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**Stress, Obesogenic Behaviors, Measures of Obesity Risk Among  
Hispanic and Non-Hispanic White Women**

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**Abstract**

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**Background:** Obesity is a complex public health problem and is a risk factor for chronic diseases such as diabetes, cardiovascular disease, and cancer. Hispanic population is growing in the United States, and obesity affects Hispanic women more than non-Hispanic White (NHW) women. Stress may shift dietary behaviors towards higher consumption of sugary and fatty foods (e.g. soft drink and fast food consumption) and promote distracted eating (e.g. eating while doing other activities such as watching TV). However, stress may affect obesogenic behaviors

differently in Hispanics and NHW women because of cultural differences, which may influence experience of stress as well as dietary behaviors and practices. The overall goal of this dissertation is to evaluate the effects of perceived stress on three obesogenic behaviors and weight status among NHW and Hispanic women. This dissertation evaluates the difference in three obesogenic behaviors (i.e. soft drink consumption, fast food consumption, and distracted eating) by ethnicity and acculturation (chapter 1), whether ethnicity or acculturation moderates the association between stress and obesogenic behaviors (Chapter 2). The mediating roles of three obesogenic behaviors in the association between stress and measures of obesity risk are examined separately among Hispanics and NHW women (Chapter 3).

**Methods:** For this dissertation, the data from socioeconomic status obesity (SESO) study was used. SESO is a population-based cohort of 1,040 women (NHW and Hispanic) in South King County who were followed for two years. Baseline data were used in chapter 1 and 2, and for chapter 3, perceived stress at baseline, average of baseline and year-two follow-up obesogenic behaviors, and measures of obesity risk at year-two follow-up were used. The associations were evaluated using multivariable linear regression models. Mediation was tested by product-of-coefficients methods.

**Results:** Chapter 1 showed that Hispanic women consumed more soft drink compared to NHW women and showed less distracted eating behavior. Less acculturation was associated with less distracted eating among Hispanics. Chapter 2 showed that perceived stress was significantly lower in Hispanics compared to NHW and in less acculturated Hispanic women compared to more acculturated Hispanic women. Ethnicity only moderated the association between perceived stress and fast food consumption. Chapter 3 showed that three behaviors combined mediated 33% of the association between perceived stress and BMI among NHW women.

**Conclusions:** These studies contribute to the understanding of the relationship of ethnicity/acclulturation with three obesogenic behaviors, perceived stress, and measures of obesity risk. There is not much data on distracted eating, specifically among the Hispanic population. Since less distracted eating was associated with less acculturation, more studies on this behavior are needed. The results suggest stress control techniques may be helpful to reduce obesity and obesogenic behaviors specifically among NHW women. Weight loss interventions for NHW women may also benefit from targeting three obesogenic dietary behaviors.

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## **DEDICATION**

To my family

To all the immigrants and refugees

## Introduction

Obesity is a complex public health problem with a multifaceted etiology and negative consequences to physical, social, and emotional health<sup>1,2</sup>. In the United States, obesity is a major cause of preventable deaths. Among women, obesity is associated with increased risk of certain types of cancer, such as endometrial and postmenopausal breast cancer<sup>3</sup>. Among U.S. women, obesity occurs disproportionately among racial and ethnic minorities. For example, in 2014, 45.6% of Hispanic women and 35.3% of non-Hispanic White (NHW) women in the United States were obese (defined as Body Mass Index [BMI]  $\geq 30$ )<sup>4</sup>. This disparity has public health importance because Hispanics comprise 17% of the U.S. population, and this number is projected to increase to 30% by 2060<sup>5</sup>.

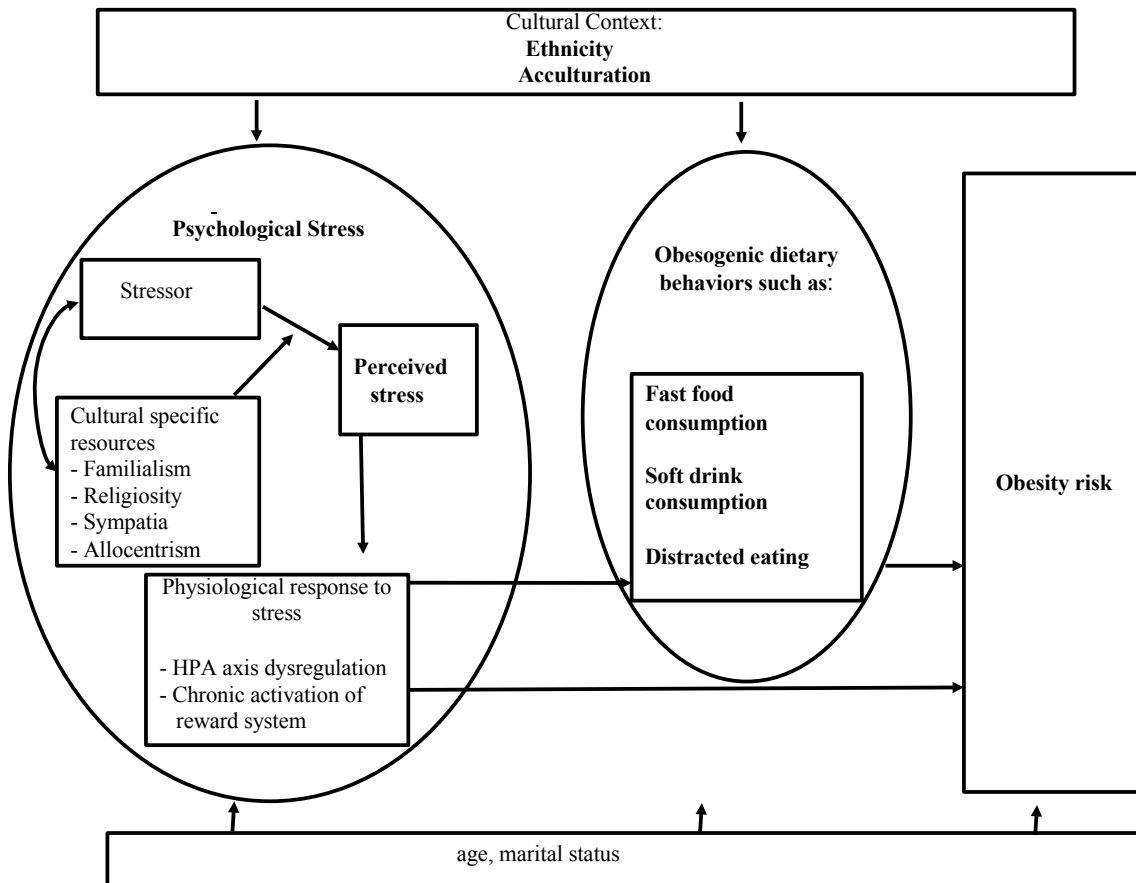
The 3 obesogenic dietary behaviors examined in this dissertation (soft drink consumption, fast food consumption, and distracted eating) are prevalent in the United States and have been associated with both obesity and stress in different epidemiologic studies.<sup>6-17</sup> These 3 behaviors may be different among Hispanics compared to NHWs. Fast food and soft drink consumption are not part of the traditional dietary practices of Hispanics<sup>18-20</sup>. Family meals are an integral aspect of eating practices in Hispanic households<sup>21</sup>. Some studies suggest that among Hispanics, family meals are important and there is less eating in front of the television<sup>22-25</sup>, which may imply less distracted eating than among other populations. However, some studies have suggested that healthy aspects of traditional Hispanic dietary practices may diminish as a result of acculturation in the United States<sup>26,27</sup>. Thus, understanding how obesogenic dietary behaviors such as soft drink consumption, fast food consumption, and distracted eating differ between Hispanic and NHW populations as well as by level of acculturation within the Hispanic population is important for developing targeted obesity prevention programs.

Chronic psychological stress is another risk factor for obesity and is thought to contribute to obesity through biological and behavioral pathways<sup>28</sup>. Chronic stress may dysregulate the hypothalamus pituitary axis (HPA) and chronically activate the reward circuitry system, which contributes to abdominal obesity and shifts dietary behavior toward higher consumption of calorie-dense “palatable foods”<sup>29</sup>. Different studies have found correlations between perceived stress and soft drink consumption, fast food consumption, and distracted eating, mostly among NHW participants<sup>30-34</sup>.

The association between stress and obesogenic dietary behaviors may be different among Hispanics compared to NHWs, considering differences in stress and coping mechanisms in these two groups. Hispanics in the United States are known to encounter specific sources of stress such as discrimination, low incomes, and poor educational and occupational opportunities<sup>35</sup>. However, cultural resources and characteristics such as sense of loyalty to and solidarity with family, collectivism or emphasis on the needs of the group, preference for positive interpersonal interactions, and religiosity are important aspects of Hispanic culture that can act as buffers in response to stress<sup>36-38</sup>.

Among Hispanics, perceived stress may differ depending on the person’s level of acculturation<sup>37</sup>. As the level of acculturation increases, protective cultural factors erode<sup>39,40</sup>. Thus, it is important to consider the level of acculturation when studying stress and its possible effects on dietary behaviors among Hispanics.

Considering the striking disparity in obesity rates between Hispanic and NHW women<sup>4</sup>, it is important to understand the interrelations among cultural, psychological, and behavioral factors regarding obesity. The conceptual model outlined in Figure 1 depicts the way that ethnicity and acculturation are associated with perceived stress, dietary behaviors, and obesity. In Chapter 1, I will evaluate how ethnicity and acculturation are associated with 3 obesogenic dietary behaviors among Hispanic and NHW women. In Chapter 2, I will evaluate how stress is associated with dietary behaviors in these 2 populations and whether this association is different based on ethnicity and level of acculturation. Finally, in Chapter 3, I will investigate whether the association between perceived stress and obesity is mediated by the 3 obesogenic dietary behaviors.



**Figure 1. Proposed conceptual model depicting how culture and acculturation are associated with perceived stress, dietary behaviors, and obesity.**

## Chapter 1

### Abstract

**Background:** Culture contributes to the observed differences in dietary behaviors between Hispanic and non-Hispanic White (NHW) populations. Traditional Hispanic diet and eating practices are healthier than American dietary behaviors. These healthy dietary behaviors could be negatively impacted by acculturation. This study investigates the differences in three obesogenic eating behaviors (soft drink consumption, fast food consumption, and distracted eating) comparing Hispanic to NHW and less acculturated to more acculturated Hispanic women.

**Methods:** We used data from 994 women ages 30–50 years in South King County in the Socioeconomic Status and Obesity Study. We looked at cross-sectional data and used multivariable linear regression models to investigate the association between ethnicity and acculturation and three obesogenic eating behaviors.

**Results:** The mean distracted eating score was lower in Hispanic women compared to NHW women (Hispanic mean: 1.7 [1.6, 1.8] and NHW mean: 2.2 [2.1, 2.3];  $P < 0.001$ ). The mean soft drink consumption per week was higher in Hispanics than NHW women (Hispanic mean: 2.2 [2.1, 2.3] and NHW mean: 1.9 [1.8, 2.1];  $P = 0.01$ ). The mean distracted eating score was significantly lower for less acculturated Hispanic women compared to more acculturated Hispanic women (less acculturated Hispanic mean: 1.6 [1.5, 1.7] and more acculturated mean: 2.1 [1.8, 2.3];  $P < 0.001$ ).

**Conclusion:** Distracted eating was observed significantly less in Hispanic and less acculturated women. This finding suggests the importance of acculturation in association with distracted

eating and could be important for obesity prevention efforts among more acculturated Hispanic women. Researchers may need to study modifiable behaviors such as distracted eating and explore their role in the difference between and within ethnicities to inform interventions to prevent obesity.

## **The Role of Ethnicity and Acculturation in Obesogenic Dietary Behaviors in the Socioeconomic Status Obesity Study (SESO)**

### **Introduction**

Obesogenic dietary behaviors are behaviors that relate to obesity. Examples of obesogenic dietary behaviors prevalent in the United States are soft drink consumption, fast food consumption, and distracted eating. These behaviors have been associated with obesity in multiple studies<sup>6-17</sup>. In the United States, the obesity rate is approximately 10 percentage points higher among Hispanic women (45.6%) compared to non-Hispanic White (NHW) women (35.3%)<sup>41</sup>. This disparity calls for understanding the differences among obesogenic dietary behaviors in these ethnic groups.

Differences in dietary behaviors between racial ethnic groups may be related to cultural differences. Edward Tylor, the pioneering English anthropologist, defines culture as a “complex whole that includes knowledge, belief, art, law, morals, customs, and any other capabilities and habits acquired by man as a member of society”<sup>42</sup>. Rules and values of a given culture or ethnic group can define food customs (eg, food preparation, family meal practices) and judgments about whether a food is acceptable, preferable, or proscribed<sup>43</sup>.

Culture is a learned practice and can be changed or unlearned due to exposure to other cultures (acculturation). In this study, acculturation refers to the process by which Hispanics adopt the attitudes, values, customs, beliefs, and behaviors of the mainstream American culture

<sup>44</sup>. The process of acculturation may thus influence dietary behaviors among Hispanics <sup>27,45</sup>.

Some aspects of traditional Hispanic dietary culture could protect against obesity. Common obesogenic dietary behaviors in the mainstream American culture, such as fast food and soft drink consumption and eating while watching TV or doing other activities, are not common components of the traditional Hispanic culture <sup>18-20,46</sup>. Han and Powell, in a study that used National Health and Nutrition Examination Survey (NHANES) data from 1999 to 2008, found that Hispanics consumed fewer calories from all types of sugary beverages, and specifically from soda, compared to NHWs <sup>46</sup>. Some evidence shows that Hispanics are more engaged in family meals, which implies less prevalence of eating while doing other activities such as watching TV <sup>22,47</sup>. And yet, here in the United States, a greater percentage of Hispanic women than NHW women are obese <sup>41</sup>. To understand why this is so, it is important to investigate any differences in obesogenic dietary behaviors between these two populations.

Hispanic diets are generally healthier than the mainstream American diet <sup>18,48</sup>, but acculturation may negatively impact some dietary behaviors among Hispanics <sup>27,49</sup>. Limited evidence suggests that adults of Latin American national origins, and specifically women of Mexican origin, who are more acculturated (eg, speak English well) are more likely to eat fast food <sup>14,49-53</sup>. Also, several studies show that Hispanic adults who are more acculturated consume more soft drinks and more foods rich in simple sugars <sup>50-52,54,55</sup>. Qualitative studies indicate that while fast food and soft drinks are not part of the traditional Hispanic diet, consumption of these foods increases when Mexicans move to the United States <sup>19,56</sup>.

It is possible that less acculturated Hispanics engage in less distracted eating than more acculturated Hispanics. Thompson et al found that children of Spanish-speaking mothers watch less TV compared to children of English-speaking mothers <sup>57</sup>, and this may suggest lower levels

of distracted eating in the first group. It is also possible that less acculturated Hispanic women engage in less obesogenic dietary behavior than more acculturated Hispanic women.

While most studies on obesogenic dietary behaviors have focused on dietary intake, some have looked into behaviors such as fast food preference<sup>50,53,58</sup> and soft drink consumption<sup>59</sup>. Few studies have looked into behaviors such as distracted eating. Moreover, only a few studies of dietary behaviors have compared both Hispanics to NHWs and less acculturated Hispanics to more acculturated Hispanics in the same study<sup>52,59,60</sup>. Understanding the differences in obesogenic dietary behaviors between ethnicities and between levels of acculturation could guide us in better targeting obesity prevention approaches.

### **Study Aims**

Our aims for this study are as follows:

Aim 1. Test the cross-sectional differences in three obesogenic dietary behaviors (soft drink consumption, fast food consumption, and distracted eating) by ethnicity (Hispanic women versus NHW women).

Aim 2. Test the cross-sectional differences in three obesogenic dietary behaviors (soft drink consumption, fast food consumption, and distracted eating) among Hispanic women by level of acculturation (less acculturated Hispanic women versus more acculturated Hispanic women) after adjusting for covariates.

We hypothesize that (1) Hispanic women will show fewer obesogenic dietary behaviors compared to NHW women, and (2) less acculturated Hispanic women will show fewer of these behaviors compared to more acculturated Hispanic women.

## **Methods**

### **Study Participants in Parent Study**

The Socioeconomic Status Obesity Study (SESO) is the parent study for this research. SESO aims to clarify the role of social, environmental, psychological, and biological factors in the relationship between socioeconomic status and obesity, and to elucidate possible pathways between the two. SESO includes a population-based cohort of 1,040 women (NHW and Hispanic) in South King County who were followed for 2 years (2010–2011 and 2012–2013). Population-based, multistage sampling methods were used to recruit the participants.

Initially, 143 Census Block Groups with a high representation of Hispanic, low-education, and low-income individuals were identified using the U.S. Census 2000. Housing segments were randomly selected within these Census Block Groups, and segments were sampled for the next stage. Trained female interviewers approached the selected households to identify and enroll eligible women. Eligibility criteria included being female; being between age 30 and 50 years; speaking English or Spanish; and having no plans to move in the next 3 years. Women with less than a high school degree were oversampled within the NHW cohort. All participants provided self-reported data on demographics, dietary behaviors, and perceived stress at baseline (year 0) and at annual follow-ups (years 1 and 2).

The study reported here used baseline data from SESO. This study excluded only women who were pregnant at baseline. This resulted in a study sample of 994 women. We then looked at three items from the SESO baseline questionnaire that we considered good estimators of obesogenic eating behaviors. We used participants' self-reported ethnicity to identify ethnicity and self-reported language spoken most of the time to identify acculturation status.

## Measures

### Obesogenic Dietary Behaviors

Soft drink consumption was measured by the question “How often do you drink soft drinks or soda pop (regular or diet)?”<sup>9</sup>. The possible responses were never, less than once a week, about once a week, 2–5 times a week, about once a day, and 2 or more times per day. Responses were coded as the number of times soft drinks were consumed per week. Thus the responses could be 0, 1, 3, 7, or 14 times per week.

Fast food consumption was measured by the question “Thinking about how often you eat out, how many times in a week or month do you eat breakfast, lunch, or dinner in a place such as McDonald’s, Burger King, Wendy’s, Arby’s, Pizza Hut, or Kentucky Fried Chicken? (Give your best guess. Write one answer.)”<sup>61</sup>. Respondents had options to write the frequency per week, per month, or per year. The answers to this question were coded as the frequency of fast food consumption per week.

Distracted eating was measured by the self-reported frequency of eating while doing other activities<sup>9</sup>. This is also called “task eating”<sup>31</sup>. We assessed the frequency of distracted eating by asking, “How often do you eat food (meals or snacks) while doing another activity, for example, watching TV, working at a computer, reading, driving, playing video games?”

Respondents chose answers from a 5-point Likert scale ranging from 0 (never) to 4 (always).

### Ethnicity and Acculturation

We created 2 constructs for ethnicity and acculturation. For the first construct, ethnicity, we used self-reported ethnicity to categorize the women in this study as Hispanic or NHW.

Among Hispanic women only, we created an acculturation construct that used language spoken most of the time to identify less acculturated and more acculturated Hispanic women. For

this study, we defined less acculturated Hispanic women as those who speak Spanish most of the time and more acculturated Hispanic women as those who speak English most of the time.

#### Covariates

Sociodemographic information about age, marital status, and education level was collected using a self-administered questionnaire.

#### **Statistical Analysis**

We used descriptive analysis to describe participants' sociodemographic characteristics and dietary behaviors by ethnicity and acculturation level (ie, Hispanics versus NHW; less acculturated versus more acculturated Hispanics). To examine differences in each obesogenic dietary behavior by ethnicity, we used a multivariable linear regression model (Model I). We adjusted Model I for marital status and age. We then used a separate model that was restricted to Hispanic women to estimate the mean differences in obesogenic dietary behaviors by acculturation level (Model II). We adjusted Model II for age and marital status.

Model I (difference by ethnicity):

$$\text{Dietary behavior} = \alpha_0 + \beta_1 \text{ ethnicity} + \delta_1 \text{ age} + \delta_2 \text{ marital status}$$

Model II (difference, among Hispanic women, by acculturation):

$$\text{Dietary behavior} = \varphi_0 + \theta_1 \text{ acculturation} + \lambda_1 \text{ age} + \lambda_2 \text{ marital status}$$

All statistical tests were 2-sided. Statistical analyses were conducted using Stata version 13 (Stata Corp., College Station, TX, USA).

## Results

Table 1 presents the characteristics reported at baseline by the 994 women in the SESO study who were not pregnant, organized by ethnicity and acculturation level. The NHW women respondents were older than the Hispanic women (NHW mean: 39.8, SD: 6.1; Hispanic mean: 38.5; SD: 5.4), and the less acculturated Hispanic women were older than their more acculturated counterparts (less acculturated Hispanic mean: 38.8; SD: 5.4; more acculturated Hispanic mean: 38.5; SD: 7.9). Overall, the education level of the NHW women was higher than that of the Hispanic women. Education level was also higher for more acculturated versus less acculturated Hispanic women. A large majority of the less acculturated Hispanic women were born in Mexico (84%), while most of the more acculturated Hispanic women were born in the United States (69%). Among the less acculturated Hispanic women, 56% had lived in the United States for more than 20 years, while 91% of the more acculturated Hispanic women and 100% of the NHW women had lived in the United States for more than 20 years. A higher percentage of the less acculturated Hispanic women were married compared to the other groups (80% of the less acculturated Hispanic women versus 67% of the more acculturated Hispanic women and 71% of the NHW women).

The median soft drink consumption for less acculturated Hispanic women, more acculturated Hispanic women, and NHW women was 2.0, 2.0, and 1.0 time(s) per week, respectively. The median fast food consumption for these groups was 0.5, 0.5, and 0.4 times per week, respectively. The median distracted eating score for all 3 groups (less acculturated Hispanic women, more acculturated Hispanic women, and NHW women) was 2.0 (sometimes) on a 5-point scale from never to always eating while doing other activities. The group of less

acculturated Hispanic women had the lowest percentage (16%) reporting distracted eating “most of the time” or “always,” followed by more acculturated Hispanic women (30%), and NHW women (40%).

<b>Table 1. Participant Characteristics at SESO Baseline, by Ethnicity and Acculturation (N = 994)</b>			
<b>Characteristic</b>	<b>Less-Acculturated Hispanic women<sup>a</sup> (N = 421)</b>	<b>More-Acculturated Hispanic women<sup>b</sup> (N = 80)</b>	<b>Non-Hispanic White Women (N = 493)</b>
	<b>Mean or % {S.D.} (n)</b>	<b>Mean or % {S.D.} (n)</b>	<b>Mean or % {S.D.} (n)</b>
<b>Age</b>	38.8 {5.5} (401)	38.5 {7.9} (79)	39.9 {6} (487)
<b>Education level</b>			
Less than high school	58.9% (248)	7.5% (6)	2.3% (11)
High school diploma or equivalent	25.9% (109)	23.8% (19)	18.7% (92)
Some college / associate's degree	9.0% (38)	37.5% (30)	29.8% (147)
Bachelor's degree / graduate or professional degree	6.2% (26)	31.3% (25)	49.3% (243)
<b>Marital status</b>			
Never married / divorced / separated	20.0% (85)	33.0% (26)	29.0% (142)
Married / living in a marriage-like relationship	80.0% (333)	67.0% (53)	71.0% (348)
<b>Country of birth</b>			
United States	2.0% (8)	68.8% (55)	95.1% (466)
Mexico	84.0% (337)	17.5% (14)	0.0% (0)
Other	14.0% (56)	13.8% (11)	4.9% (24)
<b>20+ years in the United States</b>	56.0% (235)	91% (73)	100% (493)
<b>BMI (kg/m<sup>2</sup>)</b>	30.6 {5.6} (421)	31.2 {8.3} (80)	29.9 {9.1} (493)
< 18.5	0.0 (0)	17.5 {1.1} (2)	17.5 {0.5} (6)
18.5–24.99	23 {1.6} (53)	22.5 {2.1} (13)	22.2 {1.5} (180)
25–29.99	27.3 {1.4} (168)	27.2 {1.5} (25)	27.4 {1.4} (109)
≥ 30	35.4 {4.8} (199)	37.3 {7.4} (39)	38.6 {7.9} (198)
<b>Frequency of soft drink consumption per week</b>	2.2 {1.4} (408)	2.1 {1.5} (79)	1.9 {1.6} (492)

<b>Frequency of fast food consumption per week</b>	0.8 {0.9} (391)	0.9 {1.2} (77)	0.7 {0.99} (490)
<b>Distracted eating score (range 0-4)</b>	1.6 {0.9} (405)	2.0 {0.9} (80)	2.2 {0.8} (490)
<b>Frequency of distracted eating behavior</b>			
Never	13.0% (52)	6.0% (5)	2.0% (10)
Seldom	31.0% (124)	19.0% (15)	15.0% (73)
Sometimes	40.0% (161)	45.0% (36)	43.5% (213)
Most of the time / always	16.0% (63)	30.0% (24)	40.0% (194)
<sup>a</sup> Spanish-speaking Hispanic women			
<sup>b</sup> English-speaking Hispanic women			

Table 2 shows the adjusted mean estimates and 95% confidence intervals (CIs) of the multivariable linear regression model used to investigate the differences in the 3 obesogenic dietary behaviors by ethnicity, adjusted for age and marital status. The results showed that mean soft drink consumption per week was higher among Hispanic women than NHW women (Hispanic mean: 2.2 [95% CI: 2.1, 2.3]; NHW mean: 1.9 [95% CI: 1.8, 2.1]; P = 0.01). The mean frequency of fast food consumption per week was slightly higher among Hispanic women compared to NHW women (Hispanic mean: 0.8 [95% CI: 0.7, 1.0]; NHW mean: 0.7 [95% CI: 0.6, 0.8]), but the difference was not significant (P = 0.07). The mean distracted eating score was lower among Hispanic women than NHW women (Hispanic mean: 1.7 [95% CI: 1.6, 1.8]; NHW mean: 2.2 [95% CI: 2.1, 2.3]; P < 0.001).

<b>Table 2. Adjusted Means and Confidence Intervals for Soft Drink Consumption, Fast Food Consumption, and Distracted Eating, by Ethnicity</b>			
	<b>Hispanic women (N = 501)</b>	<b>Non-Hispanic White women (N = 493)</b>	
	<b>Mean<sup>a</sup> (95% CI)</b>	<b>Mean<sup>a</sup> (95% CI)</b>	<b>P-value<sup>b</sup></b>
Soft drink consumption per week	2.2 (2.1, 2.3)	1.9 (1.8, 2.1)	0.01
Fast food consumption per week	0.8 (0.7, 1.0)	0.7 (0.6, 0.8)	0.07
Distracted eating score	1.7 (1.6, 1.8)	2.2 (2.1, 2.3)	< 0.001
<sup>a</sup> Means adjusted for age, marital status			
<sup>b</sup> Comparisons: Hispanic women vs. non-Hispanic White women			

Table 3 shows that mean soft drink consumption was higher among less acculturated Hispanic women than among their more acculturated counterparts (less acculturated Hispanic mean: 2.2 [95% CI: 2.1, 2.4]; more acculturated Hispanic mean: 2.1 [95% CI: 1.7, 2.4]), but the difference was not significant (P = 0.4). The mean fast food consumption per week was lower among less acculturated Hispanic women compared to more acculturated Hispanic women, but again the difference was not significant (less acculturated Hispanic mean: 0.8 [95% CI: 0.7, 0.9]; more acculturated Hispanic mean: 0.9 [95% CI: 0.6, 1.1]; P = 0.8). The mean distracted eating score was lower in less acculturated compared to more acculturated Hispanic women (less acculturated Hispanic mean: 1.6 [95% CI: 1.6, 1.7]; more acculturated mean: 2.1 [95% CI: 1.9, 2.3]; P < 0.001).

<b>Table 3. Adjusted Means and Confidence Intervals for Soft Drink Consumption, Fast Food Consumption, and Distracted Eating Among Hispanic Women, by Acculturation Level</b>			
	<b>Hispanic Women</b>		
	<b>Less-Acculturated Hispanic Women<sup>a</sup> (N = 421)</b>	<b>More-Acculturated Hispanic Women<sup>b</sup> (N = 80)</b>	
	<b>Mean<sup>c</sup> (95% CI)</b>	<b>Mean<sup>c</sup> (95% CI)</b>	<b>P-value<sup>d</sup></b>
Soft drink consumption per week	2.2 (2.1, 2.4)	2.1 (1.7, 2.4)	0.4
Fast food consumption per week	0.8 (0.7, 0.9)	0.9 (0.6, 1.1)	0.8
Distracted eating score	1.6 (1.6, 1.7)	2.1 (1.9, 2.3)	< 0.001
<sup>a</sup> Spanish-speaking Hispanic women <sup>b</sup> English-speaking Hispanic women <sup>c</sup> Adjusted for age, marital status <sup>d</sup> Comparisons: Spanish-speaking Hispanic women vs. English-speaking Hispanic women			

### **Discussion**

In this study, we found that after adjusting for covariates, distracted eating was significantly less in Hispanic and less acculturated Hispanic women. The frequency of soft drink consumption was significantly higher in Hispanic women compared to NHW women and fast food consumption did not differ comparing the two ethnic groups. Soft drink and fast food consumption were not different comparing less acculturated and more acculturated Hispanic women.

A novel finding of our study was that after adjusting for age and marital status, distracted eating was significantly less in Hispanic women in general and in less acculturated Hispanic

women specifically. Hispanic women were less engaged in distracted eating compared to NHW women, and less acculturated Hispanic women demonstrated even less of this behavior than more acculturated Hispanic women. Considering that the majority of the Hispanic women in the study were less acculturated, our results suggest that acculturation is the factor that drives the differences in this behavior. This finding suggests the importance of the association of acculturation with distracted eating and could be important to targeting obesity prevention efforts toward more acculturated Hispanic women.

Skeer et al found that Hispanics spend more time during the day in family eating compared to NHW, but the difference was not significant<sup>47</sup>. Their results were adjusted for nativity, which may function as a proxy for acculturation, and therefore the impact of acculturation could not be determined. A study with a nationally representative sample showed that young children of Spanish-speaking Hispanic women watch significantly less TV compared to the children of English-speaking Hispanic women<sup>57</sup>. Future longitudinal studies can investigate the possibility of changes in distracted eating behavior by acculturation.

In this study, contrary to our expectations, we found that the frequency of soft drink consumption was significantly higher in Hispanic women compared to NHW women. This was contrary to Han and Powell's findings<sup>46</sup>. In a study that used NHANES data from 1999 to 2008, Han and Powell found that Hispanics consumed fewer calories from all types of sugary beverages, and specifically soda, compared to Whites<sup>46</sup>. It is important to consider that Hispanics across the United States come from different countries while majority of the Hispanics in Seattle come from Mexico. One explanation for our finding could be the recent rise in soft drink consumption in Mexico<sup>62</sup>.

We expected to observe significantly lower soft drink and fast food consumption in less acculturated versus more acculturated Hispanic women, as other studies have found<sup>49,51,53</sup>, but our results were not significant. However, our study had only 80 participants in the more acculturated group, which reduces the power to detect differences in dietary behaviors by level of acculturation. Another explanation for the different findings could be methodological differences such as the different proxies used to measure acculturation<sup>49,51,59</sup>. For example, Wieren et al that used a 6-item acculturation scale and analyzed cross-sectional data from the 2005 and 2007 California Health Interview Survey found that more acculturation is associated with more fast food consumption but less soft drink consumption<sup>59</sup>. Sharkey et al that used nativity as proxy for acculturation in a cross-sectional study of Mexican origin adults in Texas, found that being born in Mexico was associated with less fast food consumption but not less soft drink consumption<sup>51</sup>. These methodological differences could affect the classification of acculturation status, and thus mitigate the ability to detect any differences.

This study has several limitations, such as its cross-sectional nature, low power to detect the differences in behaviors by acculturation, and the possibility of residual confounding. To address the cross-sectional limitation, we conducted a sensitivity analysis using dietary behaviors reported at the SESO year 2 follow-up and found similar results. We did not adjust our results for individual factors such as smoking, health status, and environmental factors that could affect access to food and food choices.

Ethnicity is a complex construct that may imply shared origin, social background, culture, or traditions and does not simply represent culture alone. We conceptualized acculturation as a unidirectional construct by dichotomizing participants to groups of less and

more acculturated Hispanics. However, it is important to consider that acculturation is an ongoing process that can vary across social settings and time.

Additionally, our use of language as a proxy for acculturation may have resulted in misclassification of the Hispanic participants into the less acculturated and more acculturated groups, and thus may have mitigated some of the differences we expected to see. For instance, only 56% of the less acculturated Hispanic women in our study had lived in the United States for more than 20 years. If we had chosen length of residency as the proxy for acculturation, we would have had different numbers of women in the two groups. However, given that 84% of the less acculturated Hispanic women in our groups were born in Mexico and 69% of the more acculturated Hispanic women in our groups were born in the United States, using place of birth as the proxy for acculturation would have resulted in very similar groups to those we actually used. Several other studies have also used language as a proxy for acculturation in relation to dietary behaviors<sup>48,53,63</sup>.

Our study has several strengths, such as considering both between- and within-ethnicity differences in obesogenic dietary behaviors. The current literature has not investigated differences in distracted eating, which could inform future studies and interventions. Additionally, studying these behaviors in a sample of women in South Seattle that includes higher representation of Hispanic women and NHW women with lower levels of education gives us a better opportunity to describe the obesogenic dietary behaviors by level of education. Most of the Hispanic participants in this study were of Mexican origin, which reduces the heterogeneity in culture related to country of origin.

In conclusion, we found that less acculturation is associated with less distracted eating among Hispanic women, which could point to possible cultural protective factors in this ethnic group. This finding is unique, since no previous study has considered the differences in these obesogenic dietary behaviors both between and within ethnicities. Although this study is cross-sectional and thus no causality can be inferred, the results could inform intervention studies that include cultural protective factors surrounding eating behaviors. Intervention programs could take advantage of cultural factors in cultivating healthy dietary behaviors by providing education on the importance of mindful eating and the possible changes in this behavior that may occur due to acculturation.

## Chapter 2

### Abstract

**Background:** Psychological stress may promote obesogenic dietary behaviors and, as a result, obesity, which is a major public health problem. Three behaviors associated with obesity (soft drink consumption, fast food consumption, and eating while doing other activities) are not part of traditional Hispanic dietary behaviors. Acculturation among Hispanics could negatively impact both stress and traditional dietary behaviors. Thus, in this study we will evaluate the differences in women's perceived stress levels by ethnicity and acculturation, and test whether ethnicity and acculturation modify the association between perceived stress and obesogenic dietary behaviors.

**Method:** We used responses to a 10-item perceived stress survey and dietary behaviors from 994 women ages 30–50 years (non-Hispanic white [NHW] and Hispanic) in Seattle, WA, from the Socioeconomic Status Obesity Study. Multivariable linear regression models were used to investigate the differences in perceived stress levels and the modifying effect of ethnicity and acculturation in the association between stress and obesogenic dietary behaviors.

**Result:** Perceived stress levels were significantly lower in Hispanic women compared to NHW women (13.6 versus 14.8;  $P < 0.005$ ) and in less acculturated Hispanic women than in more acculturated Hispanic women (13.1 versus 15.3;  $P < 0.005$ ). The test of interaction was only significant for the perceived stress by ethnicity in relation to fast food consumption ( $P = 0.01$ ). Among all women, 1 quartile range increase (10 units) in perceived stress, corresponded to 0.3 times per week increase in mean soft drink consumption, and 0.3 units increase in mean distracted eating on a scale of 0–4. Only among NHW women, mean fast food consumption per week increased by 3% related to 1 quartile range increase in perceived stress.

**Conclusion:** Intervention programs may benefit from including stress reduction techniques in their approaches to preventing obesity. These techniques could take advantage of Hispanic cultural protective factors and target the dietary behaviors specific to this group. Further qualitative and confirmatory research could help in identifying obesogenic dietary behaviors under stress specific to Hispanic women.

### **Does the Relationship Between Stress and Obesogenic Behaviors Vary by Ethnicity or Acculturation?**

#### **Introduction**

Soft drink consumption, fast food consumption, and distracted eating are important obesogenic dietary behaviors to study due to their prevalence in the United States and their association with obesity. Sugary beverages, including soda, are a major source of added sugars in the American diet<sup>6</sup>, and fast food consumption contributes to more than 10% of U.S. adults' caloric intake<sup>12</sup>. These behaviors have been found to be associated with obesity in multiple studies<sup>7-11,13-17</sup>. Obesity is a major public health problem that is associated with several chronic diseases<sup>64</sup> and that affects Hispanic women more than non-Hispanic White (NHW) women in the United States<sup>41</sup>.

Psychological stress has been suggested as a risk factor that could account for more frequent obesogenic dietary behaviors, such as soft drink consumption<sup>30,31</sup>, fast food consumption<sup>32,33</sup>, and distracted eating<sup>34</sup>. However, most of these studies were conducted among NHW women and evaluation of these relationships among Hispanic women is warranted. A large cross-sectional study conducted by Isasi et al., with more than 5,000 Hispanic participants with different backgrounds, found that higher perceived stress is associated with

greater energy intake and lower diet quality<sup>65</sup>. A study by Laugero et al. from the Boston Puerto Rican Health Study among older Puerto Rican adults also found that greater perceived stress is related to unhealthy dietary patterns (ie, higher intake of salty snacks and lower intake of protein, fruits, and vegetables)<sup>66</sup>.

It is plausible that the association between stress and obesogenic dietary behaviors differs by ethnicity and acculturation, since sources of stress and coping mechanisms may differ for each ethnicity and acculturation level. Hispanics may experience more stressors than NHWs, including limited socioeconomic sources<sup>35,67,68</sup>. However, they may have more resilience in coping with stressors because of cultural resources available to them. Sense of loyalty to and solidarity with the family, emphasis on the needs of the group, preference for positive interpersonal interactions, and religiosity are components of traditional Hispanic culture that can help an individual in response to stress, and buffer its negative effects<sup>36-38</sup>.

Acculturation might make the relationship between stress and obesogenic dietary behaviors more complicated among Hispanics. For instance, acculturation may negatively impact Hispanic cultural resources that help buffer the negative effects of stress<sup>39,40</sup>, and thus may modify the association between stress and obesity among Hispanics. Acculturation itself can result in higher stress and psychosocial problems (Hovey 2000). Since stress and coping mechanisms differ among Hispanics compared to NHWs, and when comparing less acculturated Hispanics to more acculturated Hispanics, it is possible that ethnicity and acculturation act as modifiers in the association between stress and obesogenic dietary behaviors. The few studies that have investigated the association between stress and diet among Hispanics did not consider differences due to acculturation<sup>65,66</sup>. Thus, it is important to evaluate associations between stress

and obesogenic dietary behaviors and test whether these associations vary by ethnicity and by level of acculturation.

### **Study Aims**

In this study, we aim to do the following:

Aim 1. Test whether ethnicity or acculturation are effect modifiers in the association between perceived stress and obesogenic dietary behaviors (ie, soft drink consumption, fast food consumption, and distracted eating behavior). Our hypothesis is that there is an interaction between perceived stress and ethnicity and between perceived stress and acculturation in association with obesogenic dietary behaviors.

Sub Aim 1. Evaluate the differences in perceived stress levels in women by ethnicity and acculturation, adjusting for age and marital status. We will test perceived stress levels comparing (1) Hispanic women and NHW women and (2) less acculturated and more acculturated Hispanic women. We hypothesize that (1) Hispanic women perceive less stress compared to NHW women and (2) less acculturated (Spanish-speaking) Hispanic women perceive lower levels of stress compared to more acculturated (English-speaking) Hispanic women.

### **Methods**

#### **Study Participants in Parent Study**

The Socioeconomic Status Obesity Study (SESO) is the parent study for this research. SESO aims to clarify the role of social, environmental, psychological, and biological factors in the relationship between socioeconomic status and obesity, and to elucidate possible pathways between the two. SESO followed a population-based cohort of 1,040 women (NHW and Hispanic) in South King County, Washington, for 2 years (2010–2011 and 2012–2013). Population-based multistage sampling methods were used to recruit the participants. Initially,

143 Census Block Groups with a high representation of Hispanic, low-education, and low-income individuals were identified using data from the U.S. Census 2000.

Housing segments were randomly selected within these Census Block Groups, and segments were sampled for the next stage. Trained female interviewers approached the selected households to identify and enroll eligible women. Eligibility criteria included: being female; being between ages 30–50 years; speaking English or Spanish; and having no plans to move in the next 3 years. Women with less education (ie, less than a high school degree) were oversampled within the NHW cohort. All participants provided self-reported data on demographics, dietary behaviors, and perceived stress at baseline (year 0) and at annual follow-ups (years 1 and 2). Study interviewers measured participants' height and weight at each time point.

For this study, we used baseline data from SESO. We excluded women who were pregnant. This resulted in an analytic sample of 994 women. We then looked at 3 items from the SESO baseline questionnaire that we considered appropriate estimators of obesogenic dietary behaviors. We used participants' self-reported perceived stress, ethnicity and language spoken most of the time, and measured height and weight.

## **Measures**

### **Obesogenic Dietary Behaviors**

Soft drink consumption was measured by asking, “How often do you drink soft drinks or soda pop (regular or diet)?”<sup>9</sup>. The responses could be never, less than once a week, about once a week, 2–5 times a week, about once a day, and 2 or more times per day. Responses were coded as the number of times soft drinks were consumed per week. The responses could be: 0, 1, 3, 7, or 14 times per week.

Fast food consumption was measured by asking, “Thinking about how often you eat out, how many times in a week or month do you eat breakfast, lunch or dinner in a place such as McDonald’s, Burger King, Wendy’s, Arby’s, Pizza Hut, or Kentucky Fried Chicken? (Give your best guess. Write one answer.)”<sup>61</sup>. Respondents had options to write the frequency per week, per month, or per year. The answers to this question were coded as the frequency of fast food consumption per week.

Distracted eating was assessed by measuring the self-reported frequency of eating while doing other activities<sup>9</sup>. This is also called task eating<sup>31</sup>. We assessed the frequency of distracted eating by asking, “How often do you eat food (meals or snacks) while doing another activity, for example, watching TV, working at a computer, reading, driving, playing video games?” Respondents chose from a 5-point Likert scale ranging from 0 (never) to 4 (always).

#### Perceived Stress Scale (PSS)

We used the Perceived Stress Scale 10-item scale (PSS-10) to measure participants’ stress level in the past 30 days at baseline (SESO year 0; Cohen 1983). The PSS-10 has been translated and validated in different languages including Spanish and has been used to measure an overall level of perceived stress<sup>69,70</sup>. Psychometric evaluation of PSS-10 was found to be superior to PSS-14 and PSS-4 in a review study<sup>71</sup>. PSS-10 is commonly used in studies to explore the association between individuals’ appraised stress levels and health outcomes<sup>72</sup>.

Each question in this 10-item questionnaire is rated using a 5-point Likert scale with a score ranging from 0 to 4. The sum of the scores is a number between 0 and 40. A higher score indicates higher levels of stress perceived by a participant. We used a validated Spanish version of PSS-10 for the Hispanic cohort in this study; the Spanish PSS-10 demonstrated adequate reliability (internal consistency,  $\alpha = 0.82$ ) and validity ( $r = 0.72$ )<sup>73</sup>.

## Ethnicity and Acculturation

We created 2 constructs of ethnicity and acculturation. For the first construct, ethnicity, we used self-reported ethnicity to categorize the population in this study as Hispanic women and NHW women.

Among Hispanic women only, we created a second construct, acculturation, using language spoken most of the time to identify less acculturated and more acculturated Hispanic women. In this study, we defined less acculturated Hispanic women as those who speak Spanish most of the time and more acculturated Hispanic women as those who speak English most of the time.

## Covariates

Sociodemographic information including age and marital status were measured using a self-administered questionnaire. We calculated participants' body mass index (BMI) at baseline from their measured weight and height.

## Statistical Methods

We conducted descriptive analyses for demographic characteristics and stress levels by ethnicity and acculturation. To examine ethnicity differences in perceived stress, we used a multivariable linear regression model. Adjustments were made for age and marital status. We estimated adjusted mean and 95% confidence interval (CI) of perceived stress for Hispanic and NHW women. To examine acculturation and differences in perceived stress, we used a multivariable linear regression model restricted to Hispanic women. Adjustments were made for age and marital status. The following models were used:

$$\text{Perceived stress} = \alpha_0 + \beta_1 \text{ ethnicity} + \delta_1 \text{ age} + \delta_2 \text{ marital status}$$

$$\text{Perceived stress} = \alpha'_0 + \beta'_1 \text{acculturation} + \delta'_1 \text{age} + \delta'_2 \text{marital status}$$

To test the modifying effect of ethnicity in the association between stress and obesogenic dietary behaviors, we fitted a multivariable linear regression model for each of the obesogenic dietary behavior outcomes (ie, soft drink consumption, fast food consumption, and distracted eating behavior) and included the ethnicity by PSS interaction term in each model. To test the modifying effect of acculturation, we restricted the analysis to Hispanic population and fitted a multivariable linear regression model for each of the obesogenic dietary behavior outcomes, with the acculturation by PSS interaction term in each model. Fast food consumption was log transformed to avoid heteroscedasticity of residual errors in the analyses. We back-transformed the coefficients for presenting the results. After fitting the regression models for each obesogenic dietary behavior, we tested the significance of the interaction terms, and stratified the results if the interactions were significant. Stratified models included adjustments for age, marital status, and BMI. The coefficients and 95% CIs related to a 10-point increase (interquartile range) in PSS-10 scores. The following models for detecting interaction were used:

$$\text{Obesogenic dietary behavior} = \varphi_0 + \theta_1 \cdot \text{PSS} + \theta_2 \cdot \text{ethnicity} + \theta_3 \cdot (\text{PSS} \cdot \text{ethnicity})$$

$$\text{Obesogenic dietary behavior} = \varphi'_0 + \theta_1 \cdot \text{PSS} + \theta'_2 \cdot \text{acculturation} + \theta'_3 \cdot (\text{PSS} \cdot \text{acculturation})$$

All statistical tests were 2-sided. Statistical analyses were conducted using Stata version 13 (Stata Corp., College Station, TX, USA).

## Results

Table 1 presents the characteristics of the 994 women in SESO who were not pregnant, by ethnicity and acculturation. Hispanic women were younger (mean age: 38.5 years; SD: 5.4),

had lower levels of education (51% had less than high school), and had a higher percentage of married individuals (78% were married) compared to NHW women (mean age: 39.8 years, SD:6.1; 21% had less than high school, 71% were married). A large majority of the Spanish-speaking Hispanic women were born in Mexico (84%) and held an education level below high school (59%), while most of the English-speaking Hispanic women were born in the United States (69%) and held education levels higher than high school (93%). A higher percentage of Spanish-speaking Hispanic women were married (80%) compared to English-speaking Hispanic women (67%).

Perceived stress levels were lower for Hispanic women compared to NHW women (Hispanic mean: 13.6, SD: 6.7; NHW mean: 14.9, SD: 6.2). Perceived stress levels were lower in Spanish-speaking Hispanic women compared to English-speaking Hispanic women (Spanish-speaking Hispanic women mean: 13.1, SD: 6.6; English-speaking Hispanic women mean: 15.5, SD).

**Table 1. Participant Characteristics at SESO Baseline, by Ethnicity and Acculturation (N = 994)**

<b>Characteristic</b>	<b>Less Acculturated Hispanic Women<sup>a</sup> (N = 421)</b>	<b>More Acculturated Hispanic Women<sup>b</sup> (N = 80)</b>	<b>Non-Hispanic White Women (N = 493)</b>
	<b>Mean or % {S.D.} (n)</b>	<b>Mean or % {S.D.} (n)</b>	<b>Mean or % {S.D.} (n)</b>
<b>Age</b>	38.8 {5.5} (401)	38.5 {7.9} (79)	39.9 {6} (487)
<b>Education level</b>			
Less than high school	59.0% (248)	7.5% (6)	20.9% (103)
High school graduate or equivalent	25.9% (109)	23.8% (19)	29.8% (147)
Some college / associate's degree	9.0% (38)	37.5% (30)	23.7% (117)
Bachelor's degree / graduate or professional degree	6.0% (26)	31.3% (25)	25.6 % (126)
<b>Marital status</b>			
Never married / divorced / separated	20.0% (85)	33.0% (26)	29.0% (142)
Married / living in a marriage-like relationship	80.0% (333)	67.0% (53)	71.0% (348)
<b>Country of birth</b>			
United States	2.0% (8)	68.8% (55)	95.1% (466)
Mexico	84% (337)	17.5% (14)	0.0% (0)
Other	14% (56)	13.8% (11)	4.9% (24)
<b>Perceived stress</b>	13.1 {6.6} (384)	15.5 {6.3} (79)	14.9 {6.2} (486)
<b>Frequency of soft drink consumption per week</b>	2.2 {1.4} (408)	2.1 {1.5} (79)	1.9 {1.6} (492)
<b>Frequency of fast food consumption per week</b>	0.8 {0.9} (391)	0.9 {1.2} (77)	0.7 {0.99} (490)
<b>Distracted eating score (range 0-4)</b>	1.6 {0.9} (405)	2.0 {0.9} (80)	2.2 {0.8} (490)
<b>Frequency of fast food per month</b>			
0	4.2% (16)	9.5% (6)	17.4% (66)
1-4	72.3% (277)	60.3% (38)	60.8% (231)
5-9	9.0% (35)	17.5% (11)	11.8% (45)
+10	14.4% (55)	12.7% (8)	10% (38)
<b>Frequency of drinking soft drink/soda</b>			

Never	10.5% (43)	15% (12)	19.5% (96)
Less than once a week	23% (94)	29% (23)	35% (172)
About once a week	26% (105)	16.5 % (13)	10.5% (52)
2–5 times per week	20.8% (85)	21.5 % (17)	13% (64)
<b>Frequency of distracted eating behavior</b>			
Never	13.0% (52)	6.0% (5)	2.0% (10)
Seldom	31.0% (124)	19.0% (15)	15.0% (73)
Sometimes	40.0% (161)	45.0% (36)	43.5% (213)
Most of the time / always	16.0% (63)	30.0% (24)	40.0% (194)
<sup>a</sup> Spanish-speaking Hispanic women			
<sup>b</sup> English-speaking Hispanic women			

Table 2 shows the results of comparing the perceived stress levels in Hispanic women and NHW women and in more acculturated and less acculturated Hispanic women. The mean perceived stress score was lower among Hispanic women compared to NHW women (Hispanic women: 13.6; NHW women: 14.8;  $P < 0.005$ ). In addition, the PSS levels among Spanish-speaking Hispanic women were significantly less than among English-speaking Hispanic women (Spanish-speaking Hispanic women: 13.1; English-speaking Hispanic women: 15.3;  $P < 0.005$ ).

<b>Table 2. Associations Between Perceived Stress, Ethnicity, and Acculturation</b>	
	<b>Adjusted Mean Perceived Stress Score (95% CI)</b>
<b>Ethnicity</b>	
Non-Hispanic White women (N = 493)	14.8 (14.2, 15.4)
Hispanic women (N = 501)	13.6** (13.0, 14.2)
<b>Acculturation</b>	
Less acculturated Hispanic women <sup>a</sup> (N = 421)	13.1**(13.9, 16.8)
More acculturated Hispanic women <sup>b</sup> (N = 80)	15.3 (12.5, 13.8)
**P < 0.005	
<sup>a</sup> Spanish-speaking Hispanic women	
<sup>b</sup> English-speaking Hispanic women	
<sup>c</sup> F test adjusted for age and marital statusComparisons: Hispanic women vs. non-Hispanic White women Spanish-speaking Hispanic women vs. English-speaking Hispanic women	

Next, we tested for differences in the associations between stress and 3 obesogenic dietary behaviors by ethnicity (Table 3). The test of interaction was only significant for the interaction between ethnicity and PSS in relation to fast food consumption ( $P = 0.01$ ). The test of interaction for perceived stress by acculturation was not significant for any of the obesogenic dietary behaviors either (soft drink consumption,  $P = 0.5$ ; fast food consumption,  $P = 0.9$ ; distracted eating,  $P = 0.7$ ).

We provided the coefficients for the association between stress and each obesogenic dietary behavior for all participants (Table 3). We also provided stratified results for Hispanic and NHW women. Corresponding to 1 quartile range increase (10 units) in perceived stress, mean soft drink consumption increased by 0.3 times per week, and mean distracted eating score increased a by 0.3 units on a scale of 0–4. Perceived stress was not associated with fast food consumption among Hispanic women but was positively associated among NHW women. Corresponding to 1 quartile range increase in perceived stress, mean times of fast food consumption per week increased by 3% in NHW women.

<b>Table 3. Increase in Obesogenic Dietary Behaviors Corresponding to 1 Interquartile Range (10 score) Increase in Perceived Stress Scale, for All Participants and by Ethnicity</b>				
	<b>All Participants (N = 994) Beta (95% CI)</b>	<b>Hispanics<sup>b</sup> (N = 501) Beta (95% CI)</b>	<b>Non-Hispanic White<sup>b</sup> (N = 493) Beta (95% CI)</b>	<b>P-value for Interaction by Ethnicity</b>
Soft drink consumption	0.3* (0.1, 0.0)	0.2 (0.3, 0.4)	0.3 (0.3, 0.5)	0.7
Fast food consumption <sup>c</sup>	Not estimable	1.1 (0.99, 1.03)	1.3* (1.01, 1.05)	0.01
Distracted eating behavior	0.3* (0.02, 0.04)	0.3 (0.02, 0.04)	0.2 (0.01, 0.03)	0.1
*P < 0.05				
<sup>a</sup> Adjusted for age, marital status, ethnicity, acculturation and BMI				
<sup>b</sup> Adjusted for age, marital status, acculturation and BMI				
<sup>c</sup> Back transformed				

### Discussion

Results from this study indicated that perceived stress was significantly lower in Hispanic women compared to NHW women and in less acculturated Hispanic women compared to more acculturated Hispanic women. The only interaction observed was between perceived stress and ethnicity in association with fast food consumption. Perceived stress was not associated with fast food consumption in Hispanic women but it was positively associated in NHW women. In the analyses of all the participants, PSS-10 was associated with all obesogenic dietary behaviors. These results could be informative for obesity prevention interventions.

As expected, we found a significantly lower level of perceived stress among Hispanic women compared to NHW women consistent with findings from a study by Krueger et al. That study used data from the 1990 National Health Interview Survey (N = 38,891), a nationally

representative sample of U.S. adults, and found that Hispanics perceive less stress<sup>74</sup>. However, 2 studies did not find any difference between stress levels among Hispanic and NHW women<sup>75,76</sup>. Turner et al. in a study among undergraduate students who were enrolled at a state university in the New York metropolitan area found no difference in perceived stress between ethnicity<sup>76</sup>. Cohen et al. found that perceived stress level was higher in Hispanics compared to NHWs (PSS score, 14 vs. 12.8)<sup>77</sup>. Different methods for capturing perceived stress and differences in demographics and acculturation levels of the Hispanic population may contribute to the inconsistency of the results.

In this study, perceived stress was significantly lower among less acculturated Hispanic women compared to more acculturated Hispanic women, as expected. Other studies also suggested that stress could be different based on the level of acculturation<sup>37</sup> and could be associated with the erosion of protective cultural factors due to acculturation<sup>78</sup>. Even though less acculturated Hispanics may experience more stressors, it is possible that cultural resources affect the response and the perception of stress<sup>40</sup>.

Several studies report that stress is associated with poor dietary choices, which is consistent with our results. Previous studies that investigated the association between stress and dietary behaviors were mainly focused on NHW women<sup>31,79</sup>, had small sample sizes<sup>80</sup>, or were conducted outside the United States<sup>32,79</sup>. Other studies found that higher perceived stress was associated with higher consumption of processed foods<sup>30,34,81</sup>, and linked stress to fast food consumption in women<sup>32,33</sup>. Also 2 cross-sectional studies among university students found a positive association between perceived stress and soft drink consumption<sup>81,82</sup>. Our results add to the existing evidence that women with the highest level of stress are more likely to be engaged in the highest level of distracted eating<sup>31</sup>.

This study has several strengths. To our knowledge, this is the first study to examine the ethnic and acculturation differences in the association between stress and obesogenic dietary behaviors. Most of the Hispanic participants were of Mexican origin, which reduced the heterogeneity in the culture related to the country of origin. We used language to define acculturation, which has been used as a proxy for acculturation in several studies<sup>48,53,63</sup>. Most of the Spanish-speaking Hispanic women were born in Mexico and most of the English-Speaking Hispanic women were born in the United States, which could decrease the heterogeneity associated with place of birth.

This study has several limitations. In this study, we conceptualized acculturation as a unidirectional concept and categorized participants to less and more acculturated. However, it is important to acknowledge that acculturation is a dynamic process that can be conceptualized as bidirectional and multidirectional. Considering acculturation as a fixed state could mitigate the differences we expected to see. It is possible that Spanish-speaking Hispanic women had adopted some parts of the American culture, while still speaking Spanish at home. If Spanish-speaking women are misclassified as less acculturated, it could decrease the chance of detecting significant interactions. Reliance on self-reported dietary behaviors and using a subjective measure of stress are other limitations of this study in addition to the cross-sectional study design.

In conclusion, we found that less acculturated Hispanics have lower levels of perceived stress compared to more acculturated Hispanics. Also, perceived stress was positively associated with obesogenic dietary behaviors in NHW. The overarching public health implication of this study is that obesity prevention interventions should be tailored to the experiences and behaviors of the target population. In this study, we did not observe any association between stress and fast

food consumption among Hispanic women. Intervention efforts that address stress and obesogenic dietary behaviors among this group should perhaps focus on other modifiable behaviors. Additional research is needed to investigate how stress may influence dietary behaviors in each population, as it is very much possible that less acculturated woman who eat a mainly traditional Hispanic diet would still resort to comfort foods or behaviors that were not covered by the SESO questionnaires used in this study. Further qualitative studies to identify the differences in dietary behaviors under stress in different ethnic groups, as well as within ethnic groups based on acculturation levels, could inform future confirmatory research and interventions. Future studies may also want to investigate the possibility of interaction of stress and obesogenic dietary behaviors when comparing less acculturated and more acculturated Hispanic women, considering that this study did not have enough power to detect such an effect. Lastly, using more comprehensive measures of acculturation could decrease the chance of misclassification in future studies.

## Chapter 3

### Abstract

**Background:** Obesity is a major cause of preventable deaths in the United States, and it is increasingly prevalent among women of reproductive age. Higher levels of chronic stress may promote obesogenic dietary behaviors and hence obesity. Indeed, chronic stress, as a coping mechanism, may shift dietary behaviors toward higher consumption of sugary and fatty foods and promote distracted eating. In this study, we will test whether 3 obesogenic dietary behaviors (soft drink consumption, fast food consumption, and distracted eating) mediate the association between stress and risk of obesity among Hispanic and non-Hispanic White (NHW) women, separately.

**Methods:** We used data from 996 women ages 30–50 years (NHW and Hispanic) in Seattle, Washington, who were followed for 2 years in the Socioeconomic Status and Obesity Study. In this study, we used measures of perceived stress at baseline, obesogenic dietary behaviors from the average of baseline and year 2, and body mass index (BMI, as primary outcome) at year 2 follow-up. We used multivariable linear regression models and tested mediation using product-of-coefficients methods.

**Results:** Perceived stress was significantly associated with BMI among NHW women ( $P < 0.005$ ). Jointly, the 3 obesogenic dietary behaviors mediated 33% of the association between stress and BMI among NHW women. Testing the mediation effect of each individual obesogenic dietary behavior showed that fast food consumption mediated 18% and distracted eating behavior mediated 10% of the association between perceived stress and BMI among NHW women. Soft drink consumption on its own did not mediate the association. Perceived stress was not associated with BMI in Hispanic women, and thus mediation was not assessed.

**Conclusion:** Our results point to the potential impact of perceived stress on consumption of soft drinks and fast food and distracted eating behavior among NHW women. Each of these behaviors leads to risk of obesity. The results suggest that weight loss interventions for NHW women at the population level could combine stress reduction strategies with interventions targeting 3 obesogenic dietary behaviors among NHW women. Different tools may be needed to measure stress and chronic stress in different populations.

## **Stress, Obesogenic Dietary Behaviors, and Obesity in Non-Hispanic White and Hispanic Women**

### **Introduction**

Obesity is a major cause of preventable deaths in the United States<sup>83</sup>. Specifically, among women, weight gain during midlife has been shown to be positively associated with the risk of developing chronic diseases such as diabetes, cardiovascular disease, and cancer<sup>84,85</sup>. Among women of reproductive age, obesity impacts women of racial and ethnic minorities disproportionately<sup>86</sup>. This disparity is most pronounced in Hispanic subpopulations<sup>4</sup>.

Chronic psychological stress has been suggested as a risk factor for weight gain<sup>28,87-90</sup>. Three prospective studies showed chronic psychological stress to be associated with increased body mass index (BMI) over a 10-year period<sup>91</sup> and over a 5-year period<sup>92</sup>, and with changes in waist circumference over a 7-year period<sup>93</sup>.

One possible mechanism that could mediate the association between stress and obesity, and one that has not been explored extensively in the literature, is obesogenic dietary behaviors. For example, stress may contribute to obesity by increasing the frequency of obesogenic dietary behaviors (eg, soft drink consumption, fast food consumption, distracted eating)<sup>29,32,88</sup>. One

longitudinal cohort study and several cross-sectional studies found that in female participants, higher perceived stress is associated with more frequent fast food and soft drink consumption<sup>30,32,33,81,94</sup>. Stress may also lead to eating while doing other activities such as watching TV (ie, distracted eating or doing other activities while eating). In a study at 33 worksites, Barrington et al found that, at baseline, higher levels of perceived stress were associated with a higher percentage of employees who practiced distracted eating always or most of the time<sup>31</sup>.

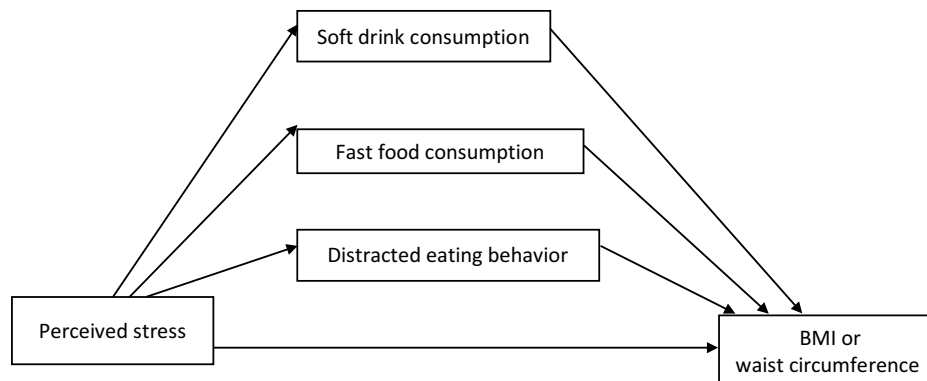
The literature that supports the association between obesogenic dietary behaviors and obesity, provides further evidence that these behaviors may act as mediators in the pathway from stress to obesity. These behaviors include soft drink consumption, fast food consumption, and distracted eating. One systematic review of randomized trials and observational studies showed that daily consumption of sugary beverages over the course of a year is associated with weight gain and increased BMI<sup>8</sup>. More importantly, a decrease in sugary beverage consumption has been associated with weight loss in intervention and longitudinal studies<sup>95,96</sup>.

A systematic review of observational and randomized trials found fast food consumption to be associated with obesity in adults<sup>13</sup>. Two prospective cohort studies showed that fast food consumption at baseline is associated with higher weights and waist circumferences after 13- and 15-year follow-ups<sup>14,15</sup>. Distracted eating has been associated with higher BMI in cross-sectional studies of adults in Wyoming, Montana, and Idaho,<sup>9</sup> and among female employees in mid-sized worksites, after adjusting for covariates such as age, gender, race, and education<sup>17</sup>.

The literature supports the mediation analysis in the non-Hispanic White (NHW) population. However, there is very little literature evaluating the association of stress, obesogenic dietary behaviors, and obesity in Hispanic populations. One cross-sectional study did not find

any association between perceived stress and BMI among Hispanics<sup>65</sup>. We will conduct an exploratory mediation analysis among Hispanic women in the Socioeconomic Status and Obesity Study (SESO).

As shown in the mediation model (Figure 1), we hypothesize that obesogenic dietary behaviors partially mediate the association between stress and measures of obesity risk (BMI and waist circumference). The goal of this study is to test this hypothesis and evaluate the extent of mediation separately in Hispanic and NHW women.



**Figure 1. Hypothesized mediation model with 3 obesogenic dietary behaviors (soft drink consumption, fast food consumption, and distracted eating) mediating the association between perceived stress and obesity risk.**

## Methods

### Study Participants in Parent Study

SESO is a population-based study of 2 cohorts (NHW and Hispanic), totaling 1,040 women in South King County, Washington who were followed for 2 years (2010–2011 and 2012–2013). SESO is the parent study for this research. Population-based multistage sampling methods were used to recruit the participants. Initially, 143 Census Block Groups with a high

representation of Hispanic, low-education, and low-income individuals were identified using data from the U.S. Census 2000. Housing segments were randomly selected within these Block Groups. Trained female interviewers approached the selected households to identify and enroll eligible women. Eligibility criteria included: being female; being ages 30–50 years; speaking English or Spanish proficiently; and having no plans to move in the next 3 years. Women with a low level of education (ie, less than a high school degree) were oversampled within the NHW cohort. All participants provided self-reported data on demographics, dietary behaviors, and perceived stress at baseline (year 0) and at the annual follow-ups (years 1 and 2). Study interviewers measured participants' height, weight, and waist circumference at each time point.

For the purposes of our analyses, we used perceived stress at baseline, average obesogenic dietary behaviors at baseline and year 2 follow-up, and measures of obesity risk at year 2 follow-up. In our analyses, we excluded women if they were pregnant at year 2 follow-up. This resulted in an analytic sample of 996 women.

## **Measures**

### **BMI and Waist Circumference (Outcomes)**

The interviewers measured height, weight, and waist circumference of the participants at year 2 follow-up of the study and we calculated participants' BMI using these measurements (kg/m<sup>2</sup>).

We chose BMI since it is the most useful population level measure of obesity in adults, but since waist circumference is a better predictor of intra-abdominal adipose tissue<sup>97,98</sup>, we chose to use it as the secondary outcome. The association between waist circumference and clinical outcomes for diabetes, coronary heart disease, and all-cause mortality rate is relatively consistent<sup>98,99</sup>.

### Perceived Stress Scale-10 (Exposure)

We used the Perceived Stress Scale 10-item questionnaire (PSS-10) at baseline to measure participants' stress level in the past 30 days<sup>72</sup>. Psychometric evaluation of this measure was found to be superior to the PSS-14 and PSS-4 in a review study<sup>71</sup>. PSS-10 is commonly used in studies to explore the association between individuals' appraised stress levels and health outcomes<sup>72</sup> (Cohen 1983). Each question in this 10-item questionnaire is rated using the 5-point Likert method and can be rated from 0 to 4. Scores are added together, and can range from 0 to 40. A higher score indicates higher levels of stress that a participant perceives. We used a validated Spanish version of the PSS-10 for the Hispanic cohort in this study. The Spanish PSS-10 demonstrated adequate reliability (internal consistency,  $\alpha = 0.82$ ) and validity ( $r = 0.72$ )<sup>73</sup>.

### Obesogenic Dietary Behaviors (Potential Mediators)

Soft drink consumption was measured using the question, "How often do you drink soft drinks or soda pop (regular or diet)?"<sup>9</sup>. The responses were coded as the number of times soft drinks were consumed per week. The responses could be: 0, 1, 3, 7, or 14 times per week. Participants answered this question at baseline, and at year 1 and year 2 follow-ups of the study.

Fast food consumption was measured using the question, "Thinking about how often you eat out, how many times in a week or month do you eat breakfast, lunch, or dinner in a place such as McDonald's, Burger King, Wendy's, Arby's, Pizza Hut, or Kentucky Fried Chicken? (Give your best guess. Write one answer.)"<sup>61</sup>. The answers to this question were coded as the frequency of fast food consumption per week. Participants answered this question at baseline, year 1, and year 2 of the study.

Distracted eating was measured by the self-reported frequency of eating while doing

other activities<sup>9</sup>. This is also called “task eating”<sup>31</sup>. We assessed the frequency of distracted eating using the question, “How often do you eat food (meals or snacks) while doing another activity, for example, watching TV, working at a computer, reading, driving, playing video games?” Respondents chose from a 5-point Likert scale ranging from 0 (never) to 4 (always).

## Covariates

Sociodemographic information including age, ethnicity, education, and marital status were measured using a self-administered questionnaire.

## Statistical Analysis

A multiple linear regression model was used to estimate and establish the association between perceived stress with BMI and between perceived stress and waist circumference, adjusted for sociodemographic variables for NHW and Hispanic women. The model is as follow:

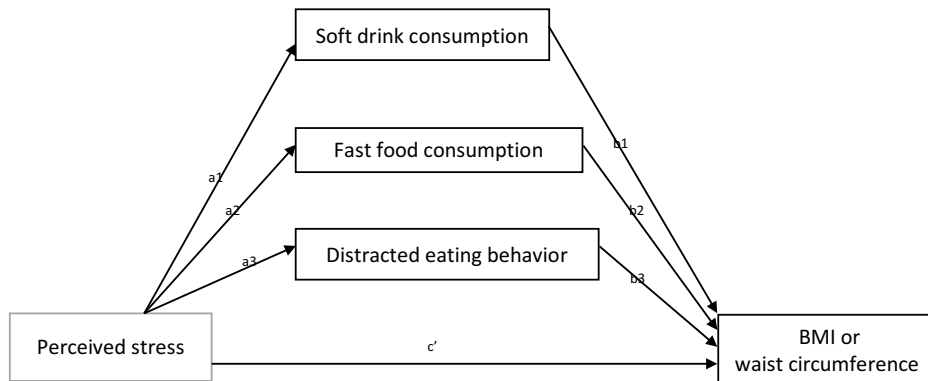
- Outcome (BMI or waist circumference) =  $\sigma_0 + \sigma_1 * \text{Perceived stress} + \sigma_2 * \text{age} + \sigma_3 * \text{education} + \sigma_4 * \text{marital status}$

$\sigma_1$  is the total effect of stress on outcome (c)

Previous studies have found that the 3 obesogenic dietary behaviors are positively associated with each other<sup>61,100</sup>. Thus, the effect of 3 mediators was tested jointly, as supported by 2 methodological papers<sup>101,102</sup>. Since the correlation between behaviors, specifically between distracted eating and the 2 other behaviors, were not strong in our data (Appendix A, Supplemental Table 1), we will also conduct mediation analysis separately for each obesogenic dietary behavior as a secondary analysis.

Figure 2 shows both the direct effect of stress on measures of obesity risk (path c') and the

indirect effects of stress on measures of obesity risk via the 3 mediators combined.



**Figure 2. Stress is hypothesized to exert indirect effect on BMI or waist circumference through 3 obesogenic dietary behaviors**

Three linear regression models were used to assess the associations between perceived stress and obesogenic dietary behaviors adjusting for covariates (path a). The statistical models are as follow:

- Soft drink consumption =  $\alpha_0 + \alpha_1 * \text{perceived stress} + \alpha_2 * \text{age} + \alpha_3 * \text{education} + \alpha_4 * \text{marital status}$
- Fast food consumption =  $\beta_0 + \beta_1 * \text{perceived stress} + \beta_2 * \text{age} + \beta_3 * \text{education} + \beta_4 * \text{marital status}$
- Distracted eating =  $\delta_0 + \delta_1 * \text{Perceived stress} + \delta_2 * \text{age} + \delta_3 * \text{education} + \delta_4 * \text{marital status}$

$\alpha_1$  is the effect of stress on soft drink consumption (a1)

$\beta_1$  is the effect of stress of fast food consumption (a2)

$\delta_1$  is the effect of stress on distracted eating behavior (a3)

In the next step, a multiple linear regression model was used to evaluate the association between obesogenic dietary behaviors and measures of obesity risk (BMI and waist

circumference), with perceived stress in the model, in addition to adjusting for all covariates (paths b1, b2, b3). The regression equation for paths b1, b2, b3 and c' are as follows:

- $BMI = \phi_0 + \phi_1 \cdot \text{soft drink consumption} + \phi_2 \cdot \text{fast food consumption} + \phi_3 \cdot \text{distracted eating} + \phi_4 \cdot \text{Perceived stress} + \phi_5 \cdot \text{age} + \phi_6 \cdot \text{education} + \phi_7 \cdot \text{marital status}$

$\phi_1$  is the effect of soft drink on the outcome (BMI or WC) (b1)

$\phi_2$  is the effect of fast food on the outcome (BMI or WC) (b2)

$\phi_3$  is the effect of distracted eating on the outcome (BMI or WC) (b3)

$\phi_4$  is the direct effect of stress on outcome (c')

To test mediation, we used product-of-coefficients methods<sup>103</sup>. For instance, the indirect effect of stress on measures of obesity risk through soft drink adjusted for other behaviors is quantified as  $a_1 \cdot b_1$ . The total indirect effect of stress on measures of obesity risk is the sum of the specific indirect effects  $\Sigma(a_k \cdot b_k)$ ,  $k=1$  to 3 (1 = soft drink consumption, 2 = fast food consumption, 3 = distracted eating behavior), and the total effect of stress on measures of obesity risk is the sum of the direct effect and all 3 of the specific indirect effects:  $c = c' + \Sigma(a_k \cdot b_k)$ ,  $k=1$  to 3. We calculated the percent mediated by dividing the total indirect effect by the total effect, multiplied by 100 ( $[\Sigma(a_k \cdot b_k)/c] \cdot 100$ ),  $k=1$  to 3. We provided biased-corrected bootstrapped 95% confidence intervals. Bootstrapping was used to create a sampling distribution of  $a \cdot b$  estimates from re-sampling of the study data. It also ran the regression equations for paths a and b simultaneously, and formed their product 1,000 times. All linear regression models were adjusted for age, education, marital status, and physical activity.

For single mediation analysis, the multiple linear regression models to estimate path c and path a resembled the regression models we used for the joint mediation analysis. To estimate

the association between each obesogenic dietary behavior and measures of obesity risk (BMI and waist circumference), with perceived stress in the model ( $\hat{b}_1, \hat{b}_2, \hat{b}_3$ ), we used 3 multiple linear regression models. The regression equation for paths  $\hat{b}_1, \hat{b}_2, \hat{b}_3$  are as follows:

- $BMI = \varphi_0 + \varphi_1 \cdot \text{soft drink consumption} + \varphi_2 \cdot \text{perceived stress} + \varphi_3 \cdot \text{age} + \varphi_4 \cdot \text{education} + \varphi_5 \cdot \text{marital status}$

$\varphi_1$  is the effect of soft drink on the outcome (BMI or WC) ( $\hat{b}_1$ )

- $BMI = \Omega_0 + \Omega_1 \cdot \text{fast food consumption} + \Omega_2 \cdot \text{perceived stress} + \Omega_3 \cdot \text{age} + \Omega_4 \cdot \text{education} + \Omega_5 \cdot \text{marital status}$

$\Omega_1$  is the effect of fast food on the outcome (BMI or WC) ( $\hat{b}_2$ )

- $BMI = \mathfrak{R}_0 + \mathfrak{R}_1 \cdot \text{distracted eating} + \mathfrak{R}_2 \cdot \text{perceived stress} + \mathfrak{R}_3 \cdot \text{age} + \mathfrak{R}_4 \cdot \text{education} + \mathfrak{R}_5 \cdot \text{marital status}$

$\mathfrak{R}_1$  is the effect of distracted eating on the outcome (BMI or WC) ( $\hat{b}_3$ )

We calculated the indirect effect of stress on measures of obesity risk through each obesogenic dietary behavior by multiplying path a by path b specific to that behavior (eg, soft drink consumption indirect effect:  $a_1 * \hat{b}_1$ ). We divided the indirect effect specific to each behavior by total effect and multiplied it by 100 to estimate the percent mediated specific to each obesogenic dietary behavior (eg, percent mediated for soft drink consumption:  $[(a_1 * \hat{b}_1) / c] * 100$ ). We provided biased-corrected bootstrapped 95% confidence intervals.

We used Stata version 13 to conduct all the analyses for this study (Stata Corp., College Station, TX, USA).

## Results

Table 1 presents the characteristics of the NHW and Hispanic women who participated in SESO. The Hispanic women on average were younger than the NHW women (Hispanic mean age: 38.5 years, SD: 5.4 years; NHW mean: 39.8 years; SD: 6.0 years;  $P < 0.001$ ). Most of the Hispanic women had a high school diploma or less (76.5%), while almost half of the NHW women in this study had a bachelor's degree or higher education (49.0%). A higher percentage of Hispanic women were married compared to NHW women (77.5% of Hispanic women vs. 71.1% of NHW women).

<b>Table 1. Participant Characteristics at SESO Year 2 Follow-up, by Ethnicity</b>		
<b>Characteristic</b>	<b>Hispanic Women (N = 506)</b>	<b>NHW Women (N = 490)</b>
	<b>Mean or % {S.D.} (n)</b>	<b>Mean or % {S.D.} (n)</b>
<b>Age</b>	38.5 {5.4} (483)	39.8 {6.0} (484)
<b>Education level</b>		
High school graduate or equivalent	76.5% (387)	21.2% (104)
Some college / associate's degree	13.2% (67)	29.8% (146)
Bachelor's degree or higher	10.3% (52)	49.0% (240)
<b>Marital status</b>		
Never married / divorced / separated	22.6% (113)	29.0% (141)
Married / living in a marriage-like relationship	77.5% (388)	71.1% (346)
<b>BMI (kg/m<sup>2</sup>) at year 2 follow-up</b>	30.4 {6} (379)	29.6 {9} (367)
<b>Waist circumference (cm) at year 2 follow-up</b>	95.7 {13} (361)	92.8 {19.7} (352)
<b>Perceived stress at baseline</b>	13.5 {6.6} (468)	14.9 {6.2} (483)
<b>Average baseline and year 2 follow-up frequency of obesogenic dietary behaviors</b>		
Soft drink consumption per week	2.8 {3.1} (323)	2.7 {3.7} (355)
Fast food consumption per week	0.8 {0.8} (310)	0.6 {0.8} (352)
Distracted eating behavior score	1.7 {0.8} (317)	2.2 {0.7} (349)

Table 2 shows the results of the association between perceived stress and measures of obesity risk separately in NHW and Hispanic women. Perceived stress was significantly

associated with both BMI and waist circumference (path *c*) in NHW women, after adjusting for potential confounders, but this association was not found in Hispanic women. Further mediation analyses were not pursued in this cohort. In NHW women, every unit increase in perceived stress was associated with a 0.9% increase in BMI and a 0.6% increase in waist circumference (back-transformed coefficients).

<b>Table 2. Association Between Perceived Stress and Measures of Obesity Risk in Participating Hispanic and NHW Women</b>		
	<b>Hispanic Women (N = 506)</b>	<b>NHW Women (N = 490)</b>
	Point Estimate <sup>a</sup> (95% CI)	Point Estimate <sup>a</sup> (95% CI)
<b>Outcome</b>		
BMI	1.001 (0.99, 1.004)	1.009** (1.004, 1.01)
Waist circumference	1.001 (0.99, 1.004)	1.006** (1.002, 1.01)
**P < 0.005		
<sup>a</sup> back transformed		
Adjusted for age, education, marital status		

Table 3 shows the results of multiple mediation analyses with all mediators in the model, restricted to NHW. All 3 obesogenic dietary behaviors jointly mediated 33% of the association between stress and BMI in NHW women, as well as 33% of the association between stress and waist circumference.

<b>Table 3. Joint Mediation Effects of Soft Drink Consumption, Fast Food Consumption, and Distracted Eating Behavior in the Association Between Perceived Stress and Adiposity Measures Among NHW Women in SESO (N = 490)</b>				
	<b>Total Effect<sup>b</sup> (path c)</b>	<b>Total Indirect Effect <math>\Sigma(a_k*b_k)</math>, k= 1 to 3 (1 = soft drink consumption, 2 = fast food consumption, 3 = distracted eating behavior)</b>	<b>Total Direct Effect (path c')</b>	<b>% Mediated (Total indirect effect/total effect) x100</b>
<b>Outcome</b>				
<b>BMI</b>				
Point estimate	<b>1.009</b>	<b>1.003</b>	<b>1.007</b>	33.00%
95% CI <sup>a</sup>	<b>1.005,1.02</b>	<b>1.001, 1.006</b>	<b>1.003, 1.01</b>	
<b>Waist circumference</b>				
Point estimate	<b>1.006</b>	<b>1.002</b>	<b>1.004</b>	33.00 %
95% CI <sup>a</sup>	<b>1.003, 1.01</b>	<b>1.009, 1.004</b>	<b>1.001, 1.008</b>	
<sup>a</sup> Bias-corrected confidence intervals (via 1000 bootstrap replications) are reported for indirect, direct, and total effects. Intervals excluding 0 are bolded.				
<sup>b</sup> back transformed				
Adjusted for age, education, marital status				

Table 4 presents the results of the specific mediation effect of soft drink consumption for NHW women. Stress was not significantly associated with soft drink consumption (path a1), whereas soft drink consumption was significantly associated with both BMI and waist circumference (path  $\hat{b}_1$ ). The indirect effect was not significant in either of the associations from stress to BMI or stress to waist circumference, indicating no specific mediating effect of soft drink consumption.

<b>Table 4. Mediating Effects of Soft Drink Consumption in Association Between Perceived Stress and Adiposity Measures Among NHW Women in SESO (N = 490)</b>						
	<b>Path c</b>	<b>Path a<sub>1 soft</sub> drink</b>	<b>Path b<sub>1 soft</sub> drink</b>	<b>a<sub>1</sub>* b<sub>1</sub></b>	<b>C'</b>	<b>Percent Mediated</b>
<b>Outcome</b>	<b>Effect of Stress on Outcomes<sup>b</sup></b>	<b>Effect of Stress on Soft Drink Consumption</b>	<b>Effect of Soft Drink Consumption on Outcomes<sup>b</sup></b>	<b>Indirect Effect of Stress on Outcome Through Soft Drink</b>	<b>Direct Effect of Stress on Outcome</b>	<b>(Indirect Effect/Total Effect) x100</b>
<b>BMI</b>						
Point estimate	<b>1.009</b>	0.02	<b>1.03</b>	1.001	<b>1.009</b>	0.00
95% CI <sup>a</sup>	<b>1.006, 1.02</b>	-0.004, 0.04	<b>1.003, 1.04</b>	0.99, 1.002	<b>1.005, 1.04</b>	-
<b>Waist circumference</b>						
Point estimate	<b>1.007</b>	0.02	<b>1.03</b>	1.001	<b>1.006</b>	0.00
95% CI <sup>a</sup>	<b>1.003, 1.01</b>	-0.007, 0.4	<b>1.01, 1.04</b>	0.99, 1.002	<b>1.002, 1.009</b>	

<sup>a</sup> Bias-corrected confidence intervals (via 1000 bootstrap replications) are reported for indirect, direct, and total effects. Intervals excluding 0 are bolded.

<sup>b</sup> back transformed

Adjusted for age, education, marital status

Table 5 shows the results of the mediation effect of fast food consumption. Perceived stress was positively associated with fast food consumption (path *a*) in NHW women, and this behavior was positively associated with both BMI and waist circumference. The indirect effect for this behavior was significant. Fast food consumption mediated 18% of the association between stress and BMI and 16% of the association between stress and waist circumference.

