TARGETING THE HOME FOOD ENVIRONMENT FOR OBESITY PREVENTION IN IMMIGRANT ETHNIC MINORITIES

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ABSTRACT

Madison Nicole LeCroy: Targeting the Home Food Environment for Obesity Prevention in Immigrant Ethnic Minorities
(Under the direction of June Stevens)

Immigrants from South Asian countries and Hispanic/Latino cultures represent the largest immigrant groups in the United Kingdom (UK) and United States (US), respectively, and are disproportionally affected by obesity. Parents influence their child's risk for obesity in part by determining the home environment. However, examinations of the home food environment in parent-child dyads from ethnic minority, immigrant families are limited. We used data from a birth cohort in the UK (Born in Bradford 1000, BiB1000; n>1700; 47% Pakistani [predominately 1st and 2nd generation immigrant mothers], 38% White British, 14% Other), and a cross-sectional study of Hispanic/Latino 8- to 16-year-olds in the US (Study of Latino Youth, SOL Youth; n>1400). We examined: 1) ethnic/immigrant differences in home food availability (HFA) of snacks and sugar-sweetened beverages (SSBs; i.e., obesogenic items) and associations between obesogenic HFA and child's obesogenic dietary intake and BMI in BiB1000, 2) longitudinal patterns of postpartum weight retention (PPWR) according to ethnic/immigrant group and associations of PPWR and obesogenic HFA in BiB1000, and 3) acculturation-related differences in food parenting practice use and associations between food parenting practices and obesogenic dietary intake in SOL Youth.

Pakistani homes had greater obesogenic HFA, which was, irrespective of ethnic/immigrant group, associated with toddlers' increased obesogenic dietary intake.

Associations between obesogenic HFA and child's BMI and mother's PPWR were largely null. First generation Pakistani immigrants had a different longitudinal pattern of PPWR than White British mothers, and 2nd generation Pakistani immigrants retained more weight at each postpartum month than White British mothers. Hispanic/Latino parents who reported greater acculturative stress were more likely to use controlling food parenting practices. Parents who used controlling practices had increased odds of having children with high obesogenic dietary intake. Parents who pressured children to eat had increased odds of having 12- to 16-year-olds with high obesogenic dietary intake.

Our findings provide novel insights into the importance of the physical and behavioral home food environment for obesity prevention in understudied ethnic minority groups. Future interventions may target the home food environment to prevent the intergenerational transmission of obesity in Pakistani and Hispanic/Latino parent-child dyads.

To my mother, grandmother (“Meme”), and sister (MacKenzie).

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LIST OF ABBREVIATIONS

BiB	Born in Bradford
BiB1000	Born in Bradford 1000
BMI	Body mass index
CI	Confidence interval
CFQ	Child Feeding Questionnaire
FFQ	Food frequency questionnaire
HCHS/SOL	Hispanic Community Health Study/Study of Latinos
HFA	Home food availability
HFAI-C	Home Food Availability Inventory Checklist
PEAS	Parenting strategies for Eating and Activity Scale
PPWR	Postpartum weight retention
SOL Youth	Hispanic Community Children's Health Study/Study of Latino Youth
SSB	Sugar-sweetened beverage
UK	United Kingdom
US	United States

CHAPTER 1: INTRODUCTION

A. Background

Individuals from South Asian countries (1) and Hispanic/Latino cultures (2) are among the fastest growing population segments in Western countries and represent the largest ethnic minority groups in the United Kingdom (UK) (1) and United States (US) (2), respectively. Compared to non-immigrant Whites, South Asian and Hispanic/Latino immigrants are disproportionally affected by the obesity epidemic (3,4). Among immigrants, increased duration of residence in a Western country and being of a later immigrant generation are associated with a higher prevalence of obesity (5). Specifically, South Asian and Hispanic/Latino youth have obesity prevalence estimates 10-50% greater than those seen for non-immigrant Whites living in Western countries (3,4). Thus there is a need to identify targets for obesity prevention for South Asian and Hispanic/Latino youth living in the UK and US, respectively.

Parent-child dyads are a promising target for obesity interventions in youth. Parents determine the child's physical and behavioral home environment and can therefore increase children's risk for obesity, particularly though the foods they make available in the home, the behaviors they model, and the food parenting practices they implement (6–8). The first 1000 days of life are of growing interest for parent-child obesity interventions (9,10). It is during this time that a child's dietary preferences are formed (11) and that women are at high risk for excessive weight gain and retention (12). However, no study has examined how the food children are exposed to in the home (i.e., home food availability [HFA]) during this time is associated with children's risk for obesity later in life. Further, studies have not characterized longitudinal patterns of postpartum weight retention (PPWR) among immigrant ethnic minorities or the potential association of HFA and PPWR. Late childhood to adolescence is another critical period for obesity intervention, yet examinations of food parenting practices, an established determinant of dietary intake in young children, are limited in older children (13). Examinations of these practices in the context of other home environment factors and in ethnic minorities are needed.

This research examined whether targeting parent-child dyads and multiple aspects of the home food environment may be beneficial for obesity prevention in South Asian and Hispanic/Latino youth of varying levels of acculturation and ages in the UK and US, respectively. Findings have the potential to inform obesity prevention interventions for individuals from South Asian countries and Hispanic/Latino cultures that may impact risk for obesity across the life course and potentially disrupt the intergenerational transmission of ethnic disparities in obesity. Data were collected in: 1) Born in Bradford 1000 (BiB1000; n>1700; 47% Pakistani, 38% White British, and 14% Other), a longitudinal multiethnic birth cohort in Bradford, UK, and 2) Hispanic Community Children's Health Study/Study of Latino Youth (SOL Youth; n>1400), a cross-sectional study of Hispanic/Latino youth aged 8-16 years in the US.

B. Research Aims

The specific aims of this research were as follows:

<u>**Aim 1**</u>: To assess if increased HFA of snacks and sugar-sweetened beverages (SSBs) at 18 months of age is associated with increased dietary intake of these items and body mass index (BMI) at 36 months of age, and whether HFA of snacks and SSBs increases across immigrant generations and is greater among Pakistani immigrants or White British individuals. *Hypothesis:*

Third generation Pakistani immigrants will have the greatest HFA of snacks and SSBs, which will be associated with increased dietary intake of these items and BMI when children are 36 months of age, irrespective of ethnicity or immigrant generation.

Aim 2: To determine if the longitudinal pattern of PPWR during the first 24 months postpartum is flatter in Pakistani immigrant or White British women, and whether greater HFA of snacks and SSBs is associated with increased PPWR. *Hypothesis: PPWR will have a quadratic pattern of change in all ethnic/immigrant groups, with the pattern being flattest among 2nd generation Pakistani immigrant women; women with high HFA of snacks and SSBs will have the greatest amount of PPWR.*

Aim 3: To determine if low use of controlling food parenting practices is associated with increased intake of snacks and SSBs in Hispanic/Latino youth, and whether this association is modified by other home food environment determinants (i.e., general parenting style and HFA of snacks and SSBs). *Hypothesis: Low use of controlling food parenting practices will be positively associated with children's consumption of snacks and SSBs, with the association being strongest in the context of a permissive parenting style and high HFA of snacks and SSBs.*

CHAPTER 2: LITERATURE REVIEW

A. Obesity in ethnic minorities and immigrants

Risk for obesity among individuals of South Asian or Hispanic/Latino origin is a major public health concern in the United Kingdom (UK) and United States (US), respectively. In the UK, South Asian children aged 4-5 years have an obesity prevalence that is approximately 10 percent greater than that of the White British (3), and Hispanic/Latino children aged 2-19 years in the US have an obesity prevalence that is nearly 50 percent greater than that seen for non-Hispanic/Latino Whites (4). Further, at a given BMI, individuals of South Asian origin have a higher percent body fat than Whites, placing them at an increased risk for obesity-related diseases (14,15). Adjustments to BMI to account for this discrepancy in adiposity (15,16) show that children of South Asian origin have a significantly greater average BMI, not just a greater prevalence of obesity, compared to White British children (17). Thus the discrepancy in obesity prevalence among individuals of South Asian origin and White British children is likely greater than that previously reported.

South Asian and Hispanic/Latino populations are growing at rapid rates in both the UK and US, with the South Asian population growing by 20 percent in the UK during the last decade (1) and the Hispanic/Latino population accounting for nearly half the increase in the total population of the US from 2010 to 2017 (2). While resident population growth partially explains the increasing ethnic minority populations, immigration is also a key factor. According to the most recent available data, individuals from South Asia (India, Pakistan, Bangladesh, Sri Lanka, Nepal, Bhutan, Afghanistan, or the Maldives) and from Hispanic/Latino cultures (Cuban, Mexican, Puerto Rican, Central American or Dominican, South American, or other Spanish cultures) are the largest immigrant groups in the UK (18) and US (19), respectively. Research among both South Asian and Hispanic/Latino immigrants has shown that greater duration of time in a Western country and being born in a Western country is associated with a higher prevalence of obesity, potentially due to changes in lifestyle norms that follow immigration (5,20–23).

Given that individuals of South Asian or Hispanic/Latino origin are the largest ethnic minority groups in the UK (1) and US (2), respectively, the UK and US will face a serious public health burden if efforts are not made to reduce the prevalence of obesity in these ethnic groups. There is a need to identify potential targets for obesity prevention among individuals of South Asian and Hispanic/Latino origin with varying degrees of acculturation living in Western countries.

B. Parent-child dyads and the home food environment

Parent-child dyads are an important target for obesity prevention interventions. Although obesity prevention interventions can target children and parents separately, intervening on both simultaneously is a cost-effective and efficient method that may help better address the social and environmental underpinnings of obesity. Parents and their children often resemble one another in weight status, reflecting similarities in eating behaviors and shared food environments (24). Parents influence their child's dietary preferences and intake in part through shaping the child's home food environment, making the home a viable target for parent-child obesity prevention interventions (6,25). The home food environment includes both the physical and sociocultural environments within a household that pertain to food and dietary habits (26) and has been shown to affect risk for childhood obesity through promoting or impeding the development of healthy eating habits (7,11,26,27). Specifically, the types of foods/beverages parents make available to children, the obesity-related behaviors parents model, and the food parenting practices parents use largely influence the dietary habits their children develop (6,8). Examining the diet-related environments and behaviors in the home may provide insight into how to modify risk for obesity among South Asian and Hispanic/Latino parent-child dyads (28).

C. The first 1000 days of life: home food availability (HFA) and postpartum weight retention (PPWR)

1. Home food availability (HFA) and toddlers

The first 1000 days of life (conception through 24 months of age) is a fundamental time to address the determinants of childhood obesity (9,10). It is during this time that children's food preferences and dietary habits are established (11). Children develop an affiliation for those foods they become most familiar with (29,30), tending to prefer what is readily available in the home (31). By the end of the first 1000 days of life, children are already consuming the foods/beverages that characterize their culture's adult diet (28). Thus if obesogenic foods are available in the home, children may prefer to include them as key components of their diet when they have more autonomy.

It is intuitive that home food availability (HFA) is associated with dietary intake, particularly among children. Children aged 2-18 years obtain 69% of their total daily energy intake from foods prepared in the home, with this percentage being highest for the youngest subgroup of children (76% for 2- to 6-year-olds) (32). Much of the research on HFA and dietary intake has focused on examining this association in cross-sectional studies of fruit and vegetable availability only (33–36). However, associations between fruit and vegetable intake and obesity are weak for both children and adults, potentially due to the low consumption and thus low variability in intake of these food groups (37). Therefore it may be more promising to focus on the HFA of obesogenic items, such as snacks and sugar-sweetened beverages (SSBs), in relation to diet and obesity(38).

Cross-sectional examinations of preschool-aged children (2- to 5-year-olds) have shown a positive association between the HFA of snacks and SSBs and consumption of these items (39,40). However, to our knowledge, no study has examined the association between HFA of snacks and SSBs and dietary intake at 18 months of age. Of the few studies that have characterized HFA during the first 1000 days of life (41–44), only two have examined the relationship between snack and SSB HFA during the first 1000 days of life and diet during later childhood (43,44). In these two studies, the authors observed that HFA of snacks at 18 months of age was associated with increased overall dietary energy density (mean kcal/kg of foods assessed in 24-hour dietary recalls) (43) but not overall diet quality two years later (44). Examining how the HFA of snacks and SSBs is longitudinally related to intake of specific obesogenic food/beverage groups may help clarify the impact of HFA during early life on the development of children's diets.

Further, studies have not examined how HFA during this time period is associated with weight status later in life. Previous studies have examined cross-sectional associations between HFA and childhood obesity with mixed findings (45–48), and the one study that examined a prospective association (45) did not include children less than 5 years of age. There is thus a need to assess how HFA during the first 1000 days of life is associated with later risk for obesity in children.

2. Postpartum weight retention (PPWR)

The first 1000 days of a child's life are also a critical period for addressing obesity prevention in mothers. The UK National Institute for Health and Clinical Excellence (NICE)

Guidelines have specifically identified the first 24 months postpartum (i.e., the latter portion of the first 1000 days of a child's life) as a critical target for weight intervention in women (49). Managing weight during this time can reduce a woman's risk for beginning another pregnancy with overweight or obesity (49), thus reducing the risk for adverse health outcomes for the mother and fetus. Specifically, obesity increases the risk for gestational diabetes, gestational hypertension, preeclampsia, birth defects, and fetal macrosomia (50,51), and children born to mothers with obesity have an increased risk for developing hypertension (52), diabetes (53), and obesity (54) throughout childhood and adolescence.

Following delivery and the mother's initial 6-week fluid readjustment period, weight above that of the pre-pregnancy weight is primarily attributable to the excess fat stores accrued during pregnancy (55). High postpartum weight retention (PPWR; maternal weight retained from pre-pregnancy to a given time after childbirth (12)) is associated with long-term risk for maternal overweight and obesity (56,57) and central adiposity (58) and may indicate that children are being exposed to an obesogenic home environment (i.e., unhealthy HFA) or are at risk for modeling obesogenic dietary behaviors (59). Reducing PPWR thus may help decrease the prevalence of obesity among women during their reproductive years as well as during later life and help prevent the intergenerational transmission of obesity and obesity-related diseases.

Similar to findings for children, HFA has been associated with dietary intake (42,60–62) and weight status (63–65) in adults and thus may be associated with PPWR. In one of the studies that examined HFA during the first 1000 days of life in association with children's dietary intake (42), the authors additionally found that HFA was directly associated with the mother's dietary intake of fruits and vegetables. However, studies have not examined how HFA during the first 1000 days of a child's life is associated with the mother's weight status. Given the importance of

PPWR for long-term risk for maternal overweight and obesity, there is a need to identify whether HFA during the postpartum period is associated with PPWR.

3. Racial/ethnic differences in home food availability (HFA)

HFA and its association with dietary intake and obesity are understudied in ethnic minorities. Although HFA is a potential target for obesity prevention in parent-child dyads, most studies have limited their examinations of HFA to non-Hispanic Whites and Blacks. A number of studies have found that HFA varies according to race/ethnicity (48,66,67), yet the ethnic minorities examined have been limited to Hispanic/Latino, American Indian, Hmong, and Somali populations (45,48,68). Although these groups are also at high-risk for obesity, their findings cannot be translated to a South Asian population. Further, HFA is likely to change among immigrant ethnic minority populations as families acculturate to their new country, yet only two previous studies have examined the association between acculturation and HFA. These studies identified increased acculturation as measured by number of years in the US (69) or preference for English (70) as a significant predictor of increased HFA of SSBs (69) and decreased HFA of fruits and vegetables (70). However, both studies limited their samples to individuals of Hispanic/Latino ethnicity and did not extend their analyses to examine how acculturation may be impacting associations of HFA with dietary intake or obesity.

Only one previous study, a small subset (n=97) of Pakistani and White British homes of 18-month-olds from Born in Bradford 1000 (BiB1000), has examined HFA in South Asian households. The authors found that Pakistani households had a greater quantity of SSBs in the home compared to White British households (71), but the study was not powered to determine if there were differences in HFA according to acculturation. Thus there is a need to examine if there are differences in availability of foods/beverages according to acculturation status in South Asian households and whether these differences persist as children age.

4. Racial/ethnic differences in postpartum weight retention (PPWR)

Race/ethnicity is also an important determinant of PPWR, yet research on PPWR in racial/ethnic minorities is limited. Similar to existing research of HFA, examinations of PPWR have primarily focused on Whites, Blacks, and Hispanics and have found significant differences in the degree of PPWR across race/ethnic groups (72). For example, after adjusting for key risk factors for PPWR (pre-pregnancy BMI, gestational weight gain, parity, breastfeeding, age, and smoking (73)), at approximately 12 months postpartum non-Hispanic Blacks have a significantly increased odds of retaining >4.5 kg (odds ratio [OR]: 1.8, 95% confidence interval [95% CI]: 1.1, 2.7) (74) or >9.1 kg (OR: 2.20, 95% CI: 1.50, 3.22) (75) compared to non-Hispanic Whites, with non-Hispanic Blacks retaining approximately 2.9 kg more than non-Hispanic Whites at 7-12 months postpartum (76). Although findings are less consistent for Hispanics/Latinos compared to non-Hispanic Whites (77–79), the collective body of literature on race/ethnicity and PPWR suggests that racial/ethnic minorities are at an increased risk for high PPWR compared to non-Hispanic Whites (80).

However, only two previous studies have examined PPWR for race/ethnic groups beyond Hispanics/Latinos, non-Hispanic Blacks, and non-Hispanic Whites (81,82), with only one examining South Asian mothers (82). After adjusting for all aforementioned risk factors in addition to physical activity, depression, mode of delivery, and weeks postpartum, the study found that South Asian women retained 2.8 kg (95% CI: 1.9, 3.6) more than Western Europeans ($p<0.01$) (82). This study, however, was limited by a short postpartum follow-up period of approximately 3 months (82). Average PPWR has been shown to continue to decrease until 12 months postpartum in a systematic review and meta-analysis (12), with average PPWR in terms of BMI (kg/m^2) of 1.48 (95% CI 1.21, 1.75) at 4 months, 1.14 (95% CI: 1.04, 1.25) at 6 months, 0.46 (95% CI 0.38, 0.54) at 12 months, and 1.18 (95% CI: 0.93, 1.43) at 18 months. It should be noted, though, that the authors of the systematic review were unable to comment on changes in PPWR specific to ethnic minority groups or through 24 months postpartum, given limitations in the existing body of literature (12).

Though other research groups have derived patterns to describe longitudinal changes in PPWR until as late as 36 months postpartum (83–87), only two previous studies have examined longitudinal patterns of weight retention among ethnic minority (non-Hispanic Black and Hispanic) versus non-Hispanic White mothers (77,79). These studies described contrasting longitudinal patterns of weight change, with Walker et al. (77) reporting that PPWR increased linearly from 3 to 12 months postpartum for ethnic minorities and decreased linearly for non-Hispanic Whites, and Rothberg et al. finding that weight loss occurred until 9 to 10 months postpartum for all ethnicities, after which weight plateaued or increased until 12 to 14 months postpartum (79). Thus it is unclear how long racial/ethnic differences in PPWR persist and how best to describe the longitudinal patterns of PPWR among ethnic/minorities in general. There is a need to examine PPWR over the full first 24 months postpartum to clarify changes in PPWR coinciding with the latter portion of the child's first 1000 days of life and to better characterize racial/ethnic differences in PPWR across the full 24-month risk period identified by NICE (12,88).

Given that South Asian women represent the largest number of non-White British deliveries in the UK National Health Service hospitals (89), there is a specific need to examine and compare PPWR of South Asian and White British women. Further, studies of immigrant populations have found that individuals who are 2nd and 3rd generation immigrants gain more weight in pregnancy compared to 1st generation women, increasing their risk for PPWR (90,91). Thus studies of PPWR of South Asian women need to consider the potential moderating role of immigrant generation in racial/ethnic differences in PPWR.

D. Youth and adolescence: food parenting practices

1. Overview of food parenting practices

In addition to the role modeling of obesity-related behaviors (as reflected in the amount of PPWR), food parenting practices are an important aspect of the behavioral home food environment. Food parenting practices, defined as the behaviors and actions implemented by parents to influence their child's attitudes, behaviors, or beliefs regarding food (92), have been associated with dietary intake in youth (6,8,13). Across the 71 different questionnaires used to assess food parenting practices (93), the most commonly used tool is the Child Feeding Questionnaire (CFQ) (94,95) proposed by Birch et al. (96). The CFQ examines three food parenting practices (Pressure to Eat, Monitoring, and Restriction), with Pressure to Eat being one of the most well-researched food parenting practices (92). Pressure to Eat is described as parents' insistence that their children eat more food and involves use of techniques such as demanding that children eat all of the food on their plates or prompting children to eat regardless of if they report being hungry or not (92). Pressure to Eat was recently associated with increased obesogenic dietary intake in a systematic review and meta-analysis (13).

2. Food parenting practices in Hispanics/Latinos

Across the 78 studies included in the aforementioned systematic review (13), only one study was conducted in a predominately Hispanic/Latino sample (13). Evidence suggests there are ethnic/racial differences in the use of food parenting practices and their associations with risk for obesity (97), and thus findings from this review may not be applicable to Hispanic/Latino populations. Racial/ethnic differences in the use and effects of food parenting practices may be explained by cultural differences in the selection and meaning of specific food parenting practices (98). Among Hispanic/Latino parents specifically, existing studies have shown that Hispanic/Latino parents favor controlling practices such as Pressure to Eat more so than non-Hispanic Whites (99,100). This may reflect that Hispanics/Latinos are more likely to favor heavier children than non-Hispanic Whites, given heavier weights indicate good parenting and health in Hispanic/Latino culture (101–103). Research among low-income Mexican Americans has also suggested that acculturation status affects choice of food parenting practices, with greater acculturation as measured by language use (104–106), years of residence in the US (104,107), or immigrant generation (104,107) being associated with higher scores for Pressure to Eat (104–107) and Restriction (106). However studies have not considered the role of acculturation in examinations of associations between food parenting practices and dietary intake in Hispanics/Latinos.

No previous studies, to our knowledge, have examined the association between food parenting practices and obesogenic dietary intake in a sample of pre-adolescent and adolescent Hispanic/Latino youth. The Hispanic/Latino study by Arredondo et al. included in the aforementioned systematic review (13) showed a positive association between controlling food parenting practices and obesogenic dietary intake among females in a sample of predominantly first generation Mexican American parents of kindergarteners and second-graders (105). However, another study of Mexican American fifth-graders that did not meet inclusion criteria for the review found no significant association between controlling food parenting practices and obesogenic dietary intake in males or females (108). It may be that food parenting practices have a different association with dietary intake in older versus younger children (13) due to older children having greater autonomy over their diets (92,109). Further, associations between the food parenting practices and obesogenic dietary intake may be moderated by sex, as was seen in the study by Arredondo et al. (105). There is a need to examine associations between food parenting practices and dietary intake in older, Hispanic/Latino youth using approaches that account for the role of acculturation and child's age and sex.

3. Combinations of food parenting practices

Food parenting practices have generally been examined independent of one another (92). However, parents actually use these practices in combination (92), and the combined effect of food parenting practices on dietary intake has been shown to differ from that of the individual effects (110), likely due to the practices negating or enhancing the effectiveness of one another. Cluster analysis is one approach that can be used to examine combinations of food parenting practices. Examining clusters of parents can show how practices are generally combined and can identify potential parent groups at risk for promoting high consumption of obesogenic foods/beverages in their children (110,111).

Despite the benefits of applying cluster analysis to studies of food parenting practices, only two previous studies have implemented this approach to examine associations with dietary intake. One study found that clusters of food parenting practices, but not the individual food parenting practices, were associated with dietary intake (110). Another study found that the food parenting practice cluster associated with the greatest consumption of snacks was characterized by decreased use of controlling food parenting practices, in contrast to the positive associations observed between individual controlling food parenting practices and obesogenic dietary intake (111). Findings from both of these studies highlight the need to move away from studying food parenting practices in isolation in order to better understand how parenting is associated with dietary intake. Given that neither of these studies was conducted in Hispanic/Latino youth and the observed differences in use of food parenting practices according to race/ethnicity, there is a need to derive food parenting practice clusters specifically for Hispanic/Latino youth.

4. Food parenting practices and the home environment

Food parenting practices may differentially affect dietary intake according to other characteristics of the home food environment. Few studies have assessed how food parenting practices may be interacting with other home food environment factors to affect obesogenic intake (112–115). HFA determines the physical environment in which food parenting practices are used. However, only one study, to our knowledge, has examined whether HFA modifies the association between food parenting practices and dietary intake (115). In their sample of racially/ethnically diverse adolescents, the study found that daily snack and SSB intake was greatest among adolescents who had a home food environment characterized by low HFA of snacks and parents' high use of Restriction (which refers to parents enforcing their own limits on a child's access to opportunities to consume foods), with the association for snack intake being further modified by parent role-modeling (115).

Parenting styles (parents' overall approach to parenting) may also influence the effectiveness of food parenting practices by determining the practices implemented, the behaviors that give those practices meaning, the nature of parent-child interactions, and the child's openness to parental influence (116). Parenting styles are determined by the degree of parents' demandingness (the extent that parents control and supervise children) and responsiveness (the extent that parents exhibit warmth and involvement) (117). Studies have indicated a need for research to examine how parenting styles modify the effectiveness of food parenting styles (118,119). However, previous studies that have examined the interaction between food parenting practices and parenting style within the context of associations with obesogenic dietary intake have mixed findings (112,113,120). Specifically, these studies have mixed findings on whether the association between Monitoring (a parenting practice defined by parents' tracking of what and how much children consume) and obesogenic intake is modified by parenting style (112,113) and which parenting style in combination with Restriction is associated with decreased obesogenic intake (112,113,120). These findings indicate a need to clarify how HFA and the degree of demandingness and responsiveness parents use modify the association between food parenting practices and dietary intake.

CHAPTER 3: METHODS

A. Overview

Chapters 4 and 5 use data from the Born in Bradford 1000 (BiB1000) study to assess risk for obesity among South Asian and White British parent-child dyads during the first 1000 days of the child's life. In those chapters we address ethnic and immigrant differences in home food availability (HFA; Chapter 4) and postpartum weight retention (PPWR; Chapter 5) for individuals of Pakistani origin compared to White British individuals. Further, in Chapter 4, we examine associations between HFA and dietary intake and obesity measured during the first 1000 days and at 36 months of age. In Chapter 5, we additionally examine whether HFA is significantly associated with PPWR. Chapter 6 uses data from the Hispanic Community Children's Health Study/Study of Latino Youth (SOL Youth) to assess how food parenting practices are associated with obesogenic dietary intake in Hispanic/Latino youth aged 8-16 years. In Chapter 6 we assess effect modification of this association by the home environment and child's socio-demographic characteristics and examine differences in the use of food parenting practices by the parent's acculturation status. Collectively this dissertation research provides insight into the home food environment of South Asian and Hispanic/Latino individuals and the importance of parent-child dyads for obesity prevention in individuals with varying degrees of acculturation and in ethnic groups that are disproportionately affected by the obesity epidemic.

B. Born in Bradford 1000 (BiB1000)

1. Study cohort

a. Born in Bradford 1000 (BiB1000) overview

The original Born in Bradford (BiB) study was designed to examine the environmental, psychological, and genetic factors that impact maternal and child health and well-being in the city of Bradford in the United Kingdom (UK) (121). Bradford is the sixth largest city in the UK and has a population that is approximately 20% Pakistani immigrants (122). Of the 326 local authority districts in England, Bradford ranks fifth in having the most highly deprived neighborhoods (123), with sixty percent of babies in the city being born to the poorest 20% of the population of England and Wales (124).

Data is routinely collected on individuals enrolled in BiB via linkage with health information systems and education databases; however, follow-up research visits were only conducted for two sub-cohorts of children: 1) Allergy and Infection Study (ALL IN) and 2) BiB1000 (125). ALL IN was created to examine associations between specific viral infections and allergies in infants while BiB1000 focused on identifying risk factors for obesity to enable the development of a culturally-tailored obesity prevention intervention for South Asian children (125,126). In addition to examining well-established targets for obesity prevention (e.g., diet and physical activity), BiB1000 assessed correlates of obesity-related behaviors that currently have a lesser evidence base in terms of their efficacy for obesity prevention (e.g., HFA) (126). Demographic characteristics of BiB1000 participants are similar to those of the full BiB cohort, with both reflecting the low socioeconomic status of Bradford, UK (Table 3.1.) (126).

b. Sampling and recruitment

All mothers booked for delivery at Bradford Royal Infirmary—the only maternity unit in Bradford and one of the busiest in the UK with approximately 5800 deliveries per year—between March 2007 and November 2010 were eligible for BiB (121,125). Nearly all women in Bradford book and give birth in this maternity unit, with only approximately 10 total women per year delivering elsewhere (121). Individuals were provided with information about the study at ~12 weeks gestation when booking their delivery at Bradford Royal Infirmary (125). On attendance at the 26-28 week gestation oral glucose tolerance test, full consent was obtained for recruitment to BiB (125). Eighty percent of mothers were recruited during the 26-28 week oral glucose tolerance test visit at Bradford Royal Infirmary, while the remainder were recruited through other contacts such as hospital appointments or during their hospital stay for the birth (125). All mothers recruited into BiB between August 2008 and March 2009 who had completed the baseline questionnaire were approached to take part in BiB1000 (126). No additional exclusion criteria were applied to BiB1000.

