


ORIGINAL ARTICLE

Consumption of obesogenic foods in non-Hispanic black mother–infant dyads

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Abstract

Obesity continues to be a problem in the United States. Of particular concern is the epidemic of early childhood obesity. A significant predictor of child diet is maternal diet, but little is known about this relationship during infancy. This study examined the association between maternal and infant consumption of key food groups from 6 to 18 months using data from the Infant Care, Feeding, and Risk of Obesity Study, a prospective cohort of 217 non-Hispanic black, low-income, first-time mothers. Using data from 24-hr dietary recalls collected during in-home visits at 6, 9, 12, and 18 months, we assessed longitudinal associations between mother and child intake of both energy-dense, nutrient-poor (obesogenic) food groups and fibre-, nutrient-rich food groups using random intercept logistic regression. Both mothers and their infants had high intake of sugar-sweetened beverages, desserts, and sweets and low intake of vegetables and whole grains. Infant consumption of key food groups was strongly associated with maternal consumption, suggesting the need for focused interventions to target maternal diet as a pathway to decreasing risk for the establishment of poor dietary patterns early in life.

KEYWORDS

diet, infant nutrition, maternal nutrition, obesity, postpartum

1 | INTRODUCTION

Childhood obesity continues to be a major public health concern, affecting even the youngest age group of infants and toddlers. Currently, 8.1% of children under 2 are considered at risk for obesity (weight-for-length ≥ 95 th percentile) with rates higher among non-Hispanic black (NHB) children compared to non-Hispanic white children (Dalenius, Borland, Smith, Polhamus, & Grummer-Strawn, 2012; Freedman, 2011; Ogden, Carroll, Kit, & Flegal, 2014). Being overweight in the first 2 years of life is associated with obesity and higher risk for chronic diseases in adolescence and adulthood (Baird et al., 2005; Nader et al., 2006; Reilly et al., 2005; Skilton et al., 2013; Stocks et al., 2011; Taveras et al., 2011). Eating patterns that emerge during infancy track through childhood and have lasting effects on the development of food preferences and control of intake later in life (Golley et al., 2013; North & Emmett, 2000; Northstone & Emmett, 2005; Skinner, Carruth, Bounds, Ziegler, & Reidy, 2002). For example, children who consume sugar-sweetened beverages (SSBs) during infancy are more likely to consume them at age 6 years whereas not consuming fruits and vegetables (F&V) makes children less likely to

consume them later on (Park, Pan, Sherry, & Li, 2014). One possible, yet understudied, determinant of infant diet is maternal diet (Howard, Mallan, Byrne, Magarey, & Daniels, 2012; Wen, Simpson, Rissel, & Baur, 2013). Mothers are typically responsible for purchasing food, preparing meals, and feeding their children. A mother's preference for and consumption of certain foods could impact whether or not they are offered to their children, which for older children has been shown to influence not only their dietary preferences, but also their weight (Fisher & Birch, 1995; Howard et al., 2012; Papas, Hurley, Quigg, Oberlander, & Black, 2009; Robinson et al., 2007; Saavedra, Deming, Dattilo, & Reidy, 2013).

For many women, diet quality is suboptimal, particularly in the postpartum period (Durham, Lovelady, Brouwer, Krause, & Ostbye, 2011; Fowles & Walker, 2006; George, Hanss-Nuss, Milani, & Freeland-Graves, 2005; Wiltheiss et al., 2013). For example, 92.7% of adult females aged 19–30 do not meet the minimum recommendation for fruit, 94.1% for vegetables and 99.8% for whole grains (Krebs-Smith, Guenther, Subar, Kirkpatrick, & Dodd, 2010). Nearly all children aged 2–3 years (99.4%) and 94.4% of adult females aged 19–30 years exceed recommendations for solid fats, and 98.3% and 85.0% exceed

recommendations for added sugars, respectively (Krebs-Smith et al., 2010). Increasing evidence suggests that consuming obesogenic foods, or energy dense/nutrient-poor foods, such as desserts, salty snacks, and SSBs in place of nutrient- and fibre-rich foods such as F&V and whole grains contributes to unhealthy eating patterns and weight gain (Houchins et al., 2012; Leahy, Birch, & Rolls, 2008; Rolls, Ello-Martin, & Tohill, 2004).

Understanding the influence that maternal diet has on infant diet may be particularly important among NHB families, owing to their different feeding practices compared to other races/ethnicities, such as greater likelihood for early introduction of inappropriate foods (Thompson & Bentley, 2013) and breastfeeding rates that lag far behind that of white and Hispanic women (Centers for Disease, C., & Prevention, 2010). Yet few studies have been conducted among dyads from this important racial/ethnic group. Given the importance of early learning on the development of food preferences and the prevalence of obesogenic diets, a need for longitudinal studies focused on infant consumption in NHB families exists. The purpose of this study is to (a) explore maternal and infant consumption of key food groups, including those associated with an obesogenic diet, from 6 to 18 months postpartum in a low-income, NHB population, (b) identify predictors of maternal and infant intake, and (c) determine associations between maternal and infant consumption of key food groups so that results can be used to guide interventions aimed at influencing intake during the first 2 years of life.