<b>Table 5. Mediating Effects of Fast Food in Association Between Perceived Stress and Adiposity Measures Among NHW Women in SESO (N = 490)</b>						
	<b>Path c</b>	<b>Path a<sub>2 fast</sub></b> food	<b>Path b<sub>2 fast</sub></b> food	<b>a<sub>2</sub>* b<sub>2</sub></b>	<b>C'</b>	<b>Percent Mediated</b>
<b>Outcome</b>	<b>Effect of Stress on Outcomes<sup>b</sup></b>	<b>Effect of Stress on Fast Food Consumption</b>	<b>Effect of Fast Food Consumption on Outcomes<sup>b</sup></b>	<b>Indirect Effect of Stress on Outcome Through Fast Food</b>	<b>Direct Effect of Stress on Outcome</b>	<b>(Indirect Effect/Total Effect) x100</b>
<b>BMI</b>						
Point estimate	<b>1.009</b>	<b>0.03</b>	<b>1.07</b>	<b>1.002</b>	<b>1.009</b>	18.00%
95% CI <sup>a</sup>	<b>1.006, 1.02</b>	<b>0.01, 0.04</b>	<b>1.04, 1.1</b>	<b>1.001, 1.003</b>	<b>1.004, 1.01</b>	-
<b>Waist circumference</b>						
Point estimate	<b>1.007</b>	<b>0.03</b>	<b>1.05</b>	<b>1.001</b>	<b>1.005</b>	16.00%
95% CI <sup>a</sup>	<b>1.003, 1.01</b>	<b>0.01, 0.04</b>	<b>1.03, 1.08</b>	<b>1.0006, 1.003</b>	<b>1.002, 1.009</b>	-
<sup>a</sup> Bias-corrected confidence intervals (via 1000 bootstrap replications) are reported for indirect, direct, and total effects. Intervals excluding 0 are bolded. <sup>b</sup> back transformed Adjusted for age, education, marital status						

Table 6 shows the results of the mediation effect of distracted eating behavior. Stress was positively associated with distracted eating behavior in NHW women, and this behavior was positively associated with both BMI and waist circumference. The indirect effect was significant, and this behavior mediated 10% of the association between stress and BMI and 14% of the association between stress and waist circumference.

<b>Table 6. Mediating Effects of Distracted Eating Behavior in Association Between Perceived Stress and Adiposity Measures Among NHW Women in SESO (N = 490)</b>						
	<b>Path c</b>	<b>Path a</b> distracted eating	<b>Path b<sub>3</sub></b> distracted eating	<b>a<sub>3</sub>* b<sub>3</sub></b>	<b>C'</b>	<b>Percent Mediated</b>
<b>Outcome</b>	<b>Effect of Stress on outcomes<sup>b</sup></b>	<b>Effect of Stress on Distracted Eating Behavior</b>	<b>Effect of Distracted Eating Behavior on Outcomes<sup>b</sup></b>	<b>Indirect Effect of Stress on Outcome Through Distracted Eating</b>	<b>Direct Effect of Stress on Outcome</b>	<b>(Indirect Effect/Total Effect) x100</b>
<b>BMI</b>						
Point estimate	<b>1.009</b>	<b>0.03</b>	<b>1.06</b>	<b>1.002</b>	<b>1.009</b>	10.00%
95% CI <sup>a</sup>	<b>1.006, 1.02</b>	<b>0.2, 0.04</b>	<b>1.01, 1.09</b>	<b>1.0002, 1.003</b>	<b>1.004, 1.01</b>	-
<b>Waist circumference</b>						
Point estimate	<b>1.007</b>	<b>0.3</b>	<b>1.03</b>	<b>1.001</b>	<b>1.006</b>	14.00%
95% CI <sup>a</sup>	<b>1.004, 1.01</b>	<b>0.02, 0.04</b>	<b>1.004, 1.06</b>	<b>0.0001, 0.002</b>	<b>1.002, 1.009</b>	-
<sup>a</sup> Bias-corrected confidence intervals (via 1000 bootstrap replications) are reported for indirect, direct, and total effects. Intervals excluding 0 are bolded. <sup>b</sup> back transformed Adjusted for age, education, marital status						

## Discussion

In the present study, we found that in NHW women's perceived stress was positively associated with both BMI and waist circumference. Soft drink consumption, fast food consumption, and distracted eating behavior jointly mediated 33% of the path from stress to BMI and 33% of the path from stress to waist circumference among NHW women. Testing the mediation effect of each individual obesogenic dietary behavior showed that fast food consumption and distracted eating behavior partially mediated the association between perceived stress and measures of obesity risks. We did not find the evidence of mediation in Hispanic women since the main effect (association between stress and measures of obesity risk) was not detected.

This is the first study to formally test the mediating effect of obesogenic dietary behaviors on the pathway between perceived stress and risk of obesity (BMI or waist circumference). Our findings in NHW women are consistent with the results of a few other studies that showed positive associations between perceived stress and BMI or waist circumference among women<sup>32,92</sup>.

The lack of association between stress and either BMI or waist circumference in Hispanics is consistent with the results of a study conducted among the Hispanic population<sup>65</sup>; Isasi et al used PSS-10 as well as a measure of chronic stress and did not find any association between perceived stress and BMI, but found a positive association between chronic stress and BMI. One explanation could be that a prolonged exposure to stressors is needed to affect weight gain. It is possible that the PSS-10 was not an appropriate measure to capture chronic stress in this population because of the low level of acculturation of the Hispanic women in the current study (84% of the Hispanic women spoke Spanish most of the time). Further studies could explore the association between the PSS and other measures of chronic stress, such as stressful life events, among Hispanic and NHW women.

The results of this study indicate that in NHW women, the association between stress and measures of obesity risk is partially mediated through the combination of soft drink consumption, fast food consumption, and distracted eating behavior. This is consistent with our hypotheses. Several studies have shown an association between stress<sup>30-33,81,94</sup>, these dietary behaviors, and measures of obesity risk<sup>8,13,17</sup>, but the present study is unique in that it tests these specific behaviors as mediators.

Our results did not show a mediating role for soft drink consumption alone in the association between stress and measures of obesity risk. Since a correlation between soft drink and fast food consumption was observed in this study, and also is supported by the literature<sup>61,100</sup>, perhaps these 2 behaviors should be considered together in the mediation analysis<sup>102</sup>. Fast food consumption individually mediated the association between stress and both measures of obesity risk, which could imply the importance of this behavior in response to stress. This mediation was supported by the fact that stress and fast food consumption were significantly associated. There are few cross-sectional studies specifically among women that link stress to fast food consumption<sup>32,104</sup>. On the other hand, fast food consumption is a prevalent obesogenic dietary behavior specifically in the United States where more than 10% of daily calories come from fast food (for women ages 20–60 years)<sup>12</sup>, and fast food consumption is strongly related to obesity<sup>13</sup>. Our results also corroborate this association.

Distracted eating mediated the association between stress and both measures of obesity risk. In our study, stress was associated with distracted eating behavior. This result is aligned with Barrington's findings, which showed that participants who experienced higher levels of stress engaged in distracted eating most of the time<sup>31</sup>. Additionally, we found a positive association between distracted eating and measures of obesity risk, which is consistent with other studies<sup>9,17</sup>.

Our results point to the importance of the combination of the 3 studied obesogenic dietary behaviors together, as the behaviors that are associated with both stress and measures of obesity risk, and can act as mediators in the association between stress and obesity. Single mediation analysis showed the importance of fast food consumption and distracted eating in the pathway from stress to obesity.

The main strength of this study is that it uses a sample that is similar to the U.S. adult population in terms of distribution of BMI and perceived stress<sup>77,86</sup>. Using a multiple mediation model to decrease the likelihood of parameter bias due to omitted variables, and using variables at different sequential points of time to establish temporality for the mediation analysis are other strengths of this study.

However, this study has several limitations. It was essentially a secondary cross-sectional analysis, using a subjective measure of stress and self-reported dietary behaviors. Furthermore, using BMI at year 2 follow-up may not add any specific benefit to our analyses given the high correlation of BMI over time. Even though we tried to do the analysis based on the nature of the proposed mediation model (baseline perceived stress, average obesogenic dietary behaviors at baseline and year 2 follow-up, and measures of obesity risk at year 2 follow-up), the analysis does not measure changes over time. Bias in self-reported stress and dietary behaviors may attenuate the strength of the associations. There are several confounders such as smoking and various medications that may also affect obesogenic dietary behaviors and stress levels, but these were not considered in this study. Also, there is a possibility for reverse causality. What we conceptualized is that stress may affect dietary behaviors, but there is a possibility that certain behaviors and being overweight or obese may themselves cause stress in individuals.

In conclusion, perceived stress was associated with measures of obesity risk in NHW women ages 30–50 years. Our data provide insight into the potential impact of daily perceived stress on soft drink and fast food consumption as well as distracted eating behavior among NHW women. The results suggest that weight loss interventions at the population level could combine stress reduction strategies with interventions targeting 3 obesogenic dietary behaviors among NHW women.

## **Conclusion**

The results from this dissertation add to our understanding of factors associated with high rates of obesity among Hispanic and NHW women. Some of the complex relationships between acculturation, obesogenic dietary behaviors, stress, and risk of obesity have been explored. The importance of this work is underscored by 2 factors: obesity is disproportionately more prevalent among Hispanic women compared to NHW women; and Hispanics are already the largest minority group in the United States, and growing in number rapidly. It is well known that obesity is a risk factor for several chronic diseases, such as diabetes, cardiovascular disease, and cancer, and has several negative social and emotional consequences. Therefore, gaining a better understanding of obesity and its risk factors in women, especially in Hispanic women, can have broad public health implications.

### **Summary of Findings**

In Chapter 1, we found that a lower level of acculturation is associated with less distracted eating behavior among Hispanic women. This is the first study that has investigated this modifiable dietary behavior by comparing Hispanic women to NHW women and less acculturated Hispanic women to more acculturated Hispanic women. Soft drink consumption was higher among Hispanic women compared to NHW women, and fast food consumption did not differ between the two groups.

In Chapter 2, we found that Hispanic women overall and less acculturated Hispanic women specifically had lower levels of perceived stress compared to NHW women. As hypothesized, the results show that perceived stress was positively associated with obesogenic

dietary behaviors, especially in NHW. However, ethnicity modified only the association between perceived stress and fast food consumption. Contrary to our hypothesis, no modifying effect of acculturation was observed in these associations between stress and obesogenic dietary behaviors.

In Chapter 3, we found that perceived stress was associated with measures of obesity risk in NHW women. Among NHW women, a combination of soft drink consumption, fast food consumption, and distracted eating partially mediated (33%) the association between perceived stress and measures of obesity risk. Among Hispanic women, perceived stress was not associated with measures of obesity risk.

### **Implications and Suggestions for Future Studies**

The findings point to the presence of cultural protective factors. If they do exist, such factors could be used in the design of intervention programs. These programs could provide education about the factors' protective effects, their benefits, and the possible changes in these behaviors with acculturation. Interventions could also be designed to help Hispanic women maintain these helpful cultural behaviors. For example, interventions could provide strategies to encourage family eating and avoid distracted eating.

The results also suggest that soft drink consumption, fast food consumption, and distracted eating mediate a considerable part of the path from stress to obesity among NHW women. The findings will help to design interventions that raise awareness about the negative effects of stress on dietary behaviors and implement stress reduction techniques to address these

behaviors. Such programs could also incorporate mindful eating techniques to address both stress and distracted eating.

Future longitudinal studies could investigate how cultural protective behaviors change in the newly immigrated Hispanic population because of acculturation. The results of this study also suggest a need for further qualitative studies to identify other modifiable dietary behaviors among Hispanics that could be negatively influenced by acculturation. Further descriptive studies designed to identify and compare dietary behaviors under stress both between and within ethnic groups would be beneficial. Thus, exploration of the role of stress in women from groups that are differentially affected by obesity, and identifying other obesogenic behaviors that may play a role in this association, are warranted.

In summary, obesity prevention programs could implement stress reduction techniques to combat obesogenic dietary behaviors and obesity. These programs could take advantage of cultural protective factors in designing interventions for specific populations. It is important to consider that Hispanic ethnicity comprises diverse groups of people; exploring the relationship between acculturation, stress, dietary behaviors, and obesity in different subgroups of the Hispanic ethnicity is warranted. Also, our results suggest that weight loss interventions at the population level could combine stress reduction strategies with interventions targeting three obesogenic dietary behaviors among NHW women.

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Appendix A:

<b>Supplemental Table 1. Correlation Between Obesogenic Dietary Behaviors</b>			
	<b>Correlation Coefficient</b>		
	<b>Fast Food Consumption</b>	<b>Soft Drink Consumption</b>	<b>Distracted Eating Behavior</b>
Soft drink	0.31*	—————	0.14*
Fast food	—————	0.31*	0.11*
*P < 0.05			