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Examining the Consumer Restaurant Environment and Dietary Intake in Children

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Examining the consumer restaurant environment and dietary intake in children

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A B S T R A C T

Within the away-from-home food environment there is a need to account for individual exposure (e.g., frequency of visitation) to that environment. The present study examined the consumer environment in both proximal and visited restaurants and their association with childrens' diet quality and anthropometrics. A cross-sectional analysis used baseline data from the Neighborhood Impact on Kids (NIK) study (2007–2009). Participants were 6–12-year-olds living in King County, WA and San Diego County, CA. This analysis (conducted 2019–2020) examined relationships between nearby restaurant count, Nutrition Environment Measures Survey in Restaurants (NEMS-R) within the child's block group, and weighted NEMS-R scores based on the restaurant where the child ate most frequently in relation to child energy intake, Healthy Eating Index (HEI-2010) total score and anthropometrics. Children's HEI-2010 scores were associated with NEMS-R scores within block groups, with children in the lowest NEMS-R tertile having significantly higher HEI scores than participants in the middle tertile. Weighted NEMS-R scores were significantly associated with waist circumference, with children in the highest NEMS-R tertile having a lower waist circumference than children in the lowest tertile. Nearby restaurant count was not associated with children's diet quality or anthropometrics. Our findings suggest the relationship between nutrition environment and child diet and anthropometrics varied depending on how nutrition environment was defined. However, findings may be limited by the low frequency of eating out reported in this sample. Food environment measures that account for individual-level behavior are needed to better understand the influence of food environments on diet and anthropometrics

1. Introduction

Food environments are referred to as the combination of physical, economic, policy and sociocultural surroundings that shape people's dietary choices (Swinburn et al., 2013). Within a community, the broader nutrition environment includes the distribution, number, type, location and accessibility of food outlets and the foods available from those outlets (Glanz et al., 2005). Restaurants and food stores make up the majority of food outlets in a community. Within the community, each restaurant and food store presents a unique consumer environment (e.g. price, promotion, availability, variety, and placement of food choices) that can impact eating behaviors (Glanz et al., 2005). The contributions of the consumer environment on diet quality and anthropometrics in children is important given consumption of foods away-from-home has increased dramatically in the United States (Lachat et al., 2012; Poti and Popkin, 2011; Powell and Nguyen, 2013;

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Briefel et al., 2009) in recent decades (Guthrie et al., 2002; Saksena et al., 2018) and the foods purchased away-from-home are typically more energy-dense and of poorer nutritional quality (Saksena et al., 2018; Lin and Guthrie, 2012; Todd, 2017; Urban et al., 2016). Specifically, national data have shown that fast food (Powell and Nguyen, 2013; Bowman et al., 2004; Rehm and Drewnowski, 2016) and full service restaurant (Powell and Nguyen, 2013) meals were associated with higher intakes of fats, sugar, and sugar-sweetened beverages in children and adolescents.

In studies examining the relationship of food environments with diet and weight outcomes (Glanz et al., 2005; Kirkpatrick et al., 2014; McKinnon et al., 2009; Caspi et al., 2012; Sacks et al., 2019), measures used to assess the community food environment have focused on density of food outlets, or proximity, usually the distance between home and a food outlet (Bivoltsis et al., 2018). The relationships between restaurant proximity or density around home and weight-related outcomes have been predominantly null in both children and adults (Sacks et al., 2019; Cobb et al., 2015; Jia et al., 2019); however, measures of density and proximity only provide one lens into the food environment and fail to capture important individual-specific nuance in other drivers of eating like if an individual actually visit these restaurants or not (Saelens et al., 2007).

The consumer environment of restaurants has rarely been included in studies (Engler-Stringer et al., 2014), despite its potential importance as an influence of food environments on childhood diet quality and anthropometric outcomes. The aim of the present study was to examine restaurant food environments using a novel approach that accounts for how frequently individuals interact with their local consumer food environment alongside more traditional food environment measures (e.g., count) with child dietary intake and anthropometrics.

