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Differences in Infant Diet Quality Index by Race and Ethnicity Predict Differences in Later Diet Quality

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A B S T R A C T

Background: Racial and ethnic disparities in infant-feeding practices may negatively influence diet quality and health.
Objectives: This study investigated the racial, ethnic, and language (English or Spanish) differences in infant diet quality, later diet quality, and weight status at 2–5 y, and whether these differences were explained through infant diet quality among participants in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).
Methods: Using the WIC Infant and Toddler Feeding Practices Study-2 (unweighted $n = 2663$; weighted $n = 362,712$), relationships between the Infant Dietary Quality Index (IDQI; range 0–1) and Healthy Eating Index-2020 (HEI-2020; range 0–100) and BMI z-score (BMIz) at 2–5 y were analyzed by race, ethnicity, and language preference [Hispanic Spanish-speaking, Hispanic English-speaking, non-Hispanic (NH) White, and NH Black participants]. Statistical interaction between IDQI and each group was evaluated in multivariable models. The mediation of each group through the IDQI was assessed using causal mediation methods.
Results: Differences in IDQI [mean (standard deviation)] were observed between Hispanic Spanish-speaking participants [0.41 (0.10)], Hispanic English-speaking participants [0.37 (0.10)], NH White participants [0.36 (0.10)], and NH Black participants [0.35 (0.09)], $P <$ 0.001. Differences in HEI-2020 occurred at 2–5 y, with the Hispanic Spanish-speaking participants having consistently higher HEI-2020 scores. Differences in BMIz were observed at 5 y, with higher scores among Hispanic Spanish-speaking participants. Interaction between race, ethnicity, and IDQI was observed for all outcomes except for BMIz at 3 y. Through mediation, IDQI explained 13%–20% of the difference in HEI-2020 scores between Hispanic Spanish-speaking and NH White participants at 2–5 y. IDQI explained 22%–25% of the difference in HEI-2020 scores between the Hispanic Spanish-speaking and NH Black participants at 4 y and 5 y.
Conclusions: Higher infant diet quality scores observed in Hispanic Spanish-speaking participants explain some of the racial and ethnic differences observed in later diet quality, suggesting that improving infant diet quality may help reduce diet disparities during early childhood.

Keywords: infant diet quality index, race, ethnicity, language, acculturation, WIC, children, HEI, complementary feeding

Introduction

Healthy growth and development during infancy are closely linked to nutrition throughout early infancy and childhood [1]. Children build lifelong eating habits starting at an early age, with many children developing long-term weight and health-influencing dietary habits by as early as 2 y [2–4]. However, racial and ethnic disparities in complementary feeding practices exist, and have been shown to negatively influence weight, diet quality, and health [5,6]. For example, compared with non-Hispanic (NH) White participants, NH Black participants are more likely to provide exclusive formula feeding, give infants bottles to sleep, and introduce solid foods earlier than recommended, which may contribute to a higher risk of obesity [7]. Therefore, it is important to identify racial and ethnic differences, which may capture differences in traditions, lifestyle, language, diet, and values [8] in diet quality and weight status during childhood, as well as determine to what extent

Abbreviations: ALSPAC, Avon Longitudinal Study of Parents and Children; AMPM, Automated Multiple Pass Method; BMIz, BMI z-score; DGA, Dietary Guidelines for Americans; HEI-2020, Healthy Eating Index-2020 scores; IDQI, Infant Diet Quality Index; NH, non-Hispanic; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children; WIC ITFPS-2, WIC Infant and Toddler Feeding Practices Study-2.

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these differences are explained through early infant diet quality.

Previous studies focusing on understanding early infant-feeding practices have primarily concentrated on higher-income and White populations [9,10]. For example, a study of 377 Caucasian participants in Canada found that at the age of 8–10 y, children who were never breastfed or breastfed for 3–6 mo were less likely to consume the recommended amount of vegetables compared than those who were breastfed for >6 mo [11]. A study using data from the Avon Longitudinal Study of Parents and Children cohort of >4000 children in the United Kingdom found that higher adherence to the complementary feeding guidelines was associated with healthier dietary patterns and higher cognitive IQ results in children aged 7–8 y [12]. Although these studies emphasized the importance of early diet quality, their limitations were that the population was not racially or ethnically diverse and the findings may not be generalizable to other racial or ethnic minority groups or low-income children that may have higher disparities in diet quality.