The initial sample size targeted for BiB1000 was 1080 mothers, which was determined assuming a 5% annual attrition and a goal of having the power to detect a 0.67 z-score difference (i.e., a 1 percentile difference) in infant's weight-for-age >12 months of age (126,127). However, due to highly successful recruitment, researchers oversampled mothers by 70%, thus increasing the amount of data available across all assessments (126). Of the 1916 women eligible for BiB1000, 1735 agreed to take part in the study (126). Of these, 28 had twin births. Mothers of twin births were excluded from our sample due to differences in growth patterning observed in this cohort (128), and those classified as Other ethnicity (n=247) were excluded due to insufficient sample sizes for each ethnicity (Bangladeshi, Polish, Slovic, and Czech (121,126)).

Overall follow up rates were at least 70% for each visit, with 92% of individuals completing follow-up assessments for at least one of these time points (125). In general, women who completed each follow-up visit were more likely to be of Pakistani origin (Table 3.2.) (129).

c. Data collection measures

Study visits for data used in Chapters 4 and 5 were conducted when children were approximately 6, 12, 18, 24, and 36 months of age (125). Most mothers (61%) preferred to have visits conducted in their homes (125), with the remainder of individuals reporting to research clinics at Bradford Royal Infirmary or local Children's Centres for some or all visits (125,126). At each study visit, study personnel assessed anthropometrics of the mother and child. All questionnaires about the mother and her children were interviewer-administered unless otherwise indicated (126).

Questionnaires administered at study visits were translated into Urdu (the national language of Pakistan) and Mirpuri, seeing as the Mirpuri population is the largest sub-group of the Pakistani population in Bradford (126). Mirpuri is an oral language only, and thus all study administrators were multilingual (126). Transliteration of all study materials involved translation, back-translation, and several rounds of piloting by bilingual and monolingual groups in collaboration with local experts in Bradford (126).

2. Variables

Details for all main variables used in the analyses are additionally provided within Chapters 4 and 5. An overview of the main exposures and outcomes, with a focus on the development, validity, and reliability of questionnaires, are provided in this section.

a. Outcomes

i. Child dietary intake

Child's diet was assessed using a modified version of a validated, self-administered food frequency questionnaire (FFQ) from the Southampton Women's Survey (130) at 18 months and from the Survey of Sugar Intake among Children in Scotland study (131) at 36 months. Details on the development and validation of each FFQ are provided below.

(a) Development and validity of 18-month food frequency questionnaire (FFQ)

Foods were selected for the original Southampton Women's Survey FFQ based on dietary intake of 18-month-olds in the National Diet and Nutrition Survey (132), 24-hour dietary recalls collected from mothers attending a clinic, and a single food diary of preterm 12-month-olds (133). A total of 78 items were included: 58 foods, 10 commercial baby foods, and 10 non-milk beverages (130). Frequency (never, <1/week, weekly [recorded number of times/week], and >1/day [recorded number of times/day]) was assessed for the previous 28 days, and all subjects were provided with prompt cards illustrating the foods included in each food group. Participants were also provided with household measures and food models to report portion sizes consumed for each item (130). Human milk, baby formula, and other milk intake were assessed using an unknown number of additional items. There was an open-ended category to list foods consumed at least once per week that were not included on the FFQ (130).

Criterion validity of the FFQ was assessed in a sample of fifty mother-child dyads randomly selected from the Southampton Women's Survey after stratifying the sample by child's sex and breastfeeding status (130). All individuals completed the FFQ and a 4-day weighed food diary. Nutrient composition of the diet was assessed by linking intake to nutrient compositions from manufacturers and a UK food composition database (134). FFQ-assessed intakes tended to be higher than those from the weighed diaries and correlations were weak to moderate for all macronutrients (Spearman's rank correlation coefficients ranged from 0.36 to 0.53) (130). However, the mean percentage difference between intake from the food diary and FFQ was less than 25% for all macronutrients, and thus the FFQ was deemed valid for assessing intake in 12-month-olds in the UK (130).

(b) Development and validity of 36-month FFQ

The FFQ used in the Survey of Sugar Intake among Children in Scotland study was based on an FFQ developed for preschoolers by the Scottish Collaborative Group (135). The FFQ was modified for use in 3- to 11-year olds-through an unknown procedure, resulting in a list of 140 foods or drinks (135), asking about the child's diet over the previous two to three months (136). The response categories were "rarely or never", "1-2 per week", "1 per week", "2-3 per week", "4-6 per week", "1 per day", "2-3 per day", "4-6 per day", and "7 or more per day", and were reported in terms of the designated "small" portion size (131). There was also an open-ended section for participants to list details of any foods consumed at least once per week that were not included on the FFQ (131). Examples of food measures were provided in a photograph on the first page of the FFQ to help parents estimate the quantities of their child's food intake in standardized terms (e.g., teaspoon, small slice, medium glass) (131).

The FFQ was pilot-tested in 84 children aged 5-16 years in Aberdeen, Scotland, which resulted in the addition of a few items to the FFQ (135). The criterion validity of the FFQ was assessed in two waves. The first wave was conducted in a random sample of 158 children from the aforementioned study, and these individuals completed both the FFQ and a 4-day food diary (136). The second wave was conducted in an unknown random sample of children who completed the FFQ and a single 24-hour dietary recall (136). Nutrient intakes from the FFQ and food diary were calculated using the National Diet and Nutrition Survey database, and individuals with FFQ-derived energy intakes below the 2.5 percentile and above the 97.5 percentile were excluded to remove six outliers (136). The FFQ provided similar intakes of total fat and saturated fatty acids (% food energy) compared to the food diary and 24-hour dietary recall but higher estimates of the intakes of energy and other nutrients (131). Further, Spearman's rank correlation coefficient was significant for all nutrients observed, indicating good validity of this FFQ (136).

(c) Modification of food frequency questionnaires (FFQs) for Born in Bradford 1000 (BiB1000)

Both FFQs were modified for BiB1000 to include eight South-Asian-specific items (chapattis [white flour], chapattis [wholemeal flour], boiled rice, fried rice, semolina pudding, milk-based puddings, sponge puddings, and other vegetables [e.g., okra, aubergine]) selected based on findings from focus groups and 24-hour dietary recalls conducted using a Pakistani population in Bradford (137). Instead of using the household measures and food models to report portion size at 18 months, mothers were given pictures and household utensils (tablespoons, teaspoons, bowls and feeding beakers) to aid in food recognition and portion size estimations (137).

(d) Definition of obesogenic items

We selected specific items from the FFQs to examine associations between HFA of snacks and SSBs and snack and SSB dietary intake in Chapter 4. The list of foods representing snack and SSB intake in the 18- and 36-month FFQs were not identical due to the use of age-appropriate, validated FFQs at each time point. Given ambiguity in what is meant by "snack" in British usage (138), the lack of a consensus definition of "snack foods" (139) in the literature, and the lack of clear recommendations for snack intake (140), our definition of snack foods was guided by the FFQ-defined food categories at 18 and 36 months. Use of an FFQ-based definition also meant that all participants were presented with the same definition of snack foods when completing the questionnaire.

At 18 months, foods were included if they were part of the “cakes, biscuits, and snacks” category. Ice cream was also included given it was assessed as a snack food on the home food availability inventory checklist (HFAI-C) and due to the interest in assessing the association between snack food HFA and dietary intake in Chapter 4. The 36-month FFQ did not include sweets in its snack category (“crisps, nuts and savory snacks”), and thus all items part of the “biscuits and cakes” or “sweets, chocolates, and ice-creams” categories were additionally included to ensure similar food groups were measured at 18 and 36 months and that the full range of snacks measured by the HFAI-C were captured. SSBs were defined at both time points as any non-dairy, high-calorie, sweetened beverages.

For the purpose of analysis, reported frequencies of intake were re-calculated to represent intake per week, to match the HFAI-C’s measurement timeframe. Two variables were derived to describe snack and SSB intake separately: 1) variety and 2) total quantity consumed weekly. To determine variety scores, individuals received a score of 0 for each item if they were non-consumers and a score of 1 if they were consumers. Items were summed within the designated snack and SSB categories. Total quantity was estimated in terms of grams (snacks) or mL (SSBs) using the USDA food composition database (141). Each FFQ item was assigned an amount in grams or mL for the designated portion size, which was multiplied by the individual’s reported frequency. Quantities were summed across items to derive a total quantity score.

ii. Child anthropometrics

Ten study staff trained by expert community researchers measured height and weight for all children in BiB1000 (142). Measurements were taken with the child's clothes removed (142). Weight was measured using SECA baby scales at all time points used in our analyses (142). All weight measurements were taken at least two times and a third was taken if the data fell outside acceptable ranges of difference between first and second measures (i.e., weight difference of 10 grams) (125). Reliability testing of the growth data measurements indicated good quality control for inter- and intra-observer technical error of measurements (r=0.96-1.00) (143). Length was measured using the Harlow Health Care neonatometer at 18 months of age, and height was measured using the SECA Leicester height measure at 36 months of age (142). Body mass index (BMI) was calculated as weight (kg) divided by length- or height-squared (m^2).

iii. Maternal anthropometrics

Ten study staff trained by expert community researchers measured height and weight for all mothers in light clothing (125,142). Maternal weight at hospital booking (~12 weeks gestation) was extracted from an electronic maternity information system. Weight at baseline and all home visit time points used in our analysis (~6, 12, 18, and 24 months follow-up) were measured with SECA digital scales (125). Maternal height was measured using the SECA Leicester height measure at baseline (125). Maternal BMI at hospital booking was calculated as weight (kg) divided by baseline height-squared (m^2).

PPWR was estimated as measured weight minus imputed pre-pregnancy weight. Similar to previous PPWR studies (144,145), pre-pregnancy weight was imputed by subtracting the amount of expected gestational weight gain (kg), according to body mass index (BMI) category and gestational age as outlined by the US Institute of Medicine (146), from measured early pregnancy weight (i.e., weight at hospital booking). BMI was calculated as early pregnancy weight (kg) divided by height-squared (m^2). Imputations assumed weight gain during the first 13 weeks gestation of 2, 1.5, 1.0, or 0.5 kg in total and 0.51, 0.42, 0.28, or 0.22 kg for each week beyond 13 weeks gestation for women with an early pregnancy BMI <18.5, 18.5-24.9, 25.0-29.9, or ≥30.0 kg/m^2, respectively (146).

b. Exposures

i. Ethnicity and immigrant generation

Ethnicity was assessed as part of the questionnaire at baseline (126). Mothers self-reported their ethnic group using the same classifications as the 2001 Census (147). Mothers were categorized as White British, Pakistani, or Other, with those of Other ethnicity being excluded from analyses as previously noted. Children were assigned the same ethnicity as their mother. Mothers additionally reported their, the baby's father's, their parents, and the baby's father's parents' country of origin. This information was used to determine immigrant generation for the mothers (Chapter 4) and their children (Chapter 5). Individuals were classified as White British, 1st generation Pakistani immigrants (born in Pakistan), 2nd generation Pakistani immigrants (at least one parent born in Pakistan), or 3rd generation Pakistani immigrants (at least one grandparent born in Pakistan). All other individuals with non-missing country of origin data were placed in an "other immigrants" group.

ii. Home food availability (HFA)

The semi-quantitative Home Food Availability Inventory Checklist (HFAI-C) was self-administered as part of a larger questionnaire packet at the 18- and 36-month visits (71). The checklist was designed to minimize participant burden, and thus foods and beverages were restricted to a list of 39 items that were available within the categories of 1) fruits (16 items including fresh, dried, and canned), 2) vegetables (12 items including fresh and canned), 3) snacks (7 items including savory and sweet), and 4) beverages (4 items including sugar- and artificially-sweetened) (71). For the purpose of Chapters 4 and 5, we only used data from the snacks category and the three SSBs from the beverage category.

(a) Home Food Availability Inventory Checklist (HFAI-C) development

Food and beverage items were selected for the HFAI-C based on responses to the Healthy Home Survey (148) and early evidence that their HFA is associated with dietary intake (149,150) and obesity (151). The Healthy Home Survey was a tool developed and validated in the United States (US) to assess home environment influencers of healthy weight in children (148). HFA questions in the Healthy Home Survey asked the participant to describe presence/absence and quantity (open-ended response) of all foods/beverages in their homes within 11 categories: fruits (fresh, dried, frozen, canned/jarred), vegetables (fresh, frozen, canned/jarred), sweet snacks, salty snacks, candies, and sodas (not diet) (148). A set list of items and quantities within four categories (fruits, vegetables, snacks, and beverages) was selected for the HFAI-C (71). The HFAI-C was modified for use in a Pakistani immigrant population by examining data from 24-hour dietary recalls taken from South Asian populations in Bradford to identify foods/beverages that were regularly consumed in this population but that were missing from the HFAI-C (71). This process did not identify completely new items for inclusion but instead identified ethnic-specific prompts and examples to be added to aid with checklist completion (71).

Participants self-reported the maximum availability of each food/beverage item in their home over the previous 7 days on the HFAI-C (71). In addition to indicating absence/presence, each participant reported whether items were available in one of three amounts: small, medium, or large (71). A range of the quantities within each item's response options of small, medium, and large was provided based on the distribution of sizes of foods/packages that were available from a Universal Product Code (UPC) scanning study (152) and on the usual packaging available for purchase in the UK (71). Examples of items from the HFAI-C categories used in our analyses and the ranges of quantity within each item's response options are provided in Table 3.3.

(b) Home Food Availability Inventory Checklist (HFAI-C) validity and reliability

Criterion validity of the HFAI-C was assessed in a convenience sample of 97 homes from the BiB1000 cohort when children were 18 months of age (71). The purpose of the validation was to ensure that the HFAI-C accurately captures 1) what is available in the home (absent/present) and 2) in what quantity items are available in the home (small, medium, or large amounts) (71). Participant HFAI-C responses were compared to gold-standard researcher-conducted open inventories (conducted on the same day the checklist was administered) on the availability of foods within the checklist-specified categories(71). Cicchetti-Allison linear weighted kappa (153) was used to assess concordance between participant and researcher responses for HFA grouped into two (absent/present) and four (absent or present in small, medium, or large amount) categories (71).

Findings indicated that this checklist has fair-to-moderate validity (i.e., kappa values of >0.20-≤0.40 for fair and >0.40-≤0.60 for moderate (154)) for assessing absence/presence (2 categories) and quantity (4 categories) (Table 3.4.) (71). Although the validation study was not powered to examine ethnic differences in validity, exploratory analyses with data stratified by ethnicity indicated that the checklist was valid for homes of both the Pakistani and White British (71). Though the validity as measured by weighted kappa is lower than other existing participant-completed measures (61,155,156), this discrepancy may be explained by differences in the study designs (71). Specifically, in BiB1000 researchers used the gold-standard (research-conducted open inventories) to assess criterion validity (71) while the other studies used interviewer-completed checklists as a proxy for this gold-standard (61,155,156).

Test-retest reliability for absence/presence was additionally examined in the same sample of 97 homes examined in the validation study (71). When the sample was restricted to participants with a test-retest period of 30 days (n=43), reliability for the snack and beverage categories was shown to be fair (i.e., intra-class correlation coefficients [ICCs] of 0.41-0.60 (157)), with ICCs of 0.52 (95% CI 0.45, 0.60) for snacks and 0.48 (95% CI 0.34, 0.60) for beverages (71). These moderate ICCs are likely explained by the researcher-conducted open inventories examining one day of HFA while the checklist refers to the maximum HFA during the past week. Although a stronger measure would be preferred in terms of both validity and reliability, findings with similar tools indicate that this checklist is capable of detecting ethnic differences in HFA (48,66,67) and associations of HFA with diet (33,36,158–160) and obesity (45,46).

(c) Home Food Availability Inventory Checklist (HFAI-C) variable derivation

HFAI-C data was used to create two variables each for the snack and SSB categories for the purpose of analysis as with the FFQs: 1) variety and 2) total quantity available in the home in the past week. To determine variety scores, each HFAI-C item was assigned a score of 0 for absence and 1 for presence, and items were summed within HFAI-C categories. For total quantity, average weight/volume for each item's designated size (e.g., 1 cup, 1 medium-sized can) was calculated by averaging weights/volumes of the specified size of common varieties or brands of each item from the USDA food composition database (141). For items whose size was "one handful", one handful of nuts or sweets and two handfuls of crisps were considered equivalent to 28.35 grams (1 ounce). Total quantity was determined at the item level by multiplying the average weight/volume by participants' quantity response (median quantity within the designated small, medium, or large quantities). Totals of all items within the given category were summed to create a category-level variable.

c. Covariates

i. Socio-demographics

Socio-demographic data for the mother and child were collected at baseline (125). Relevant questionnaire items were previously validated as part of the Millennium Cohort Study (161), Growing Up in Australia (162), the 2001 Census (147), the European Prospective Investigation into Cancer and Nutrition (163), and the 2004 Healthy Survey for England (164) questionnaires (127) and modified by the BiB project team. In addition to ethnicity, data on maternal age, maternal education (<5 General Certificate of Secondary Education [GCSE] equivalent, 5 GSCE equivalent, A-level equivalent, Higher than A-level, Other/unknown), maternal employment (currently, previously, or never employed), total number of persons in household (number of individuals within the designated age groups of <2 years, 2-15 years, 16-64 years, and >65 years), and toddler's sex were collected as part of this questionnaire (125). Employment was also assessed at 6, 12, and 24 months of age using items adapted from the Millennium Cohort Study (161) in which women reported whether there were any changes to their baseline-reported employment status, including being on maternity leave (126). All aforementioned variables were considered for covariates in analyses in Chapters 4 and 5.

ii. Maternal characteristics

Age at which mothers moved to the UK was assessed as part of the baseline questionnaire (126). Breastfeeding was assessed at all home visit time points used in analyses in Chapter 5 (126). Using questions selected from Growing Up in Australia (162), mothers indicated whether they had ever breastfed their child, if they were still breastfeeding, and what date they stopped breastfeeding at 6, 12, and 24 months. At 18 months, however, they only reported whether they had breastfed during the past four weeks. Parity data was extracted from the electronic maternity information system (126). Maternal smoking during pregnancy was assessed as part of the baseline questionnaire, and maternal smoking history was assessed at 6 and 24 months (126) using questions adapted from the Millennium Cohort Study (161). These characteristics may be important determinants of PPWR (73) and thus were considered covariates in analyses in Chapter 5.

C. Hispanic Community Children's Health Study/Study of Latino Youth (SOL Youth)

1. Study cohort

a. Overview

SOL Youth is an ancillary study of the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). HCHS/SOL is a prospective, community-based cohort study whose primary objective is to determine the risk factors for and prevalence of chronic diseases and conditions, including cardiovascular disease, pulmonary disease, and type II diabetes, in self-identified Hispanic/Latino individuals aged 18-74 years (165). SOL Youth recruited children of individuals in HCHS/SOL to examine the influence of acculturation, parenting strategies, family behaviors, and parent lifestyle behaviors on youth's lifestyle behaviors and cardiometabolic risk profiles. Demographic characteristics of SOL Youth participants were expected to reflect those of the HCHS/SOL cohort (166), with both samples having a large representation of low socioeconomic status households (Table 3.5.) (167,168).

b. Hispanic Community Health Study/Study of Latinos (HCHS/SOL) sampling

The HCHS/SOL target population was all non-institutionalized Hispanic/Latino adults aged 18-74 years and residing in the designated geographical areas (census block groups from the decennial 2000 census) across the four participating field centers (Bronx, New York; Chicago, Illinois; Miami, Florida; San Diego, California) (165,169). Participants were selected using a stratified, two-stage probability sampling design within these areas to provide a representative sample of the target population, maximize participation rates, minimize non-response, and minimize attrition during follow-up (165,169).

During the first stage of sampling, census block groups were selected at each field center using simple random sampling stratified by cross-classification of Hispanic/Latino concentration (high/low) and socioeconomic status (high/low). Additional strata were defined for the Miami and Bronx field centers to target specific population subgroups (169). Surnames and telephone numbers were assigned to each household address selected during stage 1 using the Delivery Sequence File available from the US Postal Service and through cross-referencing with telephone and commercial mailing lists (169). During stage two, household addresses in each field center were randomly sub-sampled to form three waves corresponding to the three years of recruitment (169). Household addresses were selected within each selected census block using simple random sampling stratified by Hispanic/Latino surname (169). Oversampling occurred at each stage of the probability sampling design, with oversampling of block groups in areas of high Hispanic/Latino concentration, households associated with a Hispanic/Latino surname, and persons aged 45 to 74 years (169). Overall, 632 (73%) of the 871 census block groups in the target areas were selected for the sample, and 123213 addresses were selected for recruitment (169).

c. Hispanic Community Health Study/Study of Latinos (HCHS/SOL) recruitment

The recruitment goal for each field center was 4000 Hispanic/Latino participants, with 62.5% of individuals aged 45-74 years to help ensure sufficient incidence of chronic disease (169). Across sites, a minimum of 2000 participants from each of the pre-specified Hispanic/Latino subgroups (Mexican, Puerto Rican, Cuban, and Central/South American) was also required to allow for subgroup analyses (169). Persons on active duty military service, not currently living at home, planning to move from the area in the next six months, physically unable to attend the clinic examination, or unable to complete the study questionnaires in English or Spanish were considered ineligible (165,169).

Recruitment occurred in three steps: 1) initial mailings to sampled household addresses describing the study, 2) telephone calls to households with landlines, and 3) face-to-face contact (169). A brief household screener was administered using a digital hand-held device during the face-to-face contact to determine individuals' eligibility and to implement the age sub-sampling procedure (169). After individuals consented to participate, a roster of household members was created and individual eligibility was confirmed (169). A goal of 60% participation was set at the onset of recruitment (169). Between March 2008 and June 2011, HCHS/SOL examined 16415 Hispanic/Latino adults (170).

c. Hispanic Community Children's Health Study/Study of Latino Youth (SOL Youth) recruitment

Children living with at least one parent or legal guardian who completed the HCHS/SOL baseline examination were eligible for SOL Youth (171). Each site sent initial mailings to eligible HCHS/SOL households who may have had children living in their households (171). Households were screened via telephone using a standardized script (171). SOL Youth eligibility required that the child 1) lived at least 5 days/week and 9 months/year with the HCHS/SOL parent or legal guardian, 2) was 8 to 16 years of age at the time of the SOL Youth baseline examination, 3) had no known serious physical or cognitive comorbidities that would interfere with his/her ability to complete a clinic visit, and 4) was able to read, listen, and write in English or Spanish (166,171). The goal was to recruit an equal proportion of males versus females and youth aged <11 years versus ≥11 years (166).

Between December 2011 and December 2013 (172), 6741 households were screened via telephone (167). Of the 1777 identified eligible youth, 1466 (83%) participated, corresponding to 1019 parent/guardians (172). Nearly 55% of participating parents/guardians were 18-45 years of age, and 45% were 46 to 74 years old (173). An overview of the children who participated in SOL Youth with respect to the recruitment goals is provided in Table 3.6.

d. Data collection measures

Study participation included three components: 1) an initial clinical examination at the field center lasting up to 4 hours, 2) 7 days of wearing a physical activity monitor, and 3) a second 24-hour dietary recall via telephone within a month of the initial clinic visit (172). The clinical examination included phlebotomy, anthropometry, seated blood pressure, fitness step test, pubertal stage assessment, and study questionnaires (172).

All study questionnaires used in our analyses were interviewer-administered in English or Spanish (171). A SOL Youth Translation Subcommittee was developed to review new and existing Spanish translations of questionnaires used in SOL Youth (171). This subcommittee included bilingual study members from the four field centers and coordinating center, with representation of the four Hispanic/Latino subgroups of interest (Mexican, Cuban, Puerto-Rican, and Central/South American). The final translations were certified prior to release (171).

2. Outcome: obesogenic dietary intake

a. Diet assessment methodology

Diet was assessed using two interviewer-administered 24-hour dietary recalls in the participant's language of choice (English or Spanish). The first interview was conducted in-person at the clinical examination, and the second interview was conducted via telephone at least 5 days, but no more than 30, following the first interview (171). The initial 24-hour dietary recall covered the time period from 10:00 pm two days before the interview to until 10:00 pm the night prior to the interview, due to the need to fast for 10 hours prior to the clinical exam visit. The telephone recall covered the 24 hours preceding midnight of the previous night (171). The exact day of the week for the second interview was chosen by field center staff from available participant times, with a goal of having the distribution of days across participants include all days of the week possible given clinic schedules (171).

Interviews were conducted using direct data entry into the Nutrition Data System for Research (NDSR) software developed by the Nutrition Coordinating Center (NCC) at the University of Minnesota, which employs the multiple pass procedure. NDSR versions 10-12 (2010-2012) were used to collect data, and all raw files were processed using version 13 (2013) (174). The NCC Food and Nutrient Database includes more than 18000 foods and over 7000 brand-name products. For the purpose of our analyses, findings for average servings at the food-group level were used (175,176).

To aid in recalling portion sizes, individuals were provided with food models for the in-person interview and a Food Amounts Booklet for the telephone-based recall (174). An assortment of household cups, glasses, spoons, bowls, a ruler, and replicas of select foods (including culturally specific items such as Bolillo [Mexican bread], refried beans, and enchiladas) were included in each set of models (177). To ensure that interviewers consistently chose the correct food when entering dietary data into NDSR, SOL Youth developed the Hispanic Foods Glossary (177). The glossary lists 208 foods, including fruits, vegetables, and Hispanic dishes, and helps interviewers identify foods that are referred to by different names depending on the participant's culture (177).

b. Definition of obesogenic foods/beverages

Dietary items defined as obesogenic for the purposes of our study are listed in detail in Chapter 6 and include snack foods, sweets, SSBs (any non-dairy beverage with added caloric sweeteners (178)), sweetened milk, and 100% fruit juice. Although sugar is not added to 100% fruit juice, it is included because it is similar to soda in energy and sugar content (179), and the 2015-2020 Dietary Guidelines recommend limited consumption (178).

3. Exposure: food parenting practices

a. Overview

Food parenting strategies were assessed using the Parenting Strategies for Eating and Activity Scale (PEAS) (180,181). This 26-item questionnaire was developed and validated among Latina mothers living in South San Diego County to assess Latina mothers' parenting strategies for children aged 5-8 years living in the US (181). SOL Youth minimally altered the wording and order of the PEAS items; however, information on the modification process is not available. Although we derived a new factor structure for PEAS in Chapter 6, an overview of the development of this questionnaire and its original validation is provided below.

b. Questionnaire development and validation

PEAS was developed and validated in three phases (181).

i. Phase 1

Thirty women were recruited from parent-teacher associations and participated in focus group discussions of food- and activity-related parenting strategies used in the home (181). Thirty-two items were developed for PEAS based on these discussions, and 25 items were deemed appropriate for assessing parenting of children aged 5-8 years (181). These items were translated into Spanish using a professional translation service, and bilingual/bicultural members back-translated the items and confirmed semantic equivalence (181). Items were grouped into one of five hypothesized subscales (Limit Setting, Discipline, Control, Concern, and Monitoring) and given a 5-point Likert-style response (181). The Limit Setting and Control subscales used response options ranging from disagree to agree, the Monitoring and Discipline subscales used responses of never to always, and the Concern subscale used responses of not at all to very concerned (181).

ii. Phase 2

Ninety-one women with children in kindergarten through 2nd grade completed a 64-item questionnaire, including the 25 items from the scale developed in Phase 1, socio-demographic questions, and the Child Feeding Questionnaire (CFQ; a commonly used measure of food parenting practices developed for non-Hispanic Whites) (181,182). Based on a principal component analysis with a pre-specified five-factor solution, five items with weak cross loadings were removed (181). The resulting five-factor solution was deemed appropriate based on each factor having an eigenvalue >1 and accounting for ≥50% of the total variance (183). The 20-item scale showed high reliability (184), with Cronbach's alpha coefficients for each factor ranging from 0.81-0.82, and high construct validity, with correlations between PEAS factors and subscales of the CFQ in the hypothesized directions (181).

iii. Phase 3

Seven hundred and fourteen parent-child dyads recruited for *Aventuras para Niños*, a childhood obesity prevention intervention for children in kindergarten through 2nd grade, completed a 22-page questionnaire (181). The questionnaire included a modified version of the scale developed in Phase 2 and a 30-item scale that assessed dietary behavioral strategies to reduce fat and fiber intake (181). Modifications to the 20-item scale developed in Phase 2 included adding 2 items to assess praise as a form of positive reinforcement (response options ranging from never to always) and adding 11 items from the CFQ to assess more food-parenting practices specific to Limit Setting, Control, and Concern (181). After a confirmatory factor analysis showed that a six-factor solution provided less than adequate fit (185,186), the scale was modified (181). The Concern factor (7 items) was removed given that it reduced overall model fit (181). The model was also re-estimated with correlated errors due to large correlated errors between adjacent items (181). The final model provided good fit (185,186) (X^2=1030.81, df=282; Comparative Fit Index (187) =.89, Incremental Fit Index (188) =.90, Root Mean Square Error of Approximation (189) =.06) and included five factors (Limit Setting, Discipline, Control, Monitoring, Reinforcement) (Table 3.7.) (181)**.** Construct validity of the final scale was moderate, with strategies for reducing both fat and fiber being positively associated with all factors except Control (181). Overall, PEAS showed strong reliability and construct validity (181), and its implementation in *Aventuras para Niños* indicated that associations can be detected between the parenting practice constructs measured by PEAS and dietary intake (105,190).

c. Derivation of food parenting practice clusters

Though PEAS is considered a valid means of assessing food parenting practices for the purpose of examining associations with dietary intake in Hispanics/Latinos, the factor structure of PEAS was validated only for combined food and physical activity parenting practices among Hispanic/Latino mothers of 5- to 8-year-olds. As previously mentioned, we derived a new factor structure for assessing food-specific parenting practices based on the 16 food-related questions among parents of pre-adolescent and adolescent Hispanic/Latino youth, with details provided in Chapter 6. Standardized scores for each factor were used to derive the food parenting practice clusters for our analyses, as described in the analysis section of this chapter.