2. Methods

2.1. Study sample

Children were participants in the Neighborhood Impact on Kids (NIK) study, a longitudinal cohort study that examined associations of child (6–12 years-old) obesity and related behaviors with neighborhood-level nutrition and physical activity environments in King County, Washington and San Diego County, California (Saelens et al., 2012). Neighborhoods defined by census block groups were assessed for their physical activity and nutrition environments and assigned to combinations of high/low physical activity environments and high/low nutrition environments (Frank et al., 2012). More details about neighborhood selection and differences across neighborhoods (Saelens et al., 2012, 2018; Frank et al., 2012) and NIK participant recruitment are provided elsewhere (Saelens et al., 2012). In brief, households with an interested and eligible parent and child (6–12 years-old) in eligible neighborhoods were recruited from September 2007 to January 2009. Eligibility included ability to engage in moderate intensity physical activity, and not having a medical condition that impacted weight status or growth. Participants were excluded if they were <10th body mass index (BMI) percentile-for-age and sex; had eating disorder pathology; on a medically prescribed dietary regimen; or had psychiatric problems that would interfere with participation. One child per household was eligible to participate. This NIK study was approved by the IRBs at Seattle Children's Hospital, SanDiego State University, and Emory University.

The present cross-sectional analyses used baseline data from NIK, the only time point at which full individual-level and restaurant environment data (count or consumer environment as assessed by the Nutrition Environment Survey—Restaurant [NEMS-R]) were collected. Only children with complete demographic, anthropometric, dietary and restaurant environment data were included in this analysis. Sample size (of 733 total families participating) varied dependent upon the restaurant environment (exposure) variable. Definitions for each restaurant environment variable are available in Table 1. To be included in the restaurant count analysis, a child needed to have at least one restaurant within one kilometer of their home (n = 392), the NEMS-R within block group analysis included only children who lived in block groups with one or more restaurants in which NEMS-R was assessed (n = 302), and the weighted NEMS-R analysis included children whose parent reported the frequency of the child eating at the restaurant for which a NEMS-R evaluation was conducted, regardless of where the restaurant was located (n = 317).

2.2. Measures

Demographics. Individual (e.g., child and parent age, race, ethnicity) and household-level demographic information (e.g., highest level of education for the adult) was reported by parents.

Frequency of Eating Away from Home. Parents reported the frequency of the child eating meals and snacks away from home at various locations (e.g., school cafeteria). Responses were on a 5-point Likert-based scale from 'never or almost never' to 'five or more times per week" and based on the distribution of responses, were collapsed into three categories (<1 per week, 1–4 times per week, five or more times per week) for reporting.

Restaurant Environments. Three restaurant environment variables were created for each child: neighborhood restaurant count near home within 1 km Euclidean distance (restaurant count), consumer environment of restaurants in their home block group (NEMS-R within block group), and an interaction of the consumer environment (NEMS-R) of the restaurant the child visited most frequently weighted by parent-reported visitation frequency for the child (weighted NEMS-R) (Table 1). Restaurants throughout the study counties were identified through food license/permit lists, Dun & Bradstreet business listings, and phone book listings, and geocoded. Details about restaurant enumeration are available elsewhere (Frank et al., 2012).

The consumer restaurant environment was assessed by trained and certified observers using the NEMS-R (Saelens et al., 2007) to evaluate the quality of all fast food and sit-down restaurants within the block group where any NIK participants lived. NEMS-R data collection included reviewing menus and observations of the restaurants on-site. The NEMS-R total score was calculated for each restaurant. Thresholds

Table 1
Restaurant Environment (Exposure) Variables Descriptions.

