



# The Relationship Between Housing Instability and Poor Diet Quality Among Urban Families

Clement J. Bottino, MD, MPH; Eric W. Fleegler, MD, MPH; Joanne E. Cox, MD, MPH; Erinn T. Rhodes, MD, MPH

From the Divisions of General Pediatrics (CJ Bottino and JE Cox), Emergency Medicine (EW Fleegler), Endocrinology (ER Rhodes), and Department of Pediatrics, Boston Children's Hospital; and Harvard Medical School (CJ Bottino, EW Fleegler, JE Cox, and ET Rhodes) Boston, Mass

Dr Rhodes is the Site Principal investigator for a clinical trial sponsored by Astra Zeneca and was formerly Site Principal Investigator for a clinical trial sponsored by Merck. Dr Fleegler is the inventor of the HelpSteps technology used in this study and is a consultant for Veta Health, a company that develops software for chronic disease management. Veta Health also supports HelpSteps, a system for connecting families to social services. Dr Fleegler is also an author for UpToDate (Pediatric Advance Life Support chapter). Dr Fleegler has received honorarium for Grand Rounds topics related to sedation, social determinants of health, and firearm injury prevention. In the future, it is possible that this technology will be sold commercially. If this were to occur, Dr Fleegler and Boston Children's Hospital might receive financial benefits in the form of compensation. As in all research studies, Boston Children's Hospital has taken steps designed to ensure that this potential for financial gain does not endanger research subjects or undercut the validity and integrity of the information learned by this research. The research published in this paper was conducted prior to Dr Fleegler working with Veta Health.

**ClinicalTrials.gov identifier:** [NCT01374815](https://clinicaltrials.gov/ct2/show/study/NCT01374815).

Address correspondence to Clement J. Bottino, MD, MPH, Division of General Pediatrics, Department of Pediatrics, Boston Children's Hospital, 300 Longwood Ave, Boston, MA 02115 (e-mail: [clement.bottino@childrens.harvard.edu](mailto:clement.bottino@childrens.harvard.edu)).

Received for publication September 6, 2018; accepted April 9, 2019.

## ABSTRACT

**OBJECTIVE:** To examine associations between housing instability and poor diet quality in a sample of urban parents and children.

**METHODS:** Cross-sectional study of 340 parent/guardian-child dyads visiting a pediatric primary care center in Boston, Massachusetts. The parent/guardian (hereafter, parent) completed 2 Harvard Service Food Frequency Questionnaires, one regarding their own dietary intake and one regarding their child's intake, and an assessment of health-related social needs. Diet quality was measured using the Healthy Eating Index-2010 (HEI-2010; score range 0–100). Housing instability was defined as: 1) homeless or in sheltered housing, 2) doubled up with another family, 3) utilities threatened or shut off, or 4) concerned about eviction. Multivariable logistic regression was used to measure associations between unstable housing and lowest-quartile HEI-2010 scores, adjusting for parent age, race/ethnicity, education, income, and child age.

**RESULTS:** Median (interquartile range) parent and child HEI-2010 scores were 63.8 (56.3–70.8) and 59.0 (54.2–64.7),

respectively. Housing instability was found in 136 dyads (40%). In multivariable analysis, it was associated with increased odds of lowest-quartile total parent HEI-2010 scores (adjusted odds ratio [aOR], 1.9; 95% confidence interval [95% CI], 1.1–3.5) but not child scores (aOR, 1.4; 95% CI, 0.8–2.5). It also was associated with increased odds of lowest-quartile parent HEI-2010 dietary component scores for Total vegetables and Greens and beans (aOR, 2.0; 95% CI, 1.1–3.7 and aOR, 2.5; 95% CI, 1.3–4.8, respectively).

**CONCLUSIONS:** In this urban primary care population, housing instability is associated with lower diet quality scores for parents but not children. Lower vegetable consumption appears to drive this association.

**KEYWORDS:** children; diet; diet quality; healthy eating index; housing; housing instability; parents; pediatrics; primary care; urban

**ACADEMIC PEDIATRICS** 2019;19:891–898

## WHAT'S NEW

What is the relationship between housing and diet? This study finds that in an urban primary care population, housing instability is associated with lower diet quality scores for parents, but not children, by way of lower vegetable consumption.

limiting foods that are energy-dense but nutrient-poor (eg, refined grains, added sugars, and added fats).<sup>1</sup> Despite available guidelines, poor-quality dietary patterns remain a major contributor to otherwise-preventable noncommunicable diseases.<sup>2</sup>

Extensive epidemiologic data indicate that diet quality follows a socioeconomic gradient.<sup>3</sup> Greater-quality diets are associated with greater affluence, whereas energy-dense, nutrient-poor foods are preferentially consumed by persons of lower socioeconomic status.<sup>4</sup> Hypothesized mechanisms include food prices and cost (lower diet costs are associated with lower diet-quality scores<sup>5</sup>), food access and the food environment,<sup>6</sup> and nutrition

FOOD AND NUTRITION play a crucial role in promoting health and preventing chronic disease. To this end, the *Dietary Guidelines for Americans* recommend the consumption of nutrient-dense foods (eg, fruits, vegetables, whole grains, low-fat dairy products, lean meats) while

knowledge and cultural factors (although with mixed effects).<sup>7</sup> Geographic disparities in diet quality are measurable at the census-block level.<sup>8</sup>

Housing stability (ie, the extent to which an individual's customary access to reasonable housing is secure<sup>9</sup>) is recognized as a key determinant of health.<sup>10</sup> Unstable housing circumstances such as homelessness and eviction are associated with a wide range of negative health effects, including low birth weight, respiratory infections, hospitalizations, asthma, injuries, and mental illness.<sup>11,12</sup> In addition, housing instability has been shown to have a causal, rather than consequential, role in the reproduction of urban poverty.<sup>13</sup>

