutritional status.[26] Because this measure alone may underestimate the true number of children at nutritional risk,[27] an aggregate "nutritional risk for impaired growth" categorical variable was also assessed. This variable was defined as children with weight-for-age below the 5th percentile or weight-for-height below the 10th percentile. We also calculated BMI-for-age in children 2 to 3 years of age to determine whether there is an association between receipt of LIHEAP by a household and overweight in children. For children ≥2 years of age, BMI-for-age greater than the 95th percentile is considered at risk for overweight.[28]

The second outcome variable was child health, based on 2 different types of data: (1) in all sites, the age-adjusted history of hospitalization since birth (excluding the day of the interview), as reported by the caregiver; and (2) at the Boston and Little Rock ED sites only, whether the child was acutely admitted on the day of interview (assessed by medical chart review). The rationale for using these 2 types of data was that, for those either in primary clinics or in EDs a, lifetime history of hospitalization can be ascertained, whereas acute admission, except in rare instances, is only likely occur for the children who present to EDs. In analyzing rates of acute admissions, children in EDs are compared only with other children in the 2 study EDs (Boston and Little Rock) and not with those in primary care clinics.

TABLE 1 **Data Collection Dates and Sample Size at Each Site (*N* = 7074)**

Study Site	Dates of Data Collection	Sample Size	Percentage of Overall Sample
Baltimore	June 1998 to January 2001 and January 2004 to December 2004	866	12
Boston[a]	June 1998 to December 2004	2433	34
Little Rock[a]	July 1999 to December 2004	2012	29
Minneapolis	September 1998 to December 2004	1498	21
Washington, DC	June 1998 to June 2000	265	4

[a] ED site.

Statistical Analysis

The χ^2 test for categorical data and the *t* test for continuous data were used to examine unadjusted associations among demographic characteristics, the predictor (LIHEAP receipt), and the outcomes (child growth and health). Multivariate linear regression models were used to examine differences in mean weight-for-age *z* scores. Logistic regressions were performed to examine differences in 3 nominal outcomes: the odds of growth risk, of lifetime hospitalization (ascertained in all of the sites), and of acute hospitalization (from ED sites only) by whether the household received LIHEAP. We also conducted a propensity score analysis[29] to further evaluate possible confounding because of the observed covariates. Covariates for these analyses were selected if they were associated with both the predictor and the outcomes. As recommended by Rothman,[30] for studies such as this one where data are not random numbers but actual observations, 2 tailed *P* values are reported for each analysis without Bonferroni correction.

RESULTS

Bivariate Results

Table 2 shows the sample characteristics. Among the 7074 caregivers in this low-income, LIHEAP-eligible sample, 1149 (16%) reported receipt of home energy assistance within the past year. Sixty-eight percent of LIHEAP recipients were black, compared with 56% of nonrecipients. Caregivers who received LIHEAP were more likely to be single (63% vs 54%), US born (77% vs 68%), and older (mother's mean age: 28.1 vs 26.7 years) but were less likely to be employed (44% vs 47%). Whereas all of the subjects selected for the analysis sample did not have private insurance, were renters whose heat was not included in the rent, and received benefits from ≥1 other means-tested program, caregivers who received LIHEAP were more likely to receive

TABLE 2 **Sample Characteristics of Those Without Private Medical Insurance by LIHEAP Participation**

Variable	Does Not Receive Home Energy Assistance (n = 5925), %	Receives Home Energy Assistance (n = 1149), %	P[a]
Study site			
Baltimore	11	18	
Boston[b]	33	40	
Little Rock[b]	30	19	<.0001
Minneapolis	21	21	
Washington, DC	4	2	
Caregiver race/ethnicity			
Asian/Native American	2	3	
Black	56	68	
Hispanic	23	16	<.0001
White	19	13	
Caregiver marital status			
Single	54	63	
Married/partner	40	28	<.0001
Separated/divorced	5	9	
Caregiver employed	47	44	.03
Caregiver education level			
Not high school graduate	34	3	
High school graduate	40	40	.86
Any college	26	26	
Mother US born	68	77	<.0001
Mother's mean age, y	26.7	28.1	<.0001
Household receives			
Housing subsidy	19	38	<.0001
WIC	80	85	<.0001
SSI	9	13	<.0001
TANF	23	38	<.0001
Food stamps	37	59	<.0001
Children <18 y in household	2.4	2.7	<.0001
Household food insecure	20	24	.005
Child uninsured	9	5	<.0001
Child low birth weight (<2500 g)	14	17	.04
Child's mean age, mo	12.5	13.6	.001
Child male gender	54	52	.43

[a] Group comparisons use χ^2 for categorical variables and t test for continuous variables.
[b] ED site.

WIC (85% vs 80%), SSI (13% vs 9%), TANF (38% vs 23%), and food stamps (59% vs 37%) and to live in subsidized housing (38% vs 19%) compared with nonrecipients. Children in families participating in LIHEAP were older than children in nonparticipating families (13.6 vs 12.5 months), were less likely to be uninsured (5% vs 9%), and were more likely to have had a low birth weight (17% vs 14%). Families participating in LIHEAP, compared with those not participating, had more children living in the household (2.7 vs 2.4 children) and reported more household food insecurity (24% vs 20%), suggesting that the program benefits are reaching those families at higher medical and social risk. In this sample, there were no significant group differences between recipients and nonrecipients in caregiver's education or child's gender.