Variable	Definition	Sample Size	Mean (95% CI) NEMS-R Score	Tertile Ranges for NEMS-R Scores		
				Tertile 1	Tertile 2	Tertile 3
Restaurant Count	The number of restaurants within a 1KM of the child's home.	392[a]	8.9 (7.9, 9.8)	1 to 3	4 to 9	10 to 55
NEMS-R block group	Mean NEMS-R score for all restaurants within the block group of where the child resided.	302	2.9 (2.6, 3.3)	−2.5 to 1.43	1.5 to 3.56	3.58 to 21
Weighted NEMS-R	NEMS-R score for the restaurant the parent reported that the child ate at most frequently (could be located inside or outside the neighborhood) and weighted based on frequency of visitation to that restaurant.	317	119.7 (104.0, 135.4)	−45 to 30	37.5 to 105	120 to 720

[a]This sample size includes anyone with zero restaurants within 1KM.
NEMS-R, Nutrition Environment Measures Survey—Restaurant; KM, kilometer

have not been established for the NEMS-R total score instead a higher NEMS-R total score is indicative of a more favorable consumer food environment. Across San Diego County and King County a total of 1141 restaurants had NEMS-R ratings conducted and scored.

NEMS-R within block group was the mean NEMS-R score for all restaurants within the child's residence block group. Because dietary behaviors are shaped by multiple levels of the social ecological model, a weighted NEMS-R variable was created to account for how frequently an individual interacted with their local consumer restaurant environment. Specifically, the weighted NEMS-R score was calculated from the NEMS-R score for the specific restaurant location the parent reported that the child ate at most frequently. This restaurant could be located anywhere but was included in this analysis only if a NEMS-R evaluation was conducted. The three most frequently visited restaurants by the child were reported by the parent on the NIK survey. If the restaurant visited most frequently did not have a NEMS-R score, the second most frequented restaurant with a NEMS-R score was used, and subsequently the third most frequented restaurant if a NEMS-R score was not available for the first or second most frequented restaurant. Because the frequency children visited restaurants (as reported by parent) varied from ≤1 time/month to 1 time/week, we created a weighted NEMS-R score that was a multiplicative of the frequency of visitation to that restaurant and the NEMS-R score for that restaurant. The weighted NEMS-R score was created such that less frequent visitation and to more healthy restaurants resulted in higher scores. So, participants who ate at the restaurant ≤1 time/month had the NEMS-R for that restaurant (if positive) multiplied by the reciprocal of their monthly visitation frequency (i.e., 30, assuming 30 days in a month). Participants who ate out 2–3 times/month had their NEMS-R (if positive) multiplied by the reciprocal of 2/30 (i.e. 15), and those who ate out 1 time/week (4/30) had their NEMS-R score (if positive) multiplied by 7.5. For any given NEMS-R score, the weighted NEMS-R score would be lower with higher visitation frequency. Restaurants with a negative NEMS-R score were multiplied by the frequency of visitation per month (i.e. 1 instead of 30 for eating at the restaurant ≤1 time/month; 2 for eating at the restaurant 2–3 times/month; 4 for eating at the restaurant 4–5 times/month) so that more frequent eating out was reflected with a more negative weighted NEMS-R score. For subsequent analyses, all exposure variables were categorized into tertiles, to allow for comparisons given the different metrics used in each measure.

Anthropometrics. Height and weight were collected by trained research assistants at the clinic or the family's home. BMI was calculated as kg/m^2 (Glanz et al., 2005) and standardized into BMI z-scores (z-BMI) for age and sex based on CDC 2000 norms (Kuczmarski et al., 2002). Waist circumference was measured in triplicate and then subsequently until 3 of 4 consecutive measures were within 0.5 cm (Centers for Disease Control and Prevention, 2007).

Energy Intake and Diet Quality. Dietary intake of each child was assessed by up to three random, 24-hour dietary recalls conducted by trained staff over the phone using the multiple-pass approach. For children younger than eight years old, a consensus recall approach was used with parents and children reporting together; children eight years or older reported individually with parent assistance. Parents were given two-dimensional food models (Nutrition Consulting Enterprise) to assist with portion estimation during the phone recalls. Recall data were analyzed using Nutrition Data System for Research (NDS-R) software (version 2.92) developed by the Nutrition Coordinating Center, University of Minnesota. Child's energy intake and diet quality estimates were averaged across diet recall days. Diet quality was assessed using the Healthy Eating Index-2010 (HEI-2010) total score, which evaluated adherence to the 2010 Dietary Guidelines for Americans (Guenther et al., 2014). HEI-2010 total scores ranged from 0 to 100, with a higher score indicating better diet quality.