4. Covariates

a. Socio-demographics

Socio-demographic information for the parent and child was collected during the field center visit using a questionnaire (166). Covariates relevant to analyses in Chapter 6 that were reported on the questionnaire include child's age, child's sex, parent's age, parent's sex, parent's education (<high school, high school or equivalent, >high school), parent's Hispanic background (Dominican, Central American, Cuban, Mexican, Puerto Rican, South American, Mixed/Other), and household income (<$20,000, $20,000-$40,000, >$40,000) (166). Both the parent and child completed a demographic questionnaire, but only the responses from parents were used for these analyses (166).

b. Acculturation

i. Overview of measurement

Parental acculturation was assessed in SOL Youth using the Acculturation Rating Scale for Mexican Americans II Brief (ARSMA-II Brief) (180,191). Additional measures related to acculturation, including years lived in the US, were examined (180). Existing research shows that use of ARSMA-II Brief and its predecessors (ARSMA and ARSMA-II) produce similar results to those seen when language use, years lived in the US, immigrant generation/birthplace, or a combined generation status/years in the US variable are used to approximate acculturation in examinations of acculturation and dietary intake of snacks (192). Specifically, across these measures, greater acculturation is associated with increased intake of snacks (192). However, findings are less consistent for ARSMA-II Brief compared to the other measures for dietary intake of SSBs (192,193). Although measures such as immigrant generation and years lived in a Western country can serve as proxies of acculturation (as in BiB1000), the primary measure of acculturation in Chapter 6 is the ARSMA-II Brief because it accounts for the possibility of biculturalism and marginalization as described below, whereas the other measures assume acculturation is a unidirectional process (194).

ii. Questionnaire development

The ARSMA-II Brief (191) is a 12-item questionnaire that refines the ARSMA (195) and ARSMA-II (196) questionnaires for use in large scale research studies. ARSMA-II Brief focuses on language use and preference (191), one of the four factors (language use and preference, ethnic identity and classification, cultural heritage and ethnic behaviors, and ethnic interaction (195,196)) examined in ARSMA and ARSMA-II. Responses to ARSMA-II Brief are strongly correlated with the original ARSMA (r=0.89) despite narrowing the definition of acculturation to language use and preference only (191,195).

Because ARSMA only assesses acculturation on a linear scale, it ignores the possibility of biculturalism (195,196). Thus ARSMA-II was designed to assess orthogonal acculturation, specifically measuring four multidimensional types of acculturation (197): assimilation (culture of origin replaced by dominant culture); separation (dominant culture rejected and culture of origin maintained); marginalization (neither dominant culture nor culture of origin is comfortable), and biculturalism (both cultures maintained) (196). ARSMA-II items were selected from ARSMA, but each original item was divided into two items directed at each cultural orientation (Hispanic or Anglo) separately (196). Items for ARSMA-II were further revised to be Likert-style (response options of not at all, very little, moderately, very often, almost always), and additional items were added to measure positive and negative affirmation of ethnicity (196). The factor structure and theoretical basis for ARSMA-II were based in models of acculturation not examined in ARSMA (198–201). Six items from the Mexican Oriented Scale (MOS) (referred to as the Latino Oriented Scale [LOS] in SOL Youth) and six from the Anglo Oriented Scale (AOS) were selected from ARSMA-II to create ARSMA-II Brief. For the purpose of SOL Youth, wording of the ARSMA-II Brief was slightly altered and the term "Anglos" was changed to "non-Hispanic Americans".

iii. Questionnaire validity and reliability

Two samples from the southwestern US were used to examine the validity and reliability of ARSMA-II Brief (191). Sample 1 included 277 middle school students (82% Hispanic), and Sample 2 included 108 3rd-5th graders (98% Hispanic) (191). The two-factor structure seen in ARSMA-II was confirmed for ARSMA-II Brief using principal components analysis (Table 3.8.) (191). Although a three-factor solution was also suggested based on eigenvalues and scree plot evaluation, only two items loaded onto one of the resulting factors, and thus the two-factor solution was selected (191). The internal consistency of both identified factors for ARSMA-II Brief is high (184), as indicated by Cronbach's alpha coefficients of 0.93 and 0.84 for the MOS and 0.69 and 0.75 for the AOS for Samples 1 and 2, respectively.

Construct validity was defined for this measure as whether ARSMA-II Brief accurately discriminates between Mexican Americans at different levels of acculturation (191). Because Sample 2 was closer to the US-Mexico border and more culturally homogenous than Sample 1, it was hypothesized that a higher percentage of Mexican-oriented individuals would be found in Sample 2 compared to Sample 1 (191). Construct validity was confirmed using both linear and orthogonal scales of acculturation, with the two samples significantly differing as hypothesized ($p<0.01$) (191). Concurrent validity was assessed using the participant's language preference for completing ARSMA-II Brief (191). In Sample 1 and Sample 2, a preference for Spanish was negatively correlated with linear and orthogonal acculturation values (Pearson's $r=-0.53$ and -0.49 for linear scores and -0.38 and -0.29 for orthogonal scores, respectively [$p<0.01$]), indicating significant concurrent validity (191). Although these correlations for construct validity are low to moderate, the internal consistency of the measure is high. Further, ARSMA-II Brief, its predecessors, and other bidirectional acculturation measures with stronger validity (202) have all previously been used to identify significant associations between acculturation and dietary intake, with consistent findings across studies irrespective of the acculturation measure implemented (192).

iv. Variable derivation

For the purpose of analysis, parents were classified into three acculturation groups according to mean AOS and LOS scores: bicultural (AOS and LOS≥3.0), assimilated (AOS≥3.0, LOS<3.0), and marginalized (AOS and LOS<3.0)/separated (AOS<3.0, LOS≥3.0). The marginalized and separated categories were combined because only five parents were classified as marginalized.

c. Acculturative stress

i. Overview of measurement and variable derivation

Parental acculturative stress was reported using the 9-item Acculturative Stress Index (203). Each item related to experiences with perceived discrimination, intergenerational conflict, or language conflict over the past year (203,204). Items were modified from the original questionnaire for parent-completion in SOL Youth, similar to previous studies (204). Average score on the Acculturative Stress Index was used for the purpose of analysis.

ii. Questionnaire development

The three subscales selected for the Acculturative Stress Index were developed as part of a larger assessment of acculturation and acculturative strain in a longitudinal study of adolescent drug use. The study included entry-level middle-school boys (n=6700) and a subsample of girls (n=700) in the greater Miami, Florida area (203). The authors selected validated scales of acculturation from the literature and derived original scales to assess acculturative strain (203). All scales were pilot-tested in 251 Hispanic males and females in the sixth and seventh grades, and the resulting items were assessed with principal component analysis (203). This analysis produced seven scales pertaining to acculturation and acculturative stress: language behavior, family cultural orientation, language-related conflict, familism, family acculturation conflict, ethnic awareness, and cultural identity (203). Of these, three were identified as measures of acculturative strain: language-related conflict (i.e., language conflict), family acculturation conflict (i.e., intergenerational conflict), and ethnic awareness (i.e., perceived discrimination) (203–206). Each item of the acculturative stress scales had response options indicating how frequently individuals felt the designated type of stress (not at all, very little, moderately, very often, almost always) (203).

iii. Questionnaire validity and reliability

Internal consistency and construct and criterion validity of the acculturative stress scales was assessed in 4238 Hispanic students (1745 Cubans and 2493 other Latin Americans) as part of the aforementioned study of drug use (203). Internal consistency was moderate in both Hispanic groups examined (203), and further examination of a modified parent version of this questionnaire indicated moderate consistency in a sample of 885 adolescents (674 Cubans and 211 Nicaraguans) and their parent (204) (Table 3.9.).

Construct validity was based on associations in the expected direction with nativity, years lived in the US, and selected language for questionnaire completion (203). Associations for language conflict were as expected, with individuals who took the Spanish version of the questionnaire, who were born in Hispanic country, or who had lived in the country for a short duration of time scoring higher on the scale compared to individuals who took the English version of the questionnaire, who were born in the US, or who had resided in the country for a longer duration of time, respectively (203). Perceived discrimination was not associated with any of the aforementioned items, and intergenerational conflict was only associated with these items in Cuban Hispanics (203). The three scales were significantly related to measures of substance abuse in the expected directions, indicating good criterion validity (203). Together these findings indicate sufficient content and criterion validity for use of the Acculturative Stress Index in other Hispanic adolescent populations.

5. Potential effect modifiers

a. Home food availability (HFA)

i. Overview of measurement and variable derivation

HFA was assessed using a 17-item questionnaire about the frequency of availability (never, rarely, sometimes, mostly, always) of fruits, vegetables, savory snacks, sweets, milk, and sugar- and artificially-sweetened beverages within the home over the previous 30 days (180). The questionnaire was adapted from the *Active Where?* parent-child survey (35,173). Only items identified as obesogenic in Table 3.10 were used in our analyses. The divisions were used in previous implementations of this questionnaire (33,35) and are based on nutrient values and caloric density. HFA of obesogenic items was defined as the sum of the Likert rating of frequencies of these nine obesogenic items.

ii. Questionnaire development and validation

Information on the questionnaire's development is not available. Validity and reliability of the questionnaire were assessed in three multiethnic samples: 171 adolescents aged 12-18 years (10% Hispanic) and 116 children aged 5-11 years (8% Hispanic) in a study by Ding et al. (35), and 699 children aged 6-11 years (17% Hispanic) in a study by Couch et al. (33). The questionnaire showed moderate to good consistency for obesogenic items (184) in both children and adolescents based on Cronbach's alpha coefficient (33,35). The questionnaire also showed moderate to substantial test-retest reliability (27 days between HFA questionnaire administrations) according to ICC values (157) (Table 3.11.).

Construct validity for HFA questionnaires can be determined based on whether availability of foods/beverages in the home is associated with dietary intake of the corresponding items (34,207). Construct validity was assessed in both studies using different measures of dietary intake. Ding et al. assessed fruit and vegetable intake with two questions regarding the number of servings of fruits and vegetables the child or adolescent ate in a typical day (ranging from 0-≥4 servings/day) (35). Couch et al. assessed dietary intake using three 24-hour dietary recalls, with the parent and child jointly reporting the diet if the child was <8 years of age, and the child reporting their diet with parental assistance if he/she was ≥8 years of age (33). Comparisons of HFA and dietary intake in both studies showed good construct validity of this HFA measure in children and adolescents. Specifically, significant associations between HFA and dietary intake were generally in the expected directions (Table 3.12.).

Although construct validity as indicated by both the correlations and beta coefficients could be stronger, other HFA tools with similar validity (208) have also been able to identify significant associations between HFA and dietary intake (33,36,158–160). Given the high reliability and consistency of this tool and its ability to detect associations with dietary intake, it was deemed appropriate for the purpose of assessing whether HFA is a potential modifier of the association between food parenting practices and dietary intake in SOL Youth.

b. Parenting style

i. Overview of measurement and variable derivation

Parenting style was assessed using the demandingness (7-item) and responsiveness (9-item) scales from the 16-item Authoritative Parenting Index (180,209). The Authoritative Parenting Index was reworded for SOL Youth for parents. Though parenting styles are typically studied by classifying individuals into the four parenting styles proposed by Maccoby and Martin (i.e., authoritative, authoritarian, permissive, or uninvolved) (210), we examined the scales separately using continuous scores for each scale as explained in Chapter 6.

ii. Questionnaire development

The Authoritative Parenting Index was originally developed for a study of alcohol and tobacco use in 1236 4th and 6th grade students (83% White) in central North Carolina. The Authoritative Parenting Index was designed to assess the two dimensions of authoritative parenting: demandingness and responsiveness (209). The initial version of the Authoritative Parenting Index included twenty items developed based on qualitative research of authoritative parenting (209,211–216). Items were pilot-tested in 3rd and 4th grade students to ensure that younger children could comprehend the Authoritative Parenting Index (209). Each item provides a statement to which individuals respond whether it sounds just like, a lot like, sort of like, or not like their mother/step-mother (209). To check that the index assessed demandingness and responsiveness, researchers conducted exploratory factor analyses in the aforementioned sample and in a sample of 1490 9th and 10th grade students (80% White) (209). Both factor analyses showed that the Authoritative Parenting Index measured a third factor representative of permissive parenting, but this factor had an eigenvalue <1.0 (209). Thus the three items loading on this factor in addition to another item with a low cross-loading were dropped from the Authoritative Parenting Index, with the final version and corresponding factor loadings shown in Table 3.13. (209).

iii. Questionnaire validity and reliability

Internal consistency for each dimension of parenting was assessed in the aforementioned study samples, stratified by race/ethnicity and sex, using Cronbach’s alpha coefficient. Coefficients for the responsiveness and demandingness subscale ranged from 0.71 to 0.90 and 0.65 to 0.83, respectively, indicating good internal consistency (Table 3.14.) (184,209). Although there were no differences by sex, coefficients tended to be lower among Blacks versus Whites.

Construct validity was assessed in both aforementioned samples and in 224 7th and 8th grade students (75% White) (209). Because the association of the Authoritative Parenting Index with measures of dietary intake has not been examined, validity was based on whether associations of authoritative parenting style were in the hypothesized direction with indicators of social and academic competence (e.g., self-esteem) and child risk behaviors (e.g., tobacco use) (209). Responses to the two subscales (demandingness and responsiveness) were divided into tertiles, with individuals falling into the high/low tertiles being assigned to one of four styles: authoritarian (high demandingness/low responsiveness), authoritative (high demandingness/high responsiveness), neglectful (i.e., uninvolved; low demandingness/low responsiveness), and indulgent (i.e., permissive; low demandingness/high responsiveness) (209). The Authoritative Parenting Index varied as predicted with indicators of social and academic competence and risk behaviors. Adolescents whose parents were defined as authoritative had significantly higher self-esteem, self-control, school adjustment, peer acceptance, resistance to peer influence, and conflict resolution ability; significantly lower anger proneness and alienation; and significantly lower odds of reporting substance use and violence-related behaviors than peers whose parents were defined as neglectful (209). Comparisons with parents defined as indulgent or authoritarian were also consistent with prior research providing additional support for the Authoritative Parenting Index's construct validity (209). Based on the high consistency and validity of the Authoritative Parenting Index, the tool is considered an appropriate measure of parenting styles for the purpose of assessing the potential modifying role of parenting styles in the association between food parenting practices and dietary intake.

D. Analytic methods

Details on specific methods used each analysis are provided within those chapters. An overview of the analyses, in additional to analytic details not included in the subsequent chapters, are provided below.

1. Chapter 4: Aim 1

Ethnic and immigrant differences in HFA of snacks and SSBs were examined using separate multinomial logistic regression models. In these models, ethnic or ethnic/immigrant group was the main exposure and HFA variety or quantity, divided into tertiles, was the outcome. Associations between HFA of snacks and SSBs and dietary intake of these items were also examined using multinomial logistic regression models with dietary intake divided into tertiles (with non-consumers also being examined in some analyses). Separate models were run for snacks and SSBs, and two models were examined for each food/beverage category: one for variety and another for total quantity. Each model used the corresponding HFAI-C category as the main exposure variable. Multivariable linear regression models were used to examine associations between availability of snacks and SSBs in the home and BMI. HFA score was examined as a categorical and continuous term in examining associations with dietary intake and BMI. We also conducted exploratory analyses using an interaction between the HFA score and ethnicity for all aforementioned models.

Power for Aim 1 was calculated for several outcomes: 1) HFA variety and total quantity, 2) dietary intake, and 3) BMI. Power calculations for HFA variety and total quantity were based on a chi-squared test with 5 degrees of freedom (i.e., 6 classes [three HFA quantiles*two ethnicities] - 1). Assuming a type 1 error rate of 5%, a sample size of 72 homes in each ethnic group is needed to have 80% power to detect a medium effect size (Cohen's w=0.3 (217)). Given that there were 471 White British homes and 621 Pakistani homes assessed at 18 months in BiB1000, there is sufficient power to detect ethnic differences in HFA of snacks and SSBs.

To detect differences in BMI and dietary intake, a two-sided independent samples t-test was used. Assuming a type 1 error rate of 5%, a sample size of 64 homes in each tertile of a given HFA category is needed to have 80% power to detect a medium effect size (Cohen's d=0.5 (217)). Given that 1092 homes were assessed at 18 months in BiB1000, tertiles of total quantity of HFA will include 364 homes each. Thus there is sufficient power to detect differences in dietary intake and BMI according to the main exposure of interest.

2. Chapter 5: Aim 2

A mixed effects linear regression model was fitted to investigate the association between ethnic/immigrant group and PPWR. We explored ethnic group differences as well using the same models described in Chapter 5 but with ethnicity as the main group variable. As indicated in Chapter 5, we used an unstructured covariance pattern for random effects and selected a spatial exponential covariance structure for the within-subject covariance pattern (218). However, to ensure we obtained accurate standard errors, we also examined two other covariance patterns for within-subject variance: variance components (zero covariance among repeated measures) and spatial power. We selected the spatial exponential covariance structure given this model had the lowest AIC value (based on restricted maximum likelihood estimates from a fully adjusted model).

Time in all models was considered a continuous term due to availability of measurements at each month between 4 and 28 months postpartum. Interactions between group and time (and between group and polynomial terms for time, when applicable) were used to examine differences in the longitudinal patterns of PPWR across groups. Likelihood ratio tests and joint

F-tests were used to determine whether polynomial terms were needed to define the association between time and PPWR. Specifically, we compared: 1) linear versus quadratic, 2) linear spline versus linear, and 3) quadratic spline versus quadratic (218). Three to five knots for splines were examined according to percentile-based recommendations for their locations (219). Joint F-tests determined whether there was an effect of time in each group.

Multivariable linear regression models were used to determine the association between average PPWR from 12 to 24 months postpartum and HFA (variety or quantity) of snacks or SSBs. PPWR was averaged to reflect the same time period captured by the HFAI-C at 18 months. Specifically, previous research with repeated measures of HFA from 12 to 24 months of age has indicated that HFA is relatively stable during this time period (220). Thus the measurement of HFA at 18 months postpartum is assumed to approximate the mother's average home food environment from 12 to 24 months postpartum. Effect modification by ethnic/immigrant group was explored using an interaction term.

To determine power for the Aim 2 analysis of ethnic/immigrant differences in the longitudinal patterns of PPWR, calculations were based on a mixed effects model using the web-based sample size calculation program GLIMMPSE (221). This program has been extensively tested and validated using simulated and published study results (221) and is recommended for calculating power in studies with repeated measures (222). Calculations were based on the simplest version of our proposed model. Specifically, only one repeated measure was included (number of months postpartum), which was treated as a four-level categorical variable (corresponding to the 6, 12, 18, and 24 month follow-up points), and one exposure of interest (ethnic group) was indicated. We did not conduct power analyses based on ethnic/immigrant group due to the lack of data on PPWR according to immigrant generation preventing us from completing the required input in GLIMMPSE. The primary analysis was powered on the interaction term between ethnicity and number of months postpartum using a Hotelling-Lawley Trace statistical test (222).

Approximate PPWR for each specified time point by ethnicity was estimated as follows. Based on a meta-analysis of PPWR in multiethnic populations, change in BMI from pre-pregnancy was found to be 1.14 kg/m^2 at 6 months, 0.46 kg/m^2 at 12 months, and 1.18 kg/m^2 at 18 months (12). Assuming that White British individuals are of similar height (1.67 m) to the Western Europeans assessed in the only previous study to compare Western European and South Asian women (82), this would translate into a PPWR of 3.2 kg at 6 months, 1.3 kg at 12 months, and 3.3 kg at 18 months for White British women. According to a study conducted in 864 multiethnic women living in US with data on PPWR specifically for 24 months, PPWR is expected to be 0.50 kg at 24 months for White British women (223). The only previous study to examine ethnic differences in PPWR for South Asian immigrants found that at ~3 months postpartum, South Asian women retained 2.8 kg more than Western Europeans (82). Based on previous research showing increases in the difference in rate of change between racial/ethnic minorities and Westerners at 6 and 12 months postpartum (77), South Asian women are expected to have PPWR of approximately 6.2 kg at 6 months and 4.8 kg at 12 months. Differences for 18 and 24 months were estimated to mirror changes in PPWR in Westerners (12,223), with PPWR of 6 kg at 18 months and 4 kg at 24 months.

The power calculation presumed an unstructured covariance pattern, with PPWR values correlating by 0.8 if the measurements were separated by 6 months, 0.6 if they were separated by 12 months, and 0.4 if they were separated by 18 months. Standard deviation was set at 4.9 kg for both South Asian and Western European women, based on the only study that has examined

PPWR in South Asian women (82), and was assumed to be constant over the 24-month postpartum period. Assuming a type 1 error rate of 5% and the desire to have 80% power to detect a difference in PPWR, a sample size of 139 women in each ethnic group is needed to detect a difference in trajectories based on the proposed rates of change. Given that there are at least 451 White British women and 587 Pakistani women at each time point of interest, there is sufficient power to detect ethnic differences in PPWR.

A two-sided independent samples t-test was used to determine the power to detect differences in average PPWR from 12 to 24 months postpartum. Assuming a type 1 error rate of 5%, a sample size of 64 homes in each tertile of a given HFA category is needed to have 80% power to detect a medium effect size (Cohen's d=0.5 (217)). Given there were 1092 homes assessed at 18 months in BiB1000 (137), tertiles of total quantity of HFA will include 364 homes each. Thus there is sufficient power to detect differences in PPWR according to the main exposure of interest.

3. Chapter 6: Aim 3

Analysis for Aim 3 was a three-step process: 1) determine factor structure of food-specific PEAS, 2) derive food parenting practice-based clusters, and 3) examine associations between clusters and obesogenic dietary intake. We first examined whether the factor structure of the PEAS questionnaire proposed by Larios et al. (181) was appropriate for assessing food-specific parenting practices in parents of pre-adolescent and adolescent Hispanic/Latino youth. We conducted a confirmatory factor-analysis of a four-factor structure. The fifth factor proposed by Larios et al., Reinforcement, could not be assessed given only one food-specific item loaded onto it. Due to this four-factor structure having a poor fit (X^2=874.15, df=84; RMSEA 0.10 [95%

CI: 0.09, 0.10]; SRMR=0.08; and Bentler's CFI=0.83), we derived a new factor structure as part of our analyses, as described in Chapter 6.

K-means cluster analysis was then used to derive clusters of parents based on individuals' z-transformed scores for each factor. Differences in socio-demographic characteristics of each cluster were assessed using Pearson's chi-squared tests and analysis of variance (ANOVA). Post-hoc significance levels were adjusted for using Tukey's test. A multinomial regression model was run to examine the odds of cluster membership according to acculturation status. A multiple logistic regression model was used to assess whether cluster membership was associated with high obesogenic dietary intake. Interaction terms between cluster membership and each proposed effect modifier (HFA of obesogenic items, demandingness and responsiveness, child's age group, and child's sex) were tested individually in separate models.

To determine power for Aim 3, total obesogenic dietary intake was characterized as a binary variable (high/low). However, no previous studies have examined associations between food parenting practice clusters and dichotomized (high/low) snack and SSB intake. Further, the practices that will characterize each cluster are unknown, but it is expected that at least one cluster will be characterized by low use of controlling food parenting practices (i.e., an indulgent cluster), reflecting a permissive food parenting style. A previous study of Black (n=101) and Hispanic/Latino (n=130) parents of preschoolers in Texas found that among Hispanic/Latino parents, 38.4% were expected to have a permissive parenting style (117). Thus the expected proportion of SOL Youth that would belong to the permissive food parenting practice cluster was 38.4%.

Data on the odds of having high snack and SSB intake according to food parenting practices is limited. However, a recent study of 644 non-Hispanic parents of children aged 6-13 years found that 5.3% of children whose parents exhibited a permissive food parenting style ate unhealthy snacks every day versus not every day (224). This number can be interpreted as the anticipated probability of having a high intake of snacks and SSBs for an indulgent food parenting practice cluster. The study also showed that the anticipated probability of having high intake of snacks and SSBs for a non-permissive food parenting practice cluster was 0.16 (224). Thus to detect a difference in the probability of having high versus low dietary intake of snacks and SSBs between individuals belonging to a permissive food parenting practice cluster versus a non-permissive food parenting practice cluster with 80% power and a type 1 error rate of 5%, a total sample of 267 individuals is required.

The unequal weighting and cluster sampling used SOL Youth tend to reduce the power available for statistical tests (225). Thus to account for these design effects, the required sample size must be multiplied by a factor of 1.5, indicating 401 individuals are required (225). Given that the full SOL Youth sample is 1466 children, analyses are sufficiently powered.

The alpha level for the interaction terms was set at 0.10 based on the following power calculations adjusted for the design effect (i.e., 1466 divided by the design factor of 1.5, equaling 977) for the home environment modifiers. In the only previous study to examine the interaction between parenting practices and HFA, 24.7% of Hispanic individuals had a combination of high HFA of snacks and SSBs and indulgent food parenting practices (low Restriction) (115). Based on the findings of this study, the probability of having a high intake of snacks and SSBs for an indulgent food parenting practice cluster in the context of high HFA of snacks and SSBs is estimated to be 1.3 times that seen in the context of low HFA (115). Thus with an alpha level of 0.10, there is 81% power to detect a difference in high versus low dietary intake of snacks and SSBs assuming the probability of high intake of snacks and SSBs in the context of low HFA of snacks and SSBs is 0.29. If the true probability of high intake of snacks and SSBs in the context of low HFA is lower than this in the SOL Youth sample, the alpha level would need to be increased in order to have sufficient power to detect effect measure modification.

For the interaction between food parenting practices and demandingness and responsiveness, a similar approach to power was used. No previous studies have indicated the percent of individuals that we should expect to have indulgent food parenting practices according to demandingness or responsiveness scores. However, previous studies have found an inverse association between a combination of high responsiveness and low demandingness (permissive parenting style) with scores for Monitoring (226–228). Thus it is expected that individuals with low scores for demandingness and high scores for responsiveness (i.e., a permissive parenting style) will be most likely to belong in a food parenting practice cluster characterized by low Monitoring. Given that other clusters may also be characterized by low Monitoring, we expect that ~30% of individuals with a permissive parenting style will use food parenting practices characteristic of the indulgent food parenting practice cluster. Due to inconsistencies in the literature, we conservatively set the odds of having a high snack and SSB intake for an indulgent food parenting practice cluster in the context of a permissive parenting style to be 1.25 times that seen in the context of a non-permissive parenting style (112,113,120). Thus with an alpha level of 0.10, there is 81% power to detect a difference in high versus low dietary intake of snacks and SSBs assuming the probability of high intake of snacks and SSBs in the context of a permissive food parenting style is 0.34. If the true probability of high intake of snacks and SSBs in the context of an authoritative food parenting style is lower than this in the SOL Youth sample, the alpha level would need to be increased in order to have sufficient power to detect effect modification.