2 | PARTICIPANTS AND METHODS

Data come from the Infant Care, Feeding, and Risk of Obesity Project (Infant Care), a longitudinal, observational cohort study of first-time, NHB mothers aged 18–35 years who were recruited through the North Carolina Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) (Laraia, Borja, & Bentley, 2009; Sacco, Bentley, Carby-Shields, Borja, & Goldman, 2007; Thompson, Adair, & Bentley, 2013; Thompson & Bentley, 2013; Wasser et al., 2011; Wasser et al., 2013). WIC is a federal assistance program that provides health care and nutrition for low-income pregnant and/or breastfeeding women and infants and children under 5. Data collection began in November 2003 and was completed in October 2007. Two hundred seventeen dyads were recruited. Mother–infant dyads were followed with in-home visits when infants were 3, 6, 9, 12, and 18 months of age. At each home visit, various maternal, infant, and household characteristics were assessed through interviewer-administered questionnaires. Infants who were ≤ 35 weeks gestation, < 2500 or ≥ 4500 grams in birth weight, had chronic or congenital illness, were receiving medical treatment that interfered with dietary intake, growth, or development (e.g., Down's syndrome, cerebral palsy, epilepsy, diagnosed mental retardation, cleft lip, or palate), or presented with failure-to-thrive were excluded from the study.

The analytic sample includes 179 unique mother–infant dyads with dietary intake data from at least one of the home visits at months 6, 9, 12, and 18. The protocol was approved by the Institutional Review Board at the University of North Carolina at Chapel Hill.

Key messages

- Dietary guidelines are needed for infants and toddlers. Currently, the DGAs begin at age 2; an initiative is under way to include these populations in future DGAs, which, as our study demonstrates, is necessary.
- Infancy is an opportune time to intervene, for that is when food preferences and lifelong diet habits begin to form. The impact maternal dietary behaviours can have on infants should not be ignored given the implications role modelling can have on a child's dietary habits and food preferences.
- Programs that target adoption of healthy eating behaviours in mothers may prove beneficial for young children's eating behaviours and subsequent obesity risk.

2.1 | Dietary intake

During each home visit, maternal and infant dietary intakes were assessed with computerized 24-hr dietary recalls (24HDRs) administered by trained study personnel using the Nutrient Data System for Research (version 2005; Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN). For infants, to improve estimates of usual food intakes, an additional 24HDR was collected via telephone on a random, nonconsecutive day within 2 weeks of the home visit (Thompson & Subar, 2013). Mothers were instructed in advance to obtain information about any foods and beverages consumed by the infant while not in her care. Food models and pictures were used to aid in the estimation of portion sizes. One 24HDR was used for mothers, and an average of two 24HDRs were used for infants from each visit.

Key food groups were similar to those used in the Feeding Infants and Toddlers study (FITS) and included low energy-dense foods as well as foods higher in energy density (Briefel et al., 2010). Low energy-dense food groups were defined according to the 2015–2020 Dietary Guidelines for Americans (DGAs): fruits (including 100% fruit juice), vegetables (excluding fried vegetables), whole grains, and lean protein foods (meat, poultry, seafood, eggs, soy products, and nuts) (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). Energy-dense food groups included SSBs, salty snacks, desserts and sweets, and fried vegetables, which include French fries, hash browns, and onion rings; according to the American Academy of Pediatrics, these foods are considered inappropriate for infants and toddlers and should not be consumed (American Academy of Pediatrics, 2014). Mothers and infants were defined as “consumers” of each food group (yes/no) if consumption of any amount occurred at least once in the food record.

2.2 | Predictor variables

Predictors of intake were drawn from the literature and include factors previously associated with maternal and infant diet: maternal education, age, body mass index (BMI), marital status, employment,

depression, living in a single-headed household, breastfeeding and infant weight-for-height and sex (George et al., 2005; Hendricks, Briefel, Novak, & Ziegler, 2006; Smithers et al., 2012; Wiltheiss et al., 2013). Depression was measured using the Center for Epidemiological Studies Depression Scale (Radloff, 1977). For breastfeeding status, mothers were asked at each visit whether they were still breastfeeding. Maternal weight and height were measured by a trained research assistant at a subset of visits (3, 6, and 18 months), and BMI was calculated for each individual, $\text{weight(kg)/height(m)}^2$. Weight status was categorized based on international classification guidelines: underweight/normal = BMI < 25; overweight = BMI 25–29.9; and obese = BMI ≥ 30.0 . Infant anthropometrics were measured at each home visit. Weight-for-length z-scores were calculated using the CDC/NCHS 2000 growth reference (Ogden et al., 2002).