2.3. Statistical analysis

Demographic and anthropometric characteristics (mean (95%CI), n (%)) were calculated for participants based upon each of three exposure variables (restaurant count within 1 km, NEMS-R within block group, weighted NEMS-R). Each exposure variable was examined as continuous variables (data not shown) and divided into tertiles. Given the lack of established thresholds for NEMS-R and the unlikely meaning of a single point difference for the NEMS-R score, tertiles were used to compare less favorable consumer restaurant environments to more favorable consumer restaurant environments. Similarly, tertiles for restaurants count allowed for comparison of higher restaurant density in a neighborhood to lower restaurant density.

Given the study design with nesting within block groups, a multilevel model was initially proposed, but due to insufficient variation explained (ICC = 0.01) by the nesting variable, subsequent analyses used unadjusted and adjusted multivariable generalized linear models. Each exposure variable (restaurant count, NEMS-R within block group, weighted NEMS-R) was divided into tertiles, and differences in mean energy intake, HEI-2010 total score, BMI-z score, and waist circumference were examined. Covariates were selected based on theoretical and data-driven approaches and were retained if they meaningfully ($p < 0.05$) changed regression parameters. Covariates included in the final models included: parent education (a proxy for socioeconomic status), child sex, high (vs. low) nutrition environment based on the NIK neighborhood classification, and child age. Analyses examining child z-BMI and waist circumference were further adjusted for parent BMI. Post-hoc comparisons across tertiles were made using Tukey adjustment. All analyses were conducted with SAS v. 9.4 (SAS Institute, Cary, NC) and conducted in 2019–2020.

3. Results

Descriptive characteristics based on the number of children who had data for each exposure variable (restaurant count: n = 392; NEMS-R within block group: n = 302; weighted NEMS-R: n = 317) are presented in Table 2. In each exposure variable, mean child age was approximately 9 years-old, more than 80% of participants in each sample identified as White and 20% or less identified as Hispanic.

The majority of parents who reported their child's frequency of eating away from home (n = 676) reported their child ate out <1 time/week, with 82.1% reporting <1 time/week at full-service restaurants and 84.1% <1 time/week at fast food restaurants. No parent reported that their child ate at these locations five or more times per week. When

Table 2
Child Demographics and Anthropometrics for Each Exposure Variable.

	Restaurant Count	NEMS-R within block group	Weighted NEMS-R
n	392	302	317
Age (years), M (95%CI)	9.0 (8.9, 9.2)	9.1 (9.0, 9.3)	9.2 (9.0, 9.3)
Race, n (%)			
White	321 (81.9%)	227 (80.8%)[a]	265 (83.6%)
Non-White	71 (18.1%)	54 (19.2%)[a]	52 (16.4%)
Hispanic, n (%)	75 (20.0%)	56 (19.4%)[a]	54 (17.0%)
BMI z-score, M (95%CI)	0.37 (0.28, 0.47)	0.39 (0.28, 0.49)	0.39 (0.28, 0.50)
Overweight[b,] n (%)	56 (16.0%)	44 (14.6%)	47 (16.6%)
Obese[c,] n (%)	42 (12.5%)	25 (8.3%)	34 (12.6%)
Waist Circumference (cm), M (95%CI)	63.1 (62.2, 64.1)	63.4 (62.3, 64.5)	63.8 (62.7, 64.9)

[a]Due to missing data sample size for Race is 281 and Hispanic is 288.
[b]Overweight defined as BMI-for-age and sex ≥ 85th percentile and < 95th percentile
[c]Obese defined as BMI-for-age and sex ≥ 95th percentile
NEMS-R, Nutrition Environment Measures Survey—Restaurant; n, sample size; M (95%CI), mean (95% confidence interval); BMI, body mass index

children ate out, the school cafeteria was the most common location reported (30.2% 5 or more times/week, 28.8% 1–4 times/week). Across meals, lunch was the most frequently consumed meal away from home, with 57.2% eating lunch away from home five or more times/week and 22.6% 1–4 times/week.