Unadjusted Outcomes

Table 3 shows the unadjusted outcomes. The average unadjusted z score for weight-for-age was −0.029 for children in families who did not receive LIHEAP compared with 0.033 for children in families who did receive LIHEAP (P = .16). The unadjusted rate for nutritional risk of growth problems (weight-for-age below the 5th percentile or weight-for-height below the 10th percentile) was 15% in nonrecipient families compared with 13% in LIHEAP families (P = .33). The unadjusted rate of overweight (BMI-for-age greater than the 95th percentile among children 2–3 years old) was 12% in nonrecipient families compared with 13% in LIHEAP families (P = .068). In all of the sites, the unadjusted rate of the index child's ever experiencing a hospitalization in their lifetime excluding hospitalization at birth and on the day of interview was 25% in nonrecipient families compared with 24% in LIHEAP families (P = .59). The unadjusted rate of acute hospital admission on the day of the interview (among the 4445 children in the Boston and Little Rock ED sites only) was 14% in nonrecipient families compared with 10% in LIHEAP families (P = .003).

TABLE 3 **Unadjusted Outcomes by LIHEAP Participation**

Variable	Does Not Receive Home Energy Assistance ($n = 5925$), %	Receives Home Energy Assistance ($n = 1149$), %	*P*
Mean *z* weight/age	−0.029	0.033	.16
At nutritional risk for growth problems[a]	15	13	.33
Hospitalizations since birth	25	24	.59
Acute hospital admission (Boston and Little Rock EDs, $n = 4445$)	14	10	.003
At risk for overweight[b] (2–3 years olds only, $n = 691$)	12	13	.68

[a] <5th percentile weight-for-age or <10th percentile weight-for-height.
[b] >95th percentile BMI-for-age.

Multivariate Results

Table 4 shows the multivariate results. The following variables described in Table 2 were included as covariates in the analytic model, because they were found to be associated with both the predictor (receipt of LIHEAP) and the outcomes: site of interview, year of measurement, race/ethnicity of caregiver, birthplace of mother (US born versus immigrant), marital status, whether the caregiver was employed, whether the child was low birth weight (≤2500 g), household food security status, and receipt of other assistance program benefits (WIC, subsidized housing, and whether the household received TANF or food stamps; TANF and food stamps could not be entered into the same model as individual covariates because they are highly correlated, $r = 0.61$). Age of child was included as an additional covariate in the model examining lifetime hospitalizations, because the risk of this outcome differs depending on how many years a child has had the opportunity to be hospitalized. After controlling for the relevant covariates, the adjusted weight-for-age *z* score for children in households that did not receive LIHEAP was significantly lower than for children in households that did (*z* score: −0.033 vs 0.076 vs $P = .01$). Consistent with this finding, children in households that did not receive LIHEAP had greater adjusted odds of being at nutritional risk for depressed growth than children in LIHEAP families (adjusted odds ratio [AOR]: 1.23; 95% confidence interval [CI]: 1.00–1.52; $P = .05$). However, there was no significant difference in adjusted analyses in the odds of overweight (AOR: 0.83; 95% CI: 0.46–1.49; $P = .52$) among 2- to 3-year-olds in LIHEAP recipient families versus those in nonrecipient families.

In the full sample of 7074 seen in both primary care clinics and EDs, there were no significant differences between the children from households receiving or not receiving LIHEAP in adjusted odds of hospitalizations since birth (AOR: 1.02; 95% CI: 0.86–1.20; $P = .84$), excluding the day of the visit. However, among the 4445 of 7074 families evaluated on the day of the visit to an ED in Boston or Little Rock compared with those in families who did receive LIHEAP, children whose families did not had 32% greater adjusted odds of acute hospitalization (AOR: 1.32; 95% CI: 1.00–1.74; $P = .05$).

We used the covariates included in our adjusted analyses to calculate a propensity score predicting receipt of LIHEAP and then stratified our sample into quintiles based on the propensity scores. The percentage receiving LIHEAP ranged from 5.3% in the lowest quintile to 32.9% in the highest. We then stratified the analysis sample by propensity score quintiles to analyze the effect of LIHEAP. Estimated LIHEAP effects were similar

TABLE 4 **Adjusted Outcomes by LIHEAP Participation**

Variable	Does not Receive Home Energy Assistance ($n = 5925$)	Receives Home Energy Assistance ($n = 1149$)	95% CI	*P*
Mean *z* weight/age	−0.033	0.076	NA	.01
At nutritional risk for growth problems[a]	1.23	1.00	1.00–1.52	.05
Hospitalizations since birth	1.02	1.00	0.86–1.20	.84
Acute hospital admission (Boston and Little Rock EDs, $n = 4445$)	1.32	1.00	1.00–1.74	.05
At risk for overweight[b] (2–3 years olds only, $n = 691$)	0.83	1.00	0.46–1.49	.52