2.3 | Statistical analysis

Sample characteristics at each time point (6, 9, 12, and 18 months) are described as frequencies for categorical variables and means and standard deviations for continuous variables. Data are presented as the proportion consuming any amount of a food group at each time point.

Polychoric correlation matrices were used to test for collinearity among predictors. Marital status was highly correlated with education and single-headed households ($\rho \geq 0.7$) and was therefore dropped as a predictor. We assessed the bivariate relationship of demographic and household characteristics with infant and maternal intake separately for each food group.

We used random intercept logistic regression models to assess how infant consumption of foods from each food group related to maternal consumption of that same food group, adjusting for demographic and household characteristics shown to be significant predictors in bivariate analyses, plus a variable representing study visit (time). All tests were two-sided, and p values <0.05 were regarded as statistically significant. Due to correlations between outcome variables, correction for multiple testing using the Bonferroni method (which assumes totally independent tests and variables) was not applied. To account for missingness in the demographic and household predictor values, we imputed using the last observation carried forward method. To address the potential for selection bias, differences in baseline characteristics between those who were present and those who were absent at each visit were assessed. All analyses were conducted using Stata 14 (StataCorp, College Station, TX).

TABLE 1 Demographic characteristics of mothers and infants participating in the Infant Care, Feeding, and Risk of Obesity study

	Study visit (month)					
	3 (n = 217)	6 (n = 143)	9 (n = 147)	12 (n = 120)	18 (n = 122)	
Maternal characteristics						
Age, yr (SD)	22.7 (3.8)	23.0 (3.9)	23.3 (3.9)	24.2 (4.2)***	24.5 (4.1)**	
Education, % (n)	<High school	26.7 (58)	26.6 (38)	26.5 (39)	25.0 (30)	26.2 (32)
	High school graduate	30.0 (65)	28.0 (40)	27.2 (40)	22.5 (27)**	27.9 (34)
	\geq Some college	43.3 (94)	45.5 (65)	46.3 (68)	52.5 (63)**	45.9 (56)
Married, % (n)	21 (9.8)	10.6 (15)	13.9 (19)	14.4 (16)*	17.9 (17)	
Single headed household, % (n)	19.8 (43)	24.1 (34)	23.4 (33)	24.6 (29)	29.3 (34)	
Currently working, % (n)	53.7 (115)	61.9 (86)	63.1 (89)	58.6 (68)	62.6 (72)	
Receiving WIC benefits, % (n)	96.2 (203)	93.0 (133)	90.5 (133)	85.8 (103)	73.8 (90)	
Depressed ^a , % (n)	29.8 (62)	30.4 (38)	25.0 (34)	29.2 (33)	33.6 (38)	
Breastfeeding, % (n)	22.6 (49)	16.2 (23)	11.0 (16)	6.7 (8)*	2.5 (3)*	
Obese ^b , % (n)	44.2 (96)	47.9 (67)	NA	NA	48.2 (40)	
Infant characteristics						
Sex (male), % (n)	52.3 (103)	44.1 (63)	46.9 (69)	45.0 (54)	48.4 (59)	
Overweight (>95th percentile), % (n)	13.7 (27)	15.5 (22)	15.2 (22)	12.1 (14)**	11.5 (14)	

Significantly different at baseline at

* $p < .05$.

** $p < .01$.

*** $p < .001$.

^aMeasured using the Center for Epidemiological Studies Depression Scale with a score of ≥ 16 indicating depressive symptoms.

^bWeight status was not measured at the 9- and 12-month visits.

3 | RESULTS

Dietary recalls were collected from 143 mothers–infant dyads at month 6 (65.9%), 147 at month 9 (67.7%), 120 at month 12 (55.3%), and 122 at month 18 (56.2%; see Table 1). In total, there were 179 unique mother–infant dyads across all time points. There was a high prevalence of obesity within this sample of young, first-time NHB mothers. Most mothers were receiving benefits from the North Carolina Supplemental Nutrition Program for Women, Infants, and Children (WIC), and many were employed. Few mothers were breastfeeding at 6 months, and rates significantly decreased over time. Differences among those who had complete dietary recalls versus those who did not at each time point revealed few significant differences (see Table 1). Mothers with dietary recalls at 12 months were more likely to be older, married, breastfeeding and have a higher level of education and less likely to have an overweight infant at baseline. Those with dietary recalls at 18 months were more likely to be breastfeeding at baseline.

Across study visits, most mothers reported consuming vegetables and lean protein foods, and less than half consumed fruit, juice, and whole grains on a given day (see Figure 1). Most mothers reported

consuming SSBs, and at least a quarter of the mothers consumed desserts and sweets, fried vegetables, and salty snacks on a given day. Over time, the percentage of children consuming each of the food groups increased with nearly all children consuming fruit, vegetables, lean protein foods, and juice at the 18-month visit. At the 12-month visit, at least half the children consumed SSBs, desserts and sweets, and salty snacks. At the 18-month visit, more than half the children consumed fried vegetables, SSBs, and salty snacks and over 80% consumed desserts and sweets. A smaller proportion of fruit, vegetables, and juice came from baby foods across study visits. Compared to mothers, a higher percentage of infants consumed fruit, whole grains, juice, and desserts and sweets.