The unadjusted and adjusted mean energy intake, HEI-2010 scores, BMI-z scores, and child waist circumference values across tertiles for restaurant count, NEMS-R within block group and weighted NEMS-R are show in Table 3.

Across tertiles of restaurant counts, excluding children with no restaurants within 1 km, there were no significant difference in total energy intake, HEI-2010 scores, z-BMI or child waist circumference in the unadjusted and adjusted models.

For the NEMS-R within block group there were 892 unique restaurants with a NEMS-R score. Significant differences in HEI-2010 scores were detected across tertiles in the adjusted model, with participants in the lowest NEMS-R tertile (Tertile 1) or least favorable consumer restaurant environment having significantly higher mean HEI-2010 scores than participants in middle tertile (T1: 59.7, 95%CI(54.9, 64.5) vs. T2: 55.1, 95%CI(50.1, 60.1), p = 0.037). There were no differences by average block group NEMS-R score tertile for total energy intake, zBMI, or child waist circumference in unadjusted or adjusted models.

For the weighted NEMS-R there were 279 unique restaurants with a NEMS-R score. In both unadjusted and adjusted models, children in the highest weighted NEMS-R tertile, the most favorable consumer restaurant envrioment, had significantly lower waist circumference than children in the lowest tertile, least favorable consumer restaurant environment (T3: 62.7, 95%CI (61.1, 64.3) vs. T1: 65.5, 95% CI (64.0, 67.1), p = 0.038). No other significant differences in child diet or anthropometrics were detected across weighted NEMS-R tertiles, although child BMI z-score findings were in a similar direction as child waist circumference.

4. Discussion

In this analysis, the general hypothesis that the consumer environment of the restaurant would be related to child dietary intake and anthropometrics was partially supported. A key result was that children who ate at restaurants with a more favorable consumer environment less frequently (higher weighted NEMS-R score) compared to children who ate at establishments with less favorable consumer environment more frequently (lower weighted NEMS-R score) had lower waist circumferences. An implication is that evaluating the interaction of individual (frequency of visitation) with the consumer food environment of that restaurant simultaneously (i.e., more direct and individualized exposure) may be a more promising measure of food environments with criterion validity for child health. An unexpected finding was the inverse association of a NEMS-R of the consumer restaurant environment of the child's neighborhood with children's diet quality as measured by the HEI total score. Given the lack of a significant association between tertile 1 and tertile 3, a lack of biologic plausibility, it is possible that this is a spurious association. The finding that restaurant counts within 1 km where children live were not related to child anthropometrics or child diet quality is consistent with the null findings others have reported (Sacks et al., 2019; Cobb et al., 2015; Jia et al., 2019).

Use of food environment measures weigthed by individual level behaviors such as frequency of visitation capture the fact that multiple levels of influence impact outcomes such as diet quality and weight status. Greater application of tools that holistically measure complex food environments will enhance understanding of the numerous determinants of food choice. Indeed a recent synthesis of published reviews by Sacks et al. (2019) highlighted the need for composite measures of food environments accounting for the complexity of how individuals interact with food environments.

The absence of established clinically meaningful thresholds for the NEMS-R measures may have hampered the interpretation of more versus

Table 3
Child energy intake, total HEI-2010 score, zBMI and waist circumference across tertiles of NEMS-R Restaurant Count, NEMS-R within Block Group, and Weighted NEMS-R.