Previous studies examining infant diets in more diverse populations focused on either specific feeding behaviors or dietary patterns but did not examine the longitudinal relationship between diet quality during infancy, later diet quality, and health in a diverse sample. A 2014 study of 1275 infants from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) found that at 12 mo, NH African-American infants had higher unhealthy dietary pattern scores, including greater consumption of high-sugar and high-fat foods, whereas NH White infants had dietary patterns that better adhered to the infant dietary guidelines [13]. Moreover, differences in dietary patterns have also been observed by acculturation, measured by language preference, which may be more representative of nutritional outcomes than race or ethnicity alone [14]. For example, Hispanic participants who recently immigrated to the United States tended to preserve more of their traditional food patterns, which tend to be higher in fruits and vegetables and adhere more closely to dietary guidance than Hispanic participants who lived in the United States for longer [15,16].

Despite low-income children and minorities having poorer diets and being at risk of future health disparities, few longitudinal studies focused on assessing the racial and ethnic differences in infant diet quality and later diet quality in United States children. Thus, this study aimed to determine racial, ethnic, and language (English or Spanish) differences in infant diet quality, later diet quality, and weight status at 2–5 y and if differences at 2–5 y were explained through early infant diet quality among participants in the WIC. We hypothesized that children from racial and ethnic minorities will have lower childhood diet quality scores and higher weight status at 2–5 y, which are partially explained through differences in infant diet quality. Moreover, infant diet quality will mediate the relationship between race and ethnicity and childhood diet quality and weight status at 2–5 y.

Methods

Participants

This study analyzed data from the WIC Infant and Toddler Feeding Practices Study-2 (WIC ITFPS-2), a national longitudinal study, which included mothers (>16 y) and their children aged ≤9 y. Data on participants aged ≤5 y were publicly available at the time of this analysis. The primary objectives of the WIC ITFPS-2 study were to examine infant and child feeding practices, the associations between WIC services and those practices, and the health and nutrition of children receiving WIC [17]. Study mothers were recruited from 80 WIC sites across 27 states and territories in 2013. Using stratified 2-stage sampling, WIC sites were selected among sites enrolling ≥30 eligible participants per month [17]. Participants received a prenatal interview and ≤16 postnatal interviews during the first 5 y (at 1, 3, 5, 7, 9, 11, 13, 15, 18, 24, 30, 36, 42, 48, 54, and 60 mo). Interviews were conducted by telephone by trained interviewers in English or Spanish. The interview questions covered sociodemographic information, breastfeeding initiation, and other feeding practices. Additionally, a 24-h dietary recall was collected at each follow-up, except at 30, 42, and 54 mo.

WIC ITFPS-2 participants were enrolled in 1 of 2 samples: the core longitudinal sample (n = 3503) or the supplemental sample (n = 864). The core sample was designed as an equal-probability sample of all new enrollees at the 80 WIC sites, whereas the supplemental sample was designed to focus on populations of interest, such as NH Black participants. Inclusion criteria included enrolling in the WIC for the first time for that pregnancy or infant and the ability to complete interviews in either English or Spanish. Exclusion criteria included children aged >2.5 mo at the time of recruitment, adolescent mothers aged <16 y, mothers in foster care at the time of enrollment, or foster parents enrolling a foster infant. The national study was approved by the Westat Institutional Review Board and the United States Office of Management and Budget and is registered at www.clinicaltrials.gov as NCT02031978.

Race, ethnicity, and language preference

Maternal ethnicity was self-reported at enrollment through the following question: "Are you Hispanic or Latino?" Options included yes, no, do not know, or refused. Ethnicity, which may capture components of a person's lifestyle and tradition, was examined because it may differ among social groups and influence diet [8]. Maternal race was self-reported at enrollment through the following question: "What is your race?" Options included American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White, Other (specify), do not know, or refused. If a participant reported that they were Hispanic, the interviewer asked if they were White Hispanic or Black Hispanic. Language preference (English or Spanish) was selected by combining the language reported at each interview and taking the majority language selected. Four categories were created based on this information: Hispanic Spanish-speaking, Hispanic English-speaking, NH White, and NH Black participants. English- and Spanish-speaking Hispanic participants were examined separately based on prior studies showing differences in WIC utilization and satisfaction based on language preference, as well as research showing that language use provided a comprehensive description of a population's acculturation regarding health outcomes [14,18–21] Participants identifying as multiracial or "other" race or ethnicity were excluded from analysis due to the small sample size (n = 157).