The unadjusted results from the bivariate analyses revealed various significant predictors of intake for both mothers and their infants, see Tables 2A and 2B. Higher maternal age (years), education level, and breastfeeding were associated with more favourable dietary intake in mothers and their children, and the presence of depressive symptoms was associated with less favourable intake (data not shown); maternal obesity was associated with infant intake. Therefore, maternal age, education, breastfeeding, depression, and obesity were included as covariates in the random intercept logistics regression models.

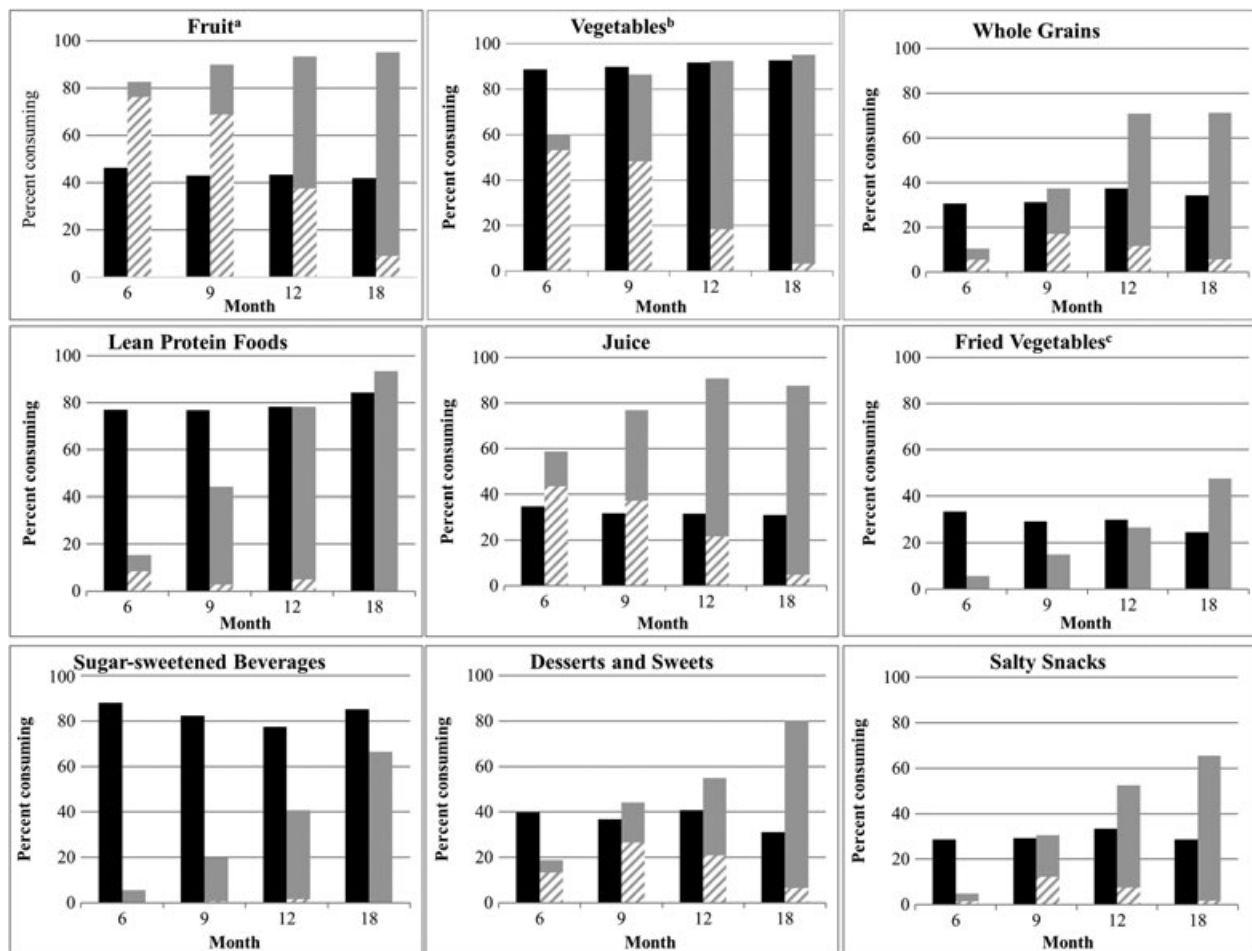


FIGURE 1 Percent consuming key food groups among mothers and infants aged 6 to 18 months participating in the Infant Care, Feeding, and Risk of Obesity study. Legend: ■ Mom, ■ Infant, ▨ Proportion of foods consumed by infants that were baby foods. ^aAll fruit, including whole fruit and juice. ^bAll vegetables, including whole and juice, excluding fried vegetables. ^cIncludes breaded and fried vegetables such as French fries, hash browns, and onion rings