Multivariate analyses are adjusted for site of interview, year of measurement, race/ethnicity of caregiver, birthplace of mother (US born versus immigrant), mother's marital status, employment status, child's low birth weight, household food security status, and receipt of other assistance program benefits (subsidized housing, WIC, TANF, or food stamps). Age of child was included as a covariate in the model for "hospitalizations since birth". NA indicates not applicable.
[a] <5th percentile weight-for-age or <10th percentile weight-for-height.
[b] >95th percentile BMI-for-age.

across quintiles, with no significant interaction between LIHEAP and propensity. Estimated LIHEAP effects and levels of statistical significance in these propensity score analyses were in agreement with results from the multiple and logistic regressions presented above.

DISCUSSION

Summary of Findings

In this sample of LIHEAP-eligible families with children <3 years old, only 16% of families received LIHEAP benefits, comparable to the national estimate that LIHEAP benefits reach only 5 million (17%) of 30 million eligible households.[1] Although by many parameters, children in LIHEAP recipient families had background characteristics suggesting higher medical and social risk than those in nonrecipient families, after controlling for these characteristics and receipt of other assistance program benefits, children in LIHEAP families had small but statistically significantly greater weight-for-age *z* scores and lower odds of nutritional risk for depressed growth than children in eligible families that did not receive LIHEAP benefits but were not more likely to be overweight. Children in LIHEAP families evaluated in the Boston and Little Rock EDs also had lower odds of acute hospitalization on the day of the interview than children in the same EDs whose families did not receive LIHEAP benefits. There was no association between LIHEAP receipt and children's history of lifetime hospitalizations since birth, excluding the day of the study visit.

There are multiple biologically plausible explanations for these findings. Young children have higher surface area/mass ratios than adults and so lose more heat at a given cold temperature.[31] Thus, although families in this sample that receive LIHEAP are more likely to report food insecurity than those who do not, if LIHEAP benefits enhance these families' ability to maintain a more thermoneutral environment, this may permit greater physiologic allocation of limited caloric intake to growth rather than thermogenesis in their children. Not only the children's metabolic expenditure but also their energy intake may be potentially impaired by the lack of LIHEAP benefits. Other research on food insecurity in the United States has shown that food budgets are those most often sacrificed to meet other survival needs in low-income families.[32] In addition, it is plausible that children at increased nutritional risk because of this winter resource shift may be more likely to require acute hospitalization in light of the well-established association between macronutrient and micronutrient deficiencies and impaired immune function.[33]

Limitations

Four important limitations of this study must be considered. First, although we sought to study a relatively homogeneous sample of renter households without private insurance who paid for their own heat, we do not know the reasons why most of these income-eligible families did not receive LIHEAP benefits. The reasons could have included lack of availability because of federal funding constraints, lack of caregivers' awareness of the program, or psychological or physical barriers to accessing the benefit. However, we do know that these caregivers' were aware of and accessed other assistance programs, because only caregivers who received benefits from ≥1 other means-tested program were included in the sample. Second, although LIHEAP effects were robust after many covariates were controlled in 2 different modes of multivariate analysis, we do not know the potential effects of unobserved differences between families that did and did not receive LIHEAP that might provide alternate explanations for these findings. Third, this cross-sectional study design can only demonstrate associations and not causation. Fourth, the sample studied is from a sentinel population. Thus, the findings do not permit a simple estimation of the associations among LIHEAP receipt, nutritional status, and health in the national population of very young children at risk. However, national survey data that would permit such estimates are not currently collected.

Implications

The World Health Organization considers analysis of indicators of young children's anthropometric status the internationally recommended method for assessing malnutrition at a population level.[34] The importance of this measure derives from both its value as a public health indicator of nutritional and health status in populations of young children and from evidence that nutritional growth retardation in early childhood has acute and persistent effects, including concurrent increased susceptibility to infectious disease and delayed mental development, later reduced intellectual capacity with poor school performance, and diminished earnings in adulthood.[9,34–36]

Federal funding for LIHEAP has historically been insufficient to serve the majority of income-eligible families, and funding has not increased with recent rapidly rising energy costs,[17–19]harsh winter conditions,[20] or rising poverty rates.[21] Many states' LIHEAP programs shut down early each winter when their funding is exhausted.[37] The findings of this research raise the concern that a confluence of trends in energy costs and public policies may exacerbate possible risks to the health and growth of young children. As of this writing (February 2006), average heating oil prices have reached $2.42 per gallon, 23% higher than when data collection for this study ended in December 2004.[19]

From a clinical perspective, pediatric health providers caring for young children from impoverished families, particularly in states with severe winters, should con-

sider encouraging families of these children to apply for LIHEAP early in the season before funding is depleted. From a public policy perspective, the findings of this study provide suggestive evidence that, particularly as fuel costs and children's poverty rates increase, meeting the national LIHEAP performance goal of increasing the percentage of recipient households with young children[2] could potentially benefit growth and health of these children.

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