Dietary intake

Each interview after the prenatal interview included a 24-h dietary recall, administered over the phone, using the USDA Automated Multiple Pass Method (AMPM) [22]. During the AMPM, a caregiver was asked to recall all of their child's dietary intake during the previous day, including the weekday or the weekend. The caregiver was asked to report all foods, beverages (including infant formula and breastfeeding), and dietary supplements for each eating event [23]. Nutrient values were taken from the USDA Food and Nutrient Database for Dietary Studies 5.0 [24]

Infant diet quality index

The infant diet quality index (IDQI) has been previously evaluated for predictive validity with later diet quality and weight status in a similar low-income sample [25]. The IDQI consisted of the following 16 components: *1*) breastfeeding duration; *2*) exclusive breastfeeding; the age of first introduction of: *3*) solids, *4*) iron-rich cereals, *5*) cow milk, *6*) sugar-sweetened beverages, *7*) salty or sweet snacks, *8*) other drinks or liquids (e.g., teas or broths), and *9*) textured foods; frequency of consuming *10*) fruit or *11*) vegetables; frequency of consuming different *12*) fruit or *13*) vegetables; *14*) nonrecommended bottle-feeding practices; *15*) use of commercial infant foods; and *16*) the number of meals and snacks.

Adiposity and dietary outcomes measured at 2–5 y

BMI z-scores

Weight and length/height measurements of the WIC ITFPS-2 children were collected at birth, 6 mo, and 1–5 y. As part of regular clinic visits, WIC sites directly measured most enrolled infants using standardized protocols. For participants who left the WIC, the study attempted to collect weight and length information from the child's health care provider. BMIz was calculated at 2–5 y using the Centers for Disease Control age- and sex-specific growth charts [26].

Healthy Eating Index-2020

Healthy Eating Index-2020 (HEI-2020) total scores were computed using the population ratio method. The HEI has been revised to reflect the 2020–2025 Dietary Guidelines for Americans (DGA) and is a valid tool for assessing diet quality among individuals aged $\geq$2 y [27] The 2020–2025 DGA emphasize various food groups, nutrient densities, and improving food and beverage choices based on energy needs. The HEI-2020 consists of 13 components; 9 components assess dietary adequacy (total fruits, whole fruits, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acids) and 4 assess overconsumption (refined grains, sodium, added sugars, and saturated fats).

Covariates

The demographic characteristics of the study child, including sex, birth weight, race, and ethnicity were collected from the mother during the first postnatal interview. Other sociodemographic variables collected from the study mother during the first study visit, unless otherwise specified, included maternal age at child's birth, marital status, maternal education level, maternal weight, gestational diabetes, household income, maternal depression score at the 3-mo visit, household size at the 7-mo visit, and maternal employment status at the 7-mo visit. These covariates (except for race and ethnicity) were controlled in multivariable models.

Statistical analysis

All analyses were weighted to address nonresponsiveness and support national estimates to represent WIC participants that met the ITFPS-2 study enrollment criteria: pregnant or early (<2.5 mo) postpartum, aged $\geq$16 y, spoke either English or Spanish, and enrolled in the WIC for the first time for that pregnancy or child at a clinic expected to enroll $\geq$30 prenatal women per month. Outcome specific survey weights were used so that the sample represented the population and compensated for both unequal sampling probabilities and nonresponsiveness [17]. Moreover, the estimation incorporated balanced replicated weights as recommended by the WIC ITFPS-2 study data-use guidelines.

Of the 4367 participants enrolled in the WIC ITFPS-2 study, participants for the current study were excluded for the following reasons and could fall into $\geq$1 of the following categories: 149 were born prematurely and had very low birth weight, 157 identified as multiracial or "other" race or ethnicity, 335 reported during any interviews within 2 y that their infants had long-term medical problems that could affect eating, and 1072 had no HEI or BMI data collected at age 2, 3, 4, or 5 y (Supplemental Figure 1). Premature infants and those with long-term medical problems were excluded because they had special dietary requirements specific to their medical situation and could be unfairly characterized as having poor diets.