A specific relationship between housing instability and diet quality has not yet been established, although several plausible mechanisms exist. First, housing instability is linked to difficulty meeting basic needs such as food, clothing, and transportation.<sup>14</sup> Conscious efforts to contain costs to meet basic needs may compromise diet quality via reduced spending on food.<sup>15</sup> Second, and independent of purely material effects, is the potential impact of chronic psychological stress associated with housing instability.<sup>16</sup> Chronic stress impairs higher-order cognitive processes such as executive function,<sup>17</sup> which are necessary for the self-regulation of eating behavior.<sup>18</sup> Third, the chaotic effects of household instability may directly impede implementation of eating-related family routines and rituals, such as consistent mealtimes.<sup>19</sup> Finally, there may be area-level effects due to a low density of healthy eating options (eg, food deserts) or a high density of unhealthy ones (eg, food swamps) clustering in locations with concentrated housing instability.<sup>20</sup>

The primary aim of the present study was to examine whether housing instability and poor diet quality are associated in a sample of urban parents and children in Boston, Massachusetts. Because dietary patterns occur relationally in the context of families, we sought as a secondary aim to examine dietary intake and quality between parents and children.

## METHODS

### STUDY DESIGN AND PARTICIPANTS

This is a cross-sectional study of parent/guardian–child dyads visiting a pediatric hospital-based primary care center in Boston, Massachusetts. During well-child care visits, parents/guardians (hereafter, parents) completed a dietary questionnaire and a web-based self-administered assessment and referral tool for health-related social needs.<sup>21</sup> The overall study was a pre–post design following the completion and impact of referrals. Presented here are the diet quality data collected at baseline. Baseline data regarding health-related social needs have been previously reported.<sup>22</sup> Eligibility criteria for participation included: 1) child age between 3 and 10 years; 2) parent and child lived together at least 5 days per week; 3) parent-confirmed verbal fluency in English; and 4) parent-confirmed comfort taking a survey on a laptop computer.

Age 3 to 10 years was targeted as a period when dietary flexibility and parental control were reasonably balanced.<sup>23</sup> Children with special health care needs were excluded, given the likelihood of unique dietary requirements. Institutional review board approval was obtained at Boston Children's Hospital and the study was registered with ClinicalTrials.gov (NCT01374815).

### DATA COLLECTION

A research assistant (RA) prescreened eligible participants from the daily well-child visit schedule and recruited at the registration desk. The RA obtained informed consent and logged the parent on to a privacy-screen equipped laptop computer in the waiting area or examination room. Parents completed self-administered, online assessments of dietary intake and health-related social needs across seven domains (food, housing, income, health care access, violence, substance use, injury prevention; needs assessment tool available at [www.helpsteps.com](http://www.helpsteps.com), available from the authors upon request). The full assessment took 30 to 40 minutes to complete and could be paused and resumed as needed. During the assessment, the RA remained available to answer parents' questions and engage accompanying children. Recruitment occurred sequentially based on laptop availability. To minimize selection bias in a busy clinic setting, overlapping eligible participants were recruited in alphabetical order of the child's last name, and parents with more than one eligible accompanying child completed the assessment for the oldest child within the target age range. Participants received grocery coupons (\$5 value), an American Academy of Pediatrics Bright Futures coloring book, and a gift card (\$20 value) as tokens of appreciation. Those who declined to participate were asked to provide their sex and reason for declination. Recruitment took place between July 2011 and August 2012.

### DIETARY INTAKE

Dietary intake was assessed using the Harvard Service Food Frequency Questionnaire (HSFFQ), a standard modified version of the original self-administered Food Frequency Questionnaire developed by Willett et al.<sup>24</sup> The HSFFQ measures the frequency of 84 foods and beverages consumed during the previous 4 weeks. Response categories range from 0 times in the last 4 weeks to 6+ times per day. Previous studies have validated the HSFFQ for use with low-income parents and children.<sup>25</sup> In the present study, each parent completed 2 HSFFQs—one regarding their own dietary intake and one regarding their child's intake. Energy and nutrient intakes were derived from completed HSFFQs per standard procedures by the Department of Nutrition at Harvard T.H. Chan School of Public Health.<sup>26</sup>

### DIET QUALITY

Diet quality was measured using the Healthy Eating Index-2010 (HEI-2010), which measures adherence to the

*Dietary Guidelines for Americans.*<sup>27</sup> HEI-2010 scores reflect dietary intake of *adequacy components*, where greater scores indicate *greater* consumption, and *moderation components*, where greater scores indicate lower consumption. Adequacy components include Total vegetables (5 points), Greens and beans (5 points), Total fruit (5 points), Whole fruit (5 points), Whole grains (10 points), Dairy (10 points), Total protein foods (5 points), Seafood and plant proteins (5 points), and Fatty acids (the ratio of polyunsaturated and monounsaturated fatty acids to saturated fatty acids; 10 points). Moderation components include Refined grains (10 points), Sodium (10 points), and Empty calories (energy from solid fat, alcohol, and added sugars; 20 points). HEI-2010 components are calculated using standard units (eg, cup or ounce equivalents) per 1000 kcal (kcal) derived from the HSFFQ data (except for Empty calories and Fatty acids). Empty calories are expressed as a percentage of total calories and Fatty acids are expressed as a ratio of polyunsaturated fats and monounsaturated fats to saturated fats. The total HEI-2010 score is the sum of all component scores with a maximum value of 100. Greater HEI-2010 scores reflect better compliance with the dietary guidelines.