Table 3.1. Socioeconomic status of BiB and BiB1000 samples

Maternal education	**BiB** (n=13199)	**BiB1000***		
		Total (n=1707)	*White British* (n=652)	*Pakistani* (n=808)
None	2356 (23%)	375 (24%)	133 (22%)	208 (27%)
School	3361 (33%)	556 (35%)	242 (41%)	261 (34%)
Further	1563 (16%)	233 (15%)	100 (17%)	97 (13%)
Higher	2772 (28%)	404 (26%)	119 (20%)	202 (26%)
Other/Unknown	3147	139	58	40

BiB Born in Bradford, *BiB1000* Born in Bradford 1000
*n=28 twin births excluded
Data source for BiB: (126)

Table 3.2. BiB1000 attrition over 36 months according to ethnicity

Ethnicity	**Baseline** (n=1460)	**6 months** (n=1130)	**12 months** (n=1086)	**18 months** (n=1092)	**24 months** (n=1042)	**36 months** (n=1038)
White British	652 (100%)	485 (71%)	481 (74%)	471 (72%)	445 (68%)	451 (69%)
Pakistani	808 (100%)	645 (79%)	628 (78%)	621 (77%)	597 (74%)	587 (73%)

BiB1000 Born in Bradford 1000

Table 3.3. Examples of BiB1000 HFAI-C items and scaling of amounts from the two categories studied

Food/Beverage	**Description**	**Size**	**Amount**			
			Absent	*Small*	*Medium*	*Large*
<u>*Snacks*</u>						
Q27. Crisps, tortilla chips	All varieties	Handful	0	1-3	4-10	>10
Q32. Cakes, muffins	All varieties	Medium portion	0	1-3	4-10	>10
<u>*Beverages*</u>						
Q34. Fizzy drinks	Not diet	Medium can/bottle	0	1-5	6-10	>10

BiB1000 Born in Bradford 1000, *HFAI-C* Home Food Availability Inventory Checklist
HFAI-C validated for both dichotomized (absence/presence) and quantity (absent or small, medium, and large amounts) responses

Table 3.4. Validity (Cicchetti-Allison linear-weighted kappa values) of HFAI-C according to ethnicity in BiB1000 (n=87)

HFA category	**Weighted kappa, 2 categories***		**Weighted kappa, 4 categories***	
	White British (n=47)	*Pakistani* (n=40)	*White British* (n=47)	*Pakistani* (n=40)
Snacks	0.47 (0.38, 0.56)	0.35 (0.26, 0.45)	0.23 (0.19, 0.29)	0.28 (0.21, 0.36)
Beverages	0.35 (0.20, 0.49)	0.43 (0.29, 0.57)	0.29 (0.17, 0.41)	0.21 (0.11, 0.32)

HFAI-C Home Food Availability Inventory Checklist, *BiB1000* Born in Bradford 1000
*****2 categories=absence/presence; 4 categories=absent or small, medium, and large amounts
Data source: (71)

Table 3.5. Socioeconomic status of HCHS/SOL and SOL Youth samples

	HCHS (n=16415)	**SOL Youth** (n=1466)
Parental education		
<High school	33%	565 (39%)
High school	27%	417 (29%)
>High school	39%	480 (32%)
Missing		4
Household income		
≤$20000	42%	750 (52%)
>$20000-$40000	36% (≤$50000)	457 (32%)
>$40000	10% (>$50000)	210 (16%)
Unknown	12%	49

HCHS/SOL Hispanic Community Health Study/Study of Latinos, *SOL Youth* Hispanic Community Children's Health Study/Study of Latino Youth
Unweighted n (weighted %)
Only the distributions in terms of percent were available from HCHS: (168)

Table 3.6. Distributions of age and sex by site in SOL Youth (n=1466)

	Age (years)		**Sex**	
	8-12	*13-16*	*Male*	*Female*
Site				
Bronx	241 (54%)	181 (46%)	209 (51%)	213 (49%)
Chicago	217 (56%)	155 (44%)	165 (50%)	207 (50%)
Miami	149 (55%)	114 (45%)	141 (51%)	122 (49%)
San Diego	237 (53%)	172 (47%)	213 (51%)	196 (49%)
Total	844 (54%)	622 (46%)	728 (51%)	738 (49%)

SOL Youth Hispanic Community Children's Health Study/Study of Latino Youth

Table 3.7. Standardized factor loadings of each item on the final full Parenting strategies for Eating and Activity Scale (PEAS) (n=714)

Item wording	Limit Setting	Monitor-ing	Discip-line	Control	Reinforce-ment
1. I limit the amount of time my child plays video games or is on the computer during the week	0.90				
2. I limit the amount of time my child plays video games or is on the computer during the weekend	0.79				
3. I limit the amount of time my child watches TV or videos during the week	0.77				
4. I limit the amount of time my child watches TV or videos during the weekend	0.77				
5. I limit the amount of soda my child drinks	0.47				
6. I limit the number of snacks my child eats	0.46				
7. How much do you keep track of amount of TV or videos your child is watching?		0.73			
8. How much do you keep track of the high fat foods your child eats?		0.71			
9. How much do you keep track of the salty snack food your child eats?		0.70			
10. How much do you keep track of sweets that your child eats?		0.69			
11. How much do you keep track of the amount of exercise your child is getting?		0.61			
12. How much do you keep track of the servings of fruits and vegetables your child is eating?		0.59			
13. My child must ask permission before getting a snack		0.26			
14. How often do you discipline your child if she/he plays video games without your permission?			0.86		
15. How often do you discipline your child if she/he watches TV without my permission?			0.85		
16. How often do you discipline your child if she/he gets a snack without your permission?			0.66		
17. How often do you discipline your child if she/he drinks soda without your permission?			0.64		
18. My child must ask permission before drinking a soda			0.21		

Item wording	Limit Setting	Monitor-ing	Discip-line	Control	Reinforce-ment
19. If I don’t regulate my child’s eating he/she would eat much less				0.73	
20. I have to make sure my child eats enough				0.72	
21. If my child says, “I’m not hungry,” I try to get them to eat anyway				0.69	
22. My child should always eat all the food on his/her plate				0.53	
23. I offer TV, video games, videos as a reward for good behavior				0.31	
24. I offer sweets as a reward for good behavior				0.21	
25. How often do you praise your child for being physically active?					0.77
26. How often do you praise your child for eating a healthy snack?					0.75

Table modified from the following source: (181)

Table 3.8. ARSMA-II Brief factor loadings for combined validation samples (n=438)

Item	MOS	AOS
I speak Spanish	0.84	-0.03
I speak English	-0.32	0.72
I enjoy speaking Spanish	0.86	-0.02
I associate with non-Hispanic Americans	0.16	0.61
I enjoy English language movies	-0.18	0.62
I enjoy Spanish language TV	0.86	0.01
I enjoy Spanish language movies	0.85	-0.08
I enjoy reading books in Spanish	0.81	-0.24
I write letters in English	-0.20	0.65
My thinking is done in the English language	-0.43	0.58
My thinking is done in the Spanish language	0.82	-0.18
My friends are of “non-Hispanic” origin	0.28	0.55

ARSMA-II Acculturation Rating Scale for Mexican Americans II Brief
Table modified from the following source: (191)

Table 3.9. Internal consistency (Cronbach's alpha coefficient) of Acculturative Stress Index in different Hispanic/Latino and age groups

	Study 1 (n=4238)		**Study 2** (n=885)	
	Cuban	*Other Hispanic*	*Child*	*Parent*
Language conflicts (language-related conflict)	0.58	0.63	0.63	0.67
1. How often has it been hard for you to get along with others because you don't speak English well?				
2. How often has it been hard for you to do well at work because of problems in understanding English?				
Acculturation conflicts (family acculturation conflict/ethnic loyalty)	0.63	0.60	0.61	0.67
3. How often have you had problems with your family because you prefer U.S. customs?				
4. How often do you feel that you would rather be more American if you had a choice?				
5. How often do you get upset at your children because they don't know U.S. ways?				
6. How often do you feel uncomfortable having to choose between non-Hispanic/Latino and Hispanic/Latino ways of doing things?				
Perceived Discrimination (ethnic awareness)	0.56	0.59	0.63	0.77
7. How often do people dislike you because you are Hispanic/Latino				
8. How often are you treated unfairly at work because you are Hispanic/Latino?				
9. How often do you see friends treated badly because they are Hispanic/Latino?				

Data from Studies 1 and 2 are from the following sources, respectively: (203,204)

Table 3.10. Classification of obesogenic and healthier items from the HFA questionnaire used in SOL Youth

Obesogenic	**Healthier items**
1. Sweet baked goods	1. Raw fruit
2. Sweetened cereal	2. Dried fruit
3. Regular chips or crackers	3. Raw vegetables
4. Chocolate candy	4. Regular or 2% milk
5. Other candy	5. 1% or fat-free milk
6. Regular sodas	6. Unsweetened cereal
7. Sports drinks	7. Baked salty snacks
8. Juice drinks	8. Diet or sugar-free sodas
9. 100% fruit juice	

HFA home food availability, *SOL Youth* Hispanic Community Children's Health Study/Study of Latino Youth

Table 3.11. Test-retest reliability (intraclass correlation coefficient) and internal consistency (Cronbach's alpha coefficient) of the HFA questionnaire used in SOL Youth

HFA	**Adolescents** (n=171)		**Children** (n=116 or 699)	
	ICC	*Alpha*	*ICC*	*Alpha*
Ding et al.	0.78	0.73	0.88	0.74
Couch et al.	-	-	-	0.76

HFA home food availability, *SOL Youth* Hispanic Community Children's Health Study/Study of Latino Youth, *ICC* intraclass correlation coefficient
Obesogenic items: chocolates, candies, cakes, regular chips, juice drinks, sugared sodas, sports drinks, whole or 2% milk, and sweetened breakfast cereals (Note: Couch et al. excluded milk)
Couch et al.: (33) and Ding et al.: (35)

Table 3.12. Construct validity of the HFA questionnaire used in SOL Youth in multiple samples

HFA	Fruits and vegetables		Sweet and savory snacks	High-calorie beverages
	Adolescents (n=171)	*Children* (n=166 or 699)	*Children* (n=699)	*Children* (n=699)
Ding et al.				
Partial correlations	-0.17*	-0.17	-	-
Couch et al.				
Beta coefficients	-	-0.27 (-0.52, -0.03)*	0.00 (-0.20, 0.19)	0.21 (0.13, 0.29)*

HFA home food availability, *SOL Youth* Hispanic Community Children's Health Study/Study of Latino Youth
*p<0.05
Multivariable models included the following covariates: encouragement/modeling related to child eating, restrictive food practices, pressure to eat, permissive food parenting practices, family rules related to child eating, frequency of dinner out/week, parent concern of healthy food costs, parent education, parent BMI, child weight status, child gender, child ethnicity, child race, and child age
Couch et al.: (33) and Ding et al.: (35)

Table 3.13. Two-factor structure of the Authoritative Parenting Index

	Study 1 (n=1236)		**Study 2** (n=1490)	
	Factor 1	*Factor 2*	*Factor 1*	*Factor 2*
Responsiveness items				
She is always telling me what to do	-0.78	0.28	-0.72	0.31
She makes rules without asking what I think	-0.72	0.28	-0.58	0.36
She makes me feel better when I am upset	0.68	0.28	0.70	0.27
She is too busy to talk to me	-0.66	0.09	-0.66	0.07
She listens to what I have to say	0.65	0.21	0.75	0.18
She likes me just the way I am	0.63	0.20	0.69	0.18
She tells me when I do a good job on things	0.56	0.34	0.62	0.31
She wants to hear about my problems	0.55	0.36	0.65	0.32
She is pleased with how I behave	0.51	0.19	0.55	0.24
Demandingness items				
She has rules that I must follow	-0.19	0.72	0.10	0.70
She tells me times when I must come home	-0.10	0.70	-0.02	0.76
She makes sure I tell her where I am going	0.10	0.61	0.08	0.69
She makes sure I go to bed on time	0.01	0.59	0.00	0.55
She asks me what I do with friends	0.03	0.51	-0.06	0.54
She knows where I am after school	0.23	0.44	0.20	0.63
She checks to see if I do my homework	0.20	0.46	0.18	0.48
Eigenvalue	5.13	2.09	5.39	2.45
% variance	32.1	13.1	33.7	15.4

Table modified from the following source: (209)

Table 3.14. Internal consistency (Cronbach's alpha coefficients) of the Authoritative Parenting Index by age and race for the two factors

	Males		**Females**		**Total** (n=615 to 774)
	White (n=238 to 297)	*Black* (n=47 to 71)	*White* (n=245 to 327)	*Black* (n=48 to 79)	
Responsiveness					
4^{th} grade	0.82	0.71	0.81	0.75	0.80
6^{th} grade	0.85	0.80	0.89	0.90	0.87
9^{th} grade	0.81	0.79	0.87	0.76	0.84
10^{th} grade	0.83	0.75	0.88	0.87	0.86
Demandingness					
4^{th} grade	0.65	0.81	0.72	0.67	0.70
6^{th} grade	0.76	0.65	0.69	0.72	0.72
9^{th} grade	0.81	0.73	0.77	0.68	0.78
10^{th} grade	0.77	0.73	0.71	0.83	0.76

Table modified from the following source: (209)

CHAPTER 4: ASSOCIATION OF AVAILABILITY OF SNACKS AND SUGAR-SWEETENED BEVERAGES (SSBS) IN THE HOME WITH DIETARY INTAKE AND BODY MASS INDEX (BMI) IN BORN IN BRADFORD 1000 (BIB1000)

A. Overview

Background: Few studies have examined how the home food environment, children's primary source of nutrition, in the first 1000 days of life (conception through 24 months of age) is linked to later risk for childhood obesity. Our objective was to describe and compare the availability of obesogenic items (snacks and sugar-sweetened beverages [SSBs]) in homes of White British and 2nd and 3rd generation Pakistani immigrant toddlers and determine whether home food availability (HFA) of obesogenic items at 18 months of age is associated with dietary intake of snacks and SSBs and BMI at 36 months of age.

Methods: Data are from White British and Pakistani families enrolled in Born in Bradford 1000 (BiB1000), a birth cohort study in the city of Bradford in the United Kingdom (UK), and all variables were measured at 18 (n=1032) and 36 (n=986) months of age. Analyses were conducted on both cross-sectional and longitudinal data. Variety and quantity of snacks and SSBs in the home were measured using the HFA Inventory Checklist (HFAI-C), and snack and SSB intake were assessed with food frequency questionnaires (FFQs). Body mass index (BMI) was calculated based on measured length or height and weight. Multinomial logistic regression models examined ethnic/immigrant differences in HFA and associations between tertiles of HFA and dietary intake. Multivariable linear regression models were used to assess associations between HFA and BMI.

Results: Pakistani households had a greater variety and quantity of snacks and SSBs available at 18 and 36 months compared to White British households, but there were no differences in HFA according to immigrant generation. Variety and quantity of snacks and SSBs in the home were positively associated with children's dietary intake of snacks and SSBs cross-sectionally and longitudinally. Associations between HFA and BMI were null in the longitudinal analysis, but greater availability of snacks and SSBs at 36 months was associated with increased BMI at 36 months.

Conclusions: Reducing the HFA of snacks and SSBs during the first 1000 days of life may help promote the development of a more healthful diet, though this may not necessarily be associated with a lower BMI during toddlerhood.

B. Introduction

Individuals from South Asia are one of the largest immigrant groups in the United States (US) (19), Canada (229), and the UK (18), with Pakistani immigrants constituting the second largest South Asian immigrant group in each country and the third largest ethnic group in the UK (1). Individuals of Pakistani origin are at an increased risk for obesity-related diseases compared to Whites of the same BMI due to their increased percent body fat at a given BMI (14). When BMI values are adjusted to account for this difference in adiposity (15,16), Pakistani children are shown to have a significantly greater BMI compared to White British children (e.g., mean BMI of 19.9 vs.18.6 kg/m^2 for males and 19.7 vs. 19.0 kg/m^2 for females 10 to 11 years of age) (17). Thus there is a need to identify potential targets for reducing risk for obesity in Pakistani children.

The first 1000 days of life (conception through 24 months of age) is a fundamental time to address the determinants of childhood obesity (9,10**)**. It is during this time that food preferences and dietary habits are established (11), with toddlers developing an affiliation for the foods they become most familiar with (29,30). At least three-quarters of toddlers' total daily energy intake comes from foods prepared in the home (32); thus it is not surprising that they tend to prefer the foods and beverages readily available in the household (31). Existing research on HFA and dietary intake in toddlers and young children has largely focused on fruits and vegetables and has found a positive association between their HFA and intake (42,40,36). However, the association between fruit and vegetable intake and obesity is weak, potentially due to the low consumption and low variability in intake of these food groups (37). It may be more promising to focus on the HFA of obesogenic items, such as snacks and SSBs, during the first 1000 days of life as a modifiable risk factor for unhealthy diets and childhood obesity (38).

Few studies have characterized HFA during the first 1000 days of life (41–44), with only two, to our knowledge, examining the relationship between snack and SSB HFA and diet during later childhood (43,44), and no studies examining the relationship with BMI. HFA has also been shown to vary according to ethnicity and degree of acculturation (48,66,67,69,230), yet examinations of South Asian and immigrant households are limited. Only one previous study, a small subset (n=97) of Pakistani and White British homes of 18-month-olds from BiB1000, has examined HFA in South Asian households. The authors found that Pakistani households had a greater quantity of SSBs in the home compared to White British households (71), but the study was not powered to determine if more acculturated households had a larger amount of SSBs available compared to less acculturated households, as has been shown in Hispanic/Latino immigrant households of adolescents in the US (69).

We developed hypotheses to address these gaps in the literature using data from BiB1000, a birth cohort in the UK designed to consider exposures to obesity in early life (126).

Our objectives were to describe the availability of obesogenic items (snacks and SSBs) in homes of White British and 2nd and 3rd generation Pakistani toddlers and to determine if HFA of obesogenic items at 18 months of age is associated with toddler's dietary intake of snacks and SSBs and BMI at 36 months of age. We additionally conducted cross-sectional analyses at 18 and 36 months of age to assess if HFA of these items was associated with diet and BMI in the expected directions at each time point. We hypothesized that Pakistani homes would have more snacks and SSBs compared to White British homes, with households of 3rd generation Pakistani immigrant toddlers having greater availability of these items than households of 2nd generation Pakistani immigrant toddlers. Further, we hypothesized that HFA of snacks and SSBs would be positively associated with dietary intake of these foods/beverages and BMI in all analyses.

C. Methods

1. Study population

BiB1000 is a birth cohort study nested within the larger Born in Bradford (BiB) study. Detailed information on study protocols for BiB and BiB1000 are published elsewhere (121,125,126). Briefly, BiB is a multiethnic cohort study that examines environmental, psychological, and genetic factors related to maternal and child health in the city of Bradford in the UK (121). Of the 326 local authority districts in England, Bradford ranks fifth in having the most highly deprived neighborhoods (123). All mothers booked for delivery at Bradford's only maternity unit (Bradford Royal Infirmary) between March 2007 and November 2010 were eligible for BiB (121,125). BiB recruited 12,453 women (13,776 pregnancies) between 2007 and 2010. Eighty percent of mothers were recruited during the 26-28 week oral glucose tolerance test visit, while the remainder were recruited during other maternity visits.

All mothers recruited into BiB between August 2008 and March 2009 who had completed the baseline questionnaire were approached to take part in frequent follow-up assessments through BiB1000 (126). Of the 1916 women recruited to BiB between these time points, 1735 agreed to take part in the study (126). Mothers of twin births (n=28) were excluded from this analysis due to differences in growth patterning observed in this cohort (128). Overall follow up rates were at least 70% for each visit, with 92% of individuals completing follow-up assessments for at least one of these time points. BiB and BiB1000 were conducted according to the guidelines of the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Bradford Research Ethics Committee (07/H1302/112). Written or verbal (for mothers unable to read and/or speak English) informed consent was obtained from all participants. Verbal consent was witnessed and formally recorded.

2. Study measures

Study visits for our analyses were conducted when children were 18 and 36 months of age (125). Most mothers (61%) preferred to have visits conducted in their homes (125), with the remainder reporting to research clinics at Bradford Royal Infirmary or local Children's Centres for some or all visits (125,126). All data were collected by interviewers in the participant's preferred language (English, Urdu, or Mirpuri) unless otherwise indicated (126).

3. Home food availability (HFA) of snacks and sugar-sweetened beverages (SSBs)

a. Measurement

HFA of snacks and SSBs was assessed using 10 of 39 items from the self-administered, semi-quantitative HFAI-C at the 18- and 36-month visits (71) (Table 4.1.). Each participant reported whether selected food/beverage items had been present during the past 7 days, and if so, the maximum quantity that had been available (small, medium, or large). Ranges for small, medium, and large quantities were provided based on the distribution of sizes of foods/packages that were available from a Universal Product Code (UPC) scanning study (152) and on the usual packaging available for purchase in the UK (71). The HFAI-C was developed and validated in a sub-sample of BiB1000 (71). Findings from the validation study indicated fair-to-moderate validity (154) for assessing absence/presence (kappa: 0.39 to 0.41) and quantity (weighted kappa: 0.25 to 0.26) of snacks and beverages (71). Exploratory analyses with data stratified by ethnicity indicated that the checklist was valid for homes of both the Pakistani and White British toddlers (71).

b. Variable derivation

HFAI-C data were used to create two variables each for the snack and SSB categories for the purpose of analysis: 1) variety and 2) total quantity available in the home in the past week. To determine variety scores, each HFAI-C item was assigned a score of 0 for absence and 1 for presence, and items were summed within HFAI-C categories. For total quantity, average weight/volume for each item's designated size (e.g., 1 cup, 1 medium-sized can) was calculated by averaging weights/volumes of the specified size of common varieties or brands of each item from the USDA food composition database (141). For items whose size was "one handful", one handful of nuts or sweets and two handfuls of crisps were considered equivalent to 28.35 grams (1 ounce). Total quantity was determined at the item level by multiplying the average weight/volume by participants' quantity response (median quantity within the designated small, medium, or large quantities). Totals of all items within the given category were summed to create a category-level variable.

4. Dietary intake

a. Measurement

Intake of snacks and SSBs was assessed using selected items from validated food FFQs from the Southampton Women's Survey (130) at 18 months and the Survey of Sugar Intake among Children in Scotland study (131) at 36 months. Both FFQs were self-administered and were modified to include additional items/prompts appropriate to the study population based on findings from focus groups and 24 hour dietary recalls in Bradford (137). The 18-month FFQ included 98 items in 16 categories assessing frequency (never, <1/week, weekly [recorded number of times/week], and >1/day [recorded number of times/day]) and amount of foods/beverages consumed over the preceding month, with an additional 7 items on breast milk consumption in the past month. During self-administration of the FFQ, pictures and household utensils (tablespoons, teaspoons, bowls and feeding beakers) were used to aid in food recognition and portion size estimations (137).

The modified 36-month FFQ included 140 items within 16 categories, asking about the child's diet over the previous two to three months (231). The response categories were "rarely or never", "1-2 per week", "1 per week", "2-3 per week", "4-6 per week", "1 per day", "2-3 per day", "4-6 per day", and "7 or more per day", and were reported in terms of the designated portion size (131). Examples of food measures were provided in a photograph to help parents estimate the quantities of their child's food intake in standardized terms (e.g., teaspoon, small slice, medium glass) (131). Both the 18- and 36-month FFQs included an open section for participants to list the frequency and amounts of any foods/beverages consumed in the respective time periods that were not included (137,231).

b. Variable derivation

The list of foods representing snack and SSB intake in the 18- and 36-month FFQs were not identical due to the use of age-appropriate, validated FFQs at each time point. Given ambiguity in what is meant by "snack" in British usage (138), the lack of a consensus definition of "snack foods" in the literature (139), and the lack of clear recommendations for snack intake (140), our definition of snack foods was guided by the FFQ-defined food categories at 18 and 36 months. Use of an FFQ-based definition also meant that all participants were presented with the same definition of snack foods when completing the questionnaire.

At 18 months, foods were included if they were part of the "cakes, biscuits, and snacks" category. Ice cream was also included given it was assessed as a snack food on the HFAI-C. The 36-month FFQ did not include sweets in its snack category ("crisps, nuts and savory snacks"), and thus all items part of the "biscuits and cakes" or "sweets, chocolates, and ice-creams" categories were additionally included to ensure similar food groups were measured at 18 and 36 months and that the full range of snacks measured by the HFAI-C were captured. SSBs were defined at both time points as any non-dairy, high-calorie, sweetened beverages.

For the purpose of analysis, reported frequencies were re-calculated to represent intake per week, to match the HFAI-C's measurement timeframe. Two variables were derived to describe snack and SSB intake separately using the same approach described above for HFAI-C: 1) variety and 2) total quantity consumed weekly. Due to a large amount of missing data in reporting of portion size consumed on the 18-month FFQ, total quantity was only derived for the 36-month FFQ. Scores for both variety and total quantity were operationalized as tertiles due to extreme skewedness in the distributions for snacks and SSBs (cut-points for each tertile indicated in Appendix 4.1.). An additional fourth category was created for variety of SSBs consumed at 18 months to represent non-consumers of SSBs. There were too few children with no dietary intake of snacks at 18 months or dietary intake of snacks or SSBs at 36 months to allow for examination of non-consumers for these category/age combinations.

5. Child anthropometrics

Ten study staff trained by expert community researchers measured length/height and weight for all children in BiB1000 (142). Measurements were taken with the child's clothes removed (142). Weight was measured using SECA baby scales (142). Length was measured using the Harlow Health Care neonatometer at 18 months of age, and height was measured using the SECA Leicester height measure at 36 months of age (142). BMI was calculated as weight (kg) divided by length- or height-squared (m^2).

6. Covariates

a. Ethnicity and immigrant generation

Mothers self-reported their ethnic group at baseline using the same classifications as the 2001 Census (126). Mothers were categorized as White British, Pakistani, or Other, with those of Other ethnicity (n=247) being excluded from the analysis due to heterogeneity of ethnicities within this group and small sample sizes of each ethnicity. Children were assigned the same ethnicity as their mother. Mothers also reported their country of origin, the age at which they immigrated to the UK (if applicable), and country of origin for the child's father and maternal and paternal grandparents. Children were classified as non-immigrants (all parents and grandparents born in the UK or Crown dependencies [England, Northern Ireland, Scotland, Wales, Channel Islands, or Isle of Man]), 2nd generation Pakistani immigrants (at least one parent born in Pakistan), or 3rd generation Pakistani immigrants (at least one grandparent born in

Pakistan). All other individuals with non-missing country of origin data were placed in an "other immigrants" group.

b. Socio-demographics

Data on maternal age, highest household education, maternal employment status, total number of persons in the household in defined age groups (<2 years, 2-15 years, 16-64 years, and >65 years), and child's sex were collected at baseline using validated items (125).

7. Analytic sample

Between 18 (n=1092) and 36 (n=1038) months, 143 White British and Pakistani individuals were lost to follow-up, and 89 who had attended the baseline visit but not the 18-month visit attended the 36-month visit. Individuals were excluded at each time point for missing socio-demographic data (n=18 or 14 at the 18- and 36-month visits, respectively), immigration information (n=10 or 9), and HFA data at the designated time point (n=32 or 29). Individuals missing dietary data or BMI were further excluded from those analyses, as shown in Tables 4.4.-4.6. At 18 months, individuals who were excluded were more likely to have a high total quantity of snacks available in the home (3691.5 vs. 2614.4 g). At 36 months, individuals who were included were more likely to be older (27.3 vs. 26.4 years). There were no other significant differences in socio-demographic or HFA data between individuals who were excluded versus included at each time point.

8. Statistical analysis

Ethnic and immigrant differences in HFA of snacks and SSBs were examined using separate multinomial logistic regression models. For these analyses, the outcome, HFA scores, were grouped into categories to aid in interpretability of estimates and to account for the highly skewed data for HFA quantity. HFA variety scores were classified as low (score of 0-2 for snacks or 1 for SSBs [reference group]), medium (score of 3-5 for snacks or 2 for SSBs), or high (score of 6-7 for snacks or 3 for SSBs). A “0” variety score was also created for SSBs at both 18 and 36 months but not for snacks, given only 19 individuals at 18 months and 9 at 36 months reported not having any snacks available in the home. HFA quantity was divided into tertiles, with cut-points for each tertile indicated in Appendix 4.2. Exploratory analyses for differences in HFA scores according to immigrant generation were conducted with ethnic/immigrant group as the main exposure and additional adjustment for mother’s age at time of immigration to the UK.

Cross-sectional and longitudinal associations between availability of snacks and SSBs in the home and dietary intake of snacks and SSBs (low intake as the reference category) were examined using multinomial logistic regression models. Separate models were run for snacks and SSBs, and two models were examined for each food/beverage category: one for variety and another for total quantity. Each model used the corresponding HFAI-C category as the main exposure variable. Multivariable linear regression models examined cross-sectional and longitudinal associations between availability of snacks and SSBs in the home and BMI. We examined associations with dietary intake and BMI using HFA score as a categorical and continuous term. We also conducted exploratory analyses using an interaction between the HFA score and ethnicity for all aforementioned models.

All models were adjusted for the following covariates: child’s sex, child’s age at time of HFA data collection, mother’s age at baseline, mother’s education, mother’s employment, child’s ethnicity, and number of individuals in household. These covariates were selected a priori based on previous studies of HFA and diet in children between 18 and 36 months of age (42–44). Longitudinal models were additionally adjusted for the child’s age at the time of outcome assessment. All analyses were conducted using SAS 9.4 software.

D. Results

An overview of the analytic sample at 18 and 36 months is provided in Table 4.2. Most households were of low socioeconomic status (~24% of mothers had <5 General Certificate of Secondary Education [GCSE] equivalent and ~57% were previously or never employed), and the majority of children were of Pakistani origin (~57%), with half being 2nd generation Pakistani immigrants. The average variety of snacks and SSBs available in the home was similar at both time points, though there was a slightly greater quantity of snacks available at 36 versus 18 months (2864.4 vs. 2614.4 g) and a smaller quantity of SSBs available at 36 versus 18 months (1882.3 vs. 1973.1 mL). The child's average BMI at both time points was approximately 16 kg/m^2.

Table 4.3. shows adjusted estimates for ethnic differences in HFA of snacks and SSBs. Results were largely consistent at 18 and 36 months, with White British homes having significantly lower odds of having a high versus low variety or quantity of snacks or SSBs in their home compared to Pakistani homes. In addition, the odds of having no SSBs versus one type of SSB available were 1.72 (95% CI: 1.11, 2.66) and 2.81 (95% CI: 1.76, 4.49) times greater for White British versus Pakistani households at 18 and 36 months, respectively. We saw no differences in HFA of snacks or SSBs according to immigrant generation (Appendix 4.3.).

Tables 4.4. and 4.5. show the adjusted estimates for the association between availability of snacks and SSBs in the home and dietary intake. All results are from multinomial logistic regression models, where the outcome was categorical dietary intake (shown as column headers) and the main exposure was HFA divided into three or four categories or assessed as a continuous variable. Odds ratios for each level of the outcome are grouped in the table according to the time HFA was examined and whether the association examined was between the variety of snacks/SSBs available and consumption or between the quantity of snacks/SSBs available and consumption.

Results in Tables 4.4. and 4.5. show that greater HFA (variety and quantity) of snacks and SSBs was associated with greater intake (variety and quantity) cross-sectionally at 18 and 36 months. For example, at 36 months, every additional type of snack made available in the home was associated with a 2.03 (95% CI: 1.78, 2.31) times greater odds of consuming a high versus low variety of snacks. For SSBs, we were also able to assess households that did not have SSBs available (see rows for "No SSBs" under Variety in Table 4.5.) and the odds of being a non-consumer versus a low consumer of SSBs at 18 months. We found that individuals with no SSBs in the home versus individuals with one type of SSB in the home had a 1.97 (95% CI: 1.32, 2.94) times greater odds of being a non-consumer versus a low consumer of SSBs at 18 months.