Although the use of nonresponsive survey weights helps address bias introduced by excluding participants without any outcome data, some participants missed covariate information or data necessary to construct the IDQI score. To handle these cases, conditional multiple imputation was conducted to incorporate information from individuals with partial data using a conservative count of 10 imputations for each analysis. Differences in race, ethnicity, and language were assessed using survey-weighted linear regression in multivariable models. Each analysis was assessed for model assumptions of linearity with the predictor of interest, homoscedasticity, and normality of residuals, as well as multicollinearity via the estimation of variance inflation factors. Statistical interaction between IDQI and each racial and ethnic group was estimated by including an interaction term between the IDQI and the group in multivariable models separately for each outcome. The mediation of race and ethnicity through the IDQI was assessed using causal mediation methods [28,29], with the racial and ethnic group with the highest IDQI score serving as the comparison group. The data analysis was conducted in the statistical packages R version 4.1.1 and SAS version 9.4.

Results

Maternal and child demographic characteristics are shown in Table 1 for the unweighted (n = 2663) and weighted (n = 362,712) samples by race, ethnicity, and language. Racial and ethnic differences were observed for maternal age, marital status, maternal education, maternal employment, maternal BMI, maternal gestational diabetes, household poverty, household size, and whether any breastmilk and/or formula was provided

TABLE 1
Characteristics of participants in the WIC Infant Toddler Feeding Practices Study-2 by race, ethnicity, and language preference (unweighted $n = 2663$, weighted $n = 362{,}712$)