### HOUSING INSTABILITY

There is, to date, neither a gold-standard measure nor a professional consensus on the definition of housing instability.<sup>9,12</sup> In the present study, housing instability was operationalized based on Sandel and Wright's concept of housing stress factors, which includes homelessness, being doubled up with another family, concern for eviction, and concern for utilities shutoff.<sup>16</sup> Survey questions were adapted from the American Housing Survey.<sup>28</sup> These included an item on housing status: What best describes your current living situation? [Rent apartment; Rent room (s) within another person's home; Own home; Homeless or living in a shelter; Doubled up with another family; Live with parents/other family; Other]. Selecting Homeless or living in a shelter or Doubled up with another family indicated housing instability. Selecting Rent apartment or Own home triggered a follow-up item: In the last 12 months, has the electric or gas company shut off the electricity or gas in your home or threatened to shut off the utilities in your home? Selecting Yes, threatened or Yes, shut off indicated housing instability. For those who selected Rent apartment, an additional item asked: Are you concerned about a possible eviction (being "kicked out") from your home? Selecting Yes or Not sure indicated housing instability.

### COVARIATES

Covariates were identified and included based on previous studies indicating associations with both housing instability and diet quality.<sup>4,12</sup> Covariates were assessed from parent self-report and included parent sex, age, race/ethnicity, education, household income, and zip code. Race/ethnicity was categorized as non-Hispanic white, non-Hispanic black, Hispanic, or other race/ethnicity. Education was categorized as less than high school, high

school diploma or General Educational Development, some college or vocational school, or college degree or higher. Household income was categorized as percent of the federal poverty level (FPL): <100%, 100% to 200%, and >200%. Zip code was used to derive neighborhood median household income based on US Census 2011 to 2015 American Community Survey 5-Year Estimates.<sup>29</sup> Covariates abstracted from the medical record included child age, sex, and body mass index percentile (based on Centers for Disease Control and Prevention clinical growth charts<sup>30</sup>).

### STATISTICAL ANALYSIS

Data were summarized using descriptive statistics. Statistical independence between categorical variables was evaluated using Chi-square tests. Normality of continuous variables was assessed using Shapiro–Wilk tests. The primary dependent variables (HEI-2010 total and dietary component scores), as well as energy intake (kcal/day), were found to be non-normally distributed. Therefore, nonparametric correlations between continuous variables were measured using Spearman's  $\rho$  ( $r_s$ ). Bivariate nonparametric associations between continuous variables and categorical covariates were measured using Wilcoxon rank sum or Kruskal–Wallis tests. Wilcoxon signed rank test was used to compare distributions of HEI-2010 total and dietary component scores among parent–child dyads.

HEI-2010 total scores can be analyzed as a continuous measure ranging from 0 to 100 points, with cutoffs for “good” (score >80), “fair” (score 51–80), and “needs improvement” (score  $\leq$ 50).<sup>31</sup> Because 85% and 86% of parent and child HEI-2010 scores, respectively, fell into the “fair” range (score 51–80; Table 1), we grouped the scores by quartiles for analysis, rather than by the cutoffs. Multivariable logistic regression was used to estimate odds ratios (OR) for lowest-quartile HEI-2010 scores (dichotomized as lowest quartile vs not-lowest quartile) according to housing instability, with adjustment for covariates. For parsimony, only covariates that were significantly associated in bivariate analysis with either the primary dependent variable (dichotomous lowest-quartile HEI-2010 score) or the primary independent variable (housing instability) were included in the regression model.

Initial dietary analysis revealed a wide distribution in energy intake, both for parents and children (see “Results, Energy Intake”). We therefore conducted a sensitivity analysis that excluded the tails of the distribution for energy intake (ie, those in the top 2.5% or bottom 2.5% of the distribution) in the multivariable regression model. We also conducted sensitivity analyses to evaluate components of the housing instability variable. These included limiting responses on the item “Are you concerned about a possible eviction (being “kicked out”) from your home?” to “Yes” (ie, excluding the response “Not Sure”), and limiting analysis to homelessness, being doubled up, or concerned about eviction (ie, excluding utilities threatened or shut off).

**Table 1.** Characteristics of 340 Parent/Guardian–Child Dyads

Characteristic (N = 340)	n (%)
Parent/guardian	
Sex, female	308 (90.6)
Age, y, mean ± SD	34.0 ± 7.6
Race/ethnicity	
Black/African American	166 (48.8)
Hispanic/Latino	111 (32.6)
Other race/ethnicity	43 (12.6)
White	20 (5.9)
Education	
Less than 12th grade	31 (9.1)
High school or equivalent	93 (27.4)
Some college or vocational school	132 (38.8)
College degree or greater	81 (23.8)
Not sure or declined to answer	3 (0.9)
Income level, %FPL	
<100	116 (34.1)
100–200	89 (26.2)
>200	86 (25.2)
Not sure or declined to answer	49 (14.4)
Neighborhood median household income* (IQR)	\$50,752 (\$45,958–\$71,712)
Housing instability <sup>†</sup>	136 (40.0)
Homeless or in sheltered housing	6 (1.8)
Doubled up with another family	4 (1.2)
Concerned for eviction <sup>‡</sup>	36 (10.6)
Utilities threatened or shut off <sup>§</sup>	113 (33.2)
Child	
Sex, female	176 (51.8)
Age, y, mean ± SD	6.4 ± 2.3
BMI percentile	
<5th	12 (3.5)
5th to <85th	189 (55.6)
85th to <95th	61 (17.9)
≥95th	78 (22.9)

SD indicates standard deviation; FPL, federal poverty level; IQR, interquartile range; and BMI, body mass index.

\*Derived from parent self-reported zip code using US Census 2011–2015 American Community Survey 5-Year Estimates.

<sup>†</sup>Housing instability defined as homeless or in sheltered housing, doubled up, concerned for eviction, or utilities threatened or shut off.