Longitudinal associations for availability of snacks and SSBs (variety and quantity) in the home at 18 months with dietary intake at 36 months were generally statistically significant in the expected direction (Tables 4.4. and 4.5.). The odds of having a high versus low intake of a variety of snacks or SSBs at 36 months was 1.27 (95% CI: 1.14, 1.42) or 1.47 (95% CI: 1.20, 1.79) times greater for every additional type of snack or SSB made available in the home at 18 months, respectively. Similarly, having a large versus small quantity of snacks or SSBs in the home at 18 months was associated with a 2.06 (95% CI: 1.30, 3.25) or 2.71 (95% CI: 1.73, 4.26) times greater odds of consuming a high versus low quantity of snacks or SSBs, respectively, at 36 months.

Adjusted associations between HFA of snacks and SSBs and BMI are shown in Table 4.6. Few adjusted estimates were significant, with overall F-tests for each categorical HFA variable being non-significant. Examination of the continuous HFA variables, however, showed a slight positive association between HFA of snacks and BMI cross-sectionally at 36 months. Specifically, for every additional 1000 g of snacks in the home, there was a 0.09 (95% CI: 0.03, 0.15) unit increase in BMI at 36 months. In our exploratory analyses of effect modification, associations with dietary intake were not consistently modified by ethnicity, and no effect modification was observed by ethnicity for associations with BMI.

E. Discussion

This is one of the first studies to examine the HFA of snacks and SSBs in Pakistani and White British households and to assess the association of HFA of snacks and SSBs during the first 1000 days of life with obesogenic dietary intake and BMI in early childhood in any ethnicity. In a sample of White British and Pakistani families living in Bradford, UK, we found that Pakistani homes had a greater variety and quantity of snacks and SSBs available in the home when toddlers were 18 and 36 months of age and that HFA of snacks and SSBs did not differ between homes of 2nd and 3rd generation Pakistani immigrant children. Irrespective of ethnicity, greater availability of snacks and SSBs in the home during the first 1000 days of life was associated with increased intake of snacks and SSBs at 36 months of age, but contrary to our hypothesis, not with BMI.

The observed ethnic differences in HFA of SSBs are consistent with previous research conducted in a subsample of BiB1000 at 18 months (230), with our study additionally finding ethnic differences in HFA of snacks. Previous studies have shown that HFA varies according to race/ethnicity during toddlerhood (41,48), but we are the first to report differences in HFA of Pakistani and White British households at 36 months of age. Contrary to our hypothesis, we did not find differences in HFA of snacks and SSBs according to immigrant generation. A comparison of immigrant generations more separated in time, for example, 1st versus 3rd

immigrant generations, may have indicated significant differences in HFA of these items that we were not able to detect.

Our findings for ethnic differences in HFA of snacks and SSBs are also similar to ethnic differences in dietary intake previously observed in BiB1000 at 18 and 36 months (137,231); thus it is not surprising that both the variety and quantity of snacks and SSBs available in the home were positively associated with dietary intake at 18 and 36 months and longitudinally. HFA of snacks and SSBs has been positively associated with dietary intake in cross-sectional examinations of preschool-aged children (2- to 5-year-olds) (39,40). However, we are the first study, to our knowledge, to examine cross-sectional associations of the HFA of snacks and SSBs and diet at 18 months of age. Given that the period between 12 and 24 months of age is when children complete the transition from breastfeeding or formula to table food (232), our findings provide new insight into an important determinant of toddler's dietary intake during this critical dietary transition period.

Only two previous studies conducted using data from the Melbourne Infant Feeding, Activity and Nutrition Trial in Australia have explored the relationship between HFA during the first 1000 days of life and later dietary intake (43,44). They found that having snacks in the home more frequently at 18 months of age was associated with greater overall dietary energy density at 3.5 years of age (43) and that increased frequency of having fruits available in the home was linked to a lower overall dietary energy density (43) and higher overall diet quality (44) at follow-up. Though our measures of HFA and diet differed, together our findings support a significant longitudinal association between HFA at 18 months and diet during toddlerhood. Due to dietary intake during infancy and toddlerhood tracking throughout childhood (233–235) and even into adulthood (236), these findings point to the importance of reducing the types and quantity of snacks and SSBs in the home in early life to promote a healthy diet.

Although HFA of snacks and SSBs was positively associated with dietary intake, associations with BMI were primarily null, with the exception of a slight positive association between HFA of snacks and SSBs and BMI in cross-sectional examinations at 36 months. It is possible that the snack and SSB items included on the HFAI-C are not major contributors to overall diet quality and energy intake in our sample and that one-week HFA does not capture important variability in HFA that affects BMI (237,238). It could also be that growth during the first years of life is more strongly related to “catch-up” or “catch-down” growth than behavioral and environmental influences, such as diet and HFA (239). Postnatal “catch-up” or “catch-down” growth occurs when changes in children’s body size and composition are driven by compensation for intrauterine factors that expedited or slowed the child’s growth during pregnancy (240,241). Thus examining associations between HFA of snacks and SSBs during the first 1000 days of life and BMI during later childhood may be a better indication of the impact of early-life HFA of these items on risk for childhood obesity.

It is also possible that the null findings are attributable to use of BMI as the outcome given diet during infancy and toddlerhood has been more strongly related to fat free mass and fat mass than to BMI during later childhood. Previous examinations of the Southampton Women’s Survey in the UK (242) and the Generation R study in the Netherlands (243) found that a healthy diet pattern at 12 months was associated with greater lean mass but not BMI among 4- and 6-year-olds, respectively (242,243). Another examination of the Southampton Women’s Survey found that a healthy diet pattern at 6 and 36 months of age was associated with lower fat mass but not BMI at 6 years of age (244). BMI systematically underestimates fat mass and thus overestimates fat free mass in South Asian children, which may have contributed to our findings (245,246). We tested an interaction term between ethnicity and HFA in all models for BMI; however, none of the interaction terms were significant, and the odds ratios stratified by ethnicity were not significantly different.

1. Strengths and limitations

This study was conducted in a large bi-ethnic sample of White British and Pakistani households. Socio-demographic and dietary data were collected using culturally appropriate, validated questionnaires, and trained study personnel measured all anthropometrics. Use of the HFAI-C as opposed to other HFA assessment tools allowed us to examine previously under-researched aspects of the home food environment, specifically variety and quantity of foods/beverages available in the home.

Due to our exclusion criteria, results from this study may not be applicable to other South Asian ethnicities. Both FFQs included more than 100 questions, which placed a high burden on participants that could have led to inaccurate dietary recall (247). Given that the categories of foods/beverages assessed in this study were measured at the end of the FFQ, participant fatigue could have resulted in inaccurate reporting of these items (247). It is also possible that the weights/volumes of some snacks and SSBs from the FFQ were not correctly specified due to assumptions regarding what constitutes a “small” portion size and use of a US-based tool for estimating weights of foods from the UK. As previously mentioned, using BMI as opposed to other measures of body composition prevented us from assessing more nuanced associations between HFA and obesity that could have clarified our findings.

2. Conclusions

In this study of White British and Pakistani toddlers, we found that Pakistani households had more obesogenic foods and beverages available in their homes during toddlerhood compared to White British households and that there were no differences in the availability of snacks and SSBs in the home of 2nd versus 3rd generation Pakistani immigrants. Though we did not observe significant associations between HFA of snacks and SSBs at 18 months and BMI at 36 months, greater HFA of snacks and SSBs during the first 1000 days of life seems to promote the incorporation of snacks and SSBs into the diet. Future studies should examine associations between HFA at 18 months and diet and BMI during late childhood to determine if the strength of the association between the home environment in the first 1000 days and dietary intake persists and to more fully determine the importance of toddlerhood nutrition on BMI. These studies should also consider examining associations with overall diet quality, fat mass, and fat free mass to better understand how HFA may be associated with risk for obesity. As a whole, our findings suggest that reducing the HFA of snacks and SSBs in early toddlerhood may help promote the development of a more healthful diet among Pakistani and White British children.

Table 4.1. Items included in the HFAI-C and FFQ definitions of snacks and SSBs

	HFAI-C	**FFQ items**	
		18-month	**36-month**
Snacks	1. Crisps and tortilla chips	1. Crisps and savory snacks	1. Regular crisps
			2. Reduced fat crisps
			3. Other savory snacks
			4. Savory biscuits, crackers, or breadsticks
	2. Salted nuts		5. Peanuts and other nuts
	3. Cakes and muffins	2. Cakes, buns, and pastries	6. Plain cakes
			7. Cakes with icing
			8. Cream cakes or gateaux
			9. Fruit cake or malt loaf
			10. Doughnuts, muffins, or pastries
			11. Cereal bars or flapjacks
			12. Scones or pancakes
	4. Biscuits	3. Chocolate and digestive biscuits	13. Chocolate biscuits or cookies
		4. Other biscuits	14. Plain biscuits
			15. Fancy biscuits
	5. Chocolate	5. Chocolate	16. Chocolate bars
	6. Sweets	6. Sweets	17. Boiled, chewy, or chocolate sweets
	7. Ice cream	7. Ice cream	18. Wrapper ice creams
			19. Other ice cream
			20. Iced lollies
SSBs	1. Fruit drinks	1. Fruit drinks	1. High juice fruit drinks
		2. Ribena	2. Regular fruit juice drinks
		3. Squash	3. Regular blackcurrant diluting juice
			4. Regular orange, lemon, or other diluting juice
			5. Other fruit-flavored drinks
	2. Fizzy drinks	4. Regular fizzy drinks	6. Regular fizzy drinks
	3. Sports drinks		

SSBs sugar-sweetened beverages, *HFAI-C* Home Food Availability Inventory Checklist, *FFQs* food frequency questionnaires

Table 4.2. Characteristics of sample at 18 and 36 months with complete covariate and HFA data

	18 months (n=1032)	**36 months** (n=986)
Socio-demographics		
Child's sex, n (%)		
Male	505 (48.9)	477 (48.4)
Female	527 (51.1)	509 (51.6)
Child's age (months), mean (SD)	18.7 (1.0)	37.0 (0.9)
Mother's baseline age (years), mean (SD)	27.1 (5.6)	27.3 (5.6)
Mother's education, n (%)		
<5 GCSE equivalent	249 (24.1)	231 (23.4)
5 GSCE equivalent	341 (33.0)	325 (33.0)
A-level equivalent	141 (13.7)	136 (13.8)
Higher than A-level	239 (23.2)	230 (23.3)
Other/unknown	62 (6.0)	64 (6.5)
Mother's baseline employment, n (%)		
Currently employed	437 (42.3)	428 (43.4)
Previously employed	268 (26.0)	263 (26.7)
Never employed	327 (31.7)	295 (29.9)
Mother's ethnicity, n (%)		
White British	454 (44.0)	430 (43.6)
Pakistani	578 (56.0)	556 (56.4)
Mother's age at immigration, mean (SD)	6.7 (10.2)	6.5 (10.1)
Child's immigrant generation, n (%)		
Non-immigrant	355 (34.3)	338 (34.3)
2nd generation Pakistani immigrant	517 (50.1)	499 (50.6)
3rd generation Pakistani immigrant	78 (7.6)	70 (7.1)
Non-Pakistani immigrant	82 (7.9)	79 (8.0)
# Individuals in house by age group, mean (SD)		
<2 years	0.2 (0.5)	0.2 (0.5)
2-15 years	1.1 (1.3)	1.2 (1.3)
16-64 years	2.8 (1.7)	2.8 (1.6)
≥65 years	0.1 (0.4)	0.1 (0.3)
Home food availability, mean (SD)		
Variety		
Snacks (0-7)	4.4 (1.7)	4.5 (1.6)
SSBs (0-3)	1.3 (1.0)	1.3 (1.0)
Quantity (g or mL/week)		
Snacks	2614.4 (1723.1)	2864.4 (1635.3)
SSBs	1973.1 (2194.9)	1882.3 (2088.9)
Obesogenic intake, mean (SD)	**n=1020***	**n=971***
Variety		
Snacks (0-7 or 20)	4.2 (1.5)	11.3 (4.1)
SSBs (0-4 or 6)	1.1 (1.0)	3.1 (1.8)
Quantity (g or mL/week)		

Snacks	-	904.6 (985.5)
SSBs	-	2814.1 (3919.0)
Body measurements, mean (SD)	**n=921***	**n=816***
BMI (kg/m^2)	16.2 (1.5)	16.3 (1.5)

HFA home food availability, *SD* standard deviation, *GCSE* General Certificate of Secondary Education, *SSBs* sugar-sweetened beverages, *BMI* body mass index

*denotes a smaller sample size due to missing food frequency questionnaire or BMI data

Table 4.3. Odds ratios (95% CIs) for higher HFA for White British vs. Pakistani toddlers

HFA at designated time	**HFA for White British vs. Pakistani (ref)**			
	Not in home	*Low*	*Medium*	*High*
Snacks				
Variety				
18 months (n=1032)	-	1.00	0.71 (0.44, 1.16)	0.44 (0.25, 0.75)**
36 months (n=986)	-	1.00	0.76 (0.45, 1.29)	0.37 (0.21, 0.66)**
Quantity				
18 months (n=1032)	-	1.00	0.60 (0.41, 0.89)*	0.43 (0.29, 0.65)**
36 months (n=986)	-	1.00	0.70 (0.47, 1.04)	0.45 (0.30, 0.69)**
SSBs				
Variety				
18 months (n=1032)	1.72 (1.11, 2.66)*	1.00	0.70 (0.46, 1.07)	0.27 (0.15, 0.49)**
36 months (n=986)	2.81 (1.76, 4.49)**	1.00	0.41 (0.26, 0.63)**	0.22 (0.12, 0.41)**
Quantity				
18 months (n=1032)	-	1.00	0.58 (0.39, 0.85)**	0.35 (0.23, 0.53)**
36 months (n=986)	-	1.00	0.34 (0.22, 0.51)**	0.22 (0.14, 0.33)**

CIs confidence intervals, *HFA* home food availability, *SSBs* sugar-sweetened beverages
*p<0.05, **p<0.01
All models adjusted for the following covariates: child’s sex, child’s age, mother’s baseline age, mother’s education, mother’s baseline employment status, mother’s ethnicity, and household size

Table 4.4. Odds ratios (95% CIs) for increased snack intake according to snack HFA

HFA at designated time	**Variety or quantity of snack intake**		
	Low	*Medium*	*High*
18 months (n=1020)			
Variety			
*Categorical***			
Low (0-2)	1.00	1.00	1.00
Medium (3-5)	1.00	2.76 (1.72, 4.44)**	4.55 (2.30, 8.99)**
High (6-7)	1.00	4.29 (2.32, 7.93)**	13.82 (6.29, 30.40)**
Continuous	1.00	1.39 (1.24, 1.57)**	1.90 (1.64, 2.21)**
36 months (n=971)			
Variety			
*Categorical***			
Low (0-2)	1.00	1.00	1.00
Medium (3-5)	1.00	3.20 (1.93, 5.31)**	2.43 (1.37, 4.33)*
High (6-7)	1.00	8.68 (4.82, 15.64)**	15.32 (8.11, 28.94)**
Continuous	1.00	1.53 (1.37, 1.70)**	2.03 (1.78, 2.31)**
Quantity			
*Categorical***			
Low	1.00	1.00	1.00
Medium	1.00	2.19 (1.52, 3.16)**	2.29 (1.49, 3.52)**
High	1.00	3.40 (2.20, 5.26)**	7.06 (4.46, 11.17)**
Continuous (per 1000 g)	1.00	1.63 (1.41, 1.88)**	2.08 (1.79, 2.42)**
18 months (Longitudinal) (n= 882)			
Variety			
*Categorical***			
Low (0-2)	1.00	1.00	1.00
Medium (3-5)	1.00	1.26 (0.80, 2.00)	1.93 (1.12, 3.35)*
High (6-7)	1.00	1.93 (1.14, 3.27)*	3.16 (1.72, 5.79)**
Continuous	1.00	1.18 (1.07, 1.31)**	1.27 (1.14, 1.42)**
Quantity			
*Categorical**			
Low	1.00	1.00	1.00
Medium	1.00	1.42 (0.96, 2.09)	1.86 (1.19, 2.89)**
High	1.00	1.17 (0.76, 1.78)	2.06 (1.30, 3.25)**
Continuous (per 1000 g)	1.00	1.05 (0.95, 1.17)	1.09 (0.98, 1.21)

CIs confidence intervals, *HFA* home food availability

*p<0.05, **p<0.01

All models adjusted for the following covariates: child's sex, child's age, mother's baseline age, mother's education, mother's baseline employment status, mother's ethnicity, and household size

Table 4.5. Odds ratios (95% CIs) for increased SSB intake according to SSB HFA

HFA at designated time	Variety or quantity of snack intake			
	No consumption	*Low*	*Medium*	*High*
18 months (n=1020)				
Variety				
*Categorical***				
No SSBs (0)	1.97 (1.32, 2.94)**	1.00	0.88 (0.56, 1.40)	0.90 (0.29, 2.80)
Low (1)	1.00	1.00	1.00	1.00
Medium (2)	1.03 (0.68, 1.56)	1.00	1.12 (0.75, 1.69)	5.65 (2.59, 12.34)**
High (3)	0.51 (0.27, 0.96)*	1.00	1.30 (0.79, 2.14)	5.68 (2.39, 13.51)**
Continuous	0.68 (0.57, 0.82)**	1.00	1.14 (0.95, 1.35)	2.06 (1.53, 2.76)**
36 months (n=971)				
Variety				
*Categorical***				
No SSBs (0)	-	1.00	0.44 (0.30, 0.66)**	0.25 (0.14, 0.45)**
Low (1)	-	1.00	1.00	1.00
Medium (2)	-	1.00	1.67 (1.11, 2.51)*	3.08 (1.94, 4.88)**
High (3)	-	1.00	1.81 (1.03, 3.16)*	4.71 (2.61, 8.49)**
Continuous	-	1.00	1.72 (1.44, 2.07)**	2.82 (2.28, 3.50)**
Quantity				
*Categorical***				
Low	-	1.00	1.00	1.00
Medium	-	1.00	2.16 (1.46, 3.20)**	1.88 (1.24, 2.84)**
High	-	1.00	2.53 (1.65, 3.90)**	4.24 (2.76, 6.50)**
Continuous (per 1000 mL)	-	1.00	1.33 (1.19, 1.49)**	1.47 (1.31, 1.64)**
18 months (Longitudinal) (n=882)				
Variety				
*Categorical***				
No SSBs (0)	-	1.00	0.69 (0.46, 1.04)	0.66 (0.40, 1.09)
Low (1)	-	1.00	1.00	1.00
Medium (2)	-	1.00	0.90 (0.60, 1.36)	1.16 (0.73, 1.85)
High (3)	-	1.00	1.79 (1.01, 3.16)*	2.59 (1.40, 4.78)**
Continuous	-	1.00	1.26 (1.05, 1.50)*	1.47 (1.20, 1.79)**
Quantity				
*Categorical***				
Low	-	1.00	1.00	1.00
Medium	-	1.00	1.29 (0.86, 1.94)	1.48 (0.98, 2.25)
High	-	1.00	1.94 (1.24, 3.04)*	2.71 (1.73, 4.26)**
Continuous (per 1000 mL)	-	1.00	1.18 (1.06, 1.30)**	1.28 (1.16, 1.42)**

CIs confidence intervals, *HFA* home food availability, *SSB* sugar-sweetened beverage
*p<0.05, **p<0.01
All models adjusted for the following covariates: child's sex, child's age, mother's baseline age, mother's education, mother's baseline employment status, mother's ethnicity, and household size

Table 4.6. Parameter estimates (95% CIs) for child's BMI according to snack and SSB HFA

HFA	**Time of BMI measurement** *18 months* (n=921)	*36 months* (n=816)	*36 months (Longitudinal)* (n=743)
Snacks			
Variety			
Categorical			
Low (0-2)	1.00	1.00	1.00
Medium (3-5)	-0.14 (-0.42, 0.15)	0.31 (-0.01, 0.62)	-0.28 (-0.60, 0.03)
High (6-7)	-0.21 (-0.53, 0.10)	0.38 (0.03, 0.72)*	-0.28 (-0.64, 0.07)
Continuous	-0.04 (-0.10, 0.01)	0.04 (-0.02, 0.11)	-0.05 (-0.11, 0.02)
Quantity			
Categorical			
Low	1.00	1.00	1.00
Medium	-0.05 (-0.28, 0.18)	0.06 (-0.19, 0.31)	-0.08 (-0.34, 0.19)
High	-0.14 (-0.38, 0.11)	0.27 (0.01, 0.53)*	-0.25 (-0.53, 0.02)
Continuous (per 1000 g)	-0.01 (-0.06, 0.05)	0.09 (0.03, 0.15)**	-0.03 (-0.09, 0.03)
SSBs			
Variety			
Categorical			
No SSBs (0)	-0.13 (-0.38, 0.12)	-0.03 (-0.30, 0.24)	0.08 (-0.20, 0.36)
Low (1)	1.00	1.00	1.00
Medium (2)	-0.27 (-0.52, -0.03)*	-0.02 (-0.28, 0.24)	-0.20 (-0.47, 0.08)
High (3)	-0.17 (-0.48, 0.14)	0.37 (0.03, 0.70)*	0.01 (-0.35, 0.38)
Continuous	-0.05 (-0.15, 0.05)	0.09 (-0.02, 0.20)	-0.06 (-0.18, 0.05)
Quantity			
Categorical			
Low	1.00	1.00	1.00
Medium	-0.21 (-0.45, 0.02)	0.07 (-0.18, 0.32)	-0.31 (-0.58, -0.04)*
High	-0.15 (-0.40, 0.09)	0.18 (-0.08, 0.43)	-0.11 (-0.37, 0.16)
Continuous (per 1000 mL)	-0.02 (-0.06, 0.03)	0.03 (-0.02, 0.08)	-0.01 (-0.06, 0.04)

CIs confidence intervals, *BMI* body mass index, *HFA* home food availability, *SSBs* sugar-sweetened beverages

*p<0.05, **p<0.01

All models adjusted for the following covariates: child's sex, child's age, mother's baseline age, mother's education, mother's baseline employment status, mother's ethnicity, and household size

CHAPTER 5: LONGITUDINAL PATTERNS OF POSTPARTUM WEIGHT RETENTION (PPWR) AND ASSOCIATIONS WITH HOME FOOD AVAILABILITY (HFA) IN BORN IN BRADFORD 1000 (BIB1000)

A. Overview

Objective: To compare longitudinal patterns of postpartum weight retention (PPWR) of White British versus 1st and 2nd generation Pakistani immigrant mothers during the first two years postpartum, and to examine associations of home food availability (HFA) of snacks and sugar-sweetened beverages (SSBs) with PPWR.

Methods: Data are from 1054 mothers from Born in Bradford 1000 (BiB1000). PPWR was calculated as measured postpartum weight minus imputed pre-pregnancy weight. HFA was evaluated using the HFA Inventory Checklist at 18 months. Mixed effects linear regression models determined longitudinal patterns of PPWR. Multivariable linear regression models examined associations of HFA with average PPWR from 12-24 months.

Results: First generation Pakistani immigrants had a greater average rate of weight loss and gain compared to White British mothers (p=0.04). Second generation Pakistani immigrants and White British mothers did not experience changes in weight over follow-up. Second generation Pakistani immigrants retained more weight than White British mothers at each month postpartum. There was some indication that HFA of SSBs, but not snacks, was associated with increased PPWR in all ethnic/immigrant groups.

Conclusions: First and second generation Pakistani immigrants are at an increased risk for long-term obesity. Future studies are needed to examine the relationship between HFA and PPWR.

B. Introduction

Pregnancy is a period of rapid weight gain among women. High PPWR (maternal weight retained from pre-pregnancy to a given time after childbirth (12)) is associated with long-term risk for maternal overweight and obesity (56,57) and central adiposity (58). High PPWR elevates a woman's risk for beginning another pregnancy with overweight or obesity, thus increasing the risk for gestational diabetes, preeclampsia, birth defects, and fetal macrosomia (50). Further, children born to mothers with obesity have an increased risk for obesity and obesity-related diseases (54). Reducing PPWR may help decrease the prevalence of obesity among women during their reproductive years and later life and help prevent the intergenerational transmission of obesity.

Previous examinations indicate that ethnic minorities, specifically non-Hispanic Blacks and Hispanics/Latinos (72), and 2nd and 3rd generation immigrants (90,91) are at increased risk for high PPWR compared to non-Hispanic Whites and 1st generation immigrants, respectively. Despite these differences, studies of PPWR among additional ethnic minority groups are limited and have not considered the role of immigrant generation. Individuals of South Asian origin comprise one of the three largest immigrant groups in the United States (US) (19) and United Kingdom (UK) (18), with Pakistani mothers accounting for the largest number of non-White deliveries in the UK National Health Service hospitals (89). However, only one observational study has examined how PPWR in any South Asian immigrant group compares to Whites (82). The study found that South Asian women living in Norway retained 2.8 kg (95% confidence interval [CI]: 1.9, 3.6) more than Western Europeans at approximately three months postpartum, but the authors did not examine whether this difference persisted at other time points or examine differences according to immigrant generation (82).

A previous systematic review and meta-analysis of PPWR indicated that weight loss continues past 3 months postpartum until 12 months postpartum, at which point women appear to regain weight (12). However, this conclusion was based on examinations of predominately White populations and on only a limited number of studies that examined weight retention beyond 12 months postpartum (12). Findings from two studies have suggested there are ethnic differences in longitudinal patterns of PPWR, though their findings differed regarding whether ethnic minorities (specifically non-Hispanic Blacks and Hispanics/Latinos) are at an increased risk for high PPWR compared to non-Hispanic Whites (77,79). To our knowledge, no studies have derived longitudinal PPWR patterns for ethnic minorities beyond non-Hispanic Blacks or Hispanics/Latinos or for immigrant groups over the recommended 24-month PPWR follow-up period (12).

Although PPWR has been suggested to plateau or increase during the second year postpartum (12,248), research on determinants of PPWR during this time period and among ethnic minorities are limited (249). The HFA of fruits and vegetables has previously been associated with dietary intake between 12 and 24 months postpartum in ethnic minority women (non-Hispanic Blacks) (42), but associations of fruit and vegetable intake and obesity are weak (37). No previous studies among any race/ethnic group have examined how the HFA of obesogenic items, such as snacks and SSBs are associated with PPWR.

The objectives of this study were thus 1) to compare longitudinal patterns of PPWR during the first 24 months postpartum among White British and 1st and 2nd generation Pakistani immigrant mothers and 2) to examine whether greater HFA of snacks and SSBs is associated with increased PPWR. We hypothesized that PPWR would have a quadratic pattern of change in all ethnic groups, with 2nd generation Pakistani immigrants losing less weight than White British mothers throughout follow-up, resulting in a flatter longitudinal PPWR pattern. We expected that 2nd generation Pakistani immigrants would retain the most weight at each time point and that greater HFA of snacks and SSBs would be associated with increased PPWR in all ethnic/immigrant groups.

C. Methods

1. Study population

All participants were enrolled in BiB1000, a birth cohort study nested within the Born in Bradford (BiB) study (125,126). The objective of BiB1000 was to identify determinants of obesity in early life (126). Detailed information regarding BiB and BiB1000 are published elsewhere (121,125,126). In short, BiB is a cohort study designed to examine maternal and child health in the multi-ethnic population of the city of Bradford (121). Bradford is one of the most deprived areas in the UK, with sixty percent of babies being born to the poorest 20% of the population of England and Wales (124). All mothers who booked their delivery at Bradford Royal Infirmary—the only maternity unit in Bradford and one of the busiest in the UK with approximately 5800 deliveries per year—between March 2007 and November 2010 were eligible for BiB (121,125). BiB recruited 12,453 women (13,776 pregnancies) between 2007 and 2010 (125).

All mothers recruited into BiB between August 2008 and March 2009 and who had completed the baseline questionnaire were offered enrollment in BiB1000 (126). Of the 1916 women, 1735 agreed to take part in the study (126). BiB and BiB1000 were conducted according to the guidelines of the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Bradford Research Ethics Committee (07/H1302/112).

Written or verbal (for mothers unable to read and/or speak English) informed consent was obtained from all participants. Verbal consent was witnessed and formally recorded.

2. Study measures

Hospital booking measurements were taken at 10-14 weeks gestation (126), and baseline measurements occurred at 26-28 weeks gestation (125). Follow-up study visits for this analysis were conducted at approximately 6, 12, 18, and 24 months postpartum. Some visits occurred more than 2 months before or after the scheduled time point, and thus “visit 1, 2, 3, and 4” is used to refer to each follow-up point, respectively. All data were collected by interviewers in the participant’s preferred language (English, Urdu, or Mirpuri) unless otherwise indicated (126).

3. Postpartum weight retention (PPWR)

BiB1000 did not collect data on pre-pregnancy weight, and thus PPWR was estimated as measured weight minus imputed pre-pregnancy weight. Similar to previous PPWR studies (144,145), pre-pregnancy weight was imputed by subtracting the amount of expected gestational weight gain (kg), according to body mass index (BMI) category and gestational age as outlined by the US Institute of Medicine (146), from measured early pregnancy weight (i.e., hospital booking weight). BMI was calculated as early pregnancy weight (kg) divided by height-squared (meters-squared; measured with a SECA Leicester height measure at baseline (125)). Imputations assumed weight gain during the first 13 weeks gestation of 2, 1.5, 1.0, or 0.5 kg in total and 0.51, 0.42, 0.28, or 0.22 kg for each week beyond 13 weeks gestation for women with an early pregnancy BMI <18.5, 18.5-24.9, 25.0-29.9, or ≥30.0 kg/m^2, respectively (146).

Mother’s weight was measured at each follow-up visit by staff trained by expert community researchers (125). Mothers wore light clothing, and all weight measurements were taken at least two times with a SECA digital scale. A third measurement was taken if the difference between measures fell outside acceptable ranges (125).