Characteristic[1]	Hispanic Spanish-speaking participants $n = 84{,}518$	Hispanic English-speaking participants $n = 102{,}075$	Non-Hispanic White participants $n = 101{,}026$	Non-Hispanic Black participants $n = 75{,}092$	*P* value
Maternal age at birth, **y**, *n* (%)[2]					<0.001
16–19	7522 (8.9)	16,920 (16.6)	10,058 (1.0)	8065 (10.7)	
20–25	24,248 (28.7)	43,585 (42.7)	45,547 (45.1)	35,183 (46.9)	
≥26	52,749 (62.4)	41,570 (40.7)	45,421 (45.0)	31,845 (42.4)	
Marital status at screening, *n* (%)					<0.001
Married	37,887 (44.8)	30,186 (29.6)	38,343 (38.0)	13,703 (18.2)	
Not married[4]	46,631 (55.2)	71,889 (70.4)	62,683 (62.0)	61,389 (81.8)	
Maternal education level at screening, *n* (%)					<0.001
Less than high school	38,160 (45.4)	23,426 (22.9)	18,790 (18.6)	12,572 (16.7)	
High school	23,899 (28.4)	44,910 (44.0)	35,741 (35.4)	29,500 (39.3)	
More than high school	22,045 (26.2)	33,739 (33.1)	46,495 (46.0)	33,021 (44.0)	
Maternal employment at 6 mo child age, *n* (%)[3]					0.003
Full-time	9954 (12.5)	19,426 (21.8)	17,527 (19.3)	17,201 (25.5)	
Part-time	13,937 (17.5)	15,531 (17.5)	17,731 (19.5)	15,845 (23.5)	
Not working for pay	55,939 (70.1)	54,028 (60.7)	55,555 (61.2)	34,349 (51.0)	
Maternal BMI at screening, kg/m^2, *n* (%)					0.004
Normal or under (<25.0)	39,135 (46.3)	44,998 (44.1)	52,716 (52.2)	30,352 (40.4)	
Overweight (25.0 to <30.0)	24,164 (28.6)	21,577 (21.1)	23,637 (23.4)	20,091 (26.8)	
Obese (≥30.0)	21,220 (25.1)	35,500 (34.8)	24,673 (24.4)	24,650 (32.8)	
Maternal gestational diabetes, *n* (%)	11,307 (14.4)	7346 (8.0)	4448 (4.9)	5761 (8.4)	0.002
Maternal postpartum depression, *n* (%)	4665 (6.9)	7440 (9.0)	8442 (10.1)	5628 (11.4)	0.294
Household poverty level at enrollment, *n* (%)[3,5]					<0.001
75% of guideline or below	60,876 (72.0)	65,440 (64.1)	50,245 (49.7)	51,999 (69.2)	
Above 75% but <130%	20,432 (24.2)	25,388 (24.9)	33,465 (33.1)	15,923 (21.2)	
Above 130% of guideline	3210 (3.8)	11,247 (11.0)	17,316 (17.1)	7171 (9.5)	
Household size at 6 mo child age, *n* (%)[3]					<0.001
2 people	5696 (7.1)	7320 (8.3)	4731 (5.2)	10,755 (16.0)	
3 people	18,755 (23.5)	20,330 (23.0)	24,822 (27.3)	22,233 (33.1)	
4 people	21,126 (26.4)	23,654 (26.8)	33,080 (36.4)	15,116 (22.5)	
5 or more people	34,302 (42.9)	36,985 (41.9)	28,181 (31.0)	19,146 (28.5)	
Child birth weight, kg, *n* (%)					0.830
Low (<2.5)	3383 (4.0)	3964 (3.9)	3571 (3.5)	4088 (5.4)	
Normal (2.5 to ≤4.5)	79,769 (94.4)	97,210 (95.2)	96,240 (95.3)	69,880 (93.1)	
High (>4.5)	1366 (1.6)	901 (0.9)	1214 (1.2)	1124 (1.5)	
Child sex, female, *n* (%)	40,677 (48.2)	47,037 (46.1)	45,661 (45.2)	35,927 (47.8)	0.838
Any breastfeeding, *n* (%)[6]	81,474 (96.4)	90,821 (89.0)	73,825 (73.1)	55,438 (73.8)	<0.001
Any formula use, *n* (%)[6]	83,582 (98.9)	99,050 (97.0)	95,622 (94.7)	72,333 (96.3)	0.010
BMIz at 2 y, mean (SD)	0.70 (1.36)	0.89 (1.31)	0.66 (1.20)	0.62 (1.23)	0.128
BMIz at 3 y, mean (SD)	0.63 (1.23)	0.63 (1.30)	0.50 (1.24)	0.39 (1.45)	0.125
BMIz at 4 y, mean (SD)	0.59 (1.45)	0.64 (1.33)	0.51 (1.34)	0.37 (1.32)	0.098
BMIz at 5 y, mean (SD)	0.84 (1.25)	0.66 (1.26)	0.58 (1.20)	0.42 (1.38)	0.001
Overweight or obese at 2 y, *n* (%)	13,379 (15.2)	16,703 (17.2)	12,277 (11.9)	6704 (9.5)	0.118
Overweight or obese at 3 y, *n* (%)	10,071 (11.9)	13,321 (13.2)	10,740 (10.6)	10,658 (14.3)	0.645
Overweight or obese at 4 y, *n* (%)	14,250 (16.9)	13,935 (13.5)	10,914 (10.9)	6751 (8.9)	0.077
Overweight or obese at 5 y, *n* (%)	15,463 (17.8)	16,167 (15.4)	11,544 (11.6)	6912 (9.7)	0.065
HEI-2020 at 2 y, mean (SD)	58.5 (11.1)	57.6 (11.1)	54.4 (10.4)	56.9 (11.2)	<0.001
HEI-2020 at 3 y, mean (SD)	60.8 (12.7)	57.8 (11.6)	55.4 (11.6)	56.9 (11.9)	<0.001
HEI-2020 at 4 y, mean (SD)	61.0 (12.6)	57.5 (12.7)	55.3 (12.3)	55.1 (12.6)	<0.001
HEI-2020 at 5 y, mean (SD)	61.0 (12.0)	55.7 (11.8)	53.4 (12.2)	54.7 (13.1)	<0.001
IDQI, mean (SD)	0.41 (0.10)	0.37 (0.10)	0.36 (0.10)	0.35 (0.09)	<0.001

Abbreviations: BMIz, BMI z-score; HEI-2020, Healthy Eating Index-2020; IDQI, Infant Diet Quality Index; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

[1] Values are survey-weighted means (SDs) or frequencies (%). Statistical inference from survey-weighted chi-square testing for categorical variables and survey-weighted linear regression for continuous variables.

[2] Maternal includes another primary caregiver if not the mother (<1% of respondents are caregivers other than the infant's biological mother at the time of enrollment).

[3] Because of missing values, the total *n* is not the same for all variables.

[4] Not married includes divorced, widowed, or separated.

[5] Income at 100% of the Federal Poverty Level was $23,550 for a family of 4 in 2013.

[6] The breastfeeding and formula categories do not add ≤100% due to coding the participants that consumed "both breast milk and formula" answers in the "any breastfeeding" category and the "any formula use" category.

to the infants during the first year. Compared with other racial and ethnic groups, more Hispanic Spanish-speaking participants were ≥26 y at birth, not working for pay, and had >5 people living in the household. Racial and ethnic differences in BMIz were observed at 5 y, with higher scores among Hispanic Spanish-speaking participants. Differences in IDQI scores at 0–1 y and HEI-2020 scores at 2–5 y were observed between Hispanic Spanish-speaking participants having consistently higher scores than the other groups.