	Tertile 1 M (95%CI)	Tertile 2 M (95%CI)	Tertile 3 M (95%CI)	p-value
Restaurant Count (n = 392)				
n	136	126	130	
Energy				
Unadjusted	1706 (1636, 1776)	1737 (1664, 1809)	1741 (1669, 1812)	0.76
Adjusted^	1588 (1475, 1701)	1559 (1445, 1672)	1618 (1505, 1731)	0.50
HEI Total Score				
Unadjusted	58.4 (56.4, 60.5)	58.0 (55.9, 60.1)	59.9 (57.8, 62.0)	0.43
Adjusted^	60.3 (56.8, 63.8)	59.3 (55.8, 62.8)	60.6 (57.2, 64.1)	0.68
z-BMI				
Unadjusted	0.47 (0.31, 0.63)	0.34 (0.17, 0.51)	0.31 (0.13, 0.48)	0.36
Adjusted^^	0.65 (0.39, 0.92)	0.45 (0.18, 0.72)	0.50 (0.23, 0.76)	0.20
Child Waist Circumference				
Unadjusted	63.3 (61.7, 65.0)	62.8 (61.1, 64.5)	63.2 (61.6, 64.9)	0.89
Adjusted^^	66.1 (63.7, 68.4)	64.7 (62.3, 67.0)	65.9 (63.6, 68.3)	0.33
NEMS-R within Block Group (n = 302)				
n	98	103	101	
Energy (kcals)				
Unadjusted	1669 (1584, 1754)	1766 (1684, 1849)	1752 (1672,1832)	0.22
Adjusted^	1499 (1349, 1650)	1570 (1414, 1727)	1565 (1418, 1712)	0.40
HEI Total Score				
Unadjusted	61.0 (58.5, 63.6)	56.8 (54.4, 59.3)	58.2 (55.8, 60.6)	0.06
Adjusted^	59.7 (54.9, 64.5)[a]	55.1 (50.1, 60.1)[b]	57.1 (52.5, 61.8)[a,b]	**0.048***
z-BMI				
Unadjusted	0.34 (0.15, 0.54)	0.37 (0.19, 0.55)	0.44 (0.26, 0.62)	0.77
Adjusted^^	0.66 (0.31, 1.00)	0.72 (0.36, 1.07)	0.80 (0.47, 1.13)	0.51
Child Waist Circumference				
Unadjusted	62.7 (60.7, 64.7)	62.9 (61.0, 64.9)	64.5 (62.6, 66.4)	0.36
Adjusted^^	69.2 (66.0, 72.4)	68.7 (65.4, 72.1)	70.4 (67.3, 73.6)	0.33
Weighted NEMS-R (n = 317)				
n	127	96	117	
Energy				
Unadjusted	1781(1697, 1865)	1745 (1649, 1841)	1774 (1689, 1859)	0.85
Adjusted^	1778 (1697, 1858)	1738 (1645, 1831)	1782 (1700, 1863)	0.75
HEI Total Score				
Unadjusted	58.1 (56.0, 60.2)	59.1 (56.7, 61.5)	56.4 (54.3, 58.5)	0.23
Adjusted^	58.1 (56.0, 60.2)	58.6 (56.1, 61.0)	56.6 (54.4, 58.7)	0.43
z-BMI				
Unadjusted	0.55 (0.37, 0.72)	0.27 (0.07, 0.47)	0.32 (0.14, 0.50)	0.08
Adjusted^^	0.52 (0.35, 0.69)	0.31 (0.11, 0.51)	0.31 (0.14, 0.49)	0.16
Child Waist Circumference				
Unadjusted	66.1 (64.3, 67.9)[a]	61.7 (59.7, 63.7)[b]	63.0 (61.2, 64.9)[a,b]	**0.004****
Adjusted^^	65.5 (64.0, 67.1)[a]	62.8 (61.0, 64.6)[b]	62.7 (61.1, 64.3)[a,b]	**0.02***

Superscript letters different from each other indicate a significant difference (p < 0.05) between tertiles.