TABLE 2A Bivariate analysis (odds ratio, 95% confidence intervals) of infant consumption of key food groups and household and demographic predictors in 6 to 18 months olds participating in the Infant Care, Feeding, and Risk of Obesity study

	Fruit ^a	Vegetables ^b	Whole grains	Lean protein foods ^c	Fried Vegetables ^d	SSB ^e	Desserts and sweets	Salty snacks
Maternal characteristics								
Age	1.03	0.95, 1.11	1.04	0.98, 1.11	1.09***	1.04, 1.15	1.02	0.98, 1.07
Edu-cation ^f	0.72	0.31, 1.66	1.07	0.58, 1.96	0.74	0.45, 1.22	0.58*	0.36, 0.94
>some college	0.69	0.32, 1.46	1.18	0.69, 2.04	1.05	0.68, 1.61	0.56**	0.37, 0.86
Employment	1.66	0.92, 3.01	0.79	0.49, 1.26	0.98	0.68, 1.41	0.72	0.50, 1.02
Breastfeeding	0.55	0.24, 1.29	0.95	0.44, 2.02	0.69	0.35, 1.37	0.46*	0.25, 0.84
Depressive symptoms	1.33	0.66, 2.66	1.26	0.74, 2.15	0.87	0.58, 1.29	1.46	0.98, 2.17
Single-headed household	0.70	0.37, 1.33	1.02	0.61, 1.72	1.20	0.80, 1.80	0.97	0.65, 1.43
Weight	1.36	0.65, 2.83	0.96	0.53, 1.74	0.85	0.51, 1.40	0.90	0.56, 1.46
Obese	2.16*	1.11, 4.20	1.51	0.88, 2.57	1.04	0.68, 1.59	0.90	0.60, 1.35
Infant characteristics								
Sex	0.41**	0.22, 0.77	1.15	0.73, 1.80	1.04	0.73, 1.49	1.00	0.71, 1.40
Weight	2.07	0.72, 6.00	1.19	0.60, 2.35	0.63	0.37, 1.08	1.01	0.61, 1.66

Note. SSB = sugar-sweetened beverage.

^aAll fruit, including whole fruit and juice

^bAll vegetables, including whole and juice, excluding fried vegetables.

^cIncludes lean meat, poultry and seafood, eggs, soy products, nuts, and seeds.

^dIncludes breaded and fried vegetables such as French fries, hash browns, and onion rings.

^eSugar-sweetened beverages.

^fReferent category is less than a high school education.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

TABLE 2B Bivariate analysis (odds ratio, 95% confidence intervals) of maternal consumption of key food groups and household and demographic predictors in mothers 6 to 18 months postpartum participating in the Infant Care, Feeding, and Risk of Obesity study

	Fruit ^a	Vegetables ^b	Whole grains	Lean protein foods ^c	Fried Vegetables ^d	SSB ^e	Desserts and sweets	Salty snacks								
Maternal characteristics																
Age	1.12***	1.05, 1.20	1.01	0.93, 1.09	1.06*	1.01, 1.13	1.02	0.96, 1.09	0.91**	0.86, 0.97	0.88**	0.81, 0.96	1.02	0.97, 1.08	1.01	0.95, 1.06
Edu-cation ^f	0.66	0.32, 1.35	1.42	0.56, 3.61	1.38	0.73, 2.60	0.51	0.25, 1.02	0.68	0.39, 1.17	1.01	0.37, 2.80	0.97	0.51, 1.84	0.74	0.39, 1.39
≥some college	2.89***	1.55, 5.38	0.94	0.43, 2.02	1.99*	1.13, 3.48	0.77	0.41, 1.47	0.44**	0.27, 0.73	0.48	0.20, 1.15	1.93*	1.10, 3.39	0.88	0.51, 1.53
Employment	1.53	0.94, 2.49	0.82	0.42, 1.58	0.94	0.61, 1.46	0.94	0.58, 1.55	1.04	0.68, 1.59	0.98	0.52, 1.83	1.53	0.97, 2.41	0.80	0.52, 1.25
Breastfeeding	2.55*	1.14, 5.74	1.69	0.48, 6.03	1.75	0.86, 3.56	0.90	0.39, 2.04	0.42*	0.19, 0.97	1.24	0.44, 3.53	1.51	0.74, 3.07	1.74	0.86, 3.53
Depressive symptoms	1.32	0.77, 2.25	1.73	0.78, 3.84	0.49**	0.30, 0.81	0.96	0.56, 1.65	1.26	0.80, 1.99	1.07	0.54, 2.12	0.79	0.49, 1.29	0.93	0.57, 1.52
Single-headed household	1.06	0.60, 1.90	0.62	0.31, 1.23	0.75	0.45, 1.26	0.64	0.38, 1.10	0.78	0.48, 1.28	0.93	0.43, 1.97	0.87	0.52, 1.45	0.58*	0.34, 0.99
Weight	1.17	0.55, 2.52	0.44	0.17, 1.12	1.31	0.69, 2.48	0.71	0.36, 1.39	0.92	0.51, 1.65	0.58	0.21, 1.60	0.85	0.44, 1.62	0.77	0.40, 1.46
Obese	0.88	0.46, 1.70	0.64	0.27, 1.51	1.34	0.77, 2.32	1.37	0.75, 2.50	0.66	0.39, 1.10	0.49	0.21, 1.16	0.87	0.50, 1.51	0.90	0.53, 1.55
Infant characteristics																
Sex	0.91	0.52, 1.59	1.11	0.58, 2.12	0.94	0.59, 1.49	0.75	0.45, 1.25	0.91	0.59, 1.40	0.79	0.39, 1.60	1.07	0.67, 1.72	0.90	0.57, 1.43
Weight	0.91	0.45, 1.86	0.57	0.25, 1.30	1.21	0.65, 2.26	1.68	0.77, 3.63	1.53	0.86, 2.73	1.54	0.57, 4.16	1.04	0.55, 1.94	0.87	0.46, 1.65