Interaction between race, ethnicity, and IDQI was observed for all outcomes except for BMIz at 3 y (Table 2). Among Hispanic Spanish-speaking participants, higher IDQI scores were associated with higher HEI-2020 scores at 2 and 5 y. For Hispanic English-speaking participants, higher IDQI scores were associated with lower BMIz scores at 2 and 4 y. For NH White participants, higher IDQI scores were associated with lower BMIz at 2 and 5 y and higher HEI-2020 for all participants at 2–5 y. For NH Black participants, higher IDQI scores were not associated with BMIz but were associated with higher HEI-2020 scores at 2–5 y.

Results of mediation for HEI-2020 by select racial and ethnic groups are shown in Table 3 as the mean difference in outcome between indicated groups (total effect), the mean difference acting through an increase in IDQI (indirect effect), and the remaining effect attributable to group differences (direct effect). IDQI explained 15.6% (95% CI: 2.6, 28.6), 15.3% (95% CI: 2.9, 27.7), 20.4% (95% CI: 6.5, 34.2), and 13.3% (95% CI: 5.9, 20.7) of the difference in HEI-2020 scores at 2, 3, 4, and 5 y, respectively, between NH White and Hispanic Spanish-speaking participants. IDQI explained 25.0% (95% CI: 1.9, 48.2) of the difference in HEI-2020 scores at 4 y and 22.0% (95% CI: 3.5, 40.5) at 5 y between NH Black compared with Hispanic Spanish-speaking participants. Results of mediation for BMIz by select racial and ethnic groups are shown in Supplemental Table 1. IDQI did not explain any of the differences in BMIz at 2, 3, 4, or 5 y between racial and ethnic groups.

Discussion

Higher infant diet quality observed in children of Hispanic Spanish-speaking participants explained up to 25% of the racial and ethnic differences observed in later diet quality but did not explain the differences in weight status in low-income United States children aged 2–5 y. Children of Hispanic Spanish-speaking participants, compared with Hispanic English-speaking participants, consistently had higher IDQI and HEI scores across all childhood time points in this study. The difference in effect sizes between Hispanic Spanish-speaking and Hispanic English-speaking participants was large. Among Hispanic English-speaking participants, there was a consistently positive but small and nonsignificant association with IDQI; whereas, among Hispanic Spanish-speaking participants, there was an increase of 26.8–33.2 points out of 100 points in the HEI-2020 score if the IDQI was shifted from 0 to 1 (reflecting a change from no adherence to total adherence to infant-feeding guidelines) at age of 2 and 5 y. Although language is not the only proxy for acculturation, these results suggest that less acculturated Hispanic children may retain more of their traditional food habits and have higher intakes of fruits, vegetables, whole-fat dairy, and fiber compared with more acculturated Hispanic children, who consume unhealthier foods, such as snacks, desserts, and fried foods [30–32]. Moreover, people born in the United States are at greater risk of lower diet quality as they get older than those born in Mexico [33].

Contrary to our hypothesis, IDQI did not explain racial and ethnic differences observed in BMIz during childhood, despite being associated with lower BMIz in this sample [25]. Racial minorities are less likely to exclusively breastfeed and have a higher prevalence of food insecurity, which may increase their risk of obesity in the first 24 mo of life [5–7,34,35], although there are multiple genetic [36,37] and environmental determinants [38] that were not captured in this study, which may be more influential in examining racial and ethnic disparities. Furthermore, BMIz is a poor predictor of adiposity among

TABLE 2
IDQI score predicting BMIz and HEI-2020 scores at different ages in the WIC Infant Toddler Feeding Practices Study-2 by race, ethnicity, and language preference (unweighted $n = 2663$, weighted $n = 362{,}712$)