4. Ethnic/immigrant group

Ethnicity was self-identified by the mother at baseline using the same ethnic group classifications as the 2001 Census (126). Mothers were categorized as White British, Pakistani, or Other, with those of Other ethnicity (n=247) excluded from the analyses. Mothers reported their country of origin, age at which they immigrated to the UK (if applicable), and country of origin of their parents and grandparents. Participants were placed into three distinct ethnic/immigrant groups for the purpose of comparing longitudinal PPWR patterns: 1) White British, 2) 1^{st} generation Pakistani immigrants (born in Pakistan), and 3) 2^{nd} generation Pakistani immigrants (one of the mother's parents born in Pakistan). Pakistani mothers who reported being of Pakistani origin but were not 1^{st} or 2^{nd} generation immigrants were excluded from the analyses (n=9).

5. Socio-demographics and pregnancy characteristics

Mothers reported their age, education, employment status, and total number of persons living in the household in defined age groups (<2 years, 2-15 years, 16-64 years, and >65 years) at baseline (125). Parity and gestational age at birth were extracted from an electronic maternity information system (127).

6. Postpartum time

Time was defined as number of months postpartum (as indicated by child's age in months) at each follow-up visit. Time was a continuous variable due to time intervals between each visit varying within and across individuals.

7. Time-varying covariates

Breastfeeding, smoking status, and maternity leave status were assessed during multiple follow-up visits.

a. Breastfeeding

At visits 1, 2, and 4, mothers indicated whether they were still breastfeeding or the date they stopped breastfeeding, and at visit 3, mothers reported whether they had breastfed during the past four weeks (126). Due to inconsistencies in reporting across visits, a new breastfeeding variable was created: mothers were designated as currently breastfeeding for a given follow-up visit if the maximum number of months they ever reported breastfeeding was greater than or equal to the months postpartum.

b. Smoking

Smoking history was assessed at baseline and at visits 1 and 4 (126). For individuals who attended visits 2 and 3, smoking status was assigned using data from the visit closest in time. In the event of inconsistencies in reports of being a "never smoker", the last report of being a current or former smoker was given precedence.

c. Maternity leave

Mothers reported changes in maternity leave status from baseline at visits 1, 2, and 4 (126). For individuals who attended visit 3, maternity leave status at this time point was assumed to be the same as at the visit closest in time. To be considered on maternity leave, individuals must have been currently or formerly employed.

8. Home food availability (HFA) of snacks and sugar-sweetened beverages (SSBs)

a. Measurement

The availability of snacks and SSBs in the home was assessed at visit 3 using 10 of 39 items from the self-administered, semi-quantitative Home Food Availability Inventory Checklist (HFAI-C) (71). Participants self-reported the maximum availability of each food/beverage item in their homes over the previous 7 days. Participants reported whether items were available, and if so, in what amount (small, medium, or large). The HFAI-C had fair-to-moderate validity for assessing absence/presence (kappa: 0.39 to 0.41) and quantity (weighted kappa: 0.25 to 0.26) of snacks and beverages in a subsample of BiB1000 (71).

b. Variable derivation

Two variables were created for each HFAI-C category: 1) variety and 2) total quantity available in the past week. Variety scores corresponded to the number of items that were available in the home (0-7 types of snacks and 0-3 types of SSBs). The maximum amount of each item available in the home was estimated as the item's average weight/volume (141) multiplied by the participants' quantity response (median quantity within the designated small, medium, or large quantities). Items were summed within the snack and SSB categories to create a category-level variable for analyses.

9. Analytic sample

Women were eligible for our analysis if they were 1st or 2nd generation Pakistani immigrant or White British mothers who had singleton live births, were not missing hospital booking weight or baseline height, and participated in at least one BiB1000 visit (n=1140). We excluded mothers missing socio-demographics (n=6), parity or gestational age at birth (n=16), age at immigration (n=5), and maternity leave or smoking status at all follow-up visits in which they attended (n=59). Our final analytic sample included 1054 mothers. There were no significant differences in socio-demographics or PPWR between individuals who were excluded versus included in our analytic sample.

10. Statistical analysis

A mixed effects linear regression model was fitted to investigate the association between ethnic/immigrant group (henceforth referred to as "group") and PPWR. We selected a spatial exponential covariance structure for the within-subject covariance pattern. This structure is recommended when measurements are not equally spaced in time and assumes correlations decrease to zero as the time between measurements increases (218). Time (centered at 4 months postpartum due to the lack of PPWR measurements from 0 to 3 months postpartum) was considered a random effect and had an unstructured covariance pattern (218).

The mixed effects model was adjusted for the following fixed effects: group, age at baseline, age at immigration, education, gestational age at birth, and parity. Time-varying covariates included breastfeeding, smoking, and maternity leave status. Likelihood ratio tests and joint F-tests examined whether polynomial terms were needed to study the association between time and PPWR. Interactions between group and time (and between group and polynomial terms for time, when applicable) were used to examine differences in the longitudinal patterns of PPWR across groups. Joint F-tests examined whether PPWR changed over time in each group. Independent samples t-tests were used to compare adjusted mean PPWR at each month postpartum between groups.

We conducted sensitivity analyses with PPWR calculated using early pregnancy weight instead of imputed pre-pregnancy weight among individuals whose weight was measured in the first trimester of pregnancy. This approach has been implemented by others when measured pre-pregnancy weight is not available (250–252). Further, changes in PPWR based on early pregnancy weight are shown to be similar to those from PPWR based on self-reported pre-pregnancy weight (12).

Multivariable linear regression models were used to examine the association between average PPWR from visits 2-4 and HFA (variety or quantity) of snacks or SSBs. PPWR was averaged to reflect the same time period captured by the HFAI-C (i.e., from ~12 to ~24 months postpartum) (220). HFAI-C variety and quantity were examined in tertiles (cut-points indicated in tables). A "0" variety score was not examined for snacks given only 16 individuals reported not having any snacks available in the home. Models were adjusted for group, age, age at immigration, education, employment status at baseline, and number of individuals living in the household. Effect modification by group was explored using an interaction term and the criterion of $p<0.10$. All aforementioned models were examined with and without adjustment for BMI at hospital booking. All analyses were conducted using SAS 9.4 (Cary, NC).

D. Results

An overview of characteristics of the analytic sample, overall and stratified by group, is provided in Tables 5.1. and 5.2. On average, mothers were 27.1 years old and of low socioeconomic status (23.1% with <5 General Certification of Secondary Education [GCSE] equivalent and 29.8% were never employed) at baseline. Overall, participants had an average BMI of 25.9 kg/m^2 at approximately 12.6 weeks gestation. Figure 5.1. shows the adjusted mean PPWR across 4 to 28 months postpartum for the selected model. This model was chosen given that inclusion of time-squared and time-squared*group terms improved model fit compared to a model with only linear terms for time (likelihood ratio test: $p<0.001$). We examined including quadratic splines with 3-5 knots. However, a joint F-test for all piecewise terms combined was not significant in any model, and thus these terms were not included.

Figure 5.1. shows that 1st generation Pakistani immigrant mothers had a significant quadratic pattern of weight change (joint F-test for effect of time: p=0.001). Their longitudinal PPWR pattern indicates that weight loss occurred until 15 months postpartum, after which weight gain began. White British and 2nd generation Pakistani immigrant mothers had no change in PPWR over follow-up (joint F-tests for the effect of time: p=0.92 and p=0.70, respectively). Differences in longitudinal PPWR patterns for 1st generation Pakistani immigrants vs. White British and 2nd generation Pakistani immigrant mothers were significant at p=0.04 and p=0.06, respectively.

PPWR was greater among 1st generation Pakistani immigrant versus White British mothers at 4 months postpartum (2.02 kg [95% CI: 0.11, 3.94] difference) and at each month between 25 and 28 months postpartum (1.96 kg [95% CI: 0.03, 3.89] difference at 25 months to 2.63 kg [95% CI: 0.49, 4.78] difference at 28 months). Second generation Pakistani immigrant mothers retained significantly more weight than White British mothers throughout the entire follow-up period. For example, 2nd generation Pakistani immigrants retained 1.66 kg (95% CI: 0.58, 2.75), 1.72 kg (95% CI: 0.69, 2.75), and 1.98 kg (95% CI: 0.71, 3.26) more than White British mothers at 6, 12, and 24 months postpartum, respectively.

Our sensitivity analysis with PPWR calculated based on measured early pregnancy weight instead of imputed pre-pregnancy weight (n=665) yielded similar results to those previously described, though estimates of PPWR were lower for all groups. The sensitivity analysis also showed no cross-sectional differences in PPWR for 1st generation Pakistani immigrant mothers versus White British mothers at any time point. Findings did not significantly differ when BMI at hospital booking was dropped as a covariate.

Results for HFA of snacks and SSBs are shown in Table 5.3. Associations between HFA of snacks and SSBs were primarily null, though the overall F-test for quantity of SSBs in the home was marginally significant (p=0.06). Having a high versus low quantity of SSBs in the home was associated with retaining 1.18 kg (95% CI: 0.15, 2.20) more postpartum in the overall sample. We did not observe effect modification by group in any models for HFA.

E. Discussion

To our knowledge, this is the first study to derive longitudinal PPWR patterns specific to any ethnic minority or immigrant group through 24 months postpartum and to examine whether HFA of any food/beverage is associated with PPWR. In a sample of 1st and 2nd generation Pakistani immigrant and White British mothers, we found a quadratic association between months postpartum and PPWR for 1st generation Pakistani immigrants, while the longitudinal patterns of PPWR were relatively flat for White British mothers and 2nd generation Pakistani immigrants. We also found that 2nd generation Pakistani immigrants had greater PPWR than White British mothers at each time point between 4 and 28 months postpartum and saw some indication that increased availability of SSBs in the home was associated with greater PPWR during the second postpartum year.

Our observation of a quadratic association between time and PPWR among 1st generation Pakistani immigrants is consistent with longitudinal PPWR patterns derived in ethnic minorities (79) and among predominately White samples in a meta-analysis (12). However, contrary to our expectations, neither 2nd generation Pakistani immigrants nor White British mothers had significant changes in PPWR over time. This finding may be due to our model not including

PPWR measurements from the first 4 months postpartum. Specifically, though women generally lose weight during the first days/weeks postpartum as fluid levels return to pre-pregnancy values (12,146), weight loss during the first 6 weeks postpartum is also affected by lifestyle factors that vary according to culture (253). The greatest rate of postpartum weight loss occurs from 2 weeks to 2-4 months postpartum in White Western populations (83,84), possibly as a result of Western culture's emphasis on a return to an active lifestyle immediately after childbirth (49). However, South Asian women tend to not begin losing weight until 2 months postpartum (254).

In Pakistani culture, mothers often adhere to a 40-day ritual of rest immediately postpartum, avoiding any physical activity and consuming a diet high in energy-dense foods (e.g., ghee and sugar) and low in fruits and vegetables (255,256). While 1st generation immigrant women continue these traditional postpartum practices after immigration (257), 2nd generation Pakistani immigrant women may adopt Western postpartum practices as part of the acculturation process, as evidenced by reports that it is difficult to continue these practices in the UK (258). This cultural difference in postpartum practices could have resulted in our longitudinal PPWR patterns capturing the period of greatest weight loss among the 1st generation Pakistani immigrant group only, explaining why their PPWR pattern was different from that of White British women and 2nd generation Pakistani immigrants.

First generation Pakistani immigrants also gained weight at a faster average rate than White British women from 16 to 28 months postpartum. This difference may reflect ethnic/immigrant group differences in the likelihood of pregnancy during follow-up. First generation Pakistani immigrant families tend to have more children, on average, than White British families (3.84 vs. 1.84 children, respectively) (259), yet only 22.7% versus 50.3% of 1st generation Pakistani immigrant and White British families, respectively, had surpassed these averages in our sample. Thus 1st generation Pakistani women may have been more likely to become pregnant during the observed postpartum period, with their gestational weight gain being mistakenly classified as PPWR.

In addition to the aforementioned differences in longitudinal PPWR patterns, we found cross-sectional differences in PPWR at each month postpartum that indicate 2nd generation Pakistani immigrants have an elevated risk for long-term obesity compared to White British women. While 1st generation Pakistani immigrant women also had greater PPWR than White British women at select months, it is unclear if these are significant differences given our sensitivity analysis. We are the first study, to our knowledge, to find a *direct* association between later immigrant generation and increased PPWR. In the only previous study to examine PPWR in South Asian immigrants, they found that South Asian immigrants (of unknown immigrant generations) retained 2.8 kg [95% CI: 1.9, 3.6]) more than Western Europeans at ~3 months postpartum (82). This difference was close to our comparisons at 4 months for White British and 1st generation Pakistani immigrants (2.02 kg [95% CI: 0.11, 3.94]), but more than 1 kg lower than that for 2nd generation Pakistani immigrants (1.65 kg [95% CI: 0.38, 2.93]). This suggests that the proportion of 1st to 2nd generation South Asian immigrant mothers in a sample affects the magnitude of differences in PPWR observed between South Asian and White European women.

Although other studies have reported a positive association between HFA and weight status in adults (63–65), we found that among the HFA of snacks and SSBs, only the HFA of SSBs was associated with PPWR. However, these findings were inconsistent, suggesting only a possible relationship between HFA of SSBs and PPWR. It is possible that the associations were largely null due to other household members consuming the items in the home instead of the mothers. The snacks and SSBs measured by the HFAI-C may also have accounted for a small percentage of overall dietary intake in our sample. Further, HFA during the first postpartum year could be a stronger determinant of PPWR during the second year, but we did not have measurements for this time period.

1. Strengths and limitations

A main strength of this study is the large sample of 1st and 2nd generation Pakistani immigrant mothers, which allowed us to examine PPWR in an under-researched ethnic group at increased risk for obesity. Our sample size and data distribution allowed us to model PPWR at the month at which measurements actually occurred as opposed to collapsing measurements for each follow-up visit. However, we did not have data on weight during the first four months postpartum and thus could not determine differences in PPWR changes during this period. We also lacked pre-pregnancy weight data, requiring us to calculate PPWR based on pre-pregnancy weight imputed according to IOM recommendations for gestational weight gain. Though 91% of women's weight gain has been correctly predicted at 12 weeks gestation according to the IOM's first trimester weight gain recommendations (260), only ~30% of White and South Asian women gain weight within the total gestational weight gain recommendations (261), which may have biased our results. The lack of data on subsequent pregnancies in the follow-up period also prevented us from disentangling the reasons for differences in weight gain during the second year postpartum.

2. Conclusions

In this study of Pakistani and White British postpartum women in the UK, 1st generation Pakistani immigrants had a significantly different longitudinal pattern of PPWR than White British women, and 2nd generation Pakistani immigrants retained more weight at each postpartum month than White British mothers. Given the novelty of these findings and the limitations of our study, additional studies are needed that replicate our findings. Future research is also needed to determine whether HFA during the 1^{s} or 2nd year postpartum is an important determinant of PPWR. Our findings suggest that culturally appropriate interventions may be needed to promote healthy postpartum weights in Pakistani immigrant mothers to promote positive maternal and fetal health outcomes and reduce the intergenerational transmission of obesity.

Table 5.1. Characteristics of analytic sample at baseline (n=1054)

	Overall (n=1054)	**White British** (n=461)	**Pakistani** (n=593)	
			1st generation (n=335)	*2nd generation* (n=258)
Socio-demographics for mother				
Age, years	27.1 (5.5)	26.8 (6.0)	28.0 (5.3)	26.6 (4.7)
Age at immigration, years	6.3 (10.0)	0.03 (0.5)	19.4 (7.5)	0.5 (3.3)
Education (n and %)				
<5 GCSE equivalent	243 (23.1)	95 (20.6)	104 (31.0)	44 (17.1)
5 GCSE equivalent	351 (33.3)	161 (34.9)	109 (32.5)	81 (31.4)
A-level equivalent	146 (13.9)	76 (16.5)	20 (6.0)	50 (19.4)
Higher than A-level	247 (23.4)	92 (20.0)	88 (26.3)	67 (26.0)
Other/Unknown	67 (6.4)	37 (8.0)	14 (4.2)	16 (6.2)
Employment (n and %)				
Currently employed	459 (43.5)	316 (68.5)	42 (12.5)	101 (39.1)
Previously employed	281 (26.7)	115 (24.9)	57 (17.0)	109 (42.2)
Never employed	314 (29.8)	30 (6.5)	236 (70.4)	48 (18.6)
Pregnancy variables				
Gestational age at early pregnancy weight measurement, weeks	12.6 (2.7)	12.5 (2.7)	12.8 (2.7)	12.6 (2.8)
Measured early pregnancy weight, kg	67.5 (16.5)	72.2 (17.8)	62.3 (13.6)	65.9 (15.2)
Imputed pre-pregnancy weight, kg	66.1 (16.9)	70.9 (18.2)	60.7 (14.0)	64.4 (15.6)
Early pregnancy BMI, kg/m^2	25.9 (5.8)	26.9 (6.2)	24.7 (5.2)	25.7 (5.5)
Imputed pre-pregnancy BMI, kg/m^2	25.3 (6.0)	26.3 (6.4)	24.0 (5.4)	25.2 (5.7)
Gestational age at birth, weeks	39.2 (1.6)	39.2 (1.7)	39.1 (1.7)	39.3 (1.4)
Parity	1.1 (1.3)	0.8 (1.1)	1.5 (1.4)	1.2 (1.3)
Home food environment at visit 3 (n=752)*				
Number of individuals in house				
<2 years	0.2 (0.4)	0.1 (0.3)	0.3 (0.5)	0.2 (0.4)
2-15 years	1.2 (1.3)	0.7 (1.0)	1.6 (1.5)	1.4 (1.3)
16-64 years	2.8 (1.7)	2.1 (0.7)	3.5 (1.9)	3.1 (2.0)
≥65 years	0.1 (0.4)	0.01 (0.1)	0.2 (0.5)	0.1 (0.4)
Home food availability of snacks				

Variety (0-7)	4.4 (1.7)	4.0 (1.7)	4.6 (1.6)	4.7 (1.7)
Quantity (g/week)	2653.1 (1810.5)	2071.3 (1408.9)	3247.4 (1865.0)	2775.8 (2046.6)
Home food availability of SSBs				
Variety (0-3)	1.3 (1.0)	0.9 (0.8)	1.7 (1.0)	1.4 (1.0)
Quantity (mL/week)	1952.5 (2252.6)	1140.8 (1421.2)	2730.5 (2943.5)	2206.8 (2590.5)

GCSE General Certificate of Secondary Education, *BMI* body mass index, *SSBs* sugar-sweetened beverages

All values are mean and standard deviation (SD) unless otherwise noted

Visit 3 occurred at approximately 18 months postpartum

Table 5.2. Description of time-varying covariates and postpartum weight retention in the analytic sample (n=1054)

	Visit 1 (n=904)	**Visit 2** (n=732)	**Visit 3** (n=650)	**Visit 4** (n=782)
Time, months postpartum	6.2 (0.8)	12.2 (1.0)	18.1 (1.0)	24.8 (1.0)
Postpartum weight retention, kg*	3.9 (6.4)	3.6 (6.1)	3.6 (6.3)	4.3 (7.6)
White British	2.9 (6.7) (n=397)	2.4 (6.0) (n=316)	2.6 (6.4) (n=270)	3.0 (8.5) (n=317)
1st generation Pakistani immigrant	5.0 (5.5) (n=279)	4.6 (5.7) (n=232)	4.2 (5.7) (n=220)	5.4 (6.3) (n=264)
2nd generation Pakistani immigrant	4.4 (6.5) (n=228)	4.3 (6.3) (n=184)	4.4 (6.5) (n=160)	4.9 (7.1) (n=191)
Maternity leave (n and %)				
No	592 (65.5)	600 (82.0)	547 (84.2)	658 (84.1)
Yes	312 (34.5)	132 (18.0)	103 (15.8)	124 (15.9)
Currently breastfeeding (n and %)				
No	730 (80.8)	660 (90.2)	596 (91.7)	766 (98.0)
Yes	174 (19.4)	72 (9.8)	54 (8.3)	16 (2.0)
Smoking status (n and %)				
Never	648 (71.7)	539 (73.6)	483 (74.3)	570 (72.9)
Current	129 (14.3)	95 (13.0)	91 (14.0)	122 (15.6)
Former	127 (14.0)	98 (13.4)	76 (11.7)	90 (11.5)

All values are mean and standard deviation (SD) unless otherwise noted

Visits 1, 2, 3, and 4 were scheduled to occur at 6, 12, 18, and 24 months postpartum, respectively

*Postpartum weight retention calculated as measured weight minus imputed pre-pregnancy weight

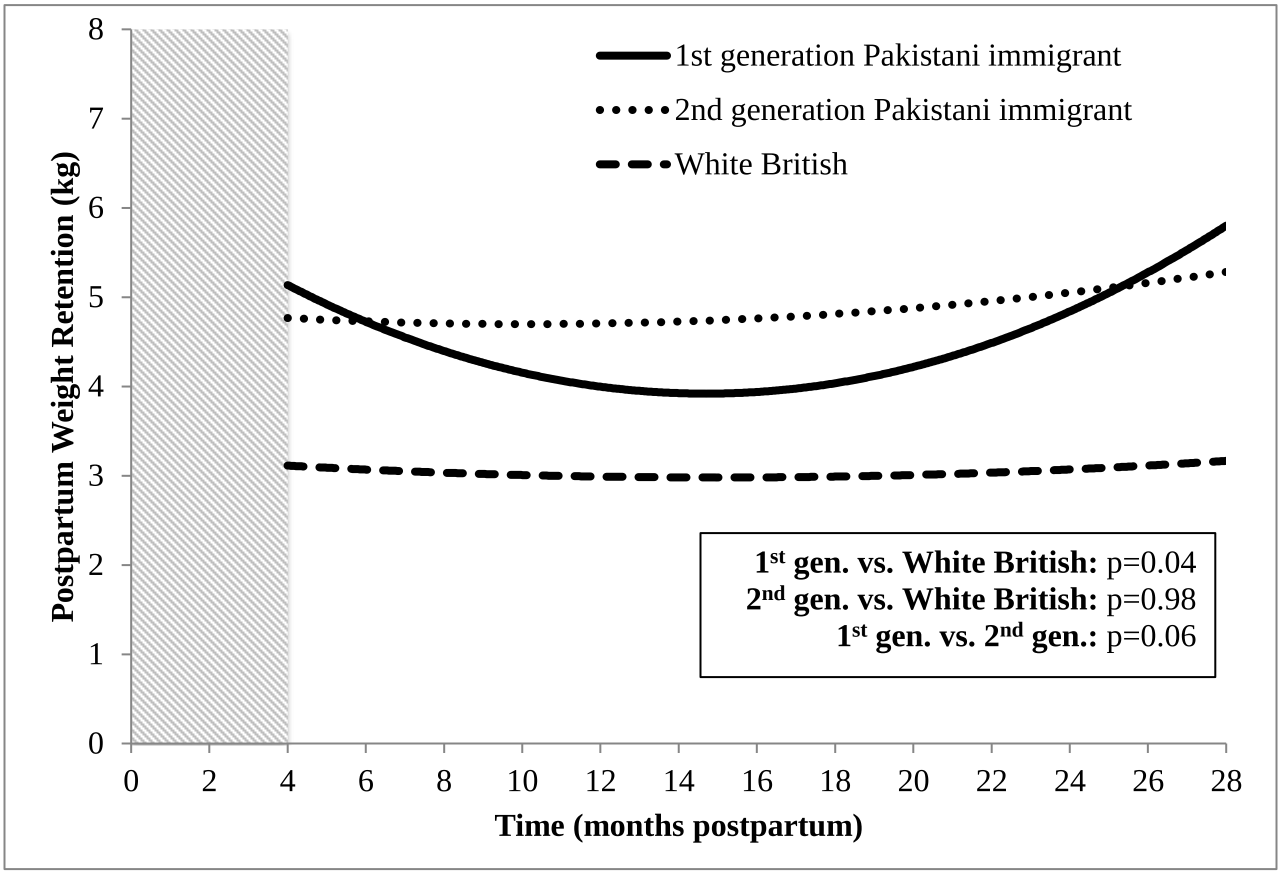

Figure 5.1. Longitudinal patterns of postpartum weight retention among 1st and 2nd generation Pakistani immigrant versus White British mothers (n=1054)
p-values are for differences in the longitudinal postpartum weight retention patterns between designated groups where "gen." means "generation Pakistani immigrant"
Estimates from mixed effects linear regression models including time, time-squared, group, time*group, time-squared*group, baseline age, age at immigration, education, gestational age at birth, parity, BMI at hospital booking, maternity leave status, smoking status, and breastfeeding status

Table 5.3. Associations between home food availability and average postpartum weight retention between visits 2 and 4 (n=752)

	Beta coefficient (95% CI)
Average PPWR between visits 2 and 4, kg (mean and SD)	3.9 (5.7)
Home food availability of snacks	
Variety	
None/Low (0-2)	Ref.
Medium (3-5)	-0.26 (-1.46, 0.94)
High (6-7)	0.15 (-1.17, 1.48)
Quantity	
Low (≤1785.7)	Ref.
Medium (>1785.7 to ≤2897.5)	0.70 (-0.28, 1.68)
High (>2897.5)	0.71 (-0.32, 1.74)
Home food availability of SSBs	
Variety	
No SSBs (0)	Ref.
Low (1)	0.46 (-0.59, 1.52)
Medium (2)	1.18 (0.05, 2.32)*
High (3)	0.98 (-0.45, 2.42)
Quantity	
Low (≤654.5)	Ref.
Medium (>654.5 to ≤1800.0)	0.86 (-0.12, 1.84)
High (>1800.0)	1.18 (0.15, 2.20)*

PPWR postpartum weight retention, *SSBs* sugar-sweetened beverages
*p<0.05
Visits 2 and 4 occurred at approximately 12 and 24 months postpartum, respectively
Postpartum weight retention calculated as measured weight minus imputed pre-pregnancy weight
Covariates in multivariable linear regression model included: group, baseline age, age at immigration, education, employment status at baseline, number of individuals in the household, and BMI at hospital booking

CHAPTER 6: ASSOCIATION OF FOOD PARENTING PRACTICES WITH OBESOGENIC DIETARY INTAKE IN THE HISPANIC COMMUNITY CHILDREN'S HEALTH STUDY/STUDY OF LATINO YOUTH (SOL YOUTH)

A. Overview

Some food parenting practices (FPPs) are associated with obesogenic dietary intake in non-Hispanic youth, but studies in Hispanics/Latinos are limited. We examined how FPPs relate to obesogenic dietary intake using cross-sectional data from 1214 Hispanic/Latino 8- to 16-year-olds and their parents/caregivers in the Hispanic Community Children's Health Study/Study of Latino Youth (SOL Youth). Diet was assessed with two 24-hour dietary recalls. Obesogenic items were snack foods, sweets, and high-sugar beverages. Three FPPs (Rules and Limits, Monitoring, and Pressure to Eat) derived from the Parenting strategies for Eating and Activity Scale (PEAS) were assessed. K-means cluster analysis identified five groups of parents with similar FPP scores. Multiple logistic regression examined associations of cluster membership with diet. Parents in the controlling cluster (high scores for all FPPs) had a 1.86 (95% CI: 1.09, 3.19) times higher odds of having children with high obesogenic dietary intake compared to parents in the indulgent cluster (low scores for all FPPs). Among parents of 12- to 16-year-olds, membership in the pressuring cluster (high Pressure to Eat, low Rules and Limits and Monitoring scores) was associated with a 2.95 (95% CI: 1.51, 5.79) times greater odds of high obesogenic dietary intake. All other associations were null. Future obesity prevention interventions for Hispanic/Latino youth may benefit from discouraging controlling FPPs, specifically Pressure to Eat in adolescents.

B. Introduction

According to the 2015-2016 National Health and Nutrition Examination Survey, Hispanic/Latino youth aged 2-19 years in the United States (US) have an obesity prevalence approximately 50 percent greater than that of non-Hispanic/Latino Whites (21.9% vs. 14.7% with body mass index [BMI] $\geq 95^{th}$ percentile, respectively) (4). Compared to youth without obesity aged 7-18 years in the US, youth with obesity are five times more likely to be adults with obesity (262), which can increase risk for comorbidities such as type 2 diabetes and cardiovascular disease (263,264). Thus, there is a critical need to identify targets for childhood obesity prevention in Hispanic/Latino youth.

Energy-dense, micronutrient-poor foods such as processed snack foods, sweets, and high-sugar beverages have been identified as obesity promoting, or obesogenic, items (178,265). Food parenting practices, defined as the behaviors and actions implemented by parents to influence their child's attitudes, behaviors, or beliefs regarding food (92), have been associated with BMI and obesogenic dietary intake (13,94,95,266). Much of the research on food parenting practices has relied on the Child Feeding Questionnaire (CFQ) (94,95), as proposed by Birch et al. (96), which examines three food parenting practices: Pressure to Eat, Monitoring, and Restriction. Pressure to Eat, described as parents' tendency to encourage children to eat more food, has been related to significantly greater obesogenic dietary intake in a recent systematic review and meta-analysis by Yee et al. (13). However, across 78 studies included in their review, only one study was conducted in a predominately Hispanic/Latino sample (13).

Growing evidence suggests there are ethnic/racial differences in the use of food parenting practices and their associations with risk for obesity (97). This may be explained by cultural differences in the selection and meaning of specific food parenting practices (98). For example, Hispanic/Latino parents have reported higher use of Pressure to Eat than non-Hispanic Whites (99,100), perhaps reflecting a cultural belief that heavier children are an indicator of good parenting and health (101–103). There also appear to be differences in the use of food parenting practices according to acculturation, with less acculturated Hispanic/Latino parents using more controlling practices, such as Pressure to Eat (104–107).