Note. SSB = sugar-sweetened beverage.

^aAll fruit, including whole fruit and juice.

^bAll vegetables, including whole and juice, excluding fried vegetables.

^cIncludes lean meat, poultry and seafood, eggs, soy products, nuts, and seeds.

^dIncludes breaded and fried vegetables such as French fries, hash browns, and onion rings.

^eSugar-sweetened beverages.

^fReferent category is less than a high school education.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

TABLE 3 Results of logistic regression random intercept models examining the odds of infants consuming key food groups if their mother consumed them in mother–infant dyads 6–18 months old participating in the Infant Care, Feeding, and Risk of Obesity study

Odds ratio and 95% confidence interval (n = 530 observations on 178 mother/infant dyads)									
Odds ratio ^a	Fruit ^a		Vegetables ^b		Whole grains		Lean protein foods ^c		
	2.76**	[1.40, 5.43]	1.23	[0.57, 2.68]	1.60	[0.98, 2.60]	1.19	[0.63, 2.25]	
Maternal characteristics									
Age (years)	1.01	[0.92, 1.10]	0.99	[0.92, 1.06]	1.08*	[1.00, 1.16]	1.00	[0.92, 1.09]	
Education ^f	0.76	[0.32, 1.81]	1.09	[0.56, 2.11]	0.60	[0.30, 1.20]	0.36*	[0.16, 0.83]	
≥some college	0.57	[0.24, 1.38]	1.12	[0.58, 2.17]	0.65	[0.33, 1.29]	0.26**	[0.11, 0.60]	
Breastfeeding	0.86	[0.34, 2.18]	1.60	[0.70, 3.65]	1.35	[0.59, 3.08]	1.83	[0.71, 4.72]	
Depressive symptoms	0.83	[0.43, 1.62]	1.17	[0.66, 2.06]	1.18	[0.69, 2.00]	2.06*	[1.10, 3.86]	
Obese	1.93	[1.00, 3.72]	1.40	[0.84, 2.34]	1.30	[0.78, 2.19]	0.65	[0.36, 1.18]	
Obesogenic foods									
Odds ratio ^a	Fried Vegetables ^d		SSB ^e		Desserts/sweets		Salty snacks		
Maternal characteristics									
Age (years)	3.82***	[2.14, 6.83]	2.19*	[1.08, 4.44]	2.24***	[1.47, 3.40]	2.03**	[1.23, 3.36]	
Education ^f	0.96	[0.88, 1.05]	0.97	[0.90, 1.05]	1.03	[0.97, 1.09]	0.98	[0.91, 1.05]	
High school	0.91	[0.43, 1.94]	0.54	[0.26, 1.11]	0.80	[0.46, 1.38]	0.37**	[0.18, 0.75]	
≥some college	0.47	[0.21, 1.04]	0.33**	[0.16, 0.69]	0.77	[0.45, 1.34]	0.57	[0.29, 1.11]	
Breastfeeding	0.86	[0.26, 2.87]	1.22	[0.45, 3.33]	0.95	[0.47, 1.89]	1.65	[0.70, 3.88]	
Depressive symptoms	2.21**	[1.23, 3.99]	1.05	[0.60, 1.85]	0.88	[0.56, 1.38]	1.22	[0.72, 2.08]	
Obese	0.87	[0.48, 1.58]	1.29	[0.74, 2.26]	0.95	[0.63, 1.44]	1.14	[0.68, 1.90]	

Note. SSB = sugar-sweetened beverage.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

^aAll fruit, including whole fruit and juice.

^bAll vegetables, including whole and juice, excluding fried vegetables.

^cIncludes lean meat, poultry and seafood, eggs, soy products, nuts, and seeds.