Outcome[1]	Hispanic Spanish-speaking participants $n = 84{,}518$	Hispanic English-speaking participants $n = 102{,}075$	Non-Hispanic White participants $n = 101{,}026$	Non-Hispanic Black participants $n = 75{,}092$	P value for interaction
BMIz at 2 y	-1.24 (-2.72, 0.24)	-2.74 (-4.60, -0.88)*	-1.31 (-2.57, -0.05)*	1.08 (-0.58, 2.74)	0.001
BMIz at 3 y	-0.56 (-2.32, 1.20)	-0.72 (-1.97, 0.54)	-0.26 (-1.97, 1.44)	-0.11 (-1.76, 1.55)	0.613
BMIz at 4 y	-0.98 (-2.83, 0.86)	-1.62 (-3.22, -0.03)*	-0.40 (-1.55, 0.74)	-0.54 (-1.82, 0.74)	0.004
BMIz at 5 y	-1.67 (-3.71, 0.36)	-1.51 (-3.08, 0.06)	-1.53 (-2.68, -0.38)*	0.67 (-0.84, 2.17)	<0.001
HEI-2020 at 2 y	33.16 (19.69, 46.63)*	12.30 (-1.41, 26.01)	11.18 (3.10, 19.26)*	14.06 (2.58, 25.53)*	<0.001
HEI-2020 at 3 y	5.55 (-9.52, 20.62)	9.26 (-7.61, 26.13)	19.42 (7.24, 31.60)*	22.43 (10.39, 34.48)*	<0.001
HEI-2020 at 4 y	4.19 (-12.25, 20.63)	15.37 (-0.52, 31.27)	25.56 (14.36, 36.76)*	17.11 (2.70, 31.52)*	<0.001
HEI-2020 at 5 y	26.75 (9.37, 44.13)*	5.61 (-9.07, 20.28)	19.23 (5.14, 33.32)*	15.02 (4.25, 25.79)*	<0.001

Abbreviations: BMIz, BMI z-score; HEI-2020, Healthy Eating Index-2020; IDQI, Infant Diet Quality Index; WIC, Special Supplemental Nutrition Program for Women, Infants and Children.

[1] Values are β-coefficients and 95% confidence intervals for IDQI (range 0–1; reflecting a change from no adherence to total adherence to infant-feeding guidelines) predicting the indicated outcome within the indicated ethnicity and language strata. Statistical inference from survey-weighted linear regression controlling for child sex and birth weight as well as maternal age at child's birth, marital status, maternal education level, maternal weight, household income, gestational diabetes, maternal depression score at the 3-mo visit, household size at the 7-mo visit, and maternal employment status at the 7-mo visit.

* Indicates associations within race strata with $P < 0.05$.

TABLE 3

Association of race and ethnicity on HEI-2020 score mediated by IDQI at different ages partitioned by causal mediation analysis in the WIC Infant Toddler Feeding Practices Study-2 by race, ethnicity, and language preference (unweighted $n = 2663$, weighted $n = 362{,}712$)

Outcome[1]	Total effect β (95% CI)	Direct effect β (95% CI)	Indirect effect β (95% CI)	Percent mediated % (95% CI)
Hispanic English-speaking vs. Hispanic Spanish-speaking participants				
HEI-2020 at 2 y	-1.95 (-3.61, -0.29)*	-1.50 (-3.18, 0.18)	-0.45 (-0.97, 0.06)	23.79 (-9.92, 57.51)
HEI-2020 at 3 y	-2.15 (-3.72, -0.58)*	-1.81 (-3.46, -0.17)*	-0.33 (-0.79, 0.12)	15.78 (-10.26, 41.82)
HEI-2020 at 4 y	-1.48 (-3.11, 0.15)	-1.11 (-2.75, 0.52)	-0.37 (-0.77, 0.03)	24.78 (-12.40, 61.96)
HEI-2020 at 5 y	-3.63 (-5.56, -1.69)*	-3.30 (-5.31, -1.29)*	-0.33 (-0.75, 0.10)	9.28 (-4.08, 22.63)
Non-Hispanic Black vs Hispanic Spanish-speaking participants				
HEI-2020 at 2 y	-1.89 (-3.91, 0.12)	-1.09 (-3.27, 1.08)	-0.80 (-1.43, -0.16)*	56.23 (-161.27, 273.72)
HEI-2020 at 3 y	-1.61 (-3.43, 0.21)	-0.71 (-2.59, 1.18)	-0.90 (-1.76, -0.05)*	65.31 (-140.91, 271.53)
HEI-2020 at 4 y	-4.07 (-5.78, -2.36)*	-3.05 (-4.88, -1.23)*	-1.02 (-1.88, -0.15)*	25.02 (1.86, 48.17)*
HEI-2020 at 5 y	-4.95 (-6.78, -3.12)*	-3.88 (-5.89, -1.86)*	-1.07 (-1.84, -0.30)*	21.96 (3.46, 40.46)*
Non-Hispanic White vs Hispanic Spanish-speaking participants				
HEI-2020 at 2 y	-4.38 (-6.39, -2.37)*	-3.71 (-5.70, -1.72)*	-0.67 (-1.12, -0.22)*	15.64 (2.64, 28.63)*
HEI-2020 at 3 y	-4.69 (-6.10, -3.27)*	-3.97 (-5.51, -2.44)*	-0.71 (-1.22, -0.20)*	15.31 (2.90, 27.72)*
HEI-2020 at 4 y	-4.85 (-7.02, -2.68)*	-3.88 (-6.06, -1.70)*	-0.97 (-1.47, -0.47)*	20.35 (6.47, 34.23)*
HEI-2020 at 5 y	-7.02 (-8.59, -5.45)*	-6.09 (-7.66, -4.51)*	-0.94 (-1.45, -0.42)*	13.32 (5.93, 20.72)*