No previous studies, to our knowledge, have examined the association between food parenting practices and obesogenic dietary intake in a sample of pre-adolescent and adolescent Hispanic/Latino youth. The Hispanic/Latino study included in the systematic review by Yee et al. (13) showed a positive association between controlling food parenting practices and obesogenic dietary intake among females in a sample of predominantly first generation Mexican American parents of kindergarteners and second-graders (105). However, another study of Mexican American fifth-graders that did not meet inclusion criteria for the Yee et al. review found no significant association between controlling food parenting practices and obesogenic dietary intake in males or females (108). It may be that food parenting practices have a different association with dietary intake in older versus younger children (13) due to older children having greater autonomy over their diets (92,109).

Food parenting practices have generally been examined independent of one another (92). However, parents actually use these practices in combination (92), and the combined effect of food parenting practices on dietary intake has been shown to differ from that of the individual effects (110). Although controlling food parenting practices such as Pressure to Eat have previously been associated with increased obesogenic dietary intake (13), Gevers et al. (111) found that a cluster of parents with *low* scores on controlling food parenting practices was more likely to have children with increased snack consumption compared to other food parenting practice clusters. Examining clusters of parents instead of the individual food parenting practices may better reflect how food parenting practices are associated with obesogenic dietary intake. Further, categorizing parents based on similarities in food parenting practices can show how practices are generally combined and can identify potential parent groups at risk for promoting high consumption of obesogenic foods/beverages in their children (110,111).

Examining these food parenting practice clusters within the context of other behavioral and physical aspects of the home food environment may provide a more complete picture of how food parenting practices are associated with dietary intake (119,267). General parenting style impacts the emotional climate of parent-child interactions and the child's responsiveness to parenting behaviors, which can moderate the efficacy of parenting practices (116). Further, the availability of obesogenic foods in the home has previously been associated with dietary intake in Hispanics/Latinos (268) and may influence whether certain food parenting practices are needed (such as setting limits on consumption of snack foods) and their effect on weight control/maintenance (32).

Thus, the objective of this research was to examine how combinations of food parenting practices are associated with obesogenic dietary intake in Hispanic/Latino youth 8 to 16 years old and whether other home food environment determinants (i.e., general parenting style and home food availability of obesogenic foods/beverages) and the child's socio-demographic characteristics (i.e., age group and sex) modify this association. Using groups derived based on parents' use of food parenting practices, we hypothesized that parents in a cluster characterized by *low* controlling food parenting practices would have children with increased odds of high obesogenic dietary intake, consistent with the study by Gevers et al. We expected this association to be strongest among pre-adolescent, female youth and in the context of a permissive parenting style (low demandingness, high responsiveness) and high home food availability (HFA) of obesogenic items.

C. Methods

1. Study population

SOL Youth (166) is an ancillary study of the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) (165). HCHS/SOL is a prospective, community-based cohort study of self-identified Hispanic/Latino individuals aged 18-74 years who were selected using a stratified, two-stage probability sampling design within designated geographical areas across the four participating field centers (Bronx, New York; Chicago, Illinois; Miami, Florida; San Diego, California), supported by a Coordinating Center at the University of North Carolina at Chapel Hill (165,169). All children living in the household of a parent/caregiver (henceforth referred to as the parent) who completed the HCHS/SOL baseline examination were eligible for SOL Youth and invited to participate (166). Of the 1777 identified eligible youth, 1466 participated, corresponding to 1019 parents. Questionnaires were interviewer-administered in English or Spanish at the initial clinical examination. Protocols for the parent and child are published (165,166,169) and were approved by the institutional review boards at each of the institutions involved. Written informed consent and assent were obtained from the parent and child, respectively.

2. Food parenting practices

Parents completed a single 26-item PEAS questionnaire (269) regardless of the number of children they had enrolled in SOL Youth. PEAS measures five parenting practices: Limit Setting, Discipline, Control, Monitoring, and Reinforcement (96,269). The original factor structure of PEAS was validated only for combined food and physical activity parenting practices among Hispanic/Latino mothers of 5- to 8-year-olds (269). We derived a new factor structure for assessing food-specific parenting practices based on the 16 food-related questions among parents of pre-adolescent and adolescent Hispanic/Latino youth (details found in Statistical Analysis).

3. Obesogenic dietary intake

Diet was assessed using two interviewer-administered 24-hour dietary recalls in the youth's language of choice (Spanish or English). The first interview was conducted in-person at the clinical examination, and the second interview was conducted via telephone at least five, but no more than 30, days later. Interviews were completed using the Nutrition Data System for Research (NDSR) software from the Nutrition Coordinating Center at the University of Minnesota, which employs the multiple pass procedure. NDSR versions 10-12 (2010-2012) were used to collect data, and all raw files were processed using version 13 (2013) (175,176). To aid in recalling portion sizes, participants were provided with food models for the in-person interview and a Food Amounts Booklet for the telephone-based recall.

Dietary items defined as obesogenic for the purposes of this study are listed in Table 6.1. and include snack foods, sweets, sugar-sweetened beverages (SSBs; any non-dairy beverage with added caloric sweeteners (178)), sweetened milk, and 100% fruit juice. Although sugar is not added to 100% fruit juice, it is included because it is similar to soda in energy and sugar content (179), and the 2015-2020 Dietary Guidelines recommend limited consumption (178). Obesogenic dietary intake was measured using the mean intake in servings per day across the two dietary recalls.

4. Home food environment characteristics

a. Home food availability (HFA) of obesogenic items

HFA of obesogenic items was assessed using a questionnaire of how often 17 selected food/beverage items were available in the home (5-point Likert-type scale ranging from never [1] to always [5] available) in any amount over the previous 30 days (35). Of these items, 9 were selected as obesogenic (regular soda, sports drinks, fruit drinks, 100% fruit juice, sweetened cereal, sweet baked goods, regular chips/crackers, chocolate candy, and other candy; Cronbach's α=0.66 in SOL Youth), similar to classifications used by Couch et al. (33) and Ding et al. (35) in previous implementations of this questionnaire**.** HFA of obesogenic items was defined as the sum of the Likert rating of frequencies of these nine obesogenic items. Thus, potential scores ranged from 9 to 45.

b. General parenting style

General parenting style was assessed using the 16-item Authoritative Parenting Index (209). The questionnaire assesses the two dimensions of authoritative parenting defined by Maccoby and Martin (210): demandingness and responsiveness (Cronbach's α=0.81 and 0.69 for demandingness and responsiveness in SOL Youth, respectively) (209). Parents completed a separate questionnaire for each child and received a continuous score for the demandingness and responsiveness subscales based on their 4-point Likert-type responses. Potential scores for demandingness ranged from 7 to 28 and from 9 to 36 for responsiveness (209). Individuals were not further classified into the four parenting styles proposed by Maccoby and Martin (i.e., authoritative, authoritarian, permissive, or uninvolved) (210) due to the Authoritative Parenting Index requiring the "tertile-split procedure" to determine parenting style (209). This approach to classification is sample-specific and results in only those individuals in the highest or lowest tertiles of each subscale being categorized. By using the individual scales, we avoided excluding a third of our sample and increased the generalizability of our findings.

5. Covariates

a. Socio-demographics

Socio-demographic information including child's age, child's sex, parent's age, parent's sex, parent's education, parent's Hispanic/Latino background, and household income were assessed during the field center visit using parent-completed questionnaires.

b. Acculturation

Parental acculturation was defined using two measures, years lived in the US (assessed with one question) and the Acculturation Rating Scale for Mexican Americans II Brief (ARSMA-II Brief) (180,191). The ARSMA-II Brief assessed language use and preference (5-point Likert-type responses) with the 6-item Hispanic/Latino Orientation Scale (LOS) and the 6-item Anglo Orientation Scale (AOS; Cronbach's α=0.85 for both LOS and AOS in SOL Youth) (191). Parents were classified into three groups according to mean AOS and LOS scores: bicultural (AOS and LOS$\geq$3.0), assimilated (AOS$\geq$3.0, LOS$<$3.0), and marginalized (AOS and LOS$<$3.0)/separated (AOS$<$3.0, LOS$\geq$3.0). The marginalized and separated categories were combined because only five parents were classified as marginalized.

c. Acculturative stress

Parental acculturative stress was reported using the 9-item Acculturative Stress Index (270). Each item related to experiences with perceived discrimination, intergenerational conflict, or language conflict over the past year (Cronbach's α=0.77 in SOL Youth) (270).

6. Statistical analysis

We conducted an exploratory factors analysis of the food-specific PEAS items on a random split half-sample to derive a new food-specific PEAS factor structure. Factors were retained by the proportion criterion and were rotated using varimax rotation. Factors were labeled according to those variables with factor loadings≥|0.30|, using names in accordance with a recent content map for food parenting practice constructs (92). A confirmatory factor analysis was conducted using the new factor structure in the validation half-sample. A k-means cluster analysis was conducted based on z-transformed scores for the new factors in parents with no missing data for any of the food-related PEAS items (n=1000). Cluster solutions with 2 to 10 clusters were examined. Each analysis was run for a maximum of 1000 iterations, and seeds containing less than or equal to 5% of the sample were removed during each iteration (271). The best solution was selected according to the pseudo-F statistic (272,273).

To examine the associations between clusters and dietary intake, dietary recalls with total energy intakes below the sex-specific first percentile or greater than the sex-specific 99th percentile, or that were unreliable according to the interviewer, were excluded (n=34). Youth with only one dietary recall were also excluded (n=104) since systematic differences were found between the in-person versus telephone dietary recalls. Remaining participants with missing covariate data (n=93; missing at least one response for the continuous covariates and at least two responses used to define the categorical covariates) and missing food-specific PEAS responses (n=27) were excluded. The final analytic sample size included 1214 youth. Individuals who were included in our sample were more likely to be of Mexican origin compared to individuals who were excluded (53.4% vs. 38.0%), but there were no other significant differences between individuals who were included versus excluded.

Differences in socio-demographic characteristics of each cluster were assessed using Pearson's chi-squared tests and analysis of variance (ANOVA). Post-hoc significance levels were adjusted for using Tukey's test. A multinomial logistic regression model was run to examine the odds of cluster membership (largest cluster as reference group) according to acculturation status and hypothesized home environment effect modifiers (HFA of obesogenic items and demandingness and responsiveness). Due to the highly skewed distribution of obesogenic dietary intake, we created two categories of intake, divided at the median (3.4 servings/day). A logistic regression model was used to assess whether cluster membership (reference group: cluster with the lowest odds of obesogenic dietary intake) was associated with high obesogenic dietary intake. Interaction terms between cluster membership and each proposed effect modifier (child's age group, child's sex, HFA of obesogenic items, and demandingness and responsiveness) were tested individually in separate logistic regression models. Presence of effect modification was based on a p-value<0.10 for the interaction term. Interaction terms between cluster membership and hypothesized effect modifiers were removed via backwards selection until all remaining interaction terms were significant at $p<0.10$. Main effects for each of the hypothesized effect modifiers were tested using the logistic regression model adjusted for all covariates and cluster membership. Covariates included child's age group (2 categories), parent's age, child's sex, parent's sex, parent's education (3 categories), household income (3 categories), field center (4 categories), parent's Hispanic/Latino background (7 categories), years parent lived in US (3 categories), ARSMA-II Brief category (3 categories), and Acculturative Stress Index.

All regression analyses and descriptive statistics accounted for stratification and for clustering by primary sampling units and were weighted to adjust for sampling probability of selection and nonresponse with the use of complex survey procedures in SAS software version 9.4 (SAS Institute).

D. Results

A description of the parent and youth participants in the analytic sample is provided in Table 6.2. Parents were predominately female (88.8%) and from low socioeconomic status households (37.8% of households had less than a high school education and 51.6% of households had an income less than $20,000). The majority of children were over 11 years of age (58.2%). Mean obesogenic dietary intake among children was 3.8 servings per day, with the majority of their intake coming from SSBs (1.1 servings per day) and sweets (1.3 servings per day).

The factor analysis identified three food-specific parenting practices (i.e., three factors) measured by PEAS (Table 6.3.; X^2=487.45, df=101;Root Mean Square Error of Approximation [RMSEA]=0.09 [95% CI: 0.08, 0.09]; Standardized Root Mean Square Residual [SRMR]=0.06; and Bentler's Comparative Fit Index [CFI]=0.84). The RMSEA<0.10 and SRMR<0.08 indicated a good model fit, with the three-factor solution reproducing the data well (274). The Bentler's CFI was less than the model fit criteria of ≥0.95, suggesting low average correlation between variables (275). We explored including correlated errors between items and allowing items to load on multiple factors; however, these changes did not improve fit. Thus, the 3-factor solution without correlated errors was selected for use. The three new factors are defined in Table 6.3. and were named Rules and Limits, Monitoring, and Pressure to Eat.

Based on standardized scores for these factors, each parent was placed into one of five clusters (Figure 6.1.). Differences were observed across clusters in the unadjusted levels of socio-demographic characteristics (Appendix 6.1.). Adjusted associations of acculturation-related measures and hypothesized home environment effect modifiers with cluster membership are shown in Table 6.4. The purpose of these analyses was to determine how acculturation and acculturative stress related to the use of food parenting practices as well as whether the hypothesized effect modifiers were related to our primary exposure (cluster membership). We found, that compared to the controlling cluster, the odds of belonging in the disciplinary, tracking, or indulgent cluster were 0.31 (95% CI: 0.17, 0.55), 0.52 (95% CI: 0.31, 0.88), and 0.57 (95% CI: 0.33, 0.99) times lower for every one-point increase in scores for the Acculturative Stress Index, respectively. For every one-point increase in responsiveness score, there was a 0.89 times lower odds of membership in the pressuring or tracking cluster compared to the controlling cluster. Further, the odds of tracking versus controlling cluster membership were 0.94 times (95% CI: 0.90, 0.99) smaller for every additional obesogenic item made available in the home.

Table 6.5. presents results of the logistic regression models for associations of food parenting practice cluster membership with obesogenic dietary intake. Results for the main effects models did not include interaction terms with any of the hypothesized effect modifiers but did include adjustment for their main effects. The joint F-test for cluster membership had a p=0.10; however, exploration of pairwise comparisons showed that parents in the controlling cluster had a 1.92 (95% CI: 1.12, 3.29) times greater odds of having children with high obesogenic dietary intake compared to those in the indulgent cluster. Further, parents in the pressuring cluster had a 2.21 (95% CI: 1.19, 4.10) times greater odds of having children with high obesogenic dietary intake compared to those in the indulgent cluster. All other associations for the main effect of cluster membership with obesogenic dietary intake were null.

We observed significant effect modification by age group for the pressuring cluster only (Table 6.5.; p=0.03). A joint F-test for cluster membership and the interaction term between pressuring cluster membership and age group had a p=0.02. Pairwise comparisons from the effect modification model showed similar results to those from our exploratory analyses in the main effects model. Specifically, membership in the controlling cluster was associated with a 1.86 (95% CI: 1.09, 3.19) times greater odds of having children with high obesogenic dietary intake compared to those in the indulgent cluster. Regarding the pressuring cluster, we found that parents of 12- to 16-year-olds in the pressuring cluster had a 2.95 (95% CI: 1.51, 5.79) times greater odds of having children with high obesogenic dietary intake compared to parents of 12- to 16-year-olds who were in the indulgent cluster, while there was no association between pressuring versus indulgent cluster membership and obesogenic dietary intake among the younger children. No other effect modification was observed for child's age group, child's sex, HFA of obesogenic items, or demandingness and responsiveness. We further explored whether the main effects of the hypothesized effect modifiers were associated with obesogenic dietary intake. We found that males had a 1.64 (95% CI: 1.22, 2.22) times greater odds of high obesogenic dietary intake compared to females, and every additional obesogenic item made available in the home was associated with a 1.06 (95% CI: 1.03, 1.09) times greater odds of high obesogenic dietary intake (results not shown in tables).

E. Discussion

This is the first study to investigate the association of food parenting practices and obesogenic dietary intake in pre-adolescent and adolescent Hispanics/Latinos. In a population-based sample of Hispanic/Latino children and their parents living in four distinct US cities, we found that, contrary to our hypothesis, parents in a cluster characterized by *high* controlling food parenting practices (controlling cluster; high scores for Rules and Limits, Monitoring, and Pressure to Eat) had increased odds of having children with high obesogenic dietary intake compared to parents in a cluster characterized by *low* controlling food parenting practices (indulgent cluster; low scores for Rules and Limits, Monitoring, and Pressure to Eat). Further, parents who reported high use of Pressure to Eat in combination with limited use of Rules and Limits and Monitoring had increased odds of having 12- to 16-year-olds with high obesogenic dietary intake compared to indulgent parents.

Although two previous studies derived food parenting practice-based clusters (110,111), we are the first to identify food parenting practice-based clusters specifically for parents of Hispanic/Latino youth. The three food-specific PEAS factors we based our clusters on are similar to factors seen in other food parenting practice instruments, with Pressure to Eat and Monitoring including all items from the corresponding factors from the CFQ (93). While parental acculturation was not a predictor of cluster membership, parental acculturative stress was inversely associated with membership in the disciplinary cluster (high Rules and Limits and Monitoring scores and low Pressure to Eat score), tracking cluster (high Monitoring and low Rules and Limits and Pressure to Eat scores), and indulgent cluster compared to the controlling cluster. This finding is consistent with previous studies' reports that general stress is positively associated with use of controlling food parenting practices, particularly Pressure to Eat (276,277). Parents may use more controlling practices under acculturative stress due to stress clouding their ability to recognize and respond to children's satiety cues (278) or due to parents using food parenting to increase their perceived control in an environment in which they generally feel a lack of control (279).

We also found that higher HFA of obesogenic items was associated with decreased odds of membership in the tracking cluster (high Monitoring score and low Rules and Limits and Pressure to Eat scores) compared to the controlling cluster and that increased responsiveness was associated with decreased odds of membership in the pressuring or tracking cluster compared to the controlling cluster. Limiting the availability of obesogenic foods in the home is an extension of Monitoring to the physical home food environment; thus it is not surprising that parents with lower HFA of obesogenic items had increased odds of belonging to the tracking cluster. Parenting styles characterized by high responsiveness have not been associated with use of Rules and Limits or Pressure to Eat in previous literature (226–228), but we observed that responsiveness was inversely associated with pressuring cluster membership. Further, previous studies have found a positive association between a combination of high responsiveness and demandingness (authoritative parenting style) with scores for Monitoring (226,228), yet responsiveness was inversely associated with odds of membership in the tracking cluster (the cluster characterized by the highest scores for Monitoring). Thus it appears that the association between responsiveness and food parenting practice clusters differs from that observed for individual food parenting practices. However, future research on parenting styles and use of food parenting practices in combination is needed to clarify these relationships.

Studies on feeding styles (parenting styles specific to the context of feeding) have shown that low-income, Hispanic/Latino parents tend to have a more permissive feeding style (117,280), which, similar to findings for a permissive parenting style (226–228), has been associated with low food parenting practice scores for Pressure to Eat and Monitoring (117). Although we did not measure feeding styles in this study, parents in the indulgent cluster seem to have had a permissive feeding style. Permissive feeding styles have been associated with increased weight status in low-income, Hispanic/Latino youth (95,112,117,280,281) and greater intake of obesogenic foods and beverages (282). However, contrary to our hypothesis and the literature, we found that the indulgent cluster was associated with the lowest odds of obesogenic dietary intake, with individuals in the controlling or pressuring cluster compared to the indulgent cluster having an increased odds of high obesogenic dietary intake.

The high use of Coercive Control, defined as "parent's pressure, intrusiveness, and dominance in relation to children's feelings and thoughts, as well as their behaviors," (92) in both the controlling and pressuring cluster may also explain why membership in these clusters was associated with increased odds of high obesogenic dietary intake compared to the indulgent cluster. Previous research has suggested that use of Coercive Control limits children's ability to self-regulate their dietary intake and promotes overconsumption of controlled foods when they are freely available (283–286). It may also be that parents used more Coercive Control in response to children having high obesogenic dietary intake; however, due to the cross-sectional design of this study, temporality cannot be established.

Another explanation is that our reference cluster, the indulgent cluster, more closely represented an uninvolved feeding style (low demandingness, low responsiveness) (117) than a permissive feeding style. Though associations between overweight/obesity and an uninvolved style appear similar to those seen with a permissive style (95,287), an uninvolved feeding style has been correlated with decreased intake of SSBs (112). The food-specific items from PEAS did not measure food parenting practices related to the responsiveness domain of feeding styles, such as Autonomy Support and Promotion (92), making it difficult to determine which feeding styles our food parenting clusters most closely resemble.

Though a previous systematic review and meta-analysis of food parenting practices and dietary intake by Yee et al. (13) did not observe effect modification by age for Pressure to Eat (comparing studies of 2- to 6-year-olds vs. 7- to 11-year-olds), the authors did observe an overall positive association between Pressure to Eat and obesogenic dietary intake. This is similar to our finding that the pressuring cluster, characterized by high Pressure to Eat and low Rules and Limits and Monitoring scores, was associated with high obesogenic dietary intake compared to the indulgent cluster, except our significant findings were limited to adolescents. This effect modification is contrary to our expectation that associations of food parenting practices and dietary intake would be stronger among pre-adolescents than adolescents due to pre-adolescents' reduced autonomy. One potential explanation is that adolescents are more responsive to Pressure to Eat than pre-adolescents. Children instinctively self-regulate food intake according to hunger and satiety, but this ability tends to weaken as they age (288). This could result in adolescents consuming more obesogenic foods in response to external pressures to eat, even in the absence of hunger.

It is also possible that the combination of high use of Pressure to Eat with limited use of Rules and Limits is responsible for the effect modification by age for the pressuring versus indulgent cluster. High scores for Pressure to Eat characterized both the pressuring and controlling cluster, yet only in the pressuring cluster where Rules and Limits and Monitoring scores were low did we see that age modified the association with obesogenic dietary intake. Previous studies have not found that age modifies the association between Monitoring and obesogenic dietary intake, but increased use of Rules and Limits has been more strongly associated with decreased obesogenic dietary intake among older versus younger children (13). Thus it makes sense that low use of Rules and Limits in combination with high Pressure to Eat would promote obesogenic intake among adolescents specifically in the pressuring versus indulgent cluster.

One would then expect that other clusters characterized by limited use of Rules and Limits would be positively associated with high obesogenic dietary intake and that age would modify these associations. However, this was not the case, with low use of Rules and Limits in the context of tracking cluster membership having a null association with obesogenic dietary intake regardless of age. These findings highlight the importance of examining food parenting practices in combination and suggest that Pressure to Eat (the main difference between the pressuring and indulgent clusters) is an important determinant of the relationship between food parenting practices and obesogenic dietary intake.

Despite the effect modification by age, we did not observe any effect modification by child's sex. It is possible that the youth in our sample presented similar awareness and responsiveness to controlling food parenting practices (105), and thus there were no observed differences in the association between food parenting practices and obesogenic dietary intake by sex. A recent meta-analysis also observed that parents did not differ in their use of Coercive Control across males and females, and thus that may explain why we did not observe effect modification by sex (289).

We also hypothesized that both HFA of obesogenic items and parenting style would modify associations between food parenting practices and obesogenic dietary intake because they define the home food environment in which food parenting practices are implemented. Though HFA of obesogenic items was positively associated with odds of obesogenic dietary intake, the interaction with food parenting practice cluster membership was not significant. Increased autonomy in food selection and decreased intake of foods from the home among 8- to 16-year-olds (32) likely resulted in the null findings for effect modification. However, Loth et al. previously observed that the association between Restriction (a construct not measured by food specific items in PEAS) and obesogenic dietary intake in their sample of racially/ethnically diverse adolescents was modified by HFA of obesogenic items. Thus HFA may only modify associations between select food parenting practices and obesogenic dietary intake.

We did not observe a significant association between parenting style and obesogenic dietary intake or a significant interaction between parenting style and food parenting practice clusters. Although the findings for parenting style and dietary intake are less consistent than those seen for feeding styles, previous literature has found that an authoritative parenting style is associated with decreased intake of snacks and SSBs (282). Studies examining parenting style as an effect modifier have had also had mixed findings (112,113,120). Theory suggests that parenting styles affect the efficacy of parenting practices by determining the practices implemented, the behaviors that give those practices meaning, the nature of parent-child interactions, and the child’s openness to parental influence (116). Given our findings and the mixed body of literature, future studies are needed to clarify the relationship between parenting style and obesogenic dietary intake and disentangle how parenting style and food parenting practices interact.

1. Strengths and limitations

A key strength of this study is the use of a large, representative sample of Hispanic/Latino youth living in multiple geographic areas and across pre-adolescence and adolescence to examine food parenting practices and their associations with obesogenic dietary intake. The development of a new factor structure for the food-specific PEAS items ensured that we were measuring food parenting practices relevant to the population of interest. Further, use of trained interviewers and examiners ensured high quality data collection for all variables, and diet measurement via multiple 24-hour dietary recalls allowed for a better representation of usual intake that other studies may not have captured.

However, our study is not without limitations. SOL Youth is a cross-sectional study, and thus no conclusions can be made regarding temporality. Parents completed a single PEAS questionnaire for all children, and it is possible that parents use different food parenting practices depending on the child's age, sex, weight status, or developmental status (290). We were also limited by PEAS not capturing responsive food parenting practices and by the lack of a questionnaire on feeding styles. These shortcomings make it difficult to determine whether food parenting practices characteristic of a more permissive or uninvolved feeding style should be recommended. Additionally, misreporting on diet assessment is a well-established limitation in nutrition epidemiology research. Examinations in children and adolescents indicate that underreporters of total energy tend to report less SSBs, sweets, and snacks than plausible reporters, all of which defined our outcome of interest (291–293). Further, obesogenic foods/beverages are frequently consumed during snack occasions, which are less structured than meal occasions and thus more prone to misreporting (291).

2. Implications

Future studies are needed to examine food parenting practices pertaining to responsiveness, such as those on child involvement, encouragement, praise, reasoning, and negotiation (92), in order to clarify whether a food parenting practice cluster resembling a permissive or uninvolved feeding style is associated with low obesogenic dietary intake. Studies should also have parents complete food parenting practice questionnaires for each child to allow for derivation of age-specific food parenting practice clusters. Such clusters could enhance the limited literature of the use and impact of food parenting practices in older children and adolescents, specifically. Longitudinal studies of food parenting practices among Hispanics/Latinos are needed to better understand the impact of food parenting practices on obesogenic dietary intake and whether child socio-demographic characteristics and home food environment characteristics modify this association.

3. Conclusions

We found that parents with high use of Rules and Limits, Monitoring, and Pressure to Eat in combination have increased odds of having children with high obesogenic dietary intake compared to parents with low use of these three practices. Further, children aged 12 to 16 years with parents who reported high use of Pressure to Eat and low use of Rules and Limits and Monitoring had increased odds of having high obesogenic dietary intake. Future interventions aimed at reducing obesogenic dietary intake in Hispanic/Latino youth may benefit from discouraging use of controlling food parenting practices, particularly Pressure to Eat among older youth.

Table 6.1. Obesogenic food/beverages categories and specific food groups included

Category	Foods/beverages included
Snack foods	Crackers (all grain varieties), snack bars (all grain varieties); snack chips (all grain varieties); and popcorn (plain and flavored)
Sweets	Ready-to-eat cereal (presweetened, all grain varieties); cakes, cookies, pies, pastries, Danish, doughnuts, cobblers (all grain varieties); frozen desserts (dairy and non-dairy); pudding and other dairy desserts (includes artificially sweetened); chocolates; candies; and miscellaneous desserts
100% fruit juice	Citrus and non-citrus juice
Sweetened milk	Ready-to drink flavored milk (whole, reduced fat, low fat and fat free), sweetened flavored milk beverage powder, and dairy-based sweetened meal replacement/supplement
SSBs	Sweetened varieties of soft drinks, fruit drinks, water, tea, coffee, coffee substitutes, and sports drinks

SSBs sugar-sweetened beverages

Table 6.2. Characteristics of analytic sample (n=1214)

	Mean or n (SD or %)
Socio-demographics	
Child's sex (n and %)	
Female	613 (49.5)
Male	601 (50.5)
Parent's sex (n and %)	
Female	1053 (88.8)
Male	161 (11.2)
Child's age, years (n and %)	
8-≤11 years	538 (41.8)
12-16 years	676 (58.2)
Parent's age, years (mean and SD)	40.9 (0.3)
Parent's education (n and %)	
<High school	455 (37.8)
High school or equivalent	342 (29.3)
>High school	417 (32.9)
Household income (n and %)	
<$20,000	625 (51.6)
$20,000-$40,000	407 (32.7)
>$40,000	182 (15.7)
Parent's Hispanic background (n and %)	
Dominican	136 (12.8)
Central American	111 (7.1)
Cuban	103 (6.4)
Mexican	614 (53.4)
Puerto Rican	130 (11.8)
South American	77 (5.2)
Mixed/Other	43 (3.2)
SOL Youth field center (n and %)	
Bronx	330 (34.5)
Chicago	290 (14.6)
Miami	230 (14.3)
San Diego	364 (36.6)
Acculturation	
Years parent lived in US (n and %)	
Born in US	160 (13.7)
<20 years	596 (49.7)
≥20 years	458 (36.6)
Parent's ARSMA-II Brief (n and %)	
Bicultural	333 (28.2)
Assimilated	91 (7.8)
Separated/marginalized	790 (64.1)
Parent's Acculturative Stress Index (mean and SD)	1.8 (0.03)
Hypothesized home environment effect modifiers	
Home food availability of obesogenic items (mean and SD)	25.8 (0.2)

Authoritative Parenting Index (mean and SD)	
Demandingness	25.1 (0.1)
Responsiveness	24.8 (0.1)
Outcome	
Obesogenic dietary intake (mean and SD)	3.8 (0.1)
Snack foods	0.4 (0.04)
Sweets	1.3 (0.1)
Sugar-sweetened beverages	1.1 (0.1)
Sweetened milk	0.2 (0.02)
100% fruit juice	0.6 (0.04)
Obesogenic dietary intake (mean and SD)*	
High	2.1 (0.1)
Low	5.4 (0.1)

SD standard deviation, *BMI* body mass index, *US* United States, *ARSMA-II Brief* Acculturation Rating Scale for Mexican Americans-II Brief, *SSBs* sugar-sweetened beverages

Unweighted n (weighted %)

*High obesogenic dietary intake: ≥median (3.4 servings of obesogenic items)

Table 6.3. Comparison of factor loadings for the exploratory versus full sample of parents in SOL Youth

Food-specific PEAS items as described in SOL Youth	**Rules and Limits**		**Monitoring**		**Pressure to Eat**	
	n 504	n 1000	n 504	n 1000	n 504	n 1000
Discipline						
1. How often do you discipline your children for drinking a soda without your permission?	**0.75**	**0.73**	0.15	0.15	0.04	0.06
2. How often must your children ask permission before drinking soda?	**0.69**	**0.69**	0.32	0.28	0.03	0.02
3. How often do you discipline your children for getting a snack without your permission?	**0.68**	**0.68**	0.09	0.11	0.14	0.14
Limit Setting						
4. I limit the number of snacks my children eat.	**0.39**	**0.40**	0.23	0.21	0.18	0.12
5. I limit the amount of soda my children drink.	**0.31**	**0.32**	0.23	0.23	0.10	0.09
Monitoring						
6. How often must your children ask permission before getting a snack?	**0.63**	**0.63**	0.25	0.20	0.15	0.10
7. How much do you keep track of the salty snack foods (potato chips, tortilla chips) that your children eat?	0.19	0.20	**0.82**	**0.81**	0.04	0.02
8. How much do you keep track of the sweet snacks (candy, ice cream, cake) that your children eat?	0.24	0.25	**0.75**	**0.74**	-0.01	0.01
9. How much do you keep track of the high fat foods that your children eat?	0.09	0.15	**0.72**	**0.73**	-0.01	-0.04
10. How much do you keep track of the servings of fruits and vegetables your children are eating?	0.26	0.24	**0.42**	**0.47**	0.06	0.07
Reinforcement						
11. How often do you praise your children for eating a healthy snack?	0.28	0.28	**0.40**	**0.32**	0.10	0.13
Control						
12. I have to be especially careful to make sure my children eat enough.	0.07	0.08	0.06	0.07	**0.61**	**0.62**
13. If I don't regulate or guide my children's eating, they would eat much less than they should.	0.01	0.03	0.03	0.03	**0.58**	**0.60**
14. If my children say, "I'm not hungry," I try to get them to eat anyway.	0.02	0.03	-0.02	0.00	**0.56**	**0.57**

15. My children should always eat all the food on their plate.	0.12	0.07	0.07	0.07	**0.43**	**0.43**
16. I offer sweets (candy, ice cream, cake) to my children as a reward for good behavior.	0.14	0.10	0.02	-0.03	**0.28**	**0.26**

Horizontal lines indicate the food-specific PEAS factor structure derived with exploratory factor analysis; bolded values indicate where each item had the highest factor loading

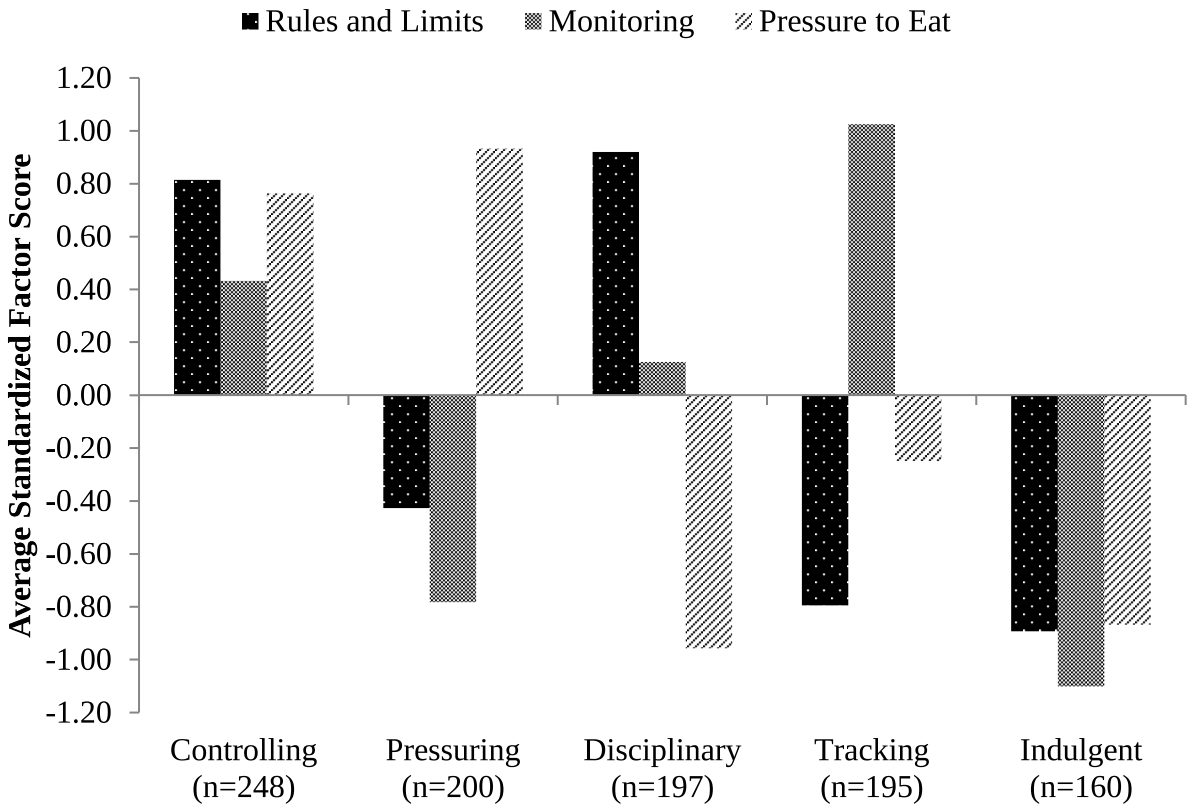

Figure 6.1. Clusters derived from k-means cluster analysis based on standardized factor scores in SOL Youth parents (n=1000)
SOL Youth Hispanic Community Children’s Health Study/Study of Latino Youth

Table 6.4. Associations of acculturation, acculturative stress, and hypothesized home environment effect modifiers with odds of specific food parenting practice cluster membership versus controlling cluster membership (n=1214)

	Controlling (n=341)	**Pressuring** (n=237)	**Disciplinary** (n=226)	**Tracking** (n=218)	**Indulgent** (n=192)
Acculturation					
Years parent lived in US					
Born in US	1.00	1.05 (0.39, 2.86)	0.75 (0.28, 2.04)	0.75 (0.28, 1.96)	0.97 (0.25, 3.79)
<20 years	1.00	1.00	1.00	1.00	1.00
≥20 years	1.00	1.07 (0.51, 2.25)	1.37 (0.62, 3.05)	1.10 (0.54, 2.24)	1.48 (0.69, 3.17)
Parent's ARSMA-II Brief					
Bicultural	1.00	0.64 (0.33, 1.26)	1.42 (0.64, 3.14)	1.73 (0.84, 3.55)	0.57 (0.23, 1.43)
Assimilated	1.00	0.56 (0.12, 2.70)	1.11 (0.34, 3.65)	0.71 (0.20, 2.55)	0.75 (0.12, 4.57)
Separated/marginalized	1.00	1.00	1.00	1.00	1.00
Parent's Acculturative Stress Index	1.00	0.99 (0.62, 1.57)	0.31 (0.17, 0.55)**	0.52 (0.31, 0.88)*	0.57 (0.33, 0.99)*
Hypothesized home environment effect modifiers					
Home food availability of obesogenic items	1.00	1.02 (0.97, 1.08)	0.96 (0.90, 1.01)	0.94 (0.90, 0.99)*	1.01 (0.96, 1.08)
Authoritative Parenting Index					
Demandingness	1.00	0.99 (0.88, 1.10)	1.05 (0.94, 1.18)	1.07 (0.95, 1.21)	0.93 (0.81, 1.07)
Responsiveness	1.00	0.89 (0.81, 0.99)*	0.91 (0.81, 1.02)	0.89 (0.80, 0.98)*	0.95 (0.84, 1.07)

US United States, *ARSMA-II Brief* Acculturation Rating Scale for Mexican Americans-II Brief

*p<0.05, **p<0.01

Models adjusted for the following covariates: child's age, parent's age, child's sex, parent's sex, parent's education, household income, SOL Youth center, Hispanic background, years parent lived in US, ARSMA-II Brief, Acculturative Stress Index, home food availability of obesogenic items, demandingness, and responsiveness

Table 6.5. Associations of specified food parenting practice cluster membership versus indulgent cluster membership with odds of high versus low obesogenic dietary intake (n=1214)

Clusters	**Odds Ratios (95% CI)**
Main effects model	
Controlling	1.92 (1.12, 3.29)*
Pressuring	2.21 (1.19, 4.10)*
Disciplinary	1.51 (0.85, 2.68)
Tracking	1.63 (0.88, 3.00)
Indulgent	1.00
Effect modification model	
Controlling	1.86 (1.09, 3.19)*
Pressuring	
8-≤11 years†	1.34 (0.62, 2.88)
12-16 years†	2.95 (1.51, 5.79)**
Disciplinary	1.46 (0.82, 2.59)
Tracking	1.61 (0.87, 2.96)
Indulgent	1.00

*p<0.05, **p<0.01

† odds of high vs. low obesogenic dietary intake for individuals in the pressuring cluster vs. indulgent cluster within given age groups

Models adjusted for the following covariates: child's age, parent's age, child's sex, parent's sex, parent's education, household income, SOL Youth center, Hispanic background, years parent lived in US, ARSMA-II Brief, Acculturative Stress Index, home food availability of obesogenic items, demandingness, and responsiveness

Effect modification model included an interaction term between age group and pressuring cluster membership

High obesogenic dietary intake: ≥median (3.4 servings of obesogenic items)

CHAPTER 7: SYNTHESIS

A. Overview

South Asian and Hispanic/Latino populations are growing at rapid rates in the United Kingdom (UK) (1) and United States (US) (2), respectively, in part due to increased immigration of these groups to Western countries (18,19). Both South Asian and Hispanic/Latino immigrants are at an increased risk for obesity and obesity-related diseases compared to Whites (3,4). In this research we sought to determine whether the home food environment is an important determinant of obesity in ethnic minority and immigrant parents and their children. This work filled several gaps in the literature including 1) how acculturation is associated with multiple measures of the home food environment in two understudied immigrant ethnic minorities, 2) whether home food availability (HFA) and postpartum weight retention (PPWR) are potential intervention targets for South Asian immigrants, and 3) how home food environment factors interact to affect risk for obesity in an understudied age and ethnic group.

Our research addressed the first literature gap in Chapters 4-6. In Chapter 4, we examined associations between acculturation, as measured by immigrant generation, and the physical home food environment. Although our findings did not support our hypothesis that HFA of snacks and sugar-sweetened beverages (SSBs) would differ according to immigrant generation, we are the first to report that 1) Pakistani households at 18 months of age have more snacks (variety and quantity) available than White British households and 2) that ethnic differences in HFA observed at 18 months of age persist when children are 36 months of age. Our findings indicate that households of 2nd and 3rd generation Pakistani immigrant children combined are more obesogenic than those of White British children. It is possible that examination of households of immigrant generations more separated in time (e.g., 1st and 3rd generation immigrants) may have indicated differences in HFA of obesogenic items according to immigrant generation that we were unable to detect.

We also addressed the first aforementioned literature gap in Chapters 5 and 6. In these chapters we illustrated the importance of acculturation and acculturative stress in relation to behavioral aspects of the home food environment. In Chapter 5, we were the first to report that longitudinal patterns of PPWR differ according to immigrant generation. The shapes of the patterns seem to indicate that 1st generation Pakistani immigrant women continue traditional Pakistani postpartum rituals while 2nd generation Pakistani immigrants adopt Western postpartum practices as part of the acculturation process. In Chapter 6, we provided new insight into how acculturation affects the use of food parenting practices. We found that acculturative stress was a more important determinant of food parenting practices than acculturation, with parents under greater acculturative stress favoring use of controlling food parenting practices, particularly Pressure to Eat. Given that high use of Pressure to Eat was associated with increased intake of obesogenic foods in our study, these findings indicate that obesity interventions for adolescents in Hispanic/Latino immigrant families may need to address parental acculturative stress in order to modify food parenting practices.

This dissertation research filled the second research gap of whether HFA and PPWR are potential intervention targets for obesity in South Asian immigrants by examining HFA of snacks and SSBs and PPWR independently in Chapters 4 and 5 and in combination in Chapter 5. Only one previous study has examined HFA in Pakistani immigrant households, and only one other study has examined PPWR in South Asian immigrant women. We are the first to examine associations between HFA and dietary intake and weight of mothers or toddlers in Pakistani immigrant households. Contrary to our hypotheses, associations between HFA of snacks and SSBs and toddler's body mass index (BMI) and mother's PPWR were primarily null. However, there was some indication in Chapter 5 that HFA of SSBs is associated with PPWR. Given the novelty of this finding, studies with measures of PPWR throughout the first 24 months postpartum, and perhaps for HFA of more items, are needed before we can recommend that future interventions target HFA of SSBs for PPWR reduction.

Despite these null associations with BMI, HFA does appear to be a good target for dietary interventions. In Chapter 4 we found that increased HFA of snacks and SSBs was associated with increased intake of snacks and SSBs cross-sectionally and longitudinally, and thus reducing the presence and amount of these items in the home may help reduce the risk for obesity among Pakistani households. It should also be noted that we are the first to report cross-sectional associations between HFA and dietary intake at 18 months of age. Given that the period between 12 and 24 months of age is when children complete the transition from breastfeeding or formula to table food (232), our findings indicate that interventions targeting HFA can have an important impact on children's early dietary patterns that may track through the rest of childhood (233–235) and even into adulthood (236)

Our findings in Chapter 5 also indicate that PPWR may be a potential target for future obesity interventions in Pakistani parent-child dyads. We found that 1st generation Pakistani immigrant women had more rapid weight regain than White British mothers from 16 to 28 months postpartum and that 2nd generation Pakistani immigrant women retained significantly more weight than White British mothers throughout the entire follow-up period. We are the first study to characterize differences in PPWR between White British and Pakistani immigrant mothers throughout 24 months postpartum and to examine differences in their longitudinal PPWR patterns. While these findings indicate a potential need for culturally appropriate obesity interventions during the postpartum period, future studies should replicate these findings before such interventions are designed due to the novelty of our findings.

Lastly, this research addressed the third literature gap in how home food environment factors interact to affect obesity in Chapter 6. Although we did not observe a significant interaction between food parenting practices and the other home food environment factors, our findings did indicate the importance of studying food parenting practices in combination. The specific combination of food parenting practices affected the directionality of associations between food parenting practices and obesogenic dietary intake, as well as whether the association was modified by age group. Specifically, high use of Pressure to Eat characterized both the controlling and pressuring cluster, yet only when it was used in combination with high use of Monitoring and Rules and Limits did parents have children with increased odds of high obesogenic dietary intake, irrespective of the child's age, compared to parents in the indulgent cluster (low Rules and Limits, Monitoring, and Pressure to Eat). Only two previous studies have derived food parenting practice combinations using cluster analysis (110,111), and this research expanded upon their work by being the first to derive clusters for Hispanic/Latino pre-adolescents and adolescents.

In addition to being the first to derive clusters for this age and ethnic group, few studies in general have examined food parenting practice studies in pre-adolescent and adolescent Hispanic youth (13,108). Research on parenting tends to focus on younger, non-Hispanic White children, and thus our finding that clusters of food parenting practices are an important determinant obesogenic dietary intake in Hispanics/Latinos and adolescents is novel.

B. Strengths

Collectively this dissertation research adds to the literature by examining relationships between the home food environment and obesogenic dietary intake and BMI in previously understudied ethnic immigrant minorities at high risk for obesity during important ages for obesity prevention. It used two well-characterized cohorts that implemented culturally appropriate, validated questionnaires and trained study personnel to assess all exposures, outcomes, and covariates of interest. Both samples included multiple generations of immigrants of varying degrees of acculturation, enabling examinations of how immigrant generation and acculturation influence multiple aspects of the home food environment.

The Born in Bradford 1000 (BiB1000) study provided a large bi-ethnic sample of White British and Pakistani households from birth through 36 months of age, allowing us to examine ethnic/immigrant group differences in HFA and PPWR, longitudinal PPWR patterns, and longitudinal associations of HFA with dietary intake and obesity during a previously understudied yet important developmental period of life. The large sample size and data distribution also meant we could use complex analytic approaches to modeling longitudinal PPWR patterns, which enabled us to contribute to the literature gap on longitudinal PPWR patterns in ethnic minority and immigrant women. Another strength of the BiB1000 cohort was that the Home Food Availability Inventory Checklist (HFAI-C) supported examination of previously under-researched aspects of the home food environment, specifically variety *and* quantity of foods available in the home.

The Hispanic Community Children's Health Study/Study of Latino Youth (SOL Youth) sample allowed for the characterization of the association between dietary intake and food parenting practices in an under-researched age and ethnic group. Previous studies of food parenting practices in Hispanics/Latinos have often focused on Mexican Americans, but the study's multicenter design with four field centers permitted recruitment and data collection from multiple Hispanic/Latino groups. Our use of complex survey procedures in our analysis allowed us to account for SOL Youth's recruitment methods and to adjust for sampling probability of selection and nonresponse. Further, our derivation of a new factor structure for the food-specific Parenting strategies for Eating and Activity Scale (PEAS) items and subsequent confirmatory factor analysis ensured that we were measuring valid food parenting practices relevant to the population of interest. The use of multiple 24-hour dietary recalls to collect data in this study also allowed for a better representation of usual intake that other studies may not have captured.

C. Limitations

Despite its strengths, this work is not without its limitations. Both the food frequency questionnaires (FFQs) used in BiB1000 and the 24-hour dietary recall used in SOL Youth were subject to recall bias (247). In BiB1000, mothers reported on behalf of their children. Although parents can accurately report dietary intake when children are cared for at home, reporting accuracy is lower for eating occasions that occur outside of their supervision, such as in a childcare setting (294). The snack/SSB items were also measured at the end of each FFQ, and thus participant fatigue could have resulted in inaccurate reporting of these items (247). With respect to SOL Youth, examinations in children and adolescents indicate that youth who underreport their energy tend to report less SSBs, sweets, and snacks than plausible reporters, all of which defined our outcome of interest (291–293). Obesogenic foods/beverages are also frequently consumed during snack occasions, which are less structured than meal occasions and thus more prone to misreporting (291). Though these biases are inherent to studying diet in children, their potential impact on our findings cannot be overlooked.

We were also limited by the study designs for both BiB1000 and SOL Youth. In BiB1000, there was an insufficient number of individuals in non-Pakistani South Asian immigrant groups, and thus our findings may not be applicable to other South Asian ethnicities. The study also did not collect information on fat mass/fat-free mass, pre-pregnancy weight, weight from 0 to 4 months postpartum, or on subsequent pregnancies. This missing data prevented us assessing more nuanced associations between HFA and obesity that could have clarified our findings presented in Chapter 4. Further, this missing information prevented us from fully capturing longitudinal changes in PPWR. With respect to examinations of HFA and PPWR, there is also concern about antecedent-consequent bias. In other words, PPWR was a measure of imputed pre-pregnancy weight up until 12-24 months postpartum and thus can be influenced by HFA during any time up until 12 months, for which no HFA measurements exist. It is possible that HFA during 12-24 months was not reflected in the degree of PPWR at 12-24 months, thus explaining our null findings.

We were also limited by the cross-sectional design of SOL Youth. It is unclear if reverse causality is responsible for our findings. In other words, parents may have been more likely to engage in controlling food parenting practices as a result of their children having high intake of snacks and SSBs. Parents also only completed a single PEAS questionnaire for all children, and it is possible that parents use different food parenting practices depending on the child's age, sex, weight status, or developmental status (290).

D. Future directions

Findings from this dissertation research have provided new insight into the importance of parent-child dyads and the home food environment for obesity prevention in immigrant ethnic minority groups living in Western countries. Specifically, our studies illustrated that reducing the

HFA of snacks and SSBs or targeting PPWR in Pakistani immigrants may help reduce the prevalence of obesity in Pakistani immigrant parent-child dyads. Further, encouraging decreased use of controlling food parenting practices in parents of Hispanic/Latino youth may help reduce obesogenic dietary intake. However, given the aforementioned limitations of these studies, future studies are needed to support these conclusions.

There is a need for studies of the association between HFA in early life and dietary intake and obesity during late childhood or adolescence to better determine the importance of early toddlerhood nutrition. Such studies should incorporate examinations of food parenting practices, parenting style, or feeding style to assess interactions between multiple aspects of the home food environment at different ages and to address concerns about temporality of these associations. These studies should consider examining associations with overall diet quality and with fat mass and fat free mass to better understand how the home food environment is associated with risk for obesity. Studies should have parents complete food parenting practice questionnaires for each child to allow for derivation of age-specific food parenting practice clusters. It may also be of interest to examine how longitudinal PPWR patterns are associated with later risk for obesity in mothers as well as with later risk for obesity in children. Findings of the current research in combination with the proposed longitudinal studies can help inform future randomized controlled trials aimed at reducing risk for obesity in South Asian and Hispanic/Latino parent-child dyads and thus reduce the intergenerational transmission of obesity.

APPENDIX 4.1.: CUT-POINTS USED TO CREATE TERTILES FOR VARIETY AND QUANTITY OF DIETARY INTAKE

HFA at designated time	Variety or quantity of SSB intake			
	None	*Low*	*Medium*	*High*
Snack				
Variety				
18 months (n=1020)	-	0-2	3-5	6-7
36 months (n=971)	-	≤9	>9 to ≤13	>13
18 months (Longitudinal) (n=882)	-	≤9	>9 to ≤13	>13
Quantity				
36 months (n=971)	-	≤446	>446 to ≤876	>876
18 months (Longitudinal) (n=882)	-	≤442	>442 to ≤876	>876
SSB				
Variety				
18 months (n=1020)	0	1	2	3-4
36 months (n=971)	-	≤2	>2 to ≤4	>4
18 months (Longitudinal) (n=882)	-	≤2	>2 to ≤4	>4
Quantity				
36 months (n=971)	-	≤889	>889 to ≤2649	>2649
18 months (Longitudinal) (n=882)	-	≤887	>887 to ≤2569	>2569

HFA home food availability, *SSB* sugar-sweetened beverage

APPENDIX 4.2.: CUT-POINTS USED TO CREATE TERTILES FOR HFA QUANTITY

Analyses	HFA		
	Low	*Medium*	*High*
18 months			
Snacks			
Ethnic differences (n=1032)	≤1772	>1772 to ≤2896	>2896
FFQ (Longitudinal) (n=882)	≤1772	>1772 to ≤2898	>2898
BMI (n=921)	≤1772	>1772 to ≤2898	>2898
BMI (Longitudinal) (n=743)	≤1772	>1772 to ≤2881	>2881
SSBs			
Ethnic differences (n=1032)	≤654	>654 to ≤1800	>1800
FFQ (Longitudinal) (n=882)	≤654	>654 to ≤1800	>1800
BMI (n=921)	≤654	>654 to ≤1800	>1800
BMI (Longitudinal) (n=743)	≤654	>654 to ≤1747	>1747
36 months			
Snacks			
Ethnic differences (n=986)	≤2001	>2001 to ≤3039	>3039
FFQ (n=971)	≤2001	>2001 to ≤3039	>3039
BMI (n=816)	≤2001	>2001 to ≤3039	>3039
SSBs			
Ethnic differences (n=986)	≤654	>654 to ≤1800	>1800
FFQ (n=971)	≤654	>654 to ≤1800	>1800
BMI (n=816)	≤654	>654 to ≤1747	>1747

HFA home food availability, *SSBs* sugar-sweetened beverages, *FFQ* food frequency questionnaire, *BMI* body mass index

APPENDIX 4.3.: ODDS RATIOS (95% CIS) FOR HIGHER HFA FOR 3RD VS. 2ND GENERATION PAKISTANI IMMIGRANT TODDLERS

HFA at designated time	**HFA for 3rd vs. 2nd generation Pakistani immigrants (ref.)**			
	Not in home	*Low*	*Medium*	*High*
Snacks				
Variety				
18 months (n=1032)	-	1.00	0.82 (0.36, 1.84)	0.76 (0.32, 1.79)
36 months (n=986)	-	1.00	1.01 (0.37, 2.76)	1.27 (0.47, 3.44)
Quantity				
18 months (n=1032)	-	1.00	0.83 (0.43, 1.59)	0.97 (0.49, 1.89)
36 months (n=986)	-	1.00	0.69 (0.34, 1.38)	1.02 (0.52, 2.01)
SSBs				
Variety				
18 months (n=1032)	0.45 (0.20, 1.00)	1.00	0.54 (0.28, 1.07)	0.74 (0.35, 1.56)
36 months (n=986)	0.58 (0.23, 1.44)	1.00	0.72 (0.36, 1.42)	0.96 (0.45, 2.06)
Quantity				
18 months (n=1032)	-	1.00	1.16 (0.60, 2.26)	0.92 (0.47, 1.81)
36 months (n=986)	-	1.00	1.07 (0.50, 2.30)	1.40 (0.70, 2.81)

CIs confidence intervals, *HFA* home food availability, *SSBs* sugar-sweetened beverages

All models adjusted for the following covariates: child's sex, child's age, mother's baseline age, mother's education, mother's baseline employment status, child's immigrant group, and household size

APPENDIX 6.1.: SOCIO-DEMOGRAPHIC CHARACTERISTICS BY FOOD PARENTING PRACTICE CLUSTER

Socio-demographics (n=1214)	**Controlling** (n=341)	**Pressuring** (n=237)	**Disciplinary** (n=226)	**Tracking** (n=218)	**Indulgent** (n=192)
Child's sex (n and %)					
Female	173 (46.0)	111 (45.9)	112 (48.5)	121 (58.2)	96 (51.4)
Male	168 (54.0)	126 (54.1)	114 (51.5)	97 (41.8)	96 (48.6)
Parent's sex (n and %)					
Female	313 (91.4)	190 (82.0)	202 (92.1)	192 (91.3)	156 (84.7)
Male	28 (8.6)	47 (18.0)	24 (7.9)	26 (8.7)	36 (15.3)
Child's age (n and %)					
8-≤11 years	182 (48.9)	90 (36.1)	114 (49.7)	88 (35.8)	64 (32.2)
12-≤16 years	159 (51.1)[a]	147 (63.9)[ab]	112 (50.3)[a]	130 (64.2)[ab]	128 (67.8)[b]
Parent's age, years (mean and SD)	39.9 (0.6)	41.7 (0.7)	40.5 (0.6)	41.1 (0.6)	41.9 (0.7)
Parent's education (n and %)					
<High school	123 (38.0)	115 (48.5)	77 (38.6)	71 (29.6)	69 (33.8)
High school or equivalent	100 (28.3)	66 (33.3)	64 (26.5)	59 (27.9)	53 (31.8)
>High school	118 (33.7)[b]	56 (18.1)[a]	85 (34.9)[b]	88 (42.4)[b]	70 (34.4)[ab]
Household income (n and %)					
<$20,000	184 (55)	127 (53.2)	102 (44.7)	115 (52.0)	97 (52.4)
$20,000-$40,000	106 (30.5)	92 (39.2)	87 (41.6)	63 (22.9)	59 (28.9)
>$40,000	51 (14.6)[ab]	18 (7.6)[a]	37 (13.8)[ab]	40 (25.1)[b]	36 (18.7)[ab]
Parent's Hispanic background (n and %)					
Dominican	27 (10.0)	32 (13.2)	22 (8.6)	23 (15.0)	23 (15.8)
Central American	37 (9.9)	16 (6.1)	13 (4.1)	27 (8.9)	12 (4.2)
Cuban	17 (4.4)[ab]	25 (7.3)[ab]	10 (1.9)[a]	24 (9.3)[b]	27 (11.4)[b]
Mexican	175 (55.2)	128 (57.4)	121 (59.7)	97 (45.1)	93 (47.1)
Puerto Rican	42 (10.4)	12 (6.7)	27 (12.4)	30 (15.1)	19 (15.0)
South American	30 (7.2)	17 (6.3)	12 (4.2)	8 (3.7)	10 (3.7)
Mixed/Other	12 (3.1)	4 (2.5)	12 (4.7)	7 (2.7)	8 (3.1)
SOL Youth field center (n and %)					
Bronx	88 (31.2)	57 (29.9)	77 (39.6)	62 (37.5)	46 (35.2)

Chicago	80 (15.9)^{ab}	89 (24.1)^{b}	40 (8.0)^{a}	36 (12.4)^{ab}	45 (12.8)^{ab}
Miami	71 (16.7)^{b}	47 (16.6)^{b}	19 (5.6)^{a}	47 (14.8)^{b}	46 (18.2)^{b}
San Diego	102 (36.2)	44 (29.4)	90 (46.8)	73 (35.2)	55 (33.8)

Unweighted n (weighted %); SD, standard deviation

*Cells in the same row without a common superscript letter significantly differed from each other

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