^dIncludes breaded and fried vegetables such as French fries, hash browns, and onion rings.

^eSugar-sweetened beverages.

^fReferent category is less than a high school education.

^gAdjusted for maternal age, education, breastfeeding, depressive symptoms, and obesity.

The results from the adjusted random intercept logistics regression models revealed that if mothers consume obesogenic foods, their infants are more likely to do so. Infants were at least 2 times as likely to consume SSBs, desserts, sweets, and salty snacks if their mother consumed them (see Table 3) and more than 3 times as likely to consume fried vegetables. Infants were more likely to consume fruit if their mother consumed it, though the association was attenuated when juice was excluded (data not shown). There were no significant associations of maternal intake of vegetables, whole grains, or lean protein foods with infant intake of these foods. Infants were more likely to consume whole grains if their mother was older. Infants were more likely to consume lean protein foods and fried vegetables if their mother exhibited depressive symptoms. Infants were less likely to consume lean protein foods, SSBs, and salty snacks if their mother had a higher education level. There were no significant associations among infants of mothers breastfeeding for any of the food groups.

4 | DISCUSSION

This study explores maternal and infant consumption of key food groups from 6 to 18 months postpartum and examines associations between maternal consumption of such foods and infant consumption. Understanding the link between diets of mothers and their young children is important as it broadens our understanding of potential pathways for influencing early life nutrition that can help to refine nutrition-focused interventions and improve dietary intakes of these young children. This study demonstrates that NHB infants are consuming obesogenic foods such as SSBs as early as 6 months and continuing to do so through infancy. Our results were similar to those in a study of a nationally representative sample of infants aged 0 to 48 months in which 43% of 9–11 months olds consumed some type of dessert, sweet, or SSB at least once in a day, and this percentage increased to 72% at 12–23 months (Saavedra et al., 2013; Siega-Riz et al., 2010).

Despite early consumption of obesogenic foods, infant diets may be better than those of their mothers given the higher proportion consuming low-energy dense foods on a given day, a finding supported elsewhere (Hoerr, Dersch, Vandembilt, Luster, & VonEye, 1998; Lee, Hoerr, & Schiffman, 2005). For example, in our sample, less than half of mothers consumed fruit and whole grains on a given day and although many consumed vegetables, the average median serving was 1.25, which is a quarter of the recommended daily amount. Furthermore, most women consumed SSBs and many consumed desserts and sweets. These results are not surprising; other research shows that for many women diet quality is suboptimal, particularly in the postpartum period (Durham et al., 2011; Fowles & Walker, 2006; George et al., 2005; Wiltheiss et al., 2013). Comparatively, nearly all children consumed vegetables on a given day and approximately twice the number of children consumed fruit and whole grains by 18 months compared to the percent of mothers consuming them. However, by 18 months, a higher number of children also consumed fried vegetables, desserts, and salty snacks compared to mothers. Although surprising, the consumption of obesogenic foods throughout infancy is not unique to this population. National survey data from the FITS

shows that potentially obesogenic diets emerge early with infants fed SSBs and energy dense foods such as desserts and candy and a substantial proportion do not consume any fruits or vegetables in a given day (Fox, Reidy, Novak, & Ziegler, 2006; Siega-Riz et al., 2010).

In assessing predictors of infant and maternal intake, it is evident that certain demographic and household characteristics can have an impact on what children and their mothers eat, particularly maternal age, education, and breastfeeding. Higher maternal education levels and age are generally associated with a more favourable eating pattern in infants (Brekke, van Odiijk, & Ludvigsson, 2007; Northstone & Emmett, 2005; Robinson et al., 2007; Smithers et al., 2012; Svensson et al., 2016). In our study, a higher education level was associated with infants being less likely to consume obesogenic foods. Mothers with higher education appear to know or follow recommendations for feeding healthier foods to their infants; however, they do not appear to apply this information to their own diet.

Our study demonstrates that infant consumption is strongly associated with that of their mother. Infants were significantly more likely to consume key food groups if their mother consumed them, particularly obesogenic foods. Interestingly, infants of mothers exhibiting depressive symptoms were more likely to consume lean protein foods and fried vegetables if their mother was consuming them. Although most lean protein foods are considered healthy choices, the most commonly consumed lean protein food among mothers in this study were chicken drumsticks with the skin eaten (data not shown), which have higher calories, fat, and saturated fat compared to other forms of chicken. In addition, the most commonly consumed fried vegetables were fast food French fries. Evidence is sparse, but some studies have linked maternal mental health to dietary patterns in older children (Ystrom, Niegel, & Vollrath, 2009). During times of stress, mothers may be more likely to feed their children, and themselves, unhealthy foods, perhaps for ease in caregiving, leading to convenient, and often unhealthy, food choices (Hurley, Black, Merry, & Caulfield, 2015; Ystrom et al., 2009).

The home environment is key to understanding the development of children's diet and food preferences, for young children ages 2–6 years consume 71% of their daily energy intake at home (Poti & Popkin, 2011). As infants make the significant dietary transition from a milk-based diet to foods indicative of their caregiver's diet, they learn what, when, and how much to eat from those around them. Although few studies exist among infants, studies among mothers of preschool-age children suggest that maternal influence on children's food intake occurs primarily through role modelling and food availability in the home (Anzman, Rollins, & Birch, 2010; Hart, Raynor, Jelalian, & Drotar, 2010; Wang, Beydoun, Li, Liu, & Moreno, 2011). Role modelling healthy food choices (e.g., F&V and foods low in added sugar and fat) is an important component to shaping healthy diets in children. Maternal preference for obesogenic foods can send conflicting messages, such as when asking a child to eat F&V that she herself is not consuming. However, few interventions aim to change maternal diet directly (Havas et al., 1998; Lioret et al., 2012; Ostbye et al., 2012). What our study shows is that an important and often overlooked path for intervening on infant diet is through maternal diet as it can influence the types of complementary foods available in the home and subsequently offered.

A major strength of this study is that it consisted of longitudinal data on matched mother–infant dyads. To our knowledge, it is the first study to focus on the consumption of key food groups in infants and toddlers among a sample of NHB, low-income mothers, a population often not well represented in national surveys. Although our focus is on a unique and understudied population, these findings should be considered with caution in light of some limitations. First, given the focus on a particular population, generalizability of findings may be limited. The women sampled were all NHB first-time mothers, recruited through WIC; future studies should include a larger, more heterogeneous sample. However, data were collected prior to the reauthorization of WIC food packages, which now include vouchers for fresh F&V, an important policy change that could influence F&V intake, warranting future research in this population. Underreporting of intake is also concern, given the large percentage of overweight or obese women in our sample (Braam, Ocke, Bueno-de-Mesquita, & Seidell, 1998; Johansson, Wikman, Ahren, Hallmans, & Johansson, 2001). However, studies indicate that foods perceived to be most healthy are the least likely to be omitted (Becker & Welten, 2001; Hirvonen, Mannisto, Roos, & Pietinen, 1997). Thus, considering the reported intakes as conservative estimates only strengthens the need to intervene, for intake of vegetables and whole grains was low, whereas that of obesogenic food groups was high. The use of a single 24HDR for assessing maternal intake could bias our estimates of episodically consumed foods due to the inability to classify an individual as a true nonconsumer. However, aggregating foods into key food groups can minimize this risk; furthermore, one-day estimates from 24HDR have been used in other studies such as the FITS, a dietary intake survey of parents and caregivers of young children (Briefel, Ziegler, Novak, & Ponza, 2006). Although we use only one 24HDR at each time point, sensitivity analyses demonstrated a lack of change in consumption patterns over time (data not shown); therefore, we chose to use one recall from each time point in order to match on infant recalls. In measuring the association between infant and maternal intake, it is important to note that we are not measuring concordance of intake, for at least one of the two 24HDR for infants was collected on a different day than the mother's. Given that approximately 60% of mothers were employed at each time point, infants are not likely to be eating every meal with their mother. The significant associations found among infant and maternal intake are likely due to both the food environment, which is largely shaped by the mother, and role modelling. Finally, as with many cohort studies, our results are subject to selection bias due to loss to follow up, especially given mothers who did not complete the study exhibited characteristics often associated with poor diets. Using the last observation carried forward method for predictors that are expected to change, such as weight and depression, could impact our findings by inducing bias as well as understating variability. However, sensitivity analyses using complete case data revealed no significant differences in results.

Future research should focus on developing effective interventions that support mothers in adopting healthy eating behaviours for themselves and their children throughout the postpartum period. Our research shows that mothers may have adequate knowledge of what constitutes a healthy diet, and thus feed their children in that way, but adequate nutrition knowledge may not be a sufficient factor in

influencing their own intake (Worsley, 2002). Given the link between maternal and infant consumption, particularly for obesogenic foods, and the importance of role modelling healthy food choices as children age and their acceptance of solid foods broadens, targeting maternal diet could be an effective strategy for preventing early life obesity.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interests.

CONTRIBUTIONS

MCK conceptualized and designed the study, acquired the data, analyzed and interpreted the data, drafted the initial manuscript, and approved the final manuscript as submitted. HMW assisted with the conceptualization and design of the study, revised the manuscript, and approved the final manuscript as submitted. LSA assisted with the conceptualization and design of the study, revised the manuscript, and approved the final manuscript as submitted. ALT assisted with the conceptualization and design of the study, revised the manuscript, and approved the final manuscript as submitted. AMS-R assisted with the conceptualization and design of the study, revised the manuscript, and approved the final manuscript as submitted. CMS assisted with the conceptualization and design of the study, revised the manuscript, and approved the final manuscript as submitted. MEB conceptualized and designed the study, revised the manuscript, and approved the final manuscript as submitted.

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