BIOPSYCHOSOCIAL FACTORS THAT INFLUENCE DIETARY BEHAVIOR IN PREGNANT WOMEN

By

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TABLE OF CONTENTS

List of Tables

List of Tables -- Continued

List of Abbreviations

ACC	Advanced Computing Center
ACT	Acceptance and Commitment Therapy
ACTH	Adrenocorticotropic Hormone
ADHD	Attention Deficit Hyperactivity Disorder
aHEI	Alternate Healthy Eating Index
AI	Adequate Intake
AIDS	Acquired Immune Deficiency Syndrome
aMED	Alternate Mediterranean Diet
AMPM	Automated Multiple Pass Method
ASA24	Automated Self-Administered 24-Hour Dietary Assessment Tool
BHES	Barriers to Healthy Eating Scale
BMI	Body Mass Index
CI	Confidence Interval
CWH	Center for Women's Health
DASH	Dietary Approaches to Stop Hypertension
DEXA	Dual Energy X-Ray Absorptiometry
DHA	Docosahexanoic Acid
DNA	Deoxyribonucleic Acid
DOHaD	Developmental Origins of Health and Disease
EAR	Estimated Average Requirement
EC	Eating Competent
ecSI 2.0	Eating Competence Satter Inventory version 2.0
ecSI/LI	Eating Competence Satter Inventory/Low-Income version
EPA	Eicosapentaenoic Acid
FFQ	Food Frequency Questionnaire

List of Abbreviations - continued

FHLC	Fetal Health Locus of Control
FHLC-C	Fetal Health Locus of Control Chance Sub-Scale
FHLC-I	Fetal Health Locus of Control Internal Sub-Scale
FHLC-P	Fetal Health Locus of Control Powerful Others Sub-Scale
FNDDS	Food and Nutrition Database for Dietary Studies
F+V	Fruits + Vegetables Combined Scores
GDM	Gestational Diabetes Mellitus
GWG	Gestational Weight Gain
HDL	High-Density Lipoproteins
HEI	Healthy Eating Index
HIPAA	Health Insurance Portability and Accountability Act of 1996
HIV	Human Immunodeficiency Virus
IBM	International Business Machines
ID	Identification
IRB	Institutional Review Board
kcal	Kilocalories
mRNA	Messenger Ribonucleic Acid
MUFA	Monounsaturated Fatty Acids
NHANES	National Health and Nutrition Examination Survey
NLOC	Nutrition Locus of Control
NY	New York
OB/GYN	Obstetrician and Gynecologist
OCTRI	Oregon Clinical and Translational Research Institute
OHSU	Oregon Health & Science University
OR	Odds Ratio

List of Abbreviations - Continued

p	Probability
PEN	Pregnancy, Exercise and Nutrition study
PUFA	Polyunsaturated Fatty Acid
RD	Registered Dietitian
REDCap	Research Electronic Data Capture
SAS	Statistical Analysis System
SD (or Std. Dev.)	Standard Deviation
SFA	Saturated Fatty Acid
SNAP	Supplemental Nutrition Assistance Program
SPSS	Statistical Package for Social Sciences
SSL	Secure Sockets Layer
TANF	Temporary Assistance for Needy Families
UK	United Kingdom
UPF	Ultra-Processed Food
U.S.	United States
USDA	United States Department of Agriculture
VAT	Visceral Adipose Tissue
WA	Washington
WIC	Special Supplemental Assistance Programs for Women, Infants and Children

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Abstract

Despite the well-accepted links between a woman's diet during pregnancy and her offspring's lifetime risk for chronic disease, very little is known about the biopsychosocial factors that influence dietary behaviors in pregnant women and how they relate to actual dietary intake. The overall research goal of the current project was to assess biopsychosocial factors that influence dietary behaviors in this population. A secondary goal was to explore how these factors relate to actual dietary intake.

This exploratory, cross-sectional study piloted the use of dietary assessment and nutrition-related biopsychosocial survey tools in a sample of pregnant women seeking pre-natal care at the OHSU Center for Women's Health. Pregnant women at any stage were eligible to participate, and completed an online 24-hour diet recall using the National Cancer Institute's Automated Self-Administered 24-hour (ASA24) Dietary Assessment Tool, the eating competence Satter Inventory (ecSI 2.0), Nutrition Locus of Control, Fetal Health Locus of Control, Barriers to Health Eating survey, United States Department of Agriculture (USDA) 2-question food insecurity screening tool, and a demographic and health history form. We collected data between February and October 2018 and analyzed surveys using logistic regression and independent sample t-tests.

Thirty-four women at all stages of pregnancy completed the study. We observed significant differences in fruits and vegetables consumption (p=0.004) and eating competence scores (p=0.032) between women who reported having received nutrition education from their obstetrician/gynecologist (OB/GYN) compared to women who had not. Although we did not find significance in most statistical tests comparing survey findings, we did observe trends in the odds of being eating competent and consuming more fruits and vegetables (OR=1.120; p=0.125), being eating competent and having a higher score on the Internal sub-scale of the Fetal Health Locus of Control (OR=1.299; p=0.170) and meeting with a dietitian and consuming more fruits and vegetables

(p=0.113), compared to participants who were not eating competent and did not meet with a dietitian during their current pregnancies. These pilot findings will help to inform future research and nutrition education efforts in this domain.

Chapter 1: Introduction & Specific Aims

A growing body of research provides evidence that a mother's nutritional status and an infant's birth weight are connected to lifetime risk for chronic diseases such as obesity, type 2 diabetes, and cardiovascular disease.[1-13] This "developmental origins" of health and disease (DOHaD) theory was first postulated by British epidemiologist Dr. David Barker, whose research showed an inverse relationship between low birth weight and an increased risk for ischemic heart disease in poorer regions of the United Kingdom.[1] Subsequent work by Dr. Barker[2] and others has demonstrated similar results in populations in Finland[3] and the Netherlands,[4] as well as in the United States,[5] India,[6] Scandinavian countries,[7] and in numerous animal models.[8-13]

The concept of fetal programming asserts that environmental factors that an embryo or fetus is exposed to in utero can reset physiological parameters that may affect the offspring's health for life.[14] Epigenetics focuses on changes in gene expression brought about by environmental factors.[15] While earlier research on the role of nutrition on fetal programming focused on maternal undernutrition,[1-7] recent research suggests that calorically dense diets that include processed foods, a common pattern in Western societies, may also result in epigenetic changes that place offspring at an increased risk for chronic diseases of adulthood.[16-20] Further, poor nutrition in the womb may result in increased chronic disease risk for multiple generations.[21-22]

According to the *2015-2020 Dietary Guidelines for Americans,* nearly half of all American adults are living with one or more preventable, chronic diseases, a trend that has been increasing over time.[23] The estimated costs of treating obesity and diabetes are at least $147 billion and $245 billion annually, respectively.[23] Yet an estimated 80 percent of American adults do not consume the recommended servings of fruits and vegetables each day, a cost-effective dietary intervention that has the potential to reduce the prevalence of chronic disease.[23] In order to change this trajectory, there is a need to

invest in novel nutrition education and dietary interventions focused on improving the health status of large segments of the population. Women of child-bearing age are of particular interest not only in regards to DOHaD, but also due to their role as key decision-makers in their households in terms of grocery shopping, meal planning and preparation.[24] The knowledge and prioritization of nutrition among women of child-bearing age therefore has the potential to influence the health of their entire families. New strategies for nutrition education are needed especially targeting this population.

In 2007, registered dietitian Ellyn Satter introduced the Satter Eating Competence Model, an alternative method for delivering nutrition education that is focused on the enjoyment of food rather than strict adherence to dietary guidelines.[25] According to this model, "competent eaters are positive, comfortable, and flexible with eating and are matter-of-fact and reliable about getting enough to eat of enjoyable and nourishing food."[25] The Satter Eating Competence Model has been described as a "Montessorian" approach to nutrition education[26] in that it is client-centered and helps guide a client through a hierarchy[27] with the overall goal of improving an individual's nutrition status and overall health. An individual's eating competence may be assessed using the validated eating competence Satter Inventory (ecSI 2.0), which is further divided into four sub-scales: 1) eating attitudes; 2) internal regulation; 3) food acceptance; and 4) eating context skills that involve the procurement, planning, and preparation of family meals.[25] The ecSI 2.0 offers a rigorous tool to assess the biological, psychological and social factors -- or biopsychosocial factors -- associated with dietary behaviors.

This project seeks to inform knowledge on what biopsychosocial factors influence dietary behaviors in pregnant women, specifically in a sample of pregnant women seeking prenatal care at the Oregon Health & Science University (OHSU) Center for Women's Health. In addition to assessing eating competence in this population, the

present study assesses nutrition locus of control[28] (whether an individual believes her health outcomes are related to personal dietary choices or external factors), fetal health locus of control[29] (whether an individual believes the health of her offspring is related to her own health-related behaviors or external factors), barriers to healthy eating[30] and food security status.[31] In addition, a 24-hour dietary recall has been collected for each participant to assess adherence to the *2015-2020 Dietary Guidelines for Americans*.[23] The underlying theoretical approach to this proposal is grounded in the Transtheoretical or Stages of Change Model[32] and Social Learning Theory[33] (that an expected effect or outcome of a behavior influences the motivation of people to engage in that behavior). Through closer examination of intrinsic, socioeconomic and external environmental factors that influence dietary behaviors in pregnant women, this research therefore seeks to inform a more personalized approach to nutrition education.

Specific Aims and Hypotheses

Despite the growing body of evidence asserting the importance of pre-natal nutrition on the lifetime health of offspring,[1-13] limited research,[18] especially in the United States, has focused on the actual composition of the diets of pregnant women. Further gaps in the literature exist in regards to factors that influence dietary behaviors in pregnant women. Previous research using the Nutrition Locus of Control,[28] Fetal Health Locus of Control,[29,34-37] and Barriers to Healthy Eating survey[30] has been instrumental in assessing and evaluating the potential for targeted nutrition intervention programs during pregnancy, yet these measures have not been previously assessed in tandem with eating competence and the Healthy Eating Index.

As an exploratory study, this research seeks to begin to address these gaps in the literature through the piloting of a survey-based research study in a sample of pregnant women seeking pre-natal care at the OHSU Center for Women's Health. The overall research goal was to assess biopsychosocial factors that influence dietary behaviors in this population. A secondary goal was to begin to examine how these factors relate to actual dietary intake. To meet these goals, 34 women at all stages of pregnancy were recruited from the OHSU Center for Women's Health to participate in this research between February and October 2018. These women completed an online 24-hour diet recall using the National Cancer Institute's Automated Self-Administered 24-hour (ASA24) Dietary Assessment Tool, as well as the eating competence Satter Inventory (ecSI 2.0), Nutrition Locus of Control, Fetal Health Locus of Control, Barriers to Health Eating survey, United States Department of Agriculture (USDA) 2-question food insecurity screening tool, and a demographic and health history form.

Specific Aim #1: To describe the diet quality, as measured by the Healthy Eating Index-2015, and biopsychosocial factors that influence dietary behaviors, as measured by the eating competence Satter Inventory (ecSI 2.0), Nutrition Locus of Control, Fetal Health Locus of Control, Barriers to Healthy Eating and USDA 2-Question Food Insecurity Screening, in a sample of pregnant women seeking pre-natal care at the OHSU Center for Women's Health.

Specific Aim #2: To determine the association between diet quality, as measured by the Healthy Eating Index-2015, and eating competence, as measured by the eating competence Satter Inventory (ecSI 2.0), in a sample of pregnant women seeking pre-natal care at the OHSU Center for Women's Health.

We hypothesized that Healthy Eating Index-2015 scores would be higher among pregnant women who are eating competent (defined as an ecSI 2.0 score ≥ 32.0) compared to pregnant women with eating competence scores < 32.0.

We hypothesized that the combined fruit and vegetable sub-scale score of the Healthy Eating Index-2015 would be higher among pregnant women who are eating competent (defined as an ecSI 2.0 score ≥ 32.0) compared to pregnant women with eating competence scores < 32.0.

Specific Aim #3: To determine the association between eating competence, as measured by the eating competence Satter Inventory (ecSI 2.0), and locus of control, as measured by the Nutrition Locus of Control and Fetal Health Locus Health of Control, in

a sample of pregnant women seeking pre-natal care at the OHSU Center for Women's Health.

We hypothesized that Nutrition Locus of Control scores would be higher (reflecting a stronger tendency toward an internal locus of control) among pregnant women who are eating competent (defined as an ecSI 2.0 score ≥ 32.0) compared to pregnant women with eating competence scores < 32.0.

We hypothesized that Fetal Health Locus of Control Chance sub-scale scores would be lower among pregnant women who are eating competent (defined as an ecSI 2.0 score ≥ 32.0) compared to pregnant women with eating competence scores < 32.0.

Specific Aim #4: To determine the association between diet quality, as measured by the Healthy Eating Index-2015, eating competence, as measured by ecSI 2.0, and locus of control, as measured by the Fetal Health Locus of Control and Nutrition Locus of Control, and having received nutrition education during pregnancy from an OB/GYN or dietitian, in a sample of pregnant women seeking pre-natal care at the OHSU Center for Women's Health.

We hypothesized that Healthy Eating Index-2015 total scores and combined fruits and vegetables sub-scale scores would be higher in pregnant women who had received nutrition education from an OB/GYN or a dietitian during their current pregnancy.

We hypothesized that pregnant women who had received nutrition education from an OB/GYN or dietitian would have higher eating competence scores compared to pregnant women who had not.

We hypothesized that Nutrition Locus of Control scores would be higher in pregnant women who had received nutrition education from an OB/GYN or dietitian compared to pregnant women who had not.

We hypothesized that Fetal Health Locus of Control Internal sub-scale scores would be higher in pregnant women who had received nutrition education from an OB/GYN or dietitian compared to pregnant women who had not.

Chapter 2: Background

Developmental Origins of Health and Disease

In a broad sense, the developmental origins of health and disease (DOHaD) paradigm focuses on how "environmental factors acting during the phase of developmental plasticity interact with genotypic variation to change the capacity of the organism to cope with its environment later in life."[38] Within the field of human nutrition, DOHaD research has concentrated on the role of gestational diet in shaping the permanent structure, function, and metabolism of the developing fetus.[39] Both gestational undernutrition and overnutrition have been linked with fetal programming that increases risk for chronic and metabolic diseases later in life, especially cardiovascular disease, hypertension, and type 2 diabetes mellitus.[1-13]

Dr. Barker's developmental origins hypothesis originated from a systematic review of birth, infant growth, and death records of over 15,000 men born in Hertfordshire, England between 1911-1930.[1] From his review of these records, Barker observed that death rates from coronary heart disease and the prevalence of type 2 diabetes mellitus and impaired glucose tolerance were proportionately higher among persons born with a lower birth weight. In that study, Barker categorized birth weight into groups based on ≤ 5.5 pounds, > 9.5 pounds, and in one pound increments therein. Barker's analysis revealed steady increases in the rate of deaths from coronary heart disease, non-insulin dependent diabetes and impaired glucose tolerance, and mean systolic blood pressure in relation to decreased birth weight in each of the groups from 8.5 to 9.5 pounds down to ≤ 5.5 pounds; risk for each of these variables began to trend upward for individuals born with a birth weight > 9.5 pounds.[1] In a follow-up birth cohort study in Hertfordshire and Preston, England, Barker and colleagues demonstrated an association between low birth weight and increased abdominal adiposity in adult life,[2]

another factor that is widely understood to increase the risk for diabetes and cardiovascular disease.

Recently, research in animal models has begun exploring the mechanisms mediating transgenerational effects of maternal diet on adult chronic disease risk in offspring.[21] Much of the focus of these studies has been on epigenetic changes. Epigenetic changes in utero cause histone or DNA modifications, which may affect synthesis of DNA transcription factors; this, in turn, modulates the rate of transcription of mRNA into proteins.[40] Epigenetic changes, brought about by nutrition and other exogenous factors, may either directly increase or decrease gene expression.[41] For example, DNA methylation in the promoter region that initiates transcription of a particular gene may be silenced; decreased expression of this particular gene may then be associated with an increased risk of a given chronic disease, such as type 2 diabetes.[41] Developmental plasticity, or neuronal changes brought about by environmental interactions including in utero undernutrition, is thought to place one at an increased risk for metabolic disease in adulthood when subsequently exposed to a nutritionally-rich environment postpartum.[40]

The Effects of Gestational Overnutrition and Maternal Obesity on Offspring

Animal Models

According to the World Health Organization, overnutrition is defined as "abnormal or excessive fat accumulation that may impair health," and typically results in overweight or obesity.[22] Animal studies on gestational overnutrition—in which animals are fed diets high in fat, added sugars, or both—demonstrate a strong causal relationship between maternal obesity and offspring adiposity, cardiovascular disease, insulin sensitivity, and glucose intolerance in adulthood.[8-13] In rodent models of gestational diabetes, there was a strong tendency for offspring to develop obesity, hyperglycemia and insulin resistance

later in life.[8] Pre-pregnancy weight, maternal weight gain, the presence of gestational diabetes, maternal insulin resistance, and maternal obesity have all been shown to result in fetal programmatic changes that greatly increase the likelihood of offspring later developing obesity, type 2 diabetes, and cardiovascular disease in animal models.[8] Further, maternal high-fat diets independent of obesity have been associated with metabolic imprinting in rodents and non-human primates, leading to an increased risk for offspring adiposity, hyperphagia, depression, and attention deficit hyperactivity disorder (ADHD).[9]

Animal research has also established that gestational diets high in fructose, a nutrient common in the Western dietary pattern, is associated with metabolic changes later in life.[10] This finding stems from a randomized controlled trial of pregnant rats who were either fed a diet exclusively of fructose solution or of rat chow and water during pregnancy. While at birth, maternal weight and pup weight were similar between the two groups, at one year of age—which is typically considered older adulthood in rats—male and female pups that were born to mothers receiving the fructose solution had higher peak glucose levels compared to the control group. Likewise, female pups that were born to mothers receiving the fructose solution had a higher percent visceral adipose tissue (VAT), higher serum concentrations of leptin and lower serum concentrations of adiponectin compared to the control group.[10]

It has been proposed that maternal obesity independent of diet can disrupt the methionine cycle, which is involved in the methylation of DNA, leading to epigenetic changes.[11] Obesity and hyperleptinemia in pregnant rats may also lead to centralized adiposity in their offspring.[11] Moreover, research in animal models has demonstrated that maternal obesity during pregnancy may alter maternal, fetal and offspring pituitary adrenal function, leading to a rise in the glucocorticoids ACTH and cortisol.[11] Research in non-human primates fed a high-fat diet has demonstrated changes in the expression of

the hypothalamic melanocortin system, which regulates appetite and energy expenditure.[12] Further, high-fat, high-fructose diets in non-human primates have been associated with an increase in pro-inflammatory cytokines[12-13] and a decrease in anti-inflammatory plasma n-3 fatty acids.[13]

Human Models

Although less well-studied than animals, the role of maternal obesity and excessive dietary intake of energy, fat and carbohydrates in humans has also been associated with adverse health outcomes in offspring.[16-18] Among a birth cohort in Finland, maternal obesity, high maternal BMI, increased fetal birthweight, and childhood BMI > 16 kg/m^2 were all associated with an increased risk of being obese as an adult; this relationship was especially profound among male offspring.[16] Further, research among the Healthy Start Study birth cohort in Colorado discovered an association between increased maternal consumption of energy, total fat, saturated fat, and carbohydrates during pregnancy and neonatal adiposity.[17-18]

In response to growing research on DOHaD, increasing focus has been placed on the importance of nutrition during the first 1,000 days of a child's life – from the moment of conception to a child's second birthday. The prevalence of maternal overweight, which has steadily increased since 1980, now exceeds the prevalence of maternal underweight in every region of the world.[19] Moreover, the prevalence of overweight and obesity in the under 5 year old population also continues to rise and may be attributable to combined risk factors associated with restricted fetal growth, stunting, and changes in population dietary and physical activity patterns.[19] As noted in a 2013 special-focus edition of *The Lancet* on maternal and child nutrition, "if trends are not reversed, increasing rates of childhood overweight and obesity will have vast implications, not only for future health-care expenditures but also for the overall

development of nations. These findings confirm the need for effective interventions and programs to reverse these anticipated trends."[20]

While there is a growing body of literature to support the assertion that both undernutrition and overnutrition during pregnancy contribute to an increased risk of adverse health outcomes for the offspring, research is limited on: (1) biopsychosocial factors that influence dietary behaviors in pregnant women and (2) possible interventions to improve maternal diets and reduce subsequent risk of chronic disease in the offspring. As a pilot study, the present research will begin to explore the first of these gaps in order to better inform future targeted nutrition education programs for pregnant women. If effective, such interventions have the potential to address this important and growing public health concern.