Abbreviations: CI, confidence interval; HEI-2020, Healthy Eating Index-2020; IDQI, IDQI, Infant Diet Quality Index; WIC, Special Supplemental Nutrition Program for Women, Infants and Children.

[1] Values are β-coefficients and 95% CIs in the ethnicity and language category predicting the indicated outcome partitioned into total, direct, and indirect effects of survey-weighted causal mediation. Models control for study child sex and birth weight as well as maternal age at child's birth, marital status, maternal education level, maternal weight, household income, gestational diabetes, maternal depression score at the 3-mo visit, household size at the 7-mo visit, and maternal employment status at the 7-mo visit.

* Indicates estimates with $P < 0.05$.

younger children [39,40]. Despite not observing a downstream association with IDQI being a mediator of BMIz, it remains important to understand the early differences in dietary risk factors during the critical complementary feeding period because it may help address racial and ethnic disparities in other health outcomes.

This study is novel in that it investigates racial and ethnic differences in infant diet quality, later diet quality, and weight status in a low-income United States sample, although the results may not be generalizable to other populations, and correction for multiple comparisons was not conducted. Although this study controlled for various factors (e.g., maternal weight) that may confound results, other factors such as genetics, which are related to racial and ethnic differences in diet and weight status, were not measured in the study. A single 24-h dietary recall at each follow-up was reported by the parents, who may overreport their child's total energy intake, as has been shown in other research [41]. However, a strength of this study is that dietary recalls were collected over multiple follow-ups to assess diet quality from ages 2 to 5 y. Infants born prematurely and with very low birth weight and those who had a long-term medical problem that could affect eating were excluded from the analysis because their special dietary needs could have unfairly characterized their diet quality. Furthermore, infants of parents from other racial and ethnic groups were excluded because their sample size was small. Moreover, nonresponse bias may have been introduced into the study because ~33% of the sample was excluded for not having BMIz or HEI-2020 scores at either 2, 3, 4, or 5 y. However, nonresponsiveness survey weights and conditional multiple imputation were used to generate estimates reflective of the original sample.

In conclusion, higher infant diet quality scores have been observed in children from Hispanic Spanish-speaking participants, which explains some of the racial and ethnic differences observed in later diet quality, although IDQI does not explain the group differences in weight status. Improving infant diet quality may help reduce disparities in diet quality during early childhood. Future research should examine racial and ethnic group differences in infant-feeding strategies (i.e., breastfeeding duration, fruit and vegetable frequency, or age of introduction of solids) for early intervention.

Author contributions

The authors' responsibilities were as follows – LEA, LDR, EAF: designed the research; LEA, LDR, EAF, CDA: conducted the research; CDA: analyzed the data; LEA, SKL: wrote the paper; LEA: took primary responsibility for the final content; and all authors: read and approved the final manuscript.

Conflicts of Interest

LA reports financial support was provided by National Institutes of Health (NIH) and the U.S. Department of Agriculture (USDA). The authors report no conflicts of interest.

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Data availability

Data described in the manuscript and a code book are publicly and freely available without restriction at https://data.nal.usda.

gov/dataset/wic-infant-and-toddler-feeding-practices-study-2-wic-itfps-2-prenatal-infant-year-5-year-datasets and https://osf.io/pmtvq/.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tjnut.2023.10.010.

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