^Adjusted for parent education, child sex, high (vs. low) neighborhood nutrition environment, child age
^^Adjusted for parent education, child sex, high (vs. low) neighborhood nutrition environment, child age, parent BMI
*$p < 0.05$; **$p < 0.01$
NEMS-R, Nutrition Environment Measures Survey—Restaurant; HEI, Healthy Eating Index; BMI, body mass index

less favorable consumer restaurant environments on the outcomes of this study (Saelens et al., 2007). Notably, across all NEMS-R variables, there was wide variability within each tertile, attenuating findings. The present study also had a large range in the highest tertile (Tertile 3) for NEMS-R, so the range of having a favorable consumer environment even in that single tertile was wide. Also, given the metropolitan nature of the study areas, having more unhealthy restaurants in a neighborhood may be a proxy for having other amenities nearby such as grocery stores that can increase the opportunity for children to eat healthfully, particularly at home (Lovasi et al., 2009). The presence of less favorable consumer environments of restaurants and grocery stores/supermarkets can coexist, meaning there is a co-occurrence/clustering of both food establishment types (Lamichhane et al., 2012) especially in more densely populated mixed-use and walkable neighborhoods. Increasing walkability could conceivably both provide more options for nearby healthy eating and encourage more physical activity, which could impact outcomes such as waist circumference as seen in this study. Adequate facilities for physical activity may also offset unhealthy food consumption (da Costa Peres et al., 2020).

It is noteworthy that children in this sample engaged in limited eating out beyond lunch at the school cafeteria (which was not included in this analysis), and this limited variability likely reduced power to detect associations. Lunch was by far the meal most often eaten away from home, mainly at the school cafeteria on weekdays. Given the number of children consuming at least one meal per week at school, future exposure models should consider the role of the school food environment within the broader influence of food environments on children's dietary intake. Examination of this relationship in an adolescent population, which may be more independently making food decisions, but also have money and transportation to access food away from home, is warranted.

Child energy intake and diet quality does not appear to be adequately explained by simply knowing the quantity or quality of restaurants where they live. In addition to understanding the quality of the specific restaurants visited, it may be necessary to simultaneously consider multiple food environments, including school, home, and food stores (Couch et al., 2014). There are likely numerous influences on how often children eat out at a restaurant and which restaurant is selected. Such factors and corresponding decisions about whether and where to eat out may be as or more important than the average quality of restaurants nearby one's home, at least for families with children. There is a critical need for the identification of behavioral pathways through which the built environment (including food establishments) impacts health outcomes as noted previously in the literature (Sacks et al., 2019; Cobb et al., 2015; Drewnowski et al., 2016).

5. Strengths and limitations

This study not only examined the influence of the neighborhood food environment through restaurant counts, a more common measure, but focused on quality of the proximal and visited restaurant environment through NEMS-R observations. A novel measure integrated the consumer restaurant environment with the reported frequency of exposure (weighted NEMS-R) to better assess expected impact on childrens' dietary intakes. Findings were in the expected direction with waist circumference, that as the exposure improved (higher quality environment and less frequent visits) waist circumference decreased.

Important study limitations were the cross-sectional design, limited racial/ethnic diversity of the sample, the low frequency of children's eating out at restaurants, and inclusion of only two geographic regions of the United Sates. While data are from 2007 to 2009 very few studies have linked restaurant environment data with outcomes, specifically dietary outcomes using 24-hour recall methodology. Although an expected relationship between the consumer environment of the restaurant visited and an important measure of child anthropometrics was observed, it remains unknown if children made choices of higher diet quality in more favorable consumer environments.

6. Conclusion

The nutrition environment of restaurants had limited associations with energy intake, diet quality, and anthropometrics of children in this sample. Given the frequency of eating out was limited in this sample, examining this relationship among more frequent consumers at restaurants is important. Identifying and measuring potential co-existing aspects of the away-from-home food environment, such as the school environment, that may influence diet and weight outcomes, is necessary.

Declaration of Competing Interest

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