Satter Eating Competence Model

The Satter Eating Competence Model was introduced by registered dietitian (RD) and family therapist Ellyn Satter in 2007 as a theoretical and practical alternative to conventional approaches to the management of food intake and body weight maintenance.[25] A biopsychosocial model, the four main components of the Satter Eating Competence Model are eating attitudes, food acceptance, regulation of food intake, and eating context—each of which have their own sub-scale on the eating competence Satter Inventory (ecSI 2.0) survey instrument. A copy of the ecSI 2.0 survey instrument may be found in Appendix B.

According to the Satter Eating Competence Model,[42] eating attitudes reflect a person's beliefs about the dignity and importance of eating, providing rather than depriving food, and food seeking rather than food avoidance. Food acceptance increases with repeated exposure to specific foods in a neutral environment. Satter defines selective eating in adulthood as often based on childhood food coercion or lack

of repeated neutral exposure to new foods. Regulation of food intake tunes into the internal management of appetite, hunger and satiety, which adjusts to predictable meal and snack routines. Internal regulation focuses on eating "enough" and stresses that concentrating on the achievement of a certain weight undermines the theory of eating competence. Eating context emphasizes the importance of family meals and menu planning. The underlying methodology behind using the Satter Eating Competence Model in nutrition education is to create harmony between what a person desires to eat based on personal pleasure and what a person should eat to promote positive health outcomes. The major components of the Satter Eating Competence Model are summarized in Table 1 below.

Table 1. Theoretical and Practical Approaches to Dietary Behavior: The Satter Eating Competence Model[25]

Behavioral Component	Definition
Eating Attitudes	Focuses on being positive and flexible about eating and the hedonic rewards that may be obtained from eating
Food Acceptance	Encourages varied consumption through intrinsic motivation of adhering to learned food preferences
Regulation of Food Intake	Regulation is achieved by tuning into physiological, homeostatic mechanisms for energy balance, such as appetite, hunger and satiety cues
Eating Context	Focuses on structure and meal planning through consuming adequate amounts of preferred foods at predictable times

The eating competence Satter Inventory (ecSI) is designed to measure the eating competence Satter Model's approach to nutrition. The original ecSI was validated in 2007 among a sample of 832 adults who were largely White (92.2%) and female (80.0%), with post-secondary education (92.9%), mean ± SD BMI of 26.0 ± 5.9kg/m^2, and who were self-reported physically active with a high rate of food security and low rate of eating disorders.[43] When compiling the scores from the survey, the mean ± SD

eating competence score among survey respondents was 31.1 ± 7.5; the score that classifies a person as “eating competent” was subsequently defined as ≥ 32.0. Based on this classification and the survey findings, participants who were not satisfied with their weight were 54% less likely to be eating competent. On the other hand, persons who had higher survey scores and who were classified as eating competent were more likely to plan meals and prepare them from scratch. Eating competence was associated with higher HDL cholesterol levels, lower triglyceride levels, lower blood pressure, and greater preference for fruits and vegetables. In a subsequent clinical cross-over trial to assess the relationships between cardiovascular biomarkers and eating competence in which 60.5% of participants were female, eating competence was positively correlated with HDL cholesterol and inversely associated with diastolic and systolic blood pressure.[44] Participants who were not classified as eating competent were five times more likely to have total cholesterol ≥ 130 mg/dL and triglyceride levels ≥ 150 mg/dL.

Eating Competence in Low-Income Populations

Following the validation of ecSI among a predominantly affluent, White, and well-educated population, an alternative version of the survey tool originally known as ecSI/LI (for low-income), was developed for use in low-income populations.[45-46] Cognitive interviews revealed confusion amongst participants regarding four items on the 16-question survey, which led researchers to rephrase these questions for the low-income version of the survey.[45] Eating competence scores amongst low-income participants ranged from 12 to 38, with a mean± SD score of 28.8 ± 8.0, and with a score of 32.0 remaining the cut-off point for being classified as "eating competent". As part of the validation process, participants determined to be eating competent on the surveys also demonstrated the attributes associated with eating context, internal regulation, eating attitudes, and food acceptance during the cognitive interviews.

Validation of the ecSI/LI revealed that eating competence in low-income women was positively associated with fruit and vegetable intake, food acceptance, physical activity, food planning, and resource management.[46] Eating competence in low-income women was negatively associated with disordered eating, BMI, dissatisfaction with body weight, and a tendency to be overweight due to emotional or external factors. The current version of ecSI is essentially the ecSI/LI; it was subsequently renamed ecSI 2.0 following its validation for use both in the general population and among people of lower socioeconomic status, with a score of 32.0 still remaining the cut-off point for classifying a person as "eating competent."[47]

The Relationships between Eating Competence and Dietary Behaviors

Eating competence has been correlated with a higher healthy eating index and significantly greater intake of fiber, iron, magnesium, potassium, zinc, vitamins A, C and E, and most B-vitamins; it is also correlated with the Prudent dietary pattern, which is characterized by greater intake of fruits, vegetables and low-fat dairy products.[47] Lower ecSI 2.0 scores, among individuals who are not classified as competent eaters, has been associated with the Western dietary pattern, which is characterized by diets higher in salt, sugar and fat.[48]

Eating competence has previously been found to be low among low-income adults participating in the Supplemental Nutrition Assistance Program (SNAP) in Pennsylvania (ecSI 2.0 mean ± SD 28.8 ± 8.3).[49] Factors that guided meal and snack planning among this population included the availability of food at home, convenience, family and mood; nutrition, on the other hand, was not identified as a major factor of consideration. Both eating competent and non-eating competent SNAP participants reported they would be more likely to make changes to their food purchases if they had more money available to spend on food. Weight management was seen to be more

important for non-eating competent participants than for eating competent participants. Lower eating competence scores were also correlated with an increased likelihood to express negative feelings regarding eating, regardless of food security status.[49]

Aside from the above studies, which examined the association between eating competence and socioeconomic status, very few studies have specifically examined the associations between demographic characteristics and eating competence. A cross-sectional study conducted among older adults (defined as 65-76 years old) in Taiwan[50] (N=564) revealed a mean eating competence of 29.3 in this population. Higher eating competence scores were significantly associated with a younger age of participants (65-70 years old vs. 71-76 years old), higher educational attainment, being in a relationship with a spouse or significant other, and living in an urban area. No significant differences were observed between genders.

Eating Competence Assessments in Young Adults

Aside from low-income women, eating competence has been most extensively studied among college students.[51-56] The evaluation of ecSI in this population has also tended to include more male participants compared to ecSI validation studies and studies with low-income participants. From survey findings using ecSI with college students, men were more likely to be eating competent than women, who were significantly more likely to report weight dissatisfaction than men.[51] In general, students who were eating competent were less likely to be dissatisfied with their weight, less likely to be attempting to lose weight, and had a lower BMI than non-eating competent students.

Higher eating competence in males versus females was also found in a subsequent study among college students participating in an online introductory nutrition course[52] and in a cross-sectional study of nearly 1,700 full-time university students in

eight states.[53] The latter study used online questionnaires to measure fruit and vegetable intake, the three-factor eating questionnaire, eating competence, emotional and psychological stress, physical activity behaviors, demographics, and perceived and desired weight among college students.[53] Based on survey responses, participants were divided into 3 clusters: 1) Psychosocially Secure with relatively low levels of weight-related concerns and a high eating competence score; 2) Behaviorally Competent with the highest reported fruit and vegetable intake and level of physical activity, higher eating competence in men, and lower eating competence in women; and 3) High Risk, who desired the greatest amount of weight loss, highest psychological and emotional distress scores, highest emotional eating scores, and lowest eating competence scores.

In another study among college students, eating behaviors were assessed using the Three-Factor Eating Questionnaire, ecSI, and the National Cancer Institute Daily Fruit and Vegetable Screener.[54-55] Thirty-two percent of males and twenty-two percent of females participating in the study were overweight or obese. Overweight and obese participants were significantly less likely to be eating competent and were significantly more likely to have greater cognitive restraint, uncontrolled eating, and emotional eating as measured by the Three-Factor Eating Questionnaire.[54] This study also found that long duration sleepers (those who sleep >8 hours/night) had significantly higher scores on the Eating Attitude and Internal Regulation sub-scales of the ecSI compared to short-duration and adequate duration sleepers.[55] These study findings suggest that sleep duration may be an important, yet oftentimes overlooked, component of obesity prevention programs.

A prospective cohort study of college students (N=264) compared the associations between emotional eating, restrained eating, over-eating and stress with anthropometric measures and adiposity at the start of college and in regards to first-semester weight gain.[56] Primary measures were the Three Factor Eating Questionnaire,

Satter Eating Competence Inventory (ecSI 2.0), Perceived Stress Scale, dual energy x-ray absorptiometry (DEXA), weight, height and waist circumference prior to and at the end of the students' first semester of college. Among the key findings were that overeating in response to external cues and emotions was associated with greater weight, BMI and waist circumference among college freshmen.

Eating Competence Assessments in Intervention Studies

Eating competence has also been assessed among individuals participating in nutrition intervention programs. “About Eating” was a web-based program developed around the Satter Eating Competence Model and designed to target low income-women.[57] The About Eating curriculum consisted of six lessons: Enjoying Eating, About Being Active, About My Size, Your Food Variety, Time to Eat, and Hunger and Fullness. While eating competence was only assessed post-intervention, eating competence was determined to be quite low overall for the group (61% with ecSI 2.0 scores < 32.0). However, following participation in the About Eating curriculum, women’s meal planning and food management skills improved as assessed through an evaluation tool developed specifically for this intervention program. Food secure participants displayed greater confidence in food management and meal planning skills than food insecure participants; the relationship between food security status and eating competence was not reported.

As a pre-cursor to the eating competence model, “Eating Order” was a 13-week nutrition education intervention program for chronic dieters based on Ellyn Satter’s *How to Eat* protocol within the *Health at Every Size* framework.[58] Evaluation of this intervention was based on improved eating attitudes and behaviors, body image, and self-esteem, regardless of the degree of weight or eating disturbance. Participants in this intervention included 36 mostly Caucasian females in their late 30s, with obesity (mean

BMI 38.4 kg/m^2), and who had previously and diligently pursued weight loss. Pre-intervention surveys among participants approached the screening cut-off for disordered eating, while post-intervention results came close to the restrained eater clinical cut-off, representing a significant shift in eating attitudes among participants pre- and post-intervention. The dropout rate for the intervention was 9%, well below the dropout rate for most weight-loss programs. A notable aspect of this intervention, as compared to other weight-loss programs, was that weight was not measured during or at the conclusion of the class.

More recently, changes in eating competence were examined following a 12-month weight loss intervention.[59] Participants were largely college-educated women with BMIs > 25 kg/m^2. In that study, eating competence was unchanged between baseline and 4 months, but increased significantly between 4 and 12 months. In addition, eating competence was inversely associated with weight change pre- and post-intervention.

Beyond the United States, eating competence has been assessed in a sample of working age Finns who were overweight or obese to assess how stress affects eating attitudes and dietary behaviors.[60] In addition to the ecSI, this survey used the Perceived Stress Scale, Intuitive Eating Scale, the Three-Factor Eating Questionnaire, Health and Taste Attitudes Scale, and a 48-hour dietary recall. Among participants in the Finnish study, individuals in the highest tertile on the Perceived Stress Scale had a lower eating competence score than those in the lowest tertile. High perceived stress was associated with eating attitudes and behaviors that could contribute to obesity and also pose a challenge in weight management.

In a subsequent study in Finland researchers investigated the effects of acceptance and commitment therapy (ACT)—an action-oriented form of psychotherapy that stems from cognitive behavioral therapy—on diet quality and self-reported eating behaviors.[61] This study was a secondary data analysis of a non-blinded randomized

controlled trial in three Finnish cities. Participants were divided into three groups: ACT-based face-to-face (n=70); ACT-based mobile app (n=78); and control (n=71). Participants were 85% female with a mean age of 49.5 years and mean BMI of 31.3 kg/m^2. In this study, eating competence and regulation of eating behavior increased in the face-to-face intervention group, but not in the mobile app or control groups. However, there were no statistical differences related to changes in diet quality as measured by a 48-hour dietary recall.

Due to its focus on flexibility, intrinsic motivation, self-regulation, and personal preference, the Satter Eating Competence Model may be classified as a non-diet intervention in the context of nutrition education. A systematic review of 18 non-diet interventions showed that these approaches to nutrition education have resulted in significant improvements in depression, disordered eating patterns and self-esteem.[62] None of the non-diet interventions reviewed have resulted in significant weight gain, or worsened blood pressure, blood glucose or cholesterol levels. Two studies demonstrated improvements in biochemical markers for cardiovascular disease among non-diet intervention participants compared to the control group.

Another intervention program taking a non-dieting approach, the “No More Diets” group intervention program was an 8-week nutrition education program for overweight and obese women incorporating elements of the Satter Eating Competence Model.[63] Facilitated by a psychologist and a dietitian, the 8-week modules were focused on why diets do not work, regular eating patterns, the hunger scale, hungry eating vs. non-hungry eating, how to reduce non-hungry eating, eating with awareness, fine-tuning nutritional knowledge, and personal reflections. Prior to participation in the group program, participants reported high levels of body shape preoccupation, disordered eating, anxiety, stress and depression compared to community norms. Following participation in the 8-week group intervention there were significant improvements in

participants' body shape preoccupation and eating competence score. However, there were no significant changes in emotional or uncontrolled eating, eating concern or reported dietary constraint.

Possible Trans-generational Effects of Eating Competence

The trans-generational effects of eating competence have also been assessed in a study of mothers of 2- to 5-year-olds.[64] In that study, eating context skills, including mindful eating and meal planning, were correlated with eating for physical rather than emotional reasons. Mothers who ranked high in eating context skills were more likely to monitor their children's food intake and to endorse the division of responsibility in feeding their children.

Measuring Eating Competence in Pregnant Women

While eating competence has been assessed in nutrition education intervention programs pre- and post-intervention, and with a variety of demographic groups, there have been no studies to date exploring eating competence specifically in pregnant women. Given the physiological changes that occur during pregnancy, the changes in hunger and satiety regulation, and the opportunity that pregnancy presents to effect changes in health behavior, this research offers an opportunity to explore the concept of eating competence during this life stage. Further, past studies have revealed lower eating competence scores among females in general. This research will begin to explore whether lower scores on eating competence emerge for pregnant women as well.

Hierarchy of Food Needs

In 2007 Ellyn Satter also introduced the concept of a Hierarchy of Food Needs[65] as a companion to the Satter Eating Competence Model. The Hierarchy of Food Needs is based on the principles outlined in Abraham Maslow's Hierarchy of Needs,[66] which asserts that an individual is on a continuum from satisfying physiological needs, safety and security, social belonging, esteem, and self-actualization; an individual cannot progress to the next level until his or her needs from the previous level are met.

Along this same vein, the Hierarchy of Food Needs seeks to address levels of food security as the primary motivators for an individual's food management. Designed for use in a nutrition education setting, this model suggests that one cannot begin to operationalize basic dietary guidelines when one has not achieved basic levels of food security, which is defined as having, "physical and economic access to sufficient, safe and nutritious foods that meets the dietary needs and food preferences for an active and healthy lifestyle."[67] The six components of the Hierarchy of Food Needs, from most basic to most complex, are listed in Table 2 below.