<sup>‡</sup>Includes “yes” (n = 23) and “not sure” (n = 13).

<sup>§</sup>Includes “yes, threatened” (n = 72 renters, n = 16 owners) and “yes, shut off” (n = 21 renters, n = 4 owners).

All statistical analyses were performed using JMP, Version 12.0 (SAS Institute Inc, Cary, NC). Goodness of fit was assessed using the Lack of Fit test as implemented in JMP. A value of  $P < .05$  was considered statistically significant except in HEI-2010 subcomponent analyses in which a more conservative  $P < .025$  was used to account for multiple comparisons.

## RESULTS

### PARTICIPANTS

Five hundred fifty-four parents were recruited: 432 enrolled and 122 declined (78.0% enrollment rate). There was no significant difference in age between parents who enrolled (mean 33.6 ± 7.3 years) and those who declined (mean 33.7 ± 6.6 years). There was a greater proportion of parents identifying as female among those who

enrolled (90.5%) compared with those who declined (78.7%;  $P < .001$ ). Among those who enrolled, there was also a greater proportion of parents identifying as Hispanic (32.9% compared with 14.8% who declined) and non-Hispanic white (6.0% compared with 3.3% who declined;  $P < .001$  for race/ethnicity). The most frequent reasons for declining to enroll were “not interested” (45.0%), and “time issue” (37.7%).

Of 432 parents who enrolled, complete dietary and housing data were available for 340 (79%). The 92 with incomplete or missing data were excluded from analysis, given complete dietary data was necessary to calculate HEI-2010 scores. No significant demographic differences were found between the 340 participants comprising the final analytic sample and the 92 with incomplete data. Characteristics of the final analytic sample are shown in [Table 1](#).

### HOUSING INSTABILITY

Housing instability was found in 136 parent–child dyads (40%; [Table 1](#)), with utilities threatened or shut off being the most frequent reason (33%). In contrast, only 2.9% reported being homeless or doubled up. Utilities threatened or shut off was reported by 93 of 241 apartment renters (38.6%), and by 20 of 62 homeowners (32.3%). Among renters, 36 (14.9%) were either concerned or not sure about eviction (“yes” [n = 23] or “not sure” [n = 13]). Housing instability was associated with lower parent education ( $P = .002$ ) and household income ( $P = .01$ ), but no other sociodemographic or clinical variables.

### ENERGY INTAKE

Median energy intake was 1797 (interquartile range [IQR] [1244–2771]) kcal/day for parents and 1647 (IQR [1150–2439]) kcal/day for children. Parent energy intake was positively correlated with child energy intake ( $r_s = 0.69$ ,  $P < .0001$ ). Parent energy intake was negatively correlated with parent age ( $r_s = -0.23$ ,  $P < .0001$ ). Lower household income level was associated with greater parent energy intake (2044 [1212–3208] kcal/day for income <100% FPL versus 1590 [1072–2250] kcal/day for income >200% FPL;  $P = .04$ ). Lower parent education was associated with greater child energy intake (2217 [1208–3277] kcal/day for less than high school versus 1576 [1120–2176] kcal/day for college degree or higher;  $P = .03$ ). Lower household income level also was associated with greater child energy intake (1936 [1207–2619] kcal/day for income <100% FPL vs 1393 [1030–1959] kcal/day for income >200% FPL;  $P = .003$ ).

### HEI-2010 TOTAL SCORES

The median parent HEI-2010 score was 63.8 (IQR 56.3–70.8), with 10 parents (2.9%) scoring >80 (“good”), 292 (85.8%) scoring 51–80 (“fair”), and 38 (11.2%) scoring ≤50 (“needs improvement”). The median child HEI-2010 score was 59.0 (IQR 54.2–64.7), with 1 child (0.3%) scoring >80 (“good”), 293 (86.2%) scoring 51–80 (“fair”), and 46 (13.5%) scoring ≤50

**Table 2.** HEI-2010 Total and Dietary Component Scores for 340 Parent/Guardian–Child Dyads

HEI-2010* Total and Dietary Components (Maximum Score)	Median Score <sup>†</sup> (IQR)		Correlation <sup>‡</sup> ( $r_s$ )	Difference in Parent–Child Score <sup>§</sup> Median (IQR)
	Parent	Child		
Total HEI score (100)	63.8 (56.3–70.8)	59.0 (54.2–64.7)	0.38	4.0 (–2.6 to 11.4)
<i>Adequacy components (greater score indicates greater consumption)</i>				
Total fruit (5)	4.8 (2.9–5)	5 (4.9–5)	0.32	0 (–1.4 to 0)
Whole fruit (5)	5 (3.1–5)	5 (4.3–5)	0.44	0 (–0.8 to 0)
Total vegetables (5)	3.9 (2.7–5)	2.0 (1.2–2.8)	0.51	1.5 (0.7–2.5)
Greens and beans (5)	3.0 (1.3–5)	0.7 (0.3–1.5)	0.37	1.4 (0.4–3.3)
Whole grains (10)	2.8 (1.3–5.2)	5.3 (3.3–8)	0.33	–1.7 (–4.0 to 0)
Dairy (10)	5.0 (3.0–5)	8.1 (5.8–10)	0.33	–1.5 (–4.3 to 0)
Total protein foods (5)	4.7 (3.4–5)	3.6 (2.6–4.5)	0.34	0.6 (0–1.5)
Seafood and plant proteins (5)	5 (3.4–5)	3.7 (1.9–5)	0.42	0.3 (0–1.7)
Fatty acids (10)	2.2 (0.7–3.4)	1.2 (0.0–2.5)	0.30	0.4 (–0.5 to 2.0)
<i>Moderation components (greater score indicates lower consumption)</i>				
Refined grains (10)	5.6 (2.0–9.5)	0.2 (0.0–4.2)	0.33	2.8 (0–6.0)
Sodium (10)	9.8 (8.6–10)	9.1 (7.5–10)	0.36	0.1 (0–1.5)
Empty calories (20)	15.0 (11.6–18.1)	14.8 (12.3–16.9)	0.29	0.4 (–2.9 to 3.2)

HEI-2010 indicates Healthy Eating Index-2010; IQR, interquartile range.

\*Mean HEI-2010 total and dietary component scores for US adults and children are, respectively: total HEI score 58.3 and 55.1; total fruit 2.6 and 3.9; whole fruit 3.5 and 4.8; total vegetables 3.5 and 2.1; greens and beans 3.6 and 0.7; whole grains 2.3 and 2.5; dairy 5.8 and 9.0; total protein foods 5.0 and 4.4; seafood and plant proteins 4.0 and 3.1; fatty acids 4.9 and 3.3; refined grains 6.4 and 4.9; sodium 4.0 and 4.9; empty calories 12.5 and 11.5. Calculation of HEI-2010 scores includes adjustment for energy intake.

†Values without a trailing zero indicate a maximum score.

‡Spearman's  $\rho$  for nonparametric correlations between parent and child scores;  $P < .001$  for all.

§Wilcoxon signed rank;  $P < .001$  for all except Empty calories ( $P = .56$ ).

(“needs improvement”). Overall child total HEI-2010 scores were significantly correlated with parent total HEI-2010 scores ( $r_s = 0.38$ ,  $P < .001$ ) although parent–child dyad scores differed ( $P$  for Wilcoxon signed rank  $< 0.001$ ; Table 2). Total parent and child HEI-2010 scores, by quartile, are shown in Appendix 1.

In bivariate analyses, housing instability was associated with lower parent total HEI-2010 score (median for stable housing 64.4 [IQR 57.8–71.3] vs median for unstable housing 62.0 [IQR 53.9–70.5],  $p$  for Wilcoxon Rank Sum = 0.02). Covariates associated with greater parent total HEI-2010 score included older parent age ( $r_s = 0.18$ ;  $P = .007$ ), greater educational attainment ( $P = .003$ ), greater household income level ( $P = .02$ ), and parent race/ethnicity ( $P = .01$ ; with black parents having the greatest scores). Parent race/ethnicity also was associated with greater child total HEI-2010 scores ( $P = .001$ ; with the greatest scores associate with black parent race/ethnicity). Child total HEI-2010 scores were not associated with housing instability or other covariates in bivariate analyses.

### HEI-2010 DIETARY COMPONENT SCORES

HEI dietary component scores were high ( $\geq 90\%$  of maximum), both for parents and children, for Total fruit and Whole fruit (where greater scores reflect greater consumption) and Sodium (where greater score reflects lower consumption). Parents also scored high for Total protein foods and Seafood and plant proteins (reflecting greater consumption). Children scored very low (near 0) for Greens and beans (reflecting lower consumption) and Refined grains (reflecting greater consumption).

For all HEI dietary components, child scores were positively correlated with parent scores ( $P < .001$  for all; Table 2). However, the distribution of scores among parent–child dyads was significantly different except for Empty calories.

### ASSOCIATION OF HOUSING INSTABILITY WITH HEI-2010 SCORE

Housing instability was significantly associated with increased odds of lowest-quartile parent HEI-2010 scores both in unadjusted and adjusted analyses (OR, 1.8; 95% confidence interval [95% CI], 1.1–2.9; adjusted odds ratio [aOR], 1.9; 95% CI, 1.1–2.9, respectively; Table 3). Housing instability also was associated with increased odds of lowest-quartile parent dietary component scores for Total vegetables and Greens and beans (aOR, 2.0; 95% CI, 1.1–3.7 and aOR, 2.5; 95% CI, 1.3–4.8, respectively) and decreased odds for lowest-quartile parent scores for Sodium (aOR, 0.5; 95% CI, 0.2–0.9). Housing instability was not significantly associated with the lowest-quartile child HEI-2010 total score in either unadjusted or adjusted analysis. However, the aOR was increased (aOR, 1.4; 95% CI, 0.8–2.5). Housing instability was significantly associated with increased odds of lowest-quartile child Whole fruit score (OR, 1.8; 95% CI 1.1–2.9), although significance was lost after adjustment.

### SENSITIVITY ANALYSIS

In a sensitivity analysis that excluded the tails of the distribution for parent energy intake (ie, those in the top 2.5% or bottom 2.5% of the distribution;  $> 6666$  kcal/day or  $< 539$  kcal/day;  $n = 16$ ), multivariable association

**Table 3.** Association Between Housing Instability and Lowest Quartile Healthy Eating Index-2010 Scores for 340 Parent/Guardian–Child Dyads

HEI-2010 Total and Dietary Component	OR for Lowest-Quartile HEI-2010 Score by Housing Instability*			
	Parent		Child	
	OR (95% CI)	aOR† (95% CI)	OR (95% CI)	aOR† (95% CI)
Total HEI score	1.8 (1.1–2.9)	1.9 (1.1–3.5)	1.4 (0.8–2.3)	1.4 (0.8–2.5)
Total fruit	1.1 (0.6–2.0)	1.2 (0.7–2.0)	1.4 (0.8–2.3)	1.2 (0.7–2.4)
Whole fruit	1.5 (0.9–2.4)	1.3 (0.7–2.2)	1.8 (1.1–2.9)	1.7 (0.9–3.2)
Total vegetables	1.9 (1.2–3.1)	2.0 (1.1–3.7)	1.4 (0.8–2.3)	1.4 (0.7–2.5)
Greens and beans	2.0 (1.2–3.3)	2.5 (1.3–4.8)	1.5 (0.9–2.4)	1.4 (0.8–2.5)
Whole grains	0.9 (0.6–1.5)	1.0 (0.6–1.8)	1.1 (0.6–2.1)	1.1 (0.7–2.3)
Dairy	1.0 (0.6–1.6)	0.9 (0.5–1.6)	1.0 (0.7–1.5)	1.0 (0.5–1.9)
Total protein foods	1.1 (0.6–1.8)	1.4 (0.8–2.5)	0.9 (0.6–1.3)	0.9 (0.5–1.6)
Seafood and plant proteins	0.9 (0.5–1.4)	1.0 (0.6–1.6)	1.2 (0.8–1.7)	1.1 (0.6–1.9)
Fatty acids	0.9 (0.5–1.5)	1.8 (0.7–2.1)	0.9 (0.5–1.5)	–‡
Refined grains	1.1 (0.8–1.6)	1.2 (0.7–2.1)	0.8 (0.5–1.4)	–‡
Sodium	0.5 (0.3–0.8)	0.5 (0.2–0.9)	1.1 (0.7–1.9)	–‡
Empty calories	1.5 (0.9–2.4)	1.8 (1.0–3.2)	1.5 (0.9–2.4)	1.3 (0.8–2.3)

HEI-2010 indicates Healthy Eating Index-2010; OR, odds ratio; CI, confidence interval; and aOR, adjusted odds ratio.

\*Defined as homeless or in sheltered housing, doubled up, utilities threatened or shut off, or concerned about eviction.

†Adjusted for parent age, race/ethnicity, education, household income, and child age; alpha for HEI total score set at 0.05 and for dietary components at 0.025 (ie,  $P < .025$ ) to account for multiple comparisons.

‡Significant lack of fit ( $P < .05$ ).

between housing instability and parent HEI-2010 lowest-quartile score remained significant (aOR, 1.8; 95% CI, 1.0–3.3). Excluding those who responded Not sure for the item “Are you concerned about a possible eviction (being “kicked out”) from your home?” (ie, limiting analysis to those responding Yes), did not attenuate the association between housing instability and lowest-quartile HEI-2010 parent score (aOR, 1.9; 95% CI, 1.1–3.4). In an analysis that included participants with housing instability only due to threatened or shut-off utilities, housing instability remained significantly associated with lowest-quartile HEI-2010 parent score (aOR, 1.9; 95% CI, 1.0–3.3). However, the association became nonsignificant in an analysis among the smaller number of remaining participants with housing instability due to other causes (ie, reporting homelessness, being doubled up, or concerned about eviction;  $n = 45$ ).

## DISCUSSION

The aim of the present study was to examine associations between housing instability and diet quality in a sample of urban parents and children. Housing instability was found to be associated with lower diet quality scores for parents but not children, with lower vegetable consumption scores for parents driving the association.

Why a relationship was found between housing instability and parent, but not child, diet quality warrants further inquiry. Parental over-reporting of children’s eating habits seems unlikely, given child diet quality scores were globally quite low, both for greens and beans and for refined carbohydrates. Perhaps parents experiencing housing instability are able to buffer their children in some way from its adverse effects. This phenomenon occurs with food insecurity, where parents may modify their own

dietary intake for the benefit of the child.<sup>32</sup> The problem with this theory is that, in contrast to food insecurity (or at least food insecurity without hunger), housing instability encompasses circumstances that are often unavoidably experienced by the entire family. In the present study, only one third of the 136 families with housing instability reported homelessness or being doubled up or had concerns for eviction. Housing instability for the remaining two thirds was due to concerns about utilities shutoff (ie, energy insecurity). It is possible that the dynamics of energy insecurity, in terms of potential buffering ability by parents, more closely resembles food insecurity than the family-wide shocks of homelessness and eviction.

Problems related to utilities were the primary reason for housing instability in this sample, and sensitivity analysis revealed a robust association between housing instability defined through utility needs (ie, energy insecurity) and lowest-quartile parent HEI-2010 scores. Previous research corroborates the relationship between housing instability and energy insecurity.<sup>12</sup> Although previous definitions of housing instability have incorporated energy insecurity,<sup>33</sup> these issues are beginning to be parsed apart. The Centers for Medicare and Medicaid Services Accountable Health Communities model, for example, lists housing instability and utility help needs as 2 distinct needs in its list of 5 core health-related social needs (along with food insecurity, transportation problems, and interpersonal safety needs).<sup>34</sup> This may be due, in part, to the distinct referral pathways for each type of need (ie, emergency shelter for someone being evicted vs utility protection for a threatened shutoff). However, there may be upstream commonalities, such as cost burden (ie, the percentage of household income needed for rent and/or utilities) that drive both housing instability and energy insecurity.<sup>35</sup>

The relatively wide distribution of energy intake found in the present study has been reported elsewhere.<sup>36</sup> The HEI-2010 partially circumvents this issue by incorporating energy intake into the calculation of component scores. The strong correlations between parent and child diet quality are also corroborated by previous studies.<sup>37</sup> Findings from the National Health and Nutrition Examination Survey indicate that the mean HEI-2010 scores for US adults and children are 58 and 55, respectively.<sup>31</sup> Median HEI-2010 scores in the present study (64 for parents and 59 for children) were in the lower range of "fair." Parents and children in the present study both scored high for consumption of total fruit, whole fruit, and sodium (where greater score reflects lower consumption). Children scored particularly low for refined grains (reflecting a high intake) and greens and beans (reflecting a low intake). This suggests specific target areas for improvement in children's diet quality.

The degree to which the association between lower parent HEI-2010 scores and housing instability is clinically meaningful is unknown. Lower HEI-2010 scores have been associated with total- and cause-specific mortality risk, including for cardiovascular disease and cancer, regardless of sex, race, and income.<sup>38</sup> These findings reinforce the need for addressing upstream social factors that may affect multiple nutritionally mediated endpoints for health.

The associations between parent HEI-2010 scores and educational and income levels are consistent with a socioeconomic gradient in diet quality.<sup>3</sup> Also consistent is the association between housing instability and lower parental education and household income.<sup>12</sup> The present study aims to identify an independent association between housing instability and poor diet quality. However, these findings reinforce the foundational role of socioeconomic status (with education and income as primary indicators) in driving these relationships.

Two observed associations were unexpected. First was the association between HEI-2010 scores and race/ethnicity, with black parents having the greatest parent and child HEI-2010 scores. This may reflect methodologic factors related to the relative socio-demographic homogeneity of the sample or, perhaps, there is an element of social desirability bias. The study data were collected at a pediatric medical home during well-child care visits, and it is conceivable that systematic racial/ethnic differences in reporting on eating patterns could occur in this context. The second unexpected association was between housing instability and a decreased odds of the lowest-quartile parent HEI-2010 component scores for sodium (consistent with greater sodium intake). There is some evidence suggesting an inverse relationship among adults between sodium intake and diet cost.<sup>39</sup> Further research is needed to clarify these relationships.

The present study has several limitations. First, the findings rely on self-reported dietary assessment, the shortcomings of which are widely recognized. However, because dietary measurement error often causes associations to be underestimated, a strong signal

likely indicates some degree of validity.<sup>40</sup> Second, the lack of a gold-standard measure of housing instability limits the cross-comparability of these findings with other research. Third, because the assessments were completed at the same time and by the same parent, both common method bias and desirability bias should be considered in the interpretation of the findings. Fourth, the data for this study were collected in 2011 to 2012, which may limit the temporal generalizability of the findings. Fifth, study participants were recruited as a convenience sample in a busy clinic setting. Although measures were taken to minimize selection bias (eg, recruitment in alphabetical order for overlapping eligible participants), the sample was not formally randomized.

The primary strength of this study is that it provides preliminary findings suggesting an independent association between housing instability and diet quality. The findings may serve to support the growing body of evidence linking housing and health. However, because the association with housing instability was found only for parent diet quality (and not child diet quality), the findings should be interpreted with care. More research is needed to clarify the specificity, temporality, and directionality of these relationships.

## CONCLUSIONS

Housing instability is associated with lower diet quality scores for parents. Multiple programs exist at the federal, state, and local levels to assist with housing instability that could potentially ameliorate not only housing problems but also have positive effects on dietary patterns. For health care providers, these findings underscore the importance of integrating screening and referral for housing instability and other health-related social needs alongside clinical nutrition. Further research is needed to identify best-practice approaches and holistic interventions aimed at addressing the social determinants of health.

## ACKNOWLEDGMENTS

We thank the American Academy of Pediatrics Bright Futures for donating child activity books, ROIhealth for donating grocery coupons, the dedicated research assistants, the HelpSteps technical team, and the patient-families at Boston Children's Hospital Primary Care. Portions of these data were presented in abstract form at the Pediatric Academic Societies' 2014 Annual Meeting, May 3-6, 2014, Vancouver, BC, Canada.

*Financial disclosure:* Academic Pediatric Association Bright Futures Young Investigator Award Program; Divisions of General Pediatrics and Emergency Medicine at Boston Children's Hospital; Program for Patient Safety and Quality at Boston Children's Hospital; and Department of Social Work at Boston Children's Hospital.

*Authorship Statement:* C.J.B. developed the research questions, led data collection and statistical analysis, and co-drafted the manuscript. E. W.F. designed the overall study, oversaw data collection, and provided critical feedback on the manuscript. J.E.C. oversaw data collection and provided critical feedback on the manuscript. E.T.R. designed the overall study, oversaw data collection, and co-drafted the manuscript. All authors approve the final manuscript and agree to be accountable for all aspects of the work.

## SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at <https://doi.org/10.1016/j.acap.2019.04.004>.

## REFERENCES

- 2015–2020 Dietary Guidelines for Americans. 8th ed. Available at: <https://health.gov/dietaryguidelines/2015/guidelines/>. Accessed February 1, 2018.
- Centers for Disease Control and Prevention. Chronic Disease Prevention and Health Promotion. Available at: <https://www.cdc.gov/chronicdisease/overview/>. Accessed February 1, 2018.
- Darmon N, Drewnowski A. Does social class predict diet quality? *Am J Clin Nutr*. 2008;87:1107–1117.
- Schroder H, Gomez SF, Ribas-Barba L, et al. Monetary diet cost, diet quality, and parental socioeconomic status in Spanish youth. *PLoS One*. 2016;11:e0161422.
- Rehm CD, Monsivais P, Drewnowski A. Relation between diet cost and Healthy Eating Index 2010 scores among adults in the United States 2007–2010. *Prev Med*. 2015;73:70–75.
- Moore LV, Diez Roux AV, Nettleton JA, et al. Associations of the local food environment with diet quality—a comparison of assessments based on surveys and geographic information systems: the multi-ethnic study of atherosclerosis. *Am J Epidemiol*. 2008;167:917–924.
- Galloway T, Johnson-Down L, Egeland GM. Socioeconomic and cultural correlates of diet quality in the Canadian Arctic: results from the 2007–2008 Inuit Health Survey. *Can J Diet Pract Res*. 2015;76:117–125.
- Drewnowski A, Aggarwal A, Cook A, et al. Geographic disparities in Healthy Eating Index scores (HEI-2005 and 2010) by residential property values: findings from Seattle Obesity Study (SOS). *Prev Med*. 2016;83:46–55.
- Frederick TJ, Chwalek M, Hughes J, et al. How stable is stable? Defining and measuring housing stability. *J Community Psychol*. 2014;42:964–979.
- Fierman AH, Beck AF, Chung EK, et al. Redesigning health care practices to address childhood poverty. *Acad Pediatr*. 2016;16(3 suppl):S136–S146.
- Grant R, Shapiro A, Joseph S, et al. The health of homeless children revisited. *Adv Pediatr*. 2007;54:173–187.
- Sandel M, Sheward R, Ettinger de Cuba S, et al. Unstable housing and caregiver and child health in renter families. *Pediatrics*. 2018.
- Desmond M. Eviction and the reproduction of urban poverty. *Am J Sociol*. 2012;118:88–133.
- King C. Food insecurity and housing instability in vulnerable families. *Rev Econ Household*. 2018;16:255–273.
- Kirkpatrick SI, Tarasuk V. Housing circumstances are associated with household food access among low-income urban families. *J Urban Health*. 2011;88:284–296.
- Sandel M, Wright RJ. When home is where the stress is: expanding the dimensions of housing that influence asthma morbidity. *Arch Dis Child*. 2006;91:942–948.
- Kim P, Evans GW, Angstadt M, et al. Effects of childhood poverty and chronic stress on emotion regulatory brain function in adulthood. *Proc Natl Acad Sci U S A*. 2013;110:18442–18447.
- Dohle S, Diel K, Hofmann W. Executive functions and the self-regulation of eating behavior: a review. *Appetite*. 2018;124:4–9.
- Mayberry LS, Shinn M, Benton JG, Wise J. Families experiencing housing instability: the effects of housing programs on family routines and rituals. *Am J Orthopsychiatry*. 2014;84:95–109.
- Smith C, Butterfass J, Richards R. Environment influences food access and resulting shopping and dietary behaviors among homeless Minnesotans living in food deserts. *Agric Human Values*. 2010;27:141–161.
- Fleegler EW, Bottino CJ, Pikcilingis A, et al. Referral system collaboration between public health and medical systems: a population health case report. NAM Perspectives. Discussion Paper. Washington, DC: National Academy of Medicine; 2016.
- Bottino CJ, Rhodes ET, Kreatsoulas C, et al. Food insecurity screening in pediatric primary care: can offering referrals help identify families in need? *Acad Pediatr*. 2017;17:497–503.
- Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. *Pediatrics*. 1998;101:539–549.
- Willett WC, Sampson L, Stampfer MJ, et al. Reproducibility and validity of a semiquantitative food frequency questionnaire. *Am J Epidemiol*. 1985;122:51–65.
- Blum RE, Wei EK, Rockett HR, et al. Validation of a food frequency questionnaire in Native American and Caucasian children 1 to 5 years of age. *Matern Child Health J*. 1999;3:167–172.
- Harvard T.H. Chan School of Public Health Department of Nutrition File Download Site. Available at: <https://regepi.bwh.harvard.edu/health/>. Accessed February 7, 2013.
- Healthy Eating Index. United States Department of Agriculture, Center for Nutrition Policy and Promotion. Available at: <https://www.cnpp.usda.gov/healthyeatingindex>. Accessed February 1, 2018.
- American Housing Survey. Available at: <https://www.census.gov/programs-surveys/ahs.html>. Accessed February 1, 2018.
- American Community Survey (ACS). Available at: <https://www.census.gov/programs-surveys/acs/>. Accessed June 14, 2017.
- Kuczumski RJ, Ogden CL, Guo SS, et al. CDC Growth Charts for the United States: methods and development. *Vital Health Stat 11*. 2000;2002(246):1–190.
- Guenther PM, Kirkpatrick SI, Reedy J, et al. The Healthy Eating Index-2010 is a valid and reliable measure of diet quality according to the 2010 Dietary Guidelines for Americans. *J Nutr*. 2014;144:399–407.
- Hanson KL, Connor LM. Food insecurity and dietary quality in US adults and children: a systematic review. *Am J Clin Nutr*. 2014;100:684–692.
- Kushel MB, Gupta R, Gee L, et al. Housing instability and food insecurity as barriers to health care among low-income Americans. *J Gen Intern Med*. 2006;21:71–77.
- Billioux A, Verlander K, Anthony S, et al. Standardized screening for health-related social needs in clinical settings: the accountable health communities screening tool. Washington, DC: National Academy of Medicine; 2017.
- Hernandez D, Bird S. Energy burden and the need for integrated low-income housing and energy policy. *Poverty Public Policy*. 2010;2:5–25.
- Murakami K, Livingstone MB. Prevalence and characteristics of misreporting of energy intake in US children and adolescents: National Health and Nutrition Examination Survey (NHANES) 2003–2012. *Br J Nutr*. 2016;115:294–304.
- Robson SM, Couch SC, Peugh JL, et al. Parent diet quality and energy intake are related to child diet quality and energy intake. *J Acad Nutr Diet*. 2016;116:984–990.
- Yu D, Sonderman J, Buchowski MS, et al. Healthy eating and risks of total and cause-specific death among low-income populations of African-Americans and other adults in the Southeastern United States: a prospective cohort study. *PLoS Med*. 2015;12:e1001830; discussion e1001830.
- Beydoun MA, Fanelli-Kuczumski MT, Allen A, et al. Monetary value of diet is associated with dietary quality and nutrient adequacy among urban adults, differentially by sex, race and poverty status. *PLoS One*. 2015;10:e0140905.
- Subar AF, Freedman LS, Tooze JA, et al. Addressing current criticism regarding the value of self-report dietary data. *J Nutr*. 2015;145:2639–2645.