Table 2. Components of the Hierarchy of Food Needs[65]

Hierarchy Level	Key Characteristics
Enough food	Individuals who are food insecure; dietary choices are driven by hunger and the drive to get enough to eat; food choices often include items perceived as being filling and sustaining; chosen food items typically have a high energy density
Acceptable food	Free from hunger and able to make subjective decisions about food; individuals may likely still be low-income and food-seeking behavior may be highly individualized based on what the person deems to be acceptable; individuals in this group are often focused on attaining personally identified core food items[68]
Reliable, ongoing access to food	People at this level are able to plan for future meals, accumulate food through stored means and budget for food purchases
Good-tasting food	Once basic food security is met, individuals are able to choose foods based on taste preferences and aesthetic attributes. As evidenced by the World War II era starvation study conducted by Ancel Keys, under conditions of starvation individuals will often consume foods they previously disliked.[69]
Novel foods	Individuals at this level are less concerned with wasting food and are open to experimenting with need foods. Research has suggested that nearly half of low-income parents are reluctant to introduce new foods to pre-school aged children out of concerns their child doesn't want them.[65]
Instrumental food	A person at this level has achieved all other levels and is able to make dietary choices based on perceived physical, cognitive or spiritual benefits. Examples include eating or avoiding certain foods to prolong life or prevent disease.

Cognitive Models of Behavior Determinants

Barriers to Healthy Eating Scale

The Barriers to Healthy Eating Scale (BHES) is derived from an 18-item validated questionnaire designed to assess dietary factors that may hinder a pregnant woman's ability to eat healthy foods and thereby place her at an increased risk for complications.[30] BHES is based on Pender's Health Promotion Model, which defines health as a positive dynamic state, rather than merely the absence of disease.[70] Items in the BHES are divided into 5 sub-scales related to the procurement of food and dietary behavior: unavailability, expense, difficulty engaging in healthy eating, inconvenience, and preference.[30] In piloting and validating this tool, researchers discovered that pregnant

women's knowledge of food preparation, individual food preferences, and access to food preparation appliances had more of an effect on women's dietary behaviors than food costs or access to grocery stores.[30]

Nutrition Locus of Control

Nutrition Locus of Control (NLOC) is derived from the concept of self-efficacy, first introduced by Badura as a key concept of Social Cognitive Theory in 1982.[71] Badura asserted that "efficacy involves a generative capability in which cognitive, social, and behavioral subskills must be organized into integrated courses of action to serve innumerable purposes…it is concerned not with the skills one has, but with the judgments of what one can do with whatever skills one possesses."[71] Self-efficacy has been associated with the Stages of Change model[72] and correlated with the movement between pre-contemplation and contemplation to action.[73] As a derivative of self-efficacy, the NLOC model may be used to predict the likelihood of dietary change; individuals with a high self-efficacy have a higher adherence to dietary interventions compared to subjects with a lower self-efficacy.[28]

As a social construct, Locus of Control originated from Rotter's Social Learning Theory.[74] Central to this model is the notion that predicated behavior related to a certain outcome will be influenced by the extent to which that outcome is valued by an individual.[72] An individual's locus of control may be internal, in the sense that the person believes his or her actions control his or her outcomes, or external, in the sense that the person believes that outside or environmental factors control his or her outcomes. An individual with an internal locus of control is likely to believe that his or her behaviors directly affect an outcome, while an individual with an external locus of control is more likely to believe that outcomes are related to chance or fate. While self-efficacy is task-specific, locus of control is domain specific. For example, an individual may have an

internal locus of control in the health domain, but an external locus of control in the social domain. The original intention of the NLOC model was that it should not be used as a measure of health- and dietary-related behaviors on its own, but in tandem with other measures.[28]

The NLOC questionnaire as a predictor of dietary behavior in pregnant women was validated following a cross-sectional study of 943 pregnant women, who were followed for 5 years to assess a number of birth outcomes.[28] The women completed both the NLOC questionnaire and a food frequency questionnaire at their first prenatal visit. Women who scored high in having an internal locus of control significantly consumed more fruits and vegetables, grains, dairy products and vegetable proteins. In contrast, women who scored high in having an external locus of control significantly consumed more red meat.

Fetal Health Locus of Control

Rooted in the same theories as the NLOC, the Fetal Health Locus of Control (FHLC) is not nutrition-specific.[29] This scale assesses whether a pregnant woman believes her actions directly impact her offspring's health outcomes. The FHLC is derived from an 18-item questionnaire validated in a cross-sectional study of 63 women attending an OB/GYN clinic in a southeastern U.S. city. This tool has three sub-scales: Internal FHLC, Powerful Others FHLC, and Chance FHLC. The original validation of this tool found that intention to attend prenatal classes was significantly associated with having an internal FHLC. In contrast, pregnant women with a chance FHLC were significantly more likely to smoke during pregnancy. Although research on the associations between FHLC and nutrition-related behavior during pregnancy is limited, subsequent studies have demonstrated a significant association between an internal FHLC and health-seeking behavior among low-income pregnant women,[34] exclusive

breast-feeding for at least six months postpartum,[35] and adherence to iron supplementation regimens during pregnancy.[36] In addition, in a study on the relationships between FHLC and diabetes prevalence during pregnancy, women with overt Type 1 or Type 2 Diabetes scored higher on the Powerful Others sub-scale of the FHLC compared to the control group without diabetes.[37] In contrast, women with gestational diabetes scored higher on the Chance sub-scale compared to women with overt diabetes and women in the control group.

FHLC has been studied more frequently in research than the BHES and NLOC. In a study of 1,467 nulliparous university students of childbearing age, students rated the Internal sub-scale twice as highly as Powerful Others and Chance.[75] Researchers in this study recommended the FHLC for possible integration into pre-conception health education programs.[75] A separate study of university women in the United States found no association between FHLC, awareness of folic acid consumption in the prevention of neural tube defects, and multi-vitamin use.[76]

In a sample of 256 pregnant Turkish women, researchers determined a positive relationship between the Internal FHLC sub-scale, age at the time of marriage, and age at the time of first pregnancy.[77] In addition, women with a high score on the Chance sub-scale were significantly more likely to have a lower educational level, lower income, be unemployed, have a higher number of past pregnancies, have unplanned pregnancies, and to initiate pre-natal care later into the pregnancy.[77] In a study of 100 pregnant Egyptian women, FHLC was positively associated with pre-natal attachment, number of deliveries, number of abortions and marital status.[78]

A study of 210 postpartum women with singleton gestation in the United States revealed that women who had had a pre-term delivery and who had smoked during pregnancy were significantly more likely to score higher on the FHLC Chance sub-scale.[79] Of note, Hispanic women scored the highest on the Powerful Others sub-scale.[79]

A prospective cohort study of 1,605 women followed from ≤ 20 weeks gestation through delivery found that the FHLC Chance sub-scale was positively associated with larger gestational weight gain.[80] The researchers concluded that women who believe that fetal health is determined by external factors are more vulnerable to non-adherence to clinical guidelines for gestational weight gain.[80]

Research using the FHLC in the United Kingdom (UK) has indicated that women who smoke during pregnancy were more likely to be in the pre-contemplation stage of change and to have a Chance FHLC and less likely to increase folic acid intake or to take vitamins and iron supplements.[81] Another study in the UK revealed that women who exercised at least two times per week during pregnancy scored significantly lower on the Internal sub-scale of the FHLC.[82] This suggests that some women may view exercise during pregnancy as having a negative impact on fetal well-being.[82] Further research in the UK discovered that pregnant women with an Internal FHLC were more likely to have the intention to breastfeed their infants compared to women with alternative feeding plans.[83]

Finally, research among 545 pregnant women in Canada found that women who smoke during pregnancy were more likely to believe that Chance and less likely to believe that Internal factors or Powerful Others affected the health of their fetuses.[84] In addition, women who drink seven or more alcoholic beverages per week during pregnancy were more likely to have a Chance FHLC and less likely to have an Internal FHLC.[85]

While all three of these cognitive models of behavior determinants have been associated with health-related behavior, research is limited on assessing these models in relation to eating competence and the Healthy Eating Index. The present research will begin to explore these mechanisms with the ultimate goal of improving the delivery of nutrition education and therefore dietary behaviors during pregnancy.

Dietary Guidelines for Pregnancy

As noted above, emerging research suggests that maternal diets that are high in fat and sugar are associated with an increased risk of metabolic syndrome, diabetes, and cardiovascular disease for the offspring later in life, although these findings have largely been concluded upon the basis of animal studies. In addition, meat-heavy maternal diets have been correlated with adult hypertension among offspring.[86] A diet that is high in salt, sugar, fat, and processed foods, and low in fruits, vegetables, and whole grains—a diet commonly associated with the Western lifestyle—has been found to increase the likelihood of obesity as well as the risk for gestational diabetes during pregnancy. In contrast, "prudent" dietary patterns such as the alternate Mediterranean diet (aMED), Dietary Approaches to Stop Hypertension (DASH), and the alternate Healthy Eating Index (aHEI) have all been associated with lower pre-pregnancy BMIs and a decreased risk of developing gestational diabetes.[87] The aMED diet is based on a Mediterranean diet that is high in fruits, vegetables and grains; moderate in fish, seafood, poultry, eggs, cheese and yogurt; and low in meats and sweets. The DASH diet was originally developed as a healthy dietary pattern to prevent and treat hypertension; it focuses on the consumption of fruits, vegetables and grains; moderate amounts of low-fat dairy, seafood, poultry, and lean meats; and minimal amounts of beans, nuts, seeds, oils, and sweets. The aHEI is based on the *Dietary Guidelines for Americans,*[23] with a greater emphasis on lean proteins compared to the HEI-2015.

Nutrients of concern during pregnancy especially include folate to prevent neural tube defects; vitamins B-6, B-12 and C to lower the risk of preeclampsia and low birth weight; iodine to prevent cognitive impairments; iron to build infant iron stores and prevent iron-deficiency anemia; the omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) to promote cognitive development and reduce the likelihood of atopic outcomes; and calcium and vitamin D to promote adequate bone

growth.[86] Typically a diet high in fruits, vegetables and whole grains combined with the provision of a pre-natal vitamin satisfies these nutrient requirements. The *2015-2020 Dietary Guidelines for Americans* also recommends pregnant women consume 8-12 ounces of low-mercury fish and seafood per week in order to meet the EPA/DHA guidelines for fetal brain development; a high quality fish oil supplement containing at least 300 mg EPA/DHA is recommended for women who do not consume fish and seafood.[23] Iron supplementation is only recommended for pregnant women with hemoglobin levels below 10.5 g/dL in the first trimester, below 11 g/dL in the second trimester, and below 10.5 g/dL in the third trimester.[88]

According to the *Scientific Report of the 2015 United States Dietary Guidelines Advisory Committee*[89] there are many similarities between pregnant women and the general population in terms of shortfall nutrients. These guidelines draw their data from the National Health and Nutrition Examination Survey (NHANES); according to the most recent NHANES for which the U.S. Dietary Guidelines are based, 26 percent of this population is below the estimated average requirement (EAR) for vitamin A, 30 percent below the EAR for vitamin C, 90 percent below the EAR for vitamin D, 94 percent below the EAR for vitamin E, 24 percent below the EAR for calcium, 29 percent below the EAR for folate, 96 percent below the EAR for iron, 92 percent below the adequate intake (AI) for fiber, and 97 percent below the AI for potassium.[89] It is important to note that this data is drawn from a sample size of 133 pregnant women across the United States, which is relatively small; thus, caution should be used in generalizing the data to all pregnant women in the United States.

Systematic reviews of total energy intake,[90] macronutrient composition,[90] and micronutrient composition[91] during pregnancy have also uncovered a number of shortfall nutrients. Of note, total energy and fiber intakes were found to be below recommendations, total fat and saturated fat intakes were above recommendations, and

total carbohydrate and polyunsaturated fatty acid (PUFA) intakes were below to borderline low compared to recommendations.[90] In terms of average micronutrient intakes during pregnancy, folate, iron, and vitamin D intakes were considerably below recommendations according to the systematic review.[91]

Recommendations for gestational weight gain are based on pre-pregnancy body mass index (BMI), with increasingly greater weight gain encouraged for women with lower BMIs.[92] These guidelines from the Institute of Medicine are based on reducing the likelihood of maternal and child obesity and postpartum weight retention; reducing the risk of glucose intolerance and insulin-resistance during pregnancy; decreasing the long-term risk for cardiovascular and metabolic diseases for both the mother and child; and improving postpartum lactation performance.

Table 3. Weight Recommendations for Women Pregnant with One Baby[92]

Pre-Pregnancy BMI and Weight Classification	Recommended Gestational Weight Gain
Underweight / BMI less than 18.5	28-40 pounds
Normal Weight / BMI between 18.5 – 24.9	25-35 pounds
Overweight / BMI between 25.0 – 29.9	15-25 pounds
Obese / BMI greater than or equal to 30.0	11-20 pounds

The Healthy Eating Index as a Measure of Diet Quality in Pregnancy

The Healthy Eating Index (HEI) is a measure of how closely a person's dietary intake conforms to the *Dietary Guidelines for Americans.* Originally developed in 1995, the HEI has subsequently been revised three times. The current version is known as the HEI-2015. The HEI is based on 13 dietary components (refer to Chapter 3 for a

breakdown of the scoring) and is scored on a scale of 0-100; higher numbers reflect greater adherence to the dietary guidelines.[93]

According to the most recently available NHANES data, the mean HEI for all Americans is 59/100.[94] Since 1995, there have been slight improvements in mean HEI over time, with the exception of a small decrease between 2013-2014. Broken down into age groups, older adults aged 65 years and above have the highest HEI (66/100), followed by adults between the ages of 18-64 (58/100), with children and adolescents between 6-17 having an HEI of 53/100.[94] In terms of the HEI sub-scales, the greatest conformity to the *Dietary Guidelines for Americans* has been observed in the consumption of whole fruits, total protein foods, and seafood and plant-based proteins. The poorest conformity has been observed in the consumption of whole grains, the ratio of unsaturated to saturated fatty acids, and sodium.[94]

A number of studies to date have used the HEI to examine the diet quality of pregnant women and women of child-bearing age in the United States. A study of 54 post-natal women in rural Mississippi followed the women for 12 months after the birth of their children.[95] Half of the women were assigned to a control group and half received a nutrition and physical activity curriculum-based intervention. The HEI-2010 was calculated from multiple pass 24-hour dietary recalls. Mean HEI in the control group ranged from 36.4-40.2 throughout the course of the study, while in the intervention group it ranged from 37.6-45.8. No significant changes in HEI were noted following participation in the nutrition and physical activity intervention.[95]

In a study of 41 term (>37 weeks) uncomplicated, singleton pregnancies delivering at OHSU, HEI-2010 was calculated from 24-hour diet recalls.[96] Lower HEI-2010 scores (≥ 10 points below the mean) were associated with an average of 200 grams higher birth weight and 1 cm longer length. However, HEI and macronutrient composition were not related to infant percent body mass or abdominal circumference.[96]

Another study conducted at OHSU, the Pregnancy, Exercise, and Nutrition (PEN) study was a randomized, controlled feasibility study of 28 pregnant women.[97] Half of participants completed a 20-session team-based curriculum designed to promote healthy dietary choices and physical activity during pregnancy and reduce the risk of gestational diabetes mellitus (GDM). This study found no relationship between fruit and vegetable intake and gestational weight gain. The mean ±SD HEI-2010 was 62.0±14.0 for all participants in the first trimester and no significant differences were observed between the intervention and control group. Following the intervention, mean ±SD HEI-2010 scores were 63.2±15.5 in the second trimester and 63.4±16.5 in the third trimester for the control group and 64.6±9.8 in the second trimester and 63.3±9.4 in the third trimester for the intervention group. Of note, 89 percent of study participants were White, 61 percent possessed a graduate degree, and 78 percent had an income ≥ $75,000 year, thus the study findings may not be generalizable. Also of note is that there were no significant differences in mean HEI scores between the first, second, and third trimesters in the control group, suggesting that a woman's dietary behaviors do not change significantly throughout the course of pregnancy.

In a study of 266 HIV-positive women enrolled in the Pediatric HIV/AIDS Cohort Study, a prospective national multicenter cohort study, HEI was assessed from three 24-hour diet recalls.[98] Mean HEI-2005 scores for this group were 56.1, while HEI-2010 scores were 47.5 based on the same diet recalls. Non-U.S. born mothers had, on average, 15-point higher mean HEI scores, while U.S.-born women who consumed alcohol, cigarettes or illicit drugs during pregnancy had 3.5-point lower mean HEI scores. Birth weight z-scores were positively associated with both HEI-2005 and HEI-2010 scores.[98]

In a cross-sectional study of 7,511 nulliparous women at eight U.S. medical centers participating in the Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-

to-Be cohort, the HEI-2010 was measured from a food frequency questionnaire (FFQ) designed to capture dietary intake during the three months around conception.[99] HEI increased with level of education, although the effect was more noticeable among non-Hispanic whites and Hispanics compared to non-Hispanic blacks. The top sources of energy in this sample were sugar-sweetened beverages, pasta dishes, and grain-based desserts; 34 percent of total energy was derived from added sugar, saturated fats and alcohol. Overall, the mean ±SD HEI-2010 for the group was 63±13, 65±12 for non-Hispanic Whites, 54±11 for non-Hispanic Blacks, and 61±12 for Hispanics.[99]

In a study of 45 mother and newborn pairs at the Women's Health Center and Obstetrics and Gynecology Clinic in St. Louis, a mean ±SD of 54.4±13.2 percent of total energy was derived from ultra-processed food (UPF).[100] UPF is defined as "formulations mostly of cheap industrial sources of dietary energy and nutrients plus additives, using a series of processes" which "all together are energy dense, high in unhealthy types of fat, refined starches, free sugars and salt, and poor sources of protein, dietary fiber and micronutrients."[101] A one-percent increase in UPF consumption was associated with a 1.33 kg increase in gestational weight gain and a 0.62 percent increase in total body adiposity in the neonate.[100]

In a study of 896 non-pregnant women aged 20-44 years who had given birth within the past five years, researchers investigated the relationship between diet quality and sleep.[102] Short sleep (≤ 6 hours per night) was not associated with diet quality, however, long sleep (≥ 9 hours per night) was associated with a lower HEI, higher consumption of empty calories, and lower consumption of fruit and protein foods.[102]

A study of 1,079 mother-offspring pairs participating in the Healthy Start Study found that HEI-2010 ranged from 18.2 to 89.5 with a mean of 54.2.[103] An HEI-2010 ≥ 57 was significantly associated with higher neonatal percent fat mass.[103]

In a study of 795 pregnant women in the United States who participated in NHANES between 2003-2012 HEI-2010 scores were based on one 24-hour diet recall with a mean HEI of 50.7[104] A significantly lower HEI was observed for women whose pre-pregnancy BMI was classified as obese compared to their underweight and normal weight counterparts. Serum iron concentrations were significantly higher in normal weight women compared to overweight women.[104]

Based on NHANES 2007-2010 data, HEI-2010 scores were compared between 20-44 year old women with a history of gestational diabetes mellitus (GDM) and women without GDM who had previously given birth.[105] The overall prevalence of GDM in this population was 7.7%. Women with a history of GDM had, on average, an HEI-2010 score that was 3.4 points lower overall compared to their counterparts.[105]

HEI has also been studied in relation to gestational weight gain (GWG). In a study of 490 pregnant women aged 16-43 years participating in NHANES 2003-2006 HEI-2005 was determined from a 24-hour recall.[106] Based on this sample, the authors concluded that HEI-2005 was not a determinant of GWG; however, inadequate intake of total vegetables and oils was associated with excessive GWG after controlling for covariates.[106]

While these studies have largely examined HEI in relation to GDM, GWG, offspring body composition, and demographic characteristics, the present study is among the first that examines HEI in relation to biopsychosocial factors that influence dietary behavior in pregnant women.

Factors that Affect Dietary Behavior among Women of Child-bearing Age

There are numerous societal and cultural factors that influence the dietary behaviors of pregnant women and women of child-bearing age. Another pilot study conducted in Oregon[107] utilized community-based participatory action research and the

PhotoVoice process to document perceived enablers and barriers to healthy eating among women of child-bearing age in the rural coastal community of Astoria. In line with the ecSI concept of eating context, participants demonstrated that advance meal planning facilitates healthy meal preparation. Family, friends, significant others and medical professionals all play a role in influencing the eating behaviors of women in this age group. The women in Astoria identified the activities of foraging, hunting and community gardening as "normal" food procurement strategies in the community. In addition, the use of modern technology, including the internet and social media platforms, may be frequented by women to identify healthy recipes. In contrast, certain cultural norms were also perceived to affect food choices in negative ways, including holiday meals, the role of mass media, an individual's financial circumstances, and busy work schedules that limit time to plan and prepare meals.

A study on the determinants of diet quality among pregnant Canadian women identified predictors of low diet quality as not being married, never previously having children, being less physically active, smoking, anxiety, and lacking support from family.[108] The presence of convenience stores, grocery stores and fast food establishments did not significantly affect diet quality, indicating that food environment plays a less important role in influencing dietary choices during pregnancy.

Among low-income women, research suggests that participation in food assistance programs has a positive association with child growth and weight, and thus one may assume maternal nutritional behaviors. In a study of Hispanic women receiving benefits from the Special Supplemental Assistance Programs for Women, Infants and Children (WIC), child weight-for-length was positively associated with having received benefits from the Supplemental Nutrition Assistance Program (SNAP).[109] Children whose mothers had ever received SNAP benefits were twice as likely to be overweight or obese compared to mothers who had never received SNAP benefits.

Food Insecurity in Pregnancy

As noted above, food security has been defined as "physical and economic access to sufficient, safe and nutritious foods that meets the dietary needs and food preferences for an active and health lifestyle."[67] Within the United States, household food security has been classified into four distinct categories, as highlighted in Table 4 below.

Table 4. Levels of Household Food Security in the United States[110]

Level of Food Security	Key Characteristics
High food security	no problem or anxiety about consistently accessing adequate food
Marginal food security	problems or anxiety at times about accessing adequate food, but quality, variety and quantity of food not substantially reduced
Low food security	reduced quality, variety and desirability of diet, but quantity of food and eating patterns not disrupted
Very low food security	at times of year, eating patterns of at least one household member are disrupted or food intake reduced due to insufficient resources

Food insecurity is a leading public health concern in the United States. Food insecure adults have an estimated 32 percent increased odds of being obese compared to adults who are food secure.[111] Food insecure children are twice as likely to report poor or fair health and 1.4 times more likely to have asthma compared to food secure children.[112] Even marginal food insecurity is associated with adverse health outcomes; this effect is most striking among children under the age of four and their mothers.[113]

In light of DOHaD, food insecurity is of concern during pregnancy. The largest study to date examining the prevalence of food insecurity among pregnant women in the United States utilized NHANES data for pregnant women from 1999 to 2008.[114] Overall, 688 out of 1,158 pregnant women participating in NHANES during this time period had household incomes ≤ 300 percent of the federal poverty level. Among these women, nineteen percent were food insecure and four percent were marginally food secure. The mean alternative HEI for this population was 41.9 and the researchers concluded that household food insecurity is not associated with overall diet quality during pregnancy. However, there is a lack of data on this population within the past decade.

Food insecurity during pregnancy has been associated with increased likelihood of depression,[115] increased risk of suicidal ideation both during pregnancy and postpartum,[116] increased gestational weight gain,[117-118] pre-gravid weight status,[118] and pregnancy-related complications.[118-119] In a study comparing food insecurity among pregnant women with adverse health outcomes, gestational diabetes mellitus (GDM) was 2.76 times more likely to occur in women in households with marginal food insecurity compared to food secure households.[118-119] Further, the prevalence of overweight and obesity among mothers is higher among single mothers who are food insecure; overweight and obesity in this population remains unchanged regardless of level of physical activity, smoking status or receipt of SNAP or WIC benefits.[120] The effects of maternal food insecurity also extend in childhood. Based on a study conducted in Oregon, toddlers in food insecure households were more likely to consume soda and less likely to consume fruits and vegetables compared to toddlers in food secure households.[121]

Food insecure pregnant women are 2.9 times more likely to be iron deficient compared to food secure pregnant women[122] and more likely to have suboptimal intake of micronutrients.[123] Food insecurity during pregnancy has been associated with having

a low internal locus of control on the Parental Health Belief Scale,[124] higher levels of stress, disordered eating, and dietary fat intake postpartum,[125] and limited self-efficacy in adopting nutrition recommendations among food insecure pregnant women with GDM.[126] To address this growing public health concern, there has been a recent shift toward recommending screening for food insecurity, housing problems, poverty, unemployment, and violence among pregnant women and the general population.[127]

The estimated prevalence of food insecurity within the state of Oregon is 14.6 percent,[128] which is higher than the national average of 11.8 percent.[129] Yet there is a noticeable gap in the literature especially in regards to the prevalence of food insecurity among pregnant women in particular within the state of Oregon and how it influences dietary behaviors during pregnancy. Given the myriad of adverse health consequences associated with food insecurity during pregnancy—both for the mother and the offspring—the present research study will begin to explore this.

Significance and Summary

Findings from this study will extend prior works on factors that influence dietary behaviors in pregnant women, namely eating competence, locus of control, barriers to healthy eating and food security status, and how these relate to actual dietary intake. As such, it is among the first studies to assess eating competence in pregnant women and the relationship between eating competence and locus of control. Through a closer examination of these components, this exploratory study seeks to both raise questions for future research on biopsychosocial factors that influence dietary behavior in pregnant women and how to tailor nutrition interventions for pregnant women in years to come. The ultimate long-term goal of this body of research is to improve nutritional intake and thus the health of both the women themselves and their offspring throughout their lifespans.

Chapter 3: Methods

General Study Design

This was a cross-sectional study targeting women at all stages of pregnancy seeking pre-natal care at the OHSU Center for Women's Health. Participants completed an online 24-hour dietary recall and a series of six online surveys, including a demographic and brief medical history questionnaire, Eating Competence Satter Inventory, Nutrition Locus of Control, Fetal Health Locus of Control, Barriers to Healthy Eating, and USDA 2-Question Food Security Screening Survey. The relationships between eating competence and diet quality, and between eating competence and locus of control, were the primary outcomes assessed. Barriers to healthy eating were also described. As an exploratory measure, the relationships between having received nutrition education during pregnancy from an OB/GYN and/or dietitian and diet quality, eating competence and locus of control were also assessed.

IRB Approval

This study was approved by the OHSU Institutional Review Board (eIRB #18026). All participants completed a consent and authorization form prior to participating in any study-related activities.

Recruitment and Sample Size

Recruitment methods included posted advertisements on the OHSU Study Participation Opportunities website and the OHSU Center for Women's Health (CWH) Clinical Trials website, and displaying recruitment fliers around the CWH. Recruitment fliers and a verbal introduction to the study were also presented by the CWH dietitian during pre-natal intake appointments and by CWH midwives during group pre-natal classes. Interested participants were encouraged to contact the study coordinator for

more information and to enroll in the study. Eligibility was defined by the inclusionary and exclusionary criteria, which is summarized in Table 5 below.

Table 5. Inclusion and Exclusion Criteria

Inclusion Criteria	**Exclusion Criteria**
Age 18 years and older	Failure to provide informed consent
Currently pregnant	
Established patient at the OHSU Center for Women's Health	
Fluent in English	

Potential participants interested in the study contacted the study coordinator via e-mail. The study coordinator reviewed inclusion and exclusion criteria with potential participants to confirm eligibility. Participants who met eligibility criteria and were still interested in study participation were then forwarded a link to an online consent and authorization form available on the secure OHSU Research Electronic Data Capture (REDCap) website. Participants were also informed that they could withdraw their participation in the study at any time by contacting the principal investigator or study coordinator. A copy of the consent and authorization form appears in Appendix A.

Once participants consented to participate in the study, the study coordinator assigned them a unique study identification number (ID) that consisted of series of consistent letters and sequential numbers (e.g. EC101, EC102, EC103) and a password for completing the ASA24 dietary recall. The key assigning participant IDs and passwords was stored in the secure REDCap database, which only the study coordinator had access to. Participants were then sent an e-mail message via REDCap that contained their study ID, password, link to complete the ASA24 dietary recall,

unique link to complete the six surveys via REDCap, and step-by-step instructions for completing the online surveys. In total, thirty-eight women at all stages of pregnancy were recruited from the population of women seeking pre-natal care at the OHSU Center for Women's Health (CWH) to participate in this study.

Description of Survey Tools

As noted above, participants completed the following surveys. Copies of all surveys may be found in Appendix B.

Automated Self-Administered 24-Hour (ASA24) Dietary Assessment Tool: The ASA24 was created and is administered by the National Cancer Institute. The ASA24 is a web-based tool that enables multiple, automatically coded, self-administered 24-hour dietary recalls. The version that was used for this study was the ASA24-2016. Respondents were electronically guided through a 24-hour recall interview using a modified version of the United States Department of Agriculture's Automated Multiple Pass Method (AMPM).[130]

During the first pass, participants were asked to provide a list of foods and drinks consumed at each meal occasion during the previous 24-hour period from midnight to midnight. Participants were required to search to find foods, drinks or supplements; search results were then filtered by food groups. Foods, drinks, and supplements reported at each meal were then recorded in the My Foods and Drinks panel within the instrument. In addition to selecting an eating occasion (e.g. breakfast, lunch, snack), participants were also prompted to select the time of the occasion before reporting the foods and drinks that were consumed.

Once participants finished creating their My Foods and Drinks list, they were asked if they consumed anything during any three-hour gaps between eating occasions. Participants were also asked if they consumed anything between midnight and the first

eating occasion, and between the last eating occasion and midnight regardless of the length of time gaps. During this review, participants had the opportunity to return to the My Foods and Drinks list to add meals and the corresponding foods, drinks, and supplements consumed.

Participants were then asked for details regarding the foods and drinks they had recorded, including form (e.g. raw), preparation method (e.g. grilled or roasted), the amount consumed, and any additions (e.g. coffee cream, sugar, salad dressing). Next, participants were prompted to review all of the foods, drinks, and supplements reported for the given intake day. If desired, participants had the option to edit existing items or add meals, foods, drinks, or supplements. Finally, participants were asked questions probing the consumption of forgotten foods and drinks (e.g. snacks, fruits, vegetables, water, tea, coffee, and supplements). Participants were required to select "yes" or "no" for each food or drink. For any "yes" response, the participant was returned to their My Foods and Drinks list to add the item. Once all foods had been added, participants were asked whether the amount of foods and beverages consumed for the day being recorded was more than usual, usual, or less than usual. This question was designed to probe whether this was a typical day's intake.

Barriers to Healthy Eating Survey (BHES): This 18-item validated survey was developed by Eileen R. Fowles and Jeanette Feucht[30] to gain an understanding of the obstacles pregnant women encounter while trying to eat nutritious foods so as to facilitate development of effective interventions designed to enhance maternal nutritional status and infant birth weight. First published in 2004, the BHES is scored on a 5-point Likert-type scale with responses ranging from 1 (strongly agree) to 5 (strongly disagree). Items 2, 3, 4, 5 and 6 of the survey are negatively worded to avoid a response set bias. The possible scoring range is between 18 and 90, with lower scores indicating fewer barriers.

Eating Competence Satter Inventory (ecSI 2.0): The ecSI 2.0 is a validated 16-question assessment tool[46] of the four components of eating competence, including eating attitude, food acceptance, regulation of food intake and body weight, and management of eating context (including family meals). ecSI 2.0 uses a 5-point Likert-type scale (never = 0, rarely = 0, sometimes = 1, often = 2, always = 3), which is summed to equal a total score between 0-48 and four sub-scale scores: eating attitudes (0-15 score corresponding to questions 1, 2, 4, 8 and 14), food acceptance (0-9 score corresponding to questions 5-7), internal regulation (0-9 score corresponding to questions 9, 10 and 13), and eating context skills (0-15 score corresponding to questions 3, 11, 12, 15 and 16). Eating competence is defined as total scores greater than or equal to 32.

Nutrition Locus of Control: The locus of control construct, as derived from Rotter's Social Learning Theory,[74] has two dimensions. Internal locus of control is the extent to which one believes in one's personal ability to control outcomes, whereas external locus of control is the extent to which one believes events are beyond personal control. Self-direction, as measured by control orientation, is believed to influence self-care efforts, and educational and clinical programs based on locus of control perspectives have been suggested as a means to promote healthy behavior patterns. The Nutrition Locus of Control is determined from an 8-question validated survey.[28] The survey is scored based on a 6-point Likert-type scale ranging from "strongly disagree" (valued at 1) to "strongly agree" (valued at 6). Higher scores are associated with a tendency toward an internal locus of control.

Fetal Health Locus of Control: The Fetal Health Locus of Control follows a similar principle to the Nutrition Locus of Control, however, rather than investigating the concept of Locus of Control for one's own health, the scale examines feelings of control over another's health. The dynamic is made especially interesting because fetal health is

so strongly tied to the mother's health behaviors. This scale has three factors: internal control, control by health professionals (powerful others), and control by God/fate/chance. Using a validated 18-question survey,[29] scoring is based on a 5-point Likert-type scale with "strongly agree" rated as 5 and "strongly disagree" rated as 1. Questions 1-6 focus on internal control, questions 7-12 focus on control by God/fate/chance, and questions 13-18 focus on control by health professionals. A higher score in a particular sub-scale is associated with a stronger tendency toward that specific locus of control.

Food Insecurity 2-Question Screening Tool: The food insecurity 2-question screening tool is a validated tool[31] that asks participants to assess their agreement with the following statements for their households: (1) "Within the past 12 months we worried whether our food would run out before we got money to buy more" and (2) "Within the past 12 months the food we bought just didn't last and we didn't have money to get more." Participants may then choose to answer "often true," "sometimes true," or "never true" for each statement. An answer of "never true" for both questions indicates high food security; an answer of "sometimes true" for at least one question indicates marginal food security; and an answer of "often true" for at least one question indicates low to very low food security.

Demographics and Brief Medical History Questionnaire: This 12-question survey asked for participants' age, race, ethnicity, highest level of education, annual household income, estimated weeks gestation, alcohol consumption prior to pregnancy, smoking status, prior pregnancies, past history of chronic health conditions, medication use, and whether the participants' health care provider had talked with them about nutrition during pregnancy.

Data Collection and Management

Participants were assigned and issued a unique study identification code (ID) and password that was used for both the completion of the ASA24 dietary recall and the REDCap surveys. The key assigning participant information with the identification codes was stored in the secure, password-protected REDCap database, which only study personnel had access to. Participants' responses to the dietary recall and surveys were connected to their study IDs and were de-identified. No protected health information was connected to individual study IDs. A REDCap database used to collect participant contact information for purposes of issuing participant incentives was kept separate from both the key assigning participant IDs and survey data; this information was not included in the data downloaded for statistical analysis. Data downloaded from the ASA24 and REDCap for purposes of statistical analysis were de-identified.

Confidentiality

Participants accessed the ASA24 dietary recall web-based tool via a unique, de-identified username and password. No personal or protected health information was stored in the ASA24 database. All other data collected from the surveys was entered by participants and stored using the REDCap data system available through the Oregon Clinical and Translational Research Institute (OCTRI). REDCap is a secure, HIPAA compatible database application that supports data capture and data export for analysis. A de-identified Excel dataset was exported from REDCap for data analysis and stored on password protected, encrypted OHSU workstations and on the web-accessible OHSU Box.com cloud storage site, with access to all locations restricted to study personnel. Standard institutional practices were followed per the OHSU Information Security and Research Data Resource Guide to maintain the confidentiality and security

of data collected in this study. Data was not made available to other investigators at OHSU or outside institutions.

REDCap contains a number of features that protect participants' privacy and data security. OCTRI's REDCap software is housed on servers located in the Information Technology Group's Advanced Computing Center (ACC), providing locked physical security. The REDCap servers are housed behind both the OHSU firewall and a second ACC firewall. All web-based data transmissions are encrypted with industry-standard SSL methods. REDCap employs a robust multi-level security system that enables researchers to easily implement "minimum necessary" data access for their research staff, including specification of data fields that are identifiers. This feature includes "single click" ability to provide completely de-identified (removing all identified data fields and shifting dates) for analysis or other purposes. User activities are logged to enable auditing of all data access. Access is integrated with OHSU's network such that users who are also OHSU employees are authenticated against their OHSU network credentials. REDCap is jointly managed in accordance with OHSU Information Security Directives by ACC staff and members of OCTRI's Biomedical Informatics Program, ensuring fidelity of database configuration and back-ups. User activities are logged to enable auditing for all data changes.

Dietary Assessment Analysis

As noted above, the Automated Self-Administered 24-Hour (ASA24, 2016 version) dietary recall system was used to capture participants' dietary intake from midnight to midnight on the day prior to participating in the study. Once the study was complete, the study coordinator requested batch analytic files from the ASA24 system, which included dietary intake data from all respondents. The ASA24 derives nutrient data from the Food and Nutrient Database for Dietary Studies (FNDDS),[131] a database

that provides the nutrient values for food and beverages reported in *What We Eat in America*, the dietary intake component of the National Health and Nutrition Examination Survey (NHANES).

Diet quality for each participant was assessed using the Healthy Eating Index (HEI). As noted above, the HEI was developed by the USDA and is a measure of how closely a person's dietary intake conforms to the *Dietary Guidelines for Americans.* The total score is the sum of 13 components, with a maximum score of 100 (see Table 6 below).[132] Intakes between the minimum and maximum standards are scored proportionately. Using Statistical Analysis System software (SAS Version 9.4; Cary, North Carolina), the ASA24 data was incorporated into an algorithm that calculated HEI scores for each participant.[133]

Table 6. Dietary Components for the Healthy Eating Index-2015 (HEI-2015)[132]

Component	Max Points	Standard for Maximum Points[i]	Standard for Minimum Score of Zero[i]
Total Fruits	5	≥ 0.8 cup equivalents	No fruit
Whole Fruits	5	≥ 0.4 cup equivalents	No whole fruit
Total Vegetables	5	≥ 1.1 cup equivalents	No vegetables
Greens & Beans	5	≥ 0.2 cup equivalents	No dark green vegetables or legumes[ii]
Whole Grains	10	≥ 1.5 oz. equivalents	No whole grains
Milk/Dairy	10	≥ 1.3 cup equivalents	No dairy
Total Protein Foods	5	≥ 2.5 oz. equivalents	No protein foods
Seafood & Plant Proteins	5	≥ 0.8 oz. equivalents	No seafood or plant proteins
Fatty Acid Ratio	10	(PUFAs + MUFAs)/SFAs[iii] ≥ 2.5	(PUFAs + MUFAs)/SFAs[iii] ≤ 1.2
Refined Grains	10	≤ 1.8 oz. equivalents	≥ 4.3 oz. equivalents
Sodium	10	≤ 1.1 gram	≥ 2.0 grams
Added Sugars	10	≤ 6.5% of total energy	≥ 26% of total energy
Saturated Fats	10	≤ 8% of total energy	≥ 16% of total energy

i: All standards represent amounts per 1,000 kcal (sometimes shown as percentage of energy) except for Fatty Acids.

ii: Legumes includes dried beans and peas.

iii: PUFA = Polyunsaturated Fatty Acids; MUFA = Monounsaturated Fatty Acids; SFA = Saturated Fatty Acids

Calculations

REDCap survey data were downloaded into Microsoft Excel (Microsoft Office for Mac 2011 Version 14.5.2; Seattle, WA). Total eating competence and sub-scale scores were summed using the following formula: never = 0, rarely = 0, sometimes = 1, often = 2, always = 3. Scores for the four sub-scales were classified as follows: eating attitudes (corresponding to questions 1, 2, 4, 8 and 14), food acceptance (corresponding to

questions 5-7), internal regulation (corresponding to questions 9, 10 and 13), and eating context skills (corresponding to questions 3, 11, 12, 15 and 16). Eating competence was defined as total scores greater than or equal to 32. Participants were then coded as "1" for eating competent or "0" for not eating competent.

Nutrition Locus of Control scores were calculated as follows: questions 1-3 and 7 were summed whereas strongly agree equaled 6 and strongly disagree equaled 1 and questions 4-6 and 8 were summed whereas strongly disagree equaled 6 and strongly agreed equaled 1. Higher scores reflected a stronger tendency toward an internal locus of control. Participants were classified as having a tendency toward an internal Nutrition Locus of Control if the sum of all responses was ≥ 24.

Fetal Health Locus of Control (FHLC) scores were calculated for each sub-scale as follows: questions 1-6 were summed to reflect a tendency toward internal control, questions 7-12 were summed to reflect a tendency toward God/fate/chance, and questions 13-18 were summed to reflect a tendency toward health professionals (Powerful Others). A higher score in a particular sub-scale was associated with a tendency toward that specific locus of control. Participants were classified as having an internal FHLC if the sum of questions 1-6 was greater than or equal to 16; a God/fate/chance FHLC if the sum of questions 7-12 was greater than or equal to 16; and a Powerful Others FHLC if the sum of questions 13-18 was greater than or equal to 16.

Responses for the Barriers to Healthy Eating Survey were divided into the following categories: strongly disagree/disagree, don't know/neutral, and agree/strongly agree. Responses to individual questions were summed on the population level to determine the top barriers identified for the population. Higher numbers were associated with top barriers.

Food security status was determined based on answers to the 2-item food insecurity screening tool. Participants were coded as "0" if they responded "never true"

to both questions to indicate high food security. Participants were coded as "1" if they responded "sometimes true" or "often true" to at least one question to indicate food insecurity.

Continuous data from the demographics and brief medical history questionnaire were downloaded as a number to reflect the actual value of the variable (e.g. age). Categorical data from this questionnaire was assigned a number from "0" to "5" to reflect the categories selected by participants (e.g. for race/ethnicity and level of education) or as "0" for no and "1" for yes to indicate an affirmative response (e.g. for alcohol consumption or smoking status) or the presence or absence of a disease state (e.g. gestational diabetes mellitus).

Data Cleaning

Data collected from REDCap, as well as HEI-2015 calculations as derived from SAS, were transferred to Microsoft Excel (Microsoft Office for Mac 2011 Version 14.5.2; Seattle, WA) and Statistical Package for Social Sciences (SPSS Version 25 for Mac; IBM; Armonk, NY) for statistical analysis.

One participant had incomplete data from the ASA24 and was excluded from all analyses involving diet quality and the HEI-2015. Four participants did not complete any surveys and were entirely excluded from the analyses.

Statistical Analysis

To describe the diet quality and biopsychosocial factors that influence dietary behaviors, means and standard deviations were calculated for the entire sample based on HEI-2015 total scores and component scores, Eating Competence total scores and sub-scale scores, Nutrition Locus of Control total scores, Fetal Health Locus of Control sub-scale scores, and participant age. Percentages were calculated for each component

of the demographic and brief medical history questionnaire and for the percentage of participants who agreed or strongly agreed with each statement on the Barriers to Healthy Eating Survey.

To determine the association between diet quality and eating competence, logistic regression analyses were conducted to compare HEI-2015 total scores with eating competence as a dichotomous variable (ecSI 2.0 ≥ 32.0 vs. ecSI 2.0 < 32) for each participant and combined HEI-2015 fruits and vegetables component scores with eating competence as a dichotomous variable for each participant. Significance was set at 0.05 and trends were identified at 0.20 given the exploratory nature of the study.

To explore the association between eating competence and locus of control, logistic regression analyses were conducted to compare NLOC total scores and FHLC sub-scale scores with eating competence as a dichotomous variable (ecSI 2.0 ≥ 32.0 vs. ecSI 2.0 < 32) for each participant. Significance was set at 0.05 and trends were identified at 0.20 given the exploratory nature of the study.

As an exploratory measure, independent sample t-tests were also conducted to compare the means between HEI-2015 total scores, HEI-2015 fruits and vegetables scores, eating competence total scores, FHLC sub-scale scores, and NLOC total scores both between participants who had received nutrition education from an OB/GYN during their current pregnancy and who had seen a dietitian at the OHSU Center for Women's Health during their current pregnancy. Significance was set at 0.05 and trends were identified at 0.20 given the exploratory nature of the study. As a cautionary measure, the nonparametric Mann-Whitney U Test was also performed when sample size for a given group was less than 10.

Chapter 4: Results

Of the 38 participants enrolled in this study, four were lost to follow-up and were not included in this analysis. One additional participant had incomplete data from the ASA24 and was excluded from analyses involving the Healthy Eating Index (HEI). Complete data sets were available for 33 participants (87 percent retention); this data was included in all of the below analyses.

Characteristics of Study Participants

Table 7 presents characteristics of pregnant women participating in this study. The mean ± SD age at enrollment was 31.35 ± 4.21 years with a range of 23-39 years. Twenty-five (73.5 percent) of participants were White and 9 percent identified as Hispanic. Ninety-four percent of participants had a bachelor's degree or higher and 91 percent reported household income of at least $50,000 per year. Five women were in the first trimester of pregnancy, 18 were in the second trimester, and 11 were in the third trimester. Twenty-five (73.5 percent) of participants reported consuming alcoholic beverages in the three months prior to becoming pregnant, with the majority reporting the consumption of three or less drinks per week. Nine percent of participants reported smoking cigarettes (including electronic cigarettes) in the three months prior to becoming pregnant, with the majority reporting the consumption of four or less cigarettes per day. Fifty-three percent of participants were primiparous, 26 percent reported one pregnancy prior to the current pregnancy, and 21 percent reported two or more pregnancies prior to the current pregnancy. Six participants had received a diagnosis of gestational diabetes mellitus (GDM), while no participants reported having received a diagnosis of pre-diabetes, type 1 diabetes or type 2 diabetes. Eighty-two percent of participants reported having received information about nutrition during pregnancy from their OB/GYN, while

35 percent reported having met with a dietitian at the Center for Women's Health during their current pregnancy.

Table 7. Participant Characteristics (N=34)

Age (y)	31.53 ± 4.21
Race, n (%)[a]	
White/Caucasian	25 (73.5)
Asian American	6 (17.6)
Black/African American	3 (8.8)
Pacific Islander	3 (8.8)
American Indian/Alaskan Native	2 (5.9)
Unknown/Declined to State	1 (2.9)
Ethnicity, n (%)	
Non-Hispanic	30 (88.2)
Hispanic	3 (8.8)
Unknown/Decline to State	1 (2.9)
Highest Level of Education, n (%)	
High School Diploma or Equivalency	1 (2.9)
Associate Degree	1 (2.9)
Bachelor's Degree	10 (29.4)
Master's Degree	13 (38.2)
Doctorate Degree	6 (17.6)
Professional Degree (MD, JD, DDS, etc.)	3 (8.8)
Annual Household Income, n (%)	
Less than $25,000	3 (8.8)
$25,000 - $50,000	0 (0)
$50,000 - $100,000	16 (47.1)
$100,000 - $200,000	12 (35.3)
More than $200,000	3 (8.8)
Estimated Weeks of Pregnancy	21.41 ± 8.79
First Trimester, n (%)	5 (14.7)
Second Trimester	18 (52.9)
Third Trimester	11 (32.4)
Reported drinking alcoholic beverages in the 3 months prior to becoming pregnant, n (%)	
Yes	25 (73.5)
No	9 (26.5)
Average weekly alcoholic beverage consumption in the 3 months prior to becoming pregnant, n (%)[b]	
Less than 1 drink/week	9 (36.0)
1-3 drinks/week	9 (36.0)

4-6 drinks/week	5 (20.0)
7-13 drinks/week	2 (8.0)
14 or more drinks/week	0 (0)
Reported smoking cigarettes (including electronic cigarettes) in the 3 months prior to becoming pregnant, n (%)	
Yes	3 (8.8)
No	31 (91.2)
Average daily cigarette consumption in the 3 months prior to becoming pregnant, n (%)[c]	
0-4 cigarettes/day	2 (66.7)
5-14 cigarettes/day	1 (33.3)
15 or more cigarettes/day	0 (0)
First Pregnancy, n (%)	
Yes	18 (52.9)
No	16 (47.1)
Pregnancies reported prior to the current pregnancy (n=16) [d]	
1 prior pregnancy	9
2 prior pregnancies	2
3 prior pregnancies	3
4 prior pregnancies	1
5 prior pregnancies	1
Co-morbidities, n (%)	
Pre-diabetes	0 (0)
Type 1 diabetes	0 (0)
Type 2 diabetes	0 (0)
Gestational diabetes	6 (17.6)
High blood pressure	1 (2.9)
None of the above	27 (79.4)
Participants who reported having received information about nutrition during pregnancy from their OB/GYN, n (%)	
Yes	30 (88.2)
No	4 (11.8)
Participants who reported meeting with a dietitian at the Center for Women's Health during their current pregnancy, n (%)	
Yes	12 (35.3)
No	22 (64.7)

Y= years; n = number of subjects; % = percentage of subjects

Results are means ± standard deviation of the mean (SD) or percentage of subjects meeting given characteristic.

[a] Participants had the option of selecting multiple races.

[b] n only includes women who reported consuming alcohol

[c] n only includes women who reported smoking cigarettes or electronic cigarettes

[d] n only includes women who reported prior pregnancies

Healthy Eating Index (HEI)

Table 8 presents the range, mean, median, and standard deviation for total kilocalories consumed, each of the 13 components of the HEI-2015, total HEI-2015 scores, and fruits and vegetables combined scores for the 33 women who completed the ASA24 dietary recall. Total kilocalories consumed ranged from 1,278 to 3,687 per day with a mean of 2,336.8 kilocalories per day and median of 2,202.2 kilocalories per day. The combined HEI-2015 score for fruits and vegetables, which was the sum of the total vegetables, greens and beans, total fruit, and whole fruit component scores, ranged from 1.9 to 20.0 with a mean of 14.2 and median of 15.0. The total HEI-2015 scores, which was the sum of the 13 components, ranged from 25.3 to 81.9, with a mean of 60.3 and a median of 61.6.

Table 8. Healthy Eating Index (HEI-2015) Component and Combined Scores as Derived from the ASA24 Dietary Recall (n=33)

	Min/Max	Mean	Median	Std. Dev.
Kilocalories	1278 - 3687	2336.8	2202.2	± 604.1
Total Vegetables	0.9 - 5.0	3.9	4.5	± 1.3
Greens and Beans	0.0 - 5.0	2.9	3.4	± 2.2
Total Fruit	0.0 - 5.0	3.5	5.0	± 2.0
Whole Fruit	0.0 - 5.0	3.9	5.0	± 1.9
Combined Fruits/Veg.	1.9 - 20.0	14.2	15.0	± 5.4
Whole Grains	0.0 - 10.0	3.6	3.4	± 3.3
Dairy	0.0 - 10.0	5.2	5.3	± 3.4
Total Protein Foods	1.1 - 5.0	4.1	5.0	± 1.3
Seafood and Plant Protein	0.0 - 5.0	3.5	5.0	± 2.1
Fatty Acid Ratio	0.0 - 10.0	6.3	7.0	± 3.4
Sodium	0.0 - 10.0	4.1	3.8	± 3.6
Refined Grains	0.0 - 10.0	6.0	7.6	± 3.8
Saturated Fat	0.0 - 10.0	5.0	5.1	± 3.1
Added Sugar	2.7 - 10.0	8.2	8.9	± 2.3
Total HEI-2015 Score	**25.3 - 81.9**	**60.3**	**61.6**	**± 12.3**

Table 9 below compares HEI-2015 total and component scores from this study's population to average scores for U.S. adults between the ages of 18 to 64, as derived from NHANES 2013-2014 data.[94] In general, our population scored higher than the U.S. population in adequacy of total vegetables, total fruit, whole fruit, combined fruits and vegetables, whole grains, and fatty acid ratio, and moderation of sodium and added

sugar. However, the average U.S. population of adults 18-64 years old scored higher in terms of adequacy of greens and beans, dairy, total protein, and seafood and plant protein, and moderation of refined grains and saturated fat.

Table 9. Average Healthy Eating Index (HEI-2015) Total and Component Scores for Study Population vs. U.S. Adults aged 18-64[94]

HEI-2015 Component	Study Average	U.S. Average
Total Vegetables	3.9	3.3
Greens and Beans	2.9	3.2
Total Fruit	3.5	2.4
Whole Fruit	3.9	3.5
Combined Fruits/Veg.	14.2	12.4
Whole Grains	3.6	2.5
Dairy	5.2	5.9
Total Protein Foods	4.1	5.0
Seafood and Plant Protein	3.5	5.0
Fatty Acid Ratio	6.3	4.6
Sodium	4.1	3.9
Refined Grains	6.0	6.3
Saturated Fat	5.0	6.0
Added Sugar	8.2	6.4
Total HEI-2015 Score	**60.3**	**58.0**

Eating Competence Scores

Table 10 presents eating competence sub-scale and total scores for the 34 women who completed the eating competence (ecSI 2.0) survey. Possible total scores on the eating competence scale ranged from 0 to 48 with the cut-off point for eating competence established at ≥ 32. Possible scores on the eating attitudes and contextual skills sub-scales ranged from 0 to 15, while possible scores on the food acceptance and food regulation sub-scales ranged from 0 to 9; there are no established cut-off points for the sub-scales. Total eating competence scores ranged from 16 to 48, with a mean of 35.4 and a median of 36.5.

Table 10. Eating Competence Total and Sub-Scale Scores as Derived from the eating competence Satter Inventory (ecSI 2.0) (N=34)

	Min/Max	Mean	Median	Std. Dev.
Eating Attitudes	5 - 15	11.4	11.5	± 2.7
Food Acceptance	1 - 9	5.8	6.0	± 2.1
Food Regulation	2 - 9	6.9	7.0	± 2.1
Eating Context	5 - 15	11.3	12.0	± 3.0
Total Scores	**16 - 48**	**35.4**	**36.5**	**± 7.9**

Table 11 presents data on the number and percent of participants who were determined to be eating competent, based on the established cut-off point of ≥ 32. Of the 34 women completing the ecSI 2.0 survey, 24 participants (70.6 percent) were classified as eating competent and 10 participants (29.4 percent) were classified as not eating competent.

Table 11. Number and Percent of Participants Classified as Eating Competent and Not Eating Competent (N=34)

Eating Competent (ecSI 2.0 ≥ 32), n (%)	24 (70.6)
Not Eating Competent (ecSI 2.0 < 32), n (%)	10 (29.4)

Barriers to Healthy Eating

Table 12 presents data on the number and percent of women participating in the Barriers to Healthy Eating Survey who agreed and disagreed that each item on the survey was a barrier. For purposes of analysis "agreed" and "strongly agreed" were grouped together, while "disagreed" and "strongly disagreed" were grouped together. The following statements received the most agreement: "I have the necessary kitchen tools to cook healthy meals" (n=34; 100 percent); "The stove works well where I live" (n=33; 97.1 percent); "The refrigerator works well where I live" (n=33; 97.1 percent); and "I like to eat fruits" (n=33; 97.1 percent). The following statements received the most disagreement: "I don't buy milk because it costs too much" (n=33; 97.1 percent); "I don't buy fruits and vegetables because they cost too much" (n=33; 97.1 percent); "I don't buy meat because it costs too much" (n=32; 94.1 percent); and "I have to go farther than 2 miles to buy food to eat" (n=31; 91.2 percent). Thirteen participants (38.3 percent) agreed with the statement "I don't have time to cook healthy meals" while 16 participants (47.1 percent) agreed with the statement "It's easier for me to pick up a meal than cook at home."

Table 12. Identified Barriers to Healthy Eating (N=34), n (%)

	Disagree[a]	Don't Know	Agree[b]
I have to go farther than 2 miles to buy food to eat.	31 (91.2)	1 (2.9)	2 (5.8)
I have to go farther than 2 miles to buy fresh fruits and vegetables.	30 (88.2)	1 (2.9)	3 (8.8)
I don't buy milk because it costs too much.	33 (97.1)	0 (0)	1 (2.9)
I don't buy meat because it costs too much.	32 (94.1)	1 (2.9)	1 (2.9)
I don't buy fruits and vegetables because they cost too much.	33 (97.1)	0 (0)	1 (2.9)
I know how to cook meals with vegetables.	4 (11.8)	0 (0)	30 (88.2)
I know how to cook meals with meat.	6 (17.6)	0 (0)	28 (82.4)
I know how to cook healthy meals.	3 (8.8)	0 (0)	31 (91.2)
The stove works where I live.	0 (0)	1 (2.9)	33 (97.1)
The refrigerator works where I live.	0 (0)	1 (2.9)	33 (97.1)
I have the necessary kitchen tools to cook healthy meals.	0 (0)	0 (0)	34 (100)
I don't have time to cook healthy meals.	20 (58.8)	4 (11.8)	10 (29.4)
It's easier for me to pick up a meal than cook at home.	14 (41.2)	10 (29.4)	16 (47.1)
I like to eat meat.	9 (26.5)	0 (0)	25 (73.5)
I like to eat vegetables.	3 (8.8)	0 (0)	31 (91.2)
I like to eat fruits.	1 (2.9)	0 (0)	33 (97.1)
I like to eat bread.	2 (5.9)	1 (2.9)	31 (91.2)
I like to drink water.	2 (5.9)	2 (5.9)	30 (88.2)

[a] Participants who responded 'disagree' and 'strongly disagree' were grouped together.

[b] Participants who responded 'agree' and 'strongly agree' were grouped together.

Food Insecurity and Accessing Food Aid

Table 13 presents data from the USDA 2-question food insecurity screening tool. Four participants (11.8 percent) responded "sometimes" to the question "We worried whether our food would run out before we got money to buy more," while three of these same participants (8.8 percent of all participants) responded "sometimes" to the question "The food that we bought just didn't last and we didn't have money to get more." No participants responded "often" to either question. Because of the overlap of participants responding "sometimes" to both questions, four participants (11.8 percent) were classified as food insecure.

Table 13. Results from the USDA 2-Question Food Insecurity Screening Tool (N=34), n (%)

	Never	Sometimes	Often
"We worried whether our food would run out before we got money to buy more."	30 (88.2)	4 (11.8)	0 (0)
"The food that we bought just didn't last and we didn't have money to get more."	31 (91.2)	3 (8.8)	0 (0)

Table 14 describes the sources of food aid that participants reported they or their family members had received in the past 12 months. Three participants (8.8 percent) received Supplemental Nutrition Assistance Program (SNAP) benefits, two participants (5.9 percent) received Special Supplemental Assistance for Women, Infants and Children (WIC) benefits, 1 participant (2.9 percent) received school breakfast and school lunch benefits, and two participants (5.9 percent) had accessed a food bank. No participants reported having utilized Temporary Assistance for Needy Families (TANF),

School Summer Meals, congregate meals, or emergency food packages. Thirty participants (88.2 percent) reported not accessing any sources of food aid.

Table 14. Food Aid Resources Accessed by Participants and their Family Members within the Past 12 Months (N=34), n (%)

Supplemental Nutrition Assistance Program (SNAP)	3 (8.8)
Temporary Assistance for Needy Families (TANF)	0 (0)
Special Supplemental Assistance for Women, Infants and Children (WIC)	2 (5.9)
School Breakfast	1 (2.9)
School Lunch	1 (2.9)
School Summer Meals	0 (0)
Food Bank	2 (5.9)
Congregate Meals	0 (0)
Emergency Food Packages	0 (0)
None of the Above	30 (88.2)

Table 15 presents a brief summary of each of the four participants who identified as food insecure. The first three participants listed in the table responded "sometimes" to both questions, while the last participant responded "sometimes" to only the first question.

Table 15. Summary of Food Insecure Participants (n=4)

Participant #1	
Healthy Eating Index Score	58
HEI Fruits & Vegetables Score	17
Eating Competent?	No
Nutrition Locus of Control Tendency	Internal
Fetal Health Locus of Control Tendencies	Internal, Powerful Others
Barriers to Healthy Eating	Cooking Skills Time to Prepare Meals Food Acceptance
Food Aid Resources Accessed	None
Age	37
Race	Asian American
Ethnicity	Non-Hispanic
Highest Level of Education	Bachelor's Degree
Annual Household Income	$50,000 - $100,000
Estimated Weeks Gestation	7 Weeks
Alcohol/Cigarette Consumption	No
Past Pregnancies	1
Co-Morbidities	Gestational Diabetes
Received nutrition education from OB/GYN?	No
Saw a dietitian at Center for Women's Health?	No
Participant #2	
Healthy Eating Index Score	n/a[a]
HEI Fruits & Vegetables Score	n/a[a]
Eating Competent?	No
Nutrition Locus of Control Tendency	Internal
Fetal Health Locus of Control Tendencies	Internal
Barriers to Healthy Eating	Cost of Food Time to Prepare Meals Food Acceptance
Food Aid Resources Accessed	SNAP Food Bank
Age	23
Race	African American/Black White/Caucasian
Ethnicity	Hispanic
Highest Level of Education	High School
Annual Household Income	Less than $25,000
Estimated Weeks Gestation	14 Weeks
Alcohol/Cigarette Consumption	Cigarettes
Past Pregnancies	0
Co-Morbidities	None
Received nutrition education from OB/GYN?	No
Saw a dietitian at Center for Women's Health?	No

Participant #3	
Healthy Eating Index Score	67
HEI Fruits & Vegetables Score	20
Eating Competent?	Yes
Nutrition Locus of Control Tendency	Internal
Fetal Health Locus of Control Tendencies	Internal
Barriers to Healthy Eating	Food Access (Distance) Cost of Food Cooking Skills Time to Prepare Meals
Food Aid Resources Accessed	None
Age	28
Race	Asian American Pacific Islander White/Caucasian
Ethnicity	Hispanic
Highest Level of Education	Master's Degree
Annual Household Income	$50,000 - $100,000
Estimated Weeks Gestation	33 Weeks
Alcohol/Cigarette Consumption	Alcohol
Past Pregnancies	0
Co-Morbidities	None
Received nutrition education from OB/GYN?	Yes
Saw a dietitian at Center for Women's Health?	Yes
Participant #4	
Healthy Eating Index Score	59
HEI Fruits & Vegetables Score	3
Eating Competent?	Yes
Nutrition Locus of Control Tendency	Internal
Fetal Health Locus of Control Tendencies	Internal, Powerful Others
Barriers to Healthy Eating	Time to Prepare Meals Food Acceptance
Food Aid Resources Accessed	Food Bank
Age	39
Race	White/Caucasian
Ethnicity	Non-Hispanic
Highest Level of Education	Master's Degree
Annual Household Income	$50,000 - $100,000
Estimated Weeks Gestation	30 Weeks
Alcohol/Cigarette Consumption	Alcohol
Past Pregnancies	1
Co-Morbidities	None
Received nutrition education from OB/GYN?	No
Saw a dietitian at Center for Women's Health?	No

[a] Participant #2 only partially complete the ASA24 dietary recall, thus a Healthy Eating Index score could not be calculated.

Nutrition Locus of Control

Table 16 presents the minimum, maximum, mean, median, and standard deviation of combined scores from the Nutrition Locus of Control (NLOC) survey. The NLOC is based on a scale of 0-48, where scores of 0-24 reflect a tendency toward an external locus of control while scores of 25-48 reflect a tendency toward an internal locus of control. Of the 34 participants who completed this survey, combined scores ranged from 31 to 47, with a mean of 39.85 and a median of 39.50. As all participants scored above 25, this reflects that 100 percent of participants had a tendency toward an internal locus of control.

Table 16. Summary of Results from Nutrition Locus of Control Survey (N=34)

	Minimum	Maximum	Mean	Median	Std. Dev.
Nutrition Locus of Control	25	48	39.85	39.50	± 4.05

Fetal Health Locus of Control

Table 17 presents the minimum, maximum, mean, median, and standard deviation of combined scores from each of the three sub-scales of the Fetal Health Locus of Control (FHLC) survey -- Internal, God/Fate/Chance, and Powerful Others. Each of these sub-scales is based on a scale of 0-30, with higher scores reflecting a stronger tendency towards a given locus of control. Of the 34 participants who completed this survey, combined scores on the Internal sub-scale ranged from 22 to 30, with a mean of 26.76 and median of 27. Combined scores on the Chance sub-scale ranged from 7 to 26, with a mean of 15.15 and a median of 14, whereas combined scores on the Powerful Others sub-scale ranged from 6 to 20, with a mean of 13.09 and a median of 12.5.

Table 17. Summary of Results from Fetal Health Locus of Control Survey (N=34)

	Minimum	Maximum	Mean	Median	Std. Dev.
Internal Sub-Scale	22	30	26.76	27	2.09
Chance Sub-Scale	7	26	15.15	14	4.79
Powerful Others Sub-Scale	6	20	13.09	12.5	3.44

Table 18 presents the number and percent of participants who scored above the mid-point (> 15) on each FHLC sub-scale, indicating a tendency toward that particular locus of control. Thirty-four participants (100 percent) scored above the mid-point on the Internal sub-scale, 14 participants (41.1 percent) scored above the mid-point on the God/Fate/Chance sub-scale, and 11 participants (32.4 percent) scored above the mid-point on the Powerful Others sub-scale.

Table 18. Participants Scoring above the Mid-Point (> 15) on the Fetal Health Locus of Control Sub-Scales (N=34)

Internal Sub-Scale, n (%)	34 (100)
Chance Sub-Scale, n (%)	14 (41.1)
Powerful Others Sub-Scale, n (%)	11 (32.4)

Associations between Healthy Eating Index and Eating Competence

The mean ± SD HEI-2015 score for non-eating competent women was 56.4 ± 6.6 (n=9), whereas the mean ± SD HEI-2015 score for eating competent women was 61.8 ± 13.6 (n=24). The results of the simple logistic regression analysis comparing these two populations are summarized in Table 19 below. While mean HEI-2015 total scores were higher overall among eating competent women, the results indicate that total HEI-2015

score is not a statistically significant correlate of eating competence (OR=1.037; 95% CI=0.972-1.107; p=0.269).

The mean ± SD combined HEI-2015 fruit and vegetable score for non-eating competent women was 11.8 ± 5.1 (n=9), whereas the mean ± SD combined HEI-2015 fruit and vegetable score for eating competent women was 15.1 ± 5.4 (n=24). The results of the simple logistic regression analysis comparing these two groups are summarized in Table 19 below. This finding trended toward significance in that eating competent women had higher combined HEI-2015 fruits and vegetables scores compared to non-eating competent women (OR=1.120; 95% CI=0.969-1.295; p=0.125).

Table 19. Summary of Simple Logistic Regression Comparing Eating Competence to Healthy Eating Index-2015 Total Scores (n=33)

	Non-EC	EC	OR	95% CI	*p*-value
n	9	24			
HEI-2015 Total	56.4 (6.6)	61.8 (13.6)	1.037	0.972-1.107	0.269
HEI-2015 F+V	11.8 (5.1)	15.1 (5.4)	1.120	0.969-1.295	0.125*

EC = Eating Competent; Values are mean (standard deviation)

OR = Odds Ratio

CI = Confidence Interval

F+V = Fruits and Vegetables combined scores

Eating Competence defined as ≥ 32.0

**Significance set at $p \leq 0.05$

*Trends identified at $p \leq 0.20$

Associations between Eating Competence, Nutrition Locus of Control and Fetal Health Locus of Control

The mean ± SD NLOC score for non-eating competent women was 38.8 ± 5.2 (n=10), whereas the mean ± SD NLOC score for eating competent women was 40.3 ± 3.5 (n=24). The results of the simple logistic regression analysis comparing these two

groups are summarized in Table 20 below. While mean NLOC scores were higher overall among eating competent women, the results indicate that a stronger tendency toward an internal NLOC is not a statistically significant correlate of eating competence (OR=1.100; 95% CI=0.909-1.332; p=0.327).

Table 20. Summary of Logistic Regression Comparing Eating Competence to Nutrition Locus of Control (NLOC) (N=34)

	Non-EC	EC	OR	95% CI	*p*-value
n	10	24			
NLOC Total	38.8 (5.2)	40.3 (3.5)	1.110	0.909-1.332	0.327

EC= Eating Competent; Values are mean (standard deviation)

OR = Odds Ratio

Eating Competence defined as ≥ 32.0

**Significance set at $p \leq 0.05$

*Trends identified at $p \leq 0.20$

For the 10 non-eating competent women, mean ± SD sub-scale scores on the FHLC were 26.0 ± 2.7, 14.9 ± 4.7, and 13.3 ± 4.1 on the Internal, Chance and Powerful Others sub-scales, respectively. For the 24 eating competent women, mean ± SD sub-scale scores were 27.1 ± 1.7, 15.3 ± 4.9, and 13.0 ± 3.2 on the Internal, Chance and Powerful Others sub-scales, respectively. The results of the multiple logistic regression analysis are summarized in Table 21 below. The results show that while a stronger tendency toward a Chance or Powerful Others FHLC is not a significant correlate of eating competence (OR=1.027 and 0.963, respectively; 95% CI=0.860-1.227 and 0.764-1.213, respectively; p=0.765 and 0.748, respectively), having a stronger tendency toward an Internal FHLC and being eating competent trended toward significance (OR=1.299; 95% CI=0.894-1.888; p=0.170).

Table 21. Summary of Logistic Regression Comparing Eating Competence to Fetal Health Locus of Control (FHLC) (N=34)

	Non-EC	EC	OR	95% CI	*p*-value
n	10	24			
FHLC-Internal	26.0 (2.7)	27.1 (1.7)	1.299	0.894-1.888	0.170*
FHLC-Chance	14.9 (4.7)	15.3 (4.9)	1.027	0.860-1.227	0.765
FHLC-Powerful	13.3 (4.1)	13.0 (3.2)	0.963	0.764-1.213	0.748

EC= Eating Competent; Values are mean (standard deviation)

OR = Odds Ratio

Eating Competence defined as ≥ 32.0

**Significance set at $p \leq 0.05$

*Trends identified at $p \leq 0.20$

Associations between Receiving Nutrition Education during Pregnancy and Healthy Eating Index, Eating Competence and Locus of Control

As an exploratory analysis, independent sample t-tests were conducted to explore the relationship between having received nutrition education from an OB/GYN during participants' current pregnancy and HEI-2015 total scores, HEI-2015 fruits and vegetables scores, eating competence, nutrition locus of control, and fetal health locus of control. Likewise, independent sample t-tests were conducted to explore the relationships between these variables and having met with a dietitian at OHSU's Center for Women's Health during participants' current pregnancy. Results are summarized in Tables 22 and 23 below. As shown in Table 22, participants who reported having received nutrition education from their OB/GYN during their current pregnancy had significantly higher HEI-2015 fruits and vegetables scores compared to women who had not received nutrition education (p=0.004). A nonparametric Mann-Whitney U Test also showed a statistically significant difference (p=0.025). These women also had

significantly higher eating competence scores (p=0.032) through an independent samples t-test and trended toward significance with a nonparametric Mann-Whitney U Test (p=0.093). In addition, as shown in Table 23, the association between participants who reported having met with a dietitian during their current pregnancy and having a higher HEI-2015 fruits and vegetables score trended toward significance (p=0.113)

Table 22. Summary of Independent Sample T-Tests Comparing Having Received Nutrition Education from an OB/GYN during Current Pregnancy with Healthy Eating Index (HEI-2015), Eating Competence, Nutrition Locus of Control (NLOC), and Fetal Health Locus of Control Internal and Powerful Others Sub-Scales (FHLC-I and FHLC-P) (N=34)

	Received Nutrition Education	Did Not Receive Nutrition Education	*p*-value
n[a]	30	4	
HEI-2015 Total	60.00 (12.2)	63.00 (16.4)	0.695
HEI-2015 Fruit + Veg[b]	15.06 (4.8)	5.96 (5.6)	0.004**
Eating Competence[c]	36.43 (7.2)	27.50 (9.7)	0.032**
NLOC	40.07 (3.9)	38.25 (5.6)	0.407
FHLC-I	26.87 (2.0)	26.00 (2.9)	0.444
FHLC-P	13.00 (3.4)	13.75 (4.6)	0.689

[a] Only 3 participants who did not receive nutrition education from their OB/GYN were included in the test comparing HEI-2015 total scores and HEI-2015 fruits and vegetables scores to having received nutrition education due to missing ASA24 dietary recall data.

[b] p = 0.025 with a nonparametric Mann-Whitney U Test

[c] p = 0.093 with a nonparametric Mann -Whitney U Test

Values are mean (standard deviation)

**Significance set at $p \leq 0.05$

*Trends identified at $p \leq 0.20$

Table 23. Summary of Independent Sample T-Tests Comparing Having Met with a Dietitian during Current Pregnancy with Healthy Eating Index (HEI-2015), Eating Competence, Nutrition Locus of Control (NLOC), and Fetal Health Locus of Control Internal and Powerful Others Sub-Scales (FHLC-I and FHLC-P) (N=34)

	Met with a Dietitian	Did Not Meet with a Dietitian	*p*-value
n[a]	12	22	
HEI-2015 Total	62.08 (10.5)	59.24 (13.4)	0.533
HEI-2015 Fruit + Veg	16.23 (3.5)	13.01 (6.0)	0.113*
Eating Competence	37.42 (6.5)	34.27 (8.5)	0.275
NLOC	40.00 (4.3)	39.77 (4.0)	0.878
FHLC-I	27.00 (1.5)	26.64 (2.4)	0.635
FHLC-P	12.08 (3.1)	13.64 (3.6)	0.214

[a] Only 21 participants who did not meet with a dietitian were included in the test comparing HEI-2015 total scores and HEI-2015 fruits and vegetables scores to having received nutrition education due to missing ASA24 dietary recall data.

Values are mean (standard deviation)

**Significance set at $p \leq 0.05$

*Trends identified at $p \leq 0.20$

Chapter 5: Discussion

Summary

This study examined diet composition and biopsychosocial factors that influence dietary behaviors in a small sample (N=34) of pregnant women seeking pre-natal care at a women's health center in an academic institution. As a pilot study, it is among the first studies to explore the associations between eating competence, nutrition locus of control (NLOC), fetal health locus of control (FHLC), barriers to healthy eating, and food security status in pregnant women.

The primary aim of this study was to describe the diet quality and biopsychosocial factors that influence dietary behaviors, as derived from a series of questionnaires—the ASA24 dietary recall, eating competence Satter Inventory (ecSI 2.0), NLOC, FHLC, Barriers to Health Eating, and USDA 2-question food insecurity screening questionnaire. Secondary aims were to test associations between diet quality and eating competence and eating competence and locus of control with these same variables. As an exploratory measure, we also examined the associations between having received nutrition education during pregnancy from an OB/GYN or dietitian and diet quality, eating competence, and locus of control. The results reported will help to inform and guide the planning for future research within the state of Oregon on factors that influence dietary behaviors in pregnant women, with the ultimate goal of improving both the health of pregnant women and their offspring.

Given the small sample size of this pilot study, it is difficult to draw firm conclusions; however several trends were identified which will help to guide future research. While we were not able to confirm our hypothesis that Healthy Eating Index (HEI-2015) scores would be significantly higher in pregnant women who were eating competent compared to pregnant women who were not eating competent, we did observe trends in the odds of being eating competent and consuming more fruits and

vegetables. In addition, while we could also not confirm our hypothesis that NLOC scores would be significantly higher in pregnant women who were eating competent compared to pregnant women who were not eating competent, we did observe trends in the odds of being eating competent and having a higher score on the Internal sub-scale of the FHLC.

On the other hand, the exploratory hypotheses that women who had received nutrition education from an OB/GYN during their current pregnancy would have significantly higher HEI-2015 fruits and vegetables component scores and higher eating competence scores were found to be significant. However, the exploratory hypotheses that women who had received nutrition education from an OB/GYN during their current pregnancy would have significantly higher HEI-2015 total scores and higher NLOC-Internal and FHLC-Internal sub-scale scores were not found to be significant. Likewise, we could not find evidence in support of the exploratory hypotheses that women who had met with a dietitian at the CWH during their current pregnancy would have significantly higher HEI-2015 total scores, eating competence scores, and NLOC-Internal and FHLC-Internal sub-scale scores. However, the exploratory hypothesis that women who had met with a dietitian during their current pregnancy would have higher HEI-2015 fruits and vegetables component scores did trend toward significance.

Comparison of Participant Demographics to General Population

The participant population of this study was largely White women, over the age of 25, with a higher socioeconomic status and education level than the general population. This both potentially skews the results toward better eating habits and limits the generalizability of the results to other populations. The average age of participants in this study was 31.5 years, which is higher than the national average of 26.6 years for first time pregnant women in the United States.[134] In addition, 44 percent of participants

reported annual household incomes above $100,000. According to the U.S. Census Bureau, the median annual household income for the United States was $60,336 in 2017 and $60,212 for the state of Oregon.[135] Ninety-four percent of participants in this study had at least a Bachelor's degree, compared to 33 percent of adult women nationwide.[136] Moreover, 74 percent of participants in this research were White, which is lower than the overall percent of White residents in Oregon (87 percent),[137] but consistent with the percent nationwide (77 percent).[138]

Dietary Intake of Women During Pregnancy

The average HEI-2015 score of 60.3 for pregnant women in this study was lower than the average HEI scores calculated from previous research that used ASA24 dietary recalls to calculate HEI in samples of pregnant women seeking pre-natal care at OHSU. A study of 41 pregnant women at OHSU with a mean age of 30.9 reported a mean HEI of 67,[96] while the OHSU Pregnancy, Exercise and Nutrition (PEN) study reported a mean HEI of 62.0 in a sample of 28 women.[97] While both of these studies used the HEI-2010 to assess diet quality, it should be noted that the demographics of PEN study participants were also largely White, highly educated, and of a higher socioeconomic status. In addition, the largest study published to date assessing the diet quality of pregnant women in the United States (N=7,511), reported an average HEI-2010 of 63; this study also reported higher HEI scores among White women and that HEI scores increased with level of education.[100]

Biopsychosocial Factors that Influence Dietary Behavior in Pregnant Women

While research is limited in regards to eating competence among pregnant women, our study results indicate higher overall levels of eating competence among our participants compared to studies involving participants with similar demographic

characteristics. It should be noted that the original eating competence validation study was conducted in a sample of largely White females with high levels of post-secondary education and high levels of food security.[43] The mean eating competence score was 31.1 in that sample compared to 35.4 in our sample. Past research has shown higher eating competence scores associated with higher socio-economic status,[45] although significant differences were not noted in our research. Previous research has also shown significantly higher HEI scores in eating competent participants compared to those who are not eating competent;[43,47-48] this was not the case in our study. Our study also found lower overall HEI scores for eating competent participants compared to previous studies. For example, in a sample of women in Pennsylvania, non-eating competent women had an HEI of 63.0 compared to an HEI of 66.2 for eating competent women.[48] Our study results found an HEI of 56.4 in non-eating competent women compared to an HEI of 61.8 in eating competent women.

As noted in Chapter 2, higher self-efficacy, as typically exhibited in people with an internal locus of control, is typically associated with greater adherence to dietary interventions.[28] The original validation study of the Nutrition Locus of Control construct reported an association between higher scores on the NLOC-Internal sub-scale and intake of fruits, vegetables, whole grains, dairy, and plant-based protein.[28] As one hundred percent of participants in our study were classified as having an internal NLOC, no associations were noted between NLOC orientation and diet composition. Our study was also among the first studies to examine the relationships between eating competence and NLOC. Again, no significant associations were noted between the two instruments.

Likewise, having an internal tendency on the Fetal Health Locus of Control has been associated with a number of health-seeking behaviors,[34-36] while having a tendency toward an external FHLC has been associated with non-adherence to clinical

guidelines.[80] As with the NLOC survey, 100 percent of participants in this study had a tendency toward an internal FHLC. However, the odds of having a higher score on the Internal sub-scale of the FHLC and being eating competent trended toward significance. As a person may score high in one or more constructs of the FHLC, 41 percent of participants also had a tendency toward a Chance FHLC and 32 percent had a tendency toward a Powerful Others FHLC. However, there were no associations between these two constructs and any other variables.

In terms of the Barriers to Healthy Eating Survey, participants in our study identified lack of time to prepare healthy meals, the convenience of picking up a meal versus preparing a meal from scratch, and knowledge of food preparation skills as their top barriers. It should be noted, however, that for every item on this survey except for access to cooking equipment, at least one participant identified it as a barrier. While pregnant women in our study did indicate barriers related to food costs, access to grocery stores, and food preferences, this demonstrates the importance of needing to address these barriers on a case-by-case basis. Our study did have some similarities with the pilot study that validated the BHES tool, although the pilot study found greater challenges related to access to appliances compared to our study.[30] While our study is among the first studies to examine barriers to healthy eating among pregnant women in Portland, a qualitative study conducted in Astoria also noted busy work schedules that limit time to plan and prepare meals as a barrier to health eating.[107]

Food Insecurity in Pregnancy

The prevalence of food insecurity among our participants was 11.8 percent, which is on par with the national average (also 11.8 percent),[129] but slightly less than the population average for the state of Oregon (14.6 percent).[128] The mean HEI-2015 score for food insecure participants in our survey was 61.7, which is well above the mean of

41.9 found among pregnant women participating in NHANES.[114] Of note, neither of the participants in our study who reported receiving WIC benefits screened positive for food insecurity, while only one out of three participants receiving SNAP benefits screened positive. Three out of four of the food insecure participants in our study reported annual household incomes above $50,000, which may make them ineligible for SNAP or WIC benefits. However, these participants also noted barriers to healthy eating such as food preparation skills, time to prepare healthy meals, and food preferences. Factors that led this population to screen positive for food insecurity deserve closer attention in future research.

A number of professional organizations, including the American Academy of Pediatrics[139] and the American Diabetes Association[140] now recommend screening for food insecurity in health care settings; this should be coupled with providing individuals who screen positive a list of resources on where to access food in their community and connecting them with other professionals who may help them determine which benefits they are eligible for. Results from food insecurity screening may also be documented in electronic medical records. Screening for food insecurity in a pre-natal clinic may be completed relatively quickly, yet has the potential to make a positive impact on the health of pregnant women, their families, and their offspring given that research has shown that food insecure pregnant women have an increased odds of having GDM[118-119] or iron-deficiency anemia, two conditions that increase the risk of complications for both the mother and baby. The role of food insecurity in influencing the health of mothers and offspring is an area for future DOHaD research as well.

Nutrition Education in Pregnancy

Significant differences were found in fruits and vegetables consumption and eating competence scores between pregnant women in this study who indicated they

had received nutrition education from their OB/GYN during their current pregnancy compared to women who had not received nutrition education from their OB/GYN. In addition, having met with a dietitian during their current pregnancy and consuming more fruits and vegetables also trended toward significance. While this was an exploratory question in this research and the extent of nutrition education received is unknown, the ability of nutrition education during pregnancy to influence dietary patterns, eating competence, self-efficacy, and birth outcomes is an area of research in need of further study. Although research is limited in regards to intervention studies that have measured eating competence scores in pregnant women pre- and post-intervention, other intervention studies among non-pregnant women that utilized nutrition education curricula built around the Satter Eating Competence Model have found significant differences in eating competence scores pre- and post-intervention.[59, 63] In addition, *My Pregnancy Plate*[141] (see Appendix D), which is built around the *Dietary Guidelines for Americans* is currently being utilized by dietitians and other health care providers at the OHSU Center for Women's Health to provide nutrition education to pregnant women. Given that the HEI is built around adherence to these guidelines, our data suggest that measuring the HEI in women who have received nutrition education through *My Pregnancy Plate* is an area for future research.

Strengths of Study Design

A strength of this study was the use of previously validated survey tools, including the ASA24, eating competence Satter Inventory (ecSI 2.0), Nutrition Locus of Control, Fetal Health Locus of Control, Barriers to Healthy Eating Survey, and 2-Question Food Insecurity Screening Tool. This eliminated the need for further validation prior to commencing this study and allowed for comparison with previous studies that

had used these tools. The fact that these surveys were self-administered offered greater convenience to participants and eliminated interviewer bias.

Another strength of this study was the use of the ASA24 dietary recall to collect dietary information from participants. In epidemiologic studies, dietary recalls are typically considered more accurate than food frequency questionnaires because they capture actual intake over a specified period of time versus usual intake over a relatively long period of time; dietary recalls are also less prone to recall bias.[142] The ASA24 also features built-in mechanisms to probe participants about their dietary intake, such as asking participants if they consumed any foods in the gap periods between meals, assisting participants with estimating portion sizes, probing for details about meals including preparation method, and asking questions about commonly forgotten foods.[143] Moreover, in a study of 1,081 adults comparing the ASA24 to an interviewer-administered 24-hour dietary recall using the automated multiple-pass method (AMPM), researchers found the ASA24 to be as reliable as the interviewer-administered AMPM; participants reported feeling the ASA24 more accurately captured their true intake and 70 percent preferred the ASA24 to an interviewer-administered AMPM.[144]

Limitations of Study Design

As noted above, this study was an exploratory study with a relatively small sample size (N=34). As such, this study was not adequately powered to identify statistically significant differences between groups, which increases the likelihood of making a Type II error when conducting statistical analyses. With a small sample size, there is a greater likelihood that outliers will influence the group mean, which reduces the ability to observe true effects and increases the probability that a null hypothesis will be erroneously accepted or rejected. In addition, due to the small sample size we were only able to test the association between two variables and not control for covariates that

may have influenced these variables, such as age, trimester of pregnancy, or income level.

A second limitation was that data were collected exclusively from participants at one OB/GYN clinic located in an academic health center. The fact that this sample was comprised largely of highly educated pregnant women, who were predominantly White and of a higher socioeconomic status, may lead the findings to not be generalizable to other populations.

Another limitation of this study was that the demographic and brief medical history questionnaire was not validated prior to commencing the study. Specifically, the questions on whether participants had received nutrition education from their OB/GYN or visited a dietitian at the CWH may have been open to interpretation and how they were interpreted may have varied from individual to individual. There may also have been differences in the level of nutrition education provided by OB/GYNs. Also, as nurse midwives were involved in participant recruitment, some participants may not have regularly seen an OB/GYN. In regards to visiting with a dietitian, this question may also have been interpreted differently across individuals. Most newly pregnant women meet with a dietitian for about 15 minutes in a group setting during their intake appointments, at which time they receive nutrition education including an introduction to *My Pregnancy Plate*.[141] Women deemed at high risk, including women with GDM, may also meet with a dietitian one-on-one during the course of their pregnancies for lengthier appointments. The extent to which the participants deemed the intake appointments as having met with a dietitian may have varied across participants. In addition, data about co-morbidities, such as GDM and hypertension, were self-reported rather than relying on medical records, which could have resulted in errors in reporting.

An additional limitation of this study was the use of only one 24-hour dietary recall to capture dietary intake. The decision to include only one dietary recall as part of

the study design was due to cost limitations, the belief that requiring multiple recalls would deter participants from completing the study or participating in it entirely, and the extended length of follow-up required to implement this method. Ideally in studies where a 24-hour dietary recall is the chosen method of dietary assessment, multiple recalls should be collected in order to more accurately collect data about a person's true intake.[142] Collecting only one day's worth of data runs the risk that the participants' intake that day was atypical and does not reflect day-to-day variations in diet or account for the possibility of participants' diets changing over the course of their pregnancies. Twenty-four hour dietary recalls are also prone to recall bias and the ASA24 in particular requires literacy and internet access to complete, which may have limited the participation of some people.

Finally the eligibility requirements and recruitment methods utilized may have introduced bias into the study findings. Participants were required to be able to understand written English, which limited the participation of participants who spoke a language other than English and may have influenced both the racial and ethnic diversity and range of participants' socioeconomic status of the sample. Advertising study recruitment on websites may have led to the participation of women who were actively seeking to enroll in clinical trials during pregnancy, which may have been a factor in the sample being highly educated. In addition, the use of a dietitian at the CWH for recruitment could have resulted in more participants with GDM. While the prevalence of GDM among women seeking pre-natal care at OHSU is not currently known, the estimated prevalence of GDM in the state of Oregon is 8.1 percent,[145] which is considerably lower than the 17.6 percent reported by our participants. Likewise, nurse midwives were also involved in recruitment of study participants, which could have more heavily skewed the participation of women seeking pre-natal care from nurse midwives compared to through OB/GYNs.

Lessons Learned

As this study was conducted at an academic medical center, at any given time it competed with a minimum of 10 other studies targeting pregnant women for recruitment, including other studies on nutrition during pregnancy. This factor alone likely influenced the overall sample size of the study, as potential participants were introduced to numerous study opportunities at the same time during their intake appointments and through recruitment flyers and web postings. The burden of participation being limited to approximately one hour and the fact that participants could complete the study according to their own time schedules was seen as beneficial to overall study participation. However, the study coordinator not being able to have face-to-face contact with potential participants for recruitment or follow-up purposes was seen as a drawback to recruitment and retention of potential participants. In addition, recruitment was only open for eight months, which likely contributed to the small sample size. Finally, it would have been helpful to validate the Demographics and Brief Medical History questionnaire prior to commencing this study to better clarify how participants interpreted the wording of the questions.

Conclusion

In this small study, we observed significant differences in fruits and vegetables consumption and eating competence scores between women who reported having received nutrition education during their OB/GYN visit compared to women who had not. Although we did not find significance in most statistical tests comparing survey findings, we did observe trends in the odds of being eating competent and consuming more fruits and vegetables, being eating competent and having a higher score on the Internal sub-scale of the Fetal Health Locus of Control, and meeting with a dietitian and consuming

more fruits and vegetables. These pilot findings will help to inform future research and nutrition education efforts in this domain.

Future Research

Future research on biopsychosocial factors that influence dietary behaviors in pregnant women should incorporate larger, more diverse samples of pregnant women, including participants with a primary language other than English, participants from more diverse socioeconomic backgrounds, and participants living in rural areas. Based on the findings of this study, a key area for exploration would be the ability of nutrition education during pregnancy—including nutrition education provided by an OB/GYN or registered dietitian—to effect change on a woman's eating competence and locus of control and how this relates to dietary intake and birth outcomes; such research could explore changes in biopsychosocial factors and dietary intake pre- and post-intervention and how these changes relate to one another. Further qualitative research may begin to explore the barriers pregnant women and women of child-bearing age face in adopting a healthy diet, as well as risk factors for food insecurity during pregnancy; quantitative research in this realm may explore the associations between food insecurity during pregnancy and birth outcomes.

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Appendix A: Consent and Authorization Form

IRB#: 18026

Research Consent Summary

You are being asked to join a research study. You do not have to join the study. Even if you decide to join now, you can change your mind later.

TITLE: Eating competence and its relationship to dietary behaviors in pregnant women

Principal Investigator: Joyanna Hansen, PhD, RD, LD
Co-Investigator: Jonathan Purnell, MD
Study Coordinator: Becky A. Johnson, MA

1. The purpose of this study is to learn more about the nutrition and diet composition of pregnant women and factors that influence the dietary choices they make during pregnancy.
2. We want to learn about:
    a. The types and amounts of food and beverages you consume
    b. Attitudes that influence diet and nutrition decisions
    c. Barriers to accessing food and preparing meals
3. The research study is unfunded, but participant compensation is being provided by Dr. Jonathan Purnell.
4. If you join the study, you will complete 6 online surveys, accessed through 2 separate links that will be provided to you via e-mail. The time to complete all 6 surveys will be approximately 1 hour. There is no follow up.
5. If you complete all 6 surveys, you will receive a $20 Fred Meyer gift card.
6. There is a potential risk of loss of confidentiality involved with participation in this study. The surveys involve some sensitive questions about your health conditions and your family's annual income, which you may decline to answer at any time.

OREGON HEALTH & SCIENCE UNIVERSITY

IRB#: 18026

Research Consent and Authorization Form

TITLE: Eating competence and its relationship to dietary behaviors in pregnant women

PRINCIPAL INVESTIGATOR: Joyanna Hansen, PhD, RD, LD
hansejo@ohsu.edu
(503) 494-4263

CO-INVESTIGATOR: Jonathan Purnell, MD
purnellj@ohsu.edu

STUDY COORDINATOR: Becky Johnson, MA
johnsbec@ohsu.edu

FUNDED BY: This study is unfunded, but compensation for study participants is provided by the co-investigator, Dr. Jonathan Purnell.

SUPPORTED BY: Oregon Health & Science University Center for Women's Health

PURPOSE:
You have been invited to participate in this research study because you are an active patient at the OHSU Center for Women's Health and are currently pregnant. The purpose of this study is to learn more about the nutrition and diet composition of pregnant women and what influences the dietary choices they make during pregnancy.

Participation involves approximately 1 hour of your time to complete a series of electronic surveys, including a 24-hour dietary recall. This study will enroll up to 50 pregnant women (18 years of age or older) who are active patients at the OHSU Center for Women's Health.

PROCEDURES:
If you agree to participate in this study, you will be provided with 2 links to access the online surveys.

The first survey will ask you about all of the foods and beverages you have consumed within the past 24 hours.

The second set of surveys will list a series of statements about factors that influence the decisions you make around your diet, of which you will be asked to rate your agreement or disagreement with the statements. You will also be asked a few questions such as age, race, income level, education level, and any medical diagnoses you may have.

At any point in the surveys, you may choose not to answer a question or may withdraw from the study.

RISKS AND DISCOMFORTS:
Some of these questions may seem personal or embarrassing. They may upset you. You may refuse to answer any of the questions that you do not wish to answer.

Although we have made efforts to protect your identity, there is a small risk of loss of confidentiality by participating in this study.

BENEFITS:
By serving as a participant, you may help us learn how to benefit patients in the future.

ALTERNATIVES:
You may choose not to be in this study. You do not need to participate in this research study to receive treatment from the OHSU Center for Women's Health.

CONFIDENTIALITY:
We will take steps to keep your personal information confidential, but we cannot guarantee total privacy. All data will be directly entered into a secure, OHSU database and only accessible to the primary investigator and study coordinator. Data will be de-identified prior to analysis so that no personal identifiers will be attached to your responses.

We will create and collect health information about you as described in the Purpose and Procedures sections of this form. Health information is private and is protected under federal law and Oregon law. By agreeing to be in this study, you are giving permission (also called authorization) for us to use and disclose your health information as described in this form.

The investigators, study staff, and others at OHSU may use the information we collect and create about you in order to conduct and oversee this research study.

We may release this information to others outside of OHSU who are involved in conducting or overseeing research, including The Office for Human Research Protections, a federal agency that oversees research involving humans. Those listed above may also be permitted to review and copy your records.

We will not release information about you to others not listed above, unless required or permitted by law. We will not use your name or your identity for publication or publicity purposes, unless we have your special permission.

Under Oregon law, suspected child or elder abuse must be reported to appropriate authorities.

When we send information outside of OHSU, they may no longer be protected under federal or Oregon law. In this case, your information could be used and re-released without your permission.

We may continue to use and disclose your information as described above indefinitely.

COMMERCIAL DEVELOPMENT
Information about you or obtained from you in this research may be used for commercial purposes, such as making a discovery that could, in the future, be patented or licensed to a company, which could result in a possible financial benefit to that company, OHSU, and its researchers. There are no plans to pay you if this happens. You will not have any property rights or ownership or financial interest in or arising from products or data that may result from your participation in this study. Further, you will have no responsibility or liability for any use that may be made of your information.

COSTS:
There will be no cost to you or your insurance company to participate in this study.

You will receive a $20 gift card as compensation for completing the surveys.

LIABILITY:
If you believe you have been injured or harmed as a result of participating in this data collection, contact Joyanna Hansen, PhD, RD, LD at (503) 494-4263.

OHSU does not offer any financial compensation or payment for the cost of any injury or harm. However, you are not prevented from seeking to collect compensation for injury related to negligence on the part of those involved in the research. Oregon law (Oregon Tort Claims Act (ORS 30.260 through 30.300) may limit the dollar amount that you may recover from OHSU or its caregivers and researchers for a claim relating to care or research at OHSU, and the time you have to bring a claim.

If you have questions on this subject, please call the OHSU Research Integrity Office at (503) 494-7887.

PARTICIPATION:
If you have any questions, concerns, or complaints regarding this study now or in the future, contact Joyanna Hansen, PhD, RD, LD at (503) 494-4263.

This research is being overseen by an Institutional Review Board ("IRB"). You may talk to the IRB at (503) 494-7887 or irb@ohsu.edu if:

- Your questions, concerns, or complaints are not being answered by the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research subject.
- You want to get more information or provide input about this research.

You may also submit a report to the OHSU Integrity Hotline online at https://secure.ethicspoint.com/domain/media/en/gui/18915/index.html or by calling toll-free (877) 733-8313 (anonymous and available 24 hours a day, 7 days a week).

Your participation in this study is voluntary. You do not have to join this or any research study. You do not have to allow the use and disclosure of your health information in the study, but if you do not, you cannot be in the study.

If you do join the study and later change your mind, you have the right to quit at any time. This includes the right to withdraw your authorization to use and disclose your health information. If you choose not to join any or all parts of this study, or if you withdraw early from any or all parts of the study, there will be no penalty or loss of benefits to which you are otherwise entitled, including being able to receive health care services or insurance coverage for services. Talk to the investigator if you want to withdraw from the study.

If you no longer want your health information to be used and disclosed as described in this form, you must send a written request or email stating that you are revoking your authorization to:

Joyanna Hansen, PhD, RD, LD
Dept. of Molecular & Medical Genetics
Oregon Health & Science University
3181 SW Sam Jackson Park Road
Mailcode: GH 214
Portland, OR 97239
hansejo@ohsu.edu

Your request will be effective as of the date we receive it. However, health information collected before your request is received may continue to be used and disclosed to the extent that we have already acted based on your authorization.

If you choose to withdraw from the research study, no further information will be requested from you. However, you will not receive compensation unless you complete the study.

If in the future you decide you no longer want to participate in this research, we will remove your name and any other identifiers from your information, but the material will not be destroyed and we will continue to use it for research.

We will give you any new information during the course of this research study that might change the way you feel about being in the study.

You do not have to be in any research study offered by your care team at the OHSU Center for Women's Health.

ELECTRONIC CONSENT:
Your submission of this electronic form by clicking on "I AGREE TO PARTICIPATE" indicates that you have read the entire Information Form and that you agree to take these surveys. If you change your mind, you may exit the surveys at any time.

Participant Name: _____

Date: _____

___ Yes, I agree to participate in this research study. By checking this box, I agree that I have read the entire Information Form and I agree to take these surveys. If I change my mind about participating in this research, I may exit the surveys at any time.

___ No, I do not wish to participate in this research.

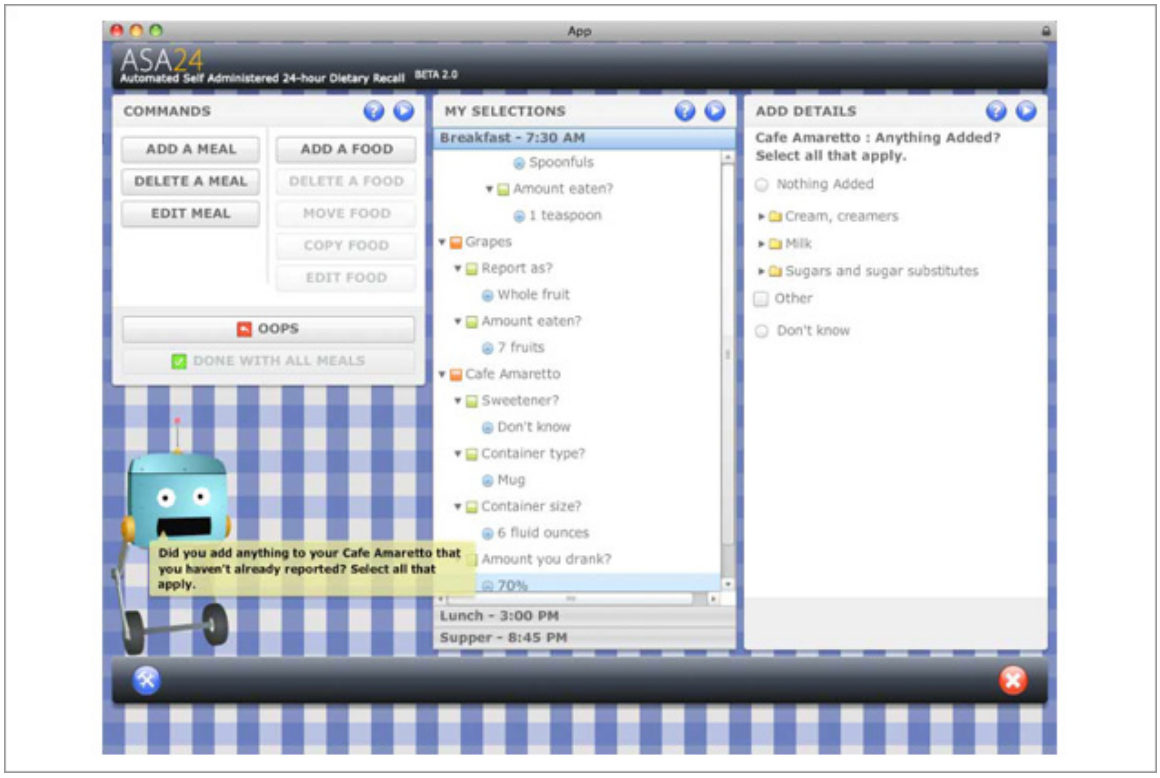
Appendix B: Survey Tools

Automated Self-Administered 24-Hour Dietary Recall (ASA-24) Overview

Meal-based Quick List
During the first pass of the 24-hour recall, Respondents are asked to provide a list of the foods and drinks consumed at each meal occasion during the previous 24-hour recall period from midnight-to-midnight or, optionally, for the past 24-hours (starting at the time of the first login).

Respondents are required to search to find foods, drinks or supplements; search results can then be filtered by food groups, if desired. Foods, drinks and supplements reported at each meal are recorded in the My Foods and Drinks panel within the instrument. In addition to selecting an eating occasion (e.g., breakfast, lunch, snack), Respondents are also prompted to specify the time of the occasion before reporting the foods and drinks consumed. Contextual information will also be collected, including where meals were eaten, whether television or computers were used during meals, and whether the meal was eaten alone or with others.

Figure 1. Example of Viewer Screen

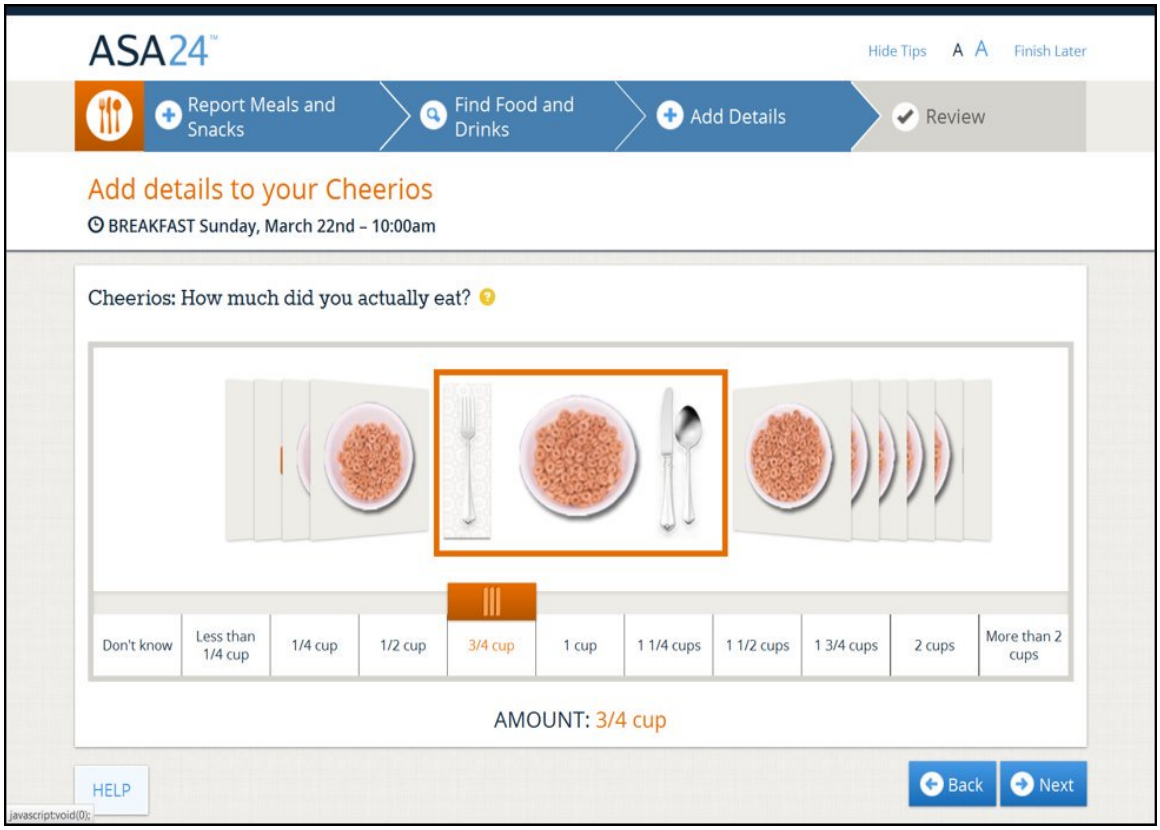


Meal Gap Review
Once Respondents finish creating their My Foods and Drinks list at the end of the Quick List, they are asked if they consumed anything during any 3-hour gaps between eating occasions. For the midnight-to-midnight version of the 24-hour recalls and for food records, Respondents are also asked if they consumed anything between midnight and

the first eating occasion, and between the last eating occasion and midnight regardless of the length of time gaps. During a Gap Review, Respondents have the opportunity to return to the Quick List to add meal(s) and the corresponding foods, drinks, and supplements consumed.

Detail Pass
Respondents are asked for details about the foods and drinks they recorded during the Quick List, including form (e.g., raw), preparation methods (e.g., grilled or roasted), the amount consumed, and any additions (e.g., sugar, coffee cream, salad dressing). An option is available to probe Respondents about the source (e.g. grocery store, farmer's market, etc.) of all or most of the ingredients in the reported foods and drinks.

Figure 2. Example of Probing Question Regarding Portion Size



Final Review
Respondents are prompted to review all of the foods, drinks, and, supplements reported for the intake day. If desired, Respondents can return to the Quick List to edit existing items or to add meals, foods, drinks and supplements.

Forgotten Foods
Following the Final Review, Respondents are asked questions probing the consumption of commonly forgotten foods and drinks (e.g., snack foods, fruits, vegetables, cheese, water, coffee, tea, and supplements). Respondents must select either "Yes" or "No" for each food and drink. For any "Yes" response, the Respondent is returned to the Quick

List to add the forgotten item(s).

Last Chance
After Forgotten Foods, Respondents are asked if they have reported all foods, drinks and supplements. If not, Respondents will be returned to the Quick List to add more items; otherwise, they will move to the Usual Intake Question.

Usual Intake Question
For recalls, the final question asks: Was the amount of food and drink that you had yesterday more than usual, usual, or less than usual? This question probes whether this was a typical day's intake.

More information about the ASA-24 is available at the following website: https://epi.grants.cancer.gov/asa24/

Barriers to Healthy Eating Survey

Rate the following statements on a scale of 1 to 5, with 1 indicating 'Strongly Disagree' and 5 indicating 'Strongly Agree.'

	Strongly Disagree	Disagree	Don't Know	Agree	Strongly Agree
1. I have to go farther than 2 miles to buy food to eat.	1	2	3	4	5
2. I have to go father than 2 miles to buy fresh fruits and vegetables.	1	2	3	4	5
3. I don't buy milk because it costs too much.	1	2	3	4	5
4. I don't buy meat because it costs too much.	1	2	3	4	5
5. I don't buy fruits and vegetables because they cost too much.	1	2	3	4	5
6. I know how to cook meals with vegetables.	1	2	3	4	5
7. I know how to cook meals with meat.	1	2	3	4	5
8. I know how to cook healthy meals.	1	2	3	4	5
9. The stove works well where I live.	1	2	3	4	5
10. The refrigerator works well where I live.	1	2	3	4	5
11. I have the necessary kitchen tools to cook healthy meals.	1	2	3	4	5
12. I don't have time to cook healthy meals.	1	2	3	4	5
13. It's easier for me to pick up a meal than cook at home.	1	2	3	4	5
14. I like to eat meat.	1	2	3	4	5
15. I like to eat vegetables.	1	2	3	4	5
16. I like to eat fruits.	1	2	3	4	5
17. I like to eat bread.	1	2	3	4	5
18. I like to drink water.	1	2	3	4	5

Eating Competence Satter Inventory

Below are statements about your eating. Think about each one, and then check the box that is the best response for you.

A = Always O = Often S = Sometimes R = Rarely N = Never

	A	O	S	R	N
1. I am relaxed about eating.	☐	☐	☐	☐	☐
2. I am comfortable about eating enough.	☐	☐	☐	☐	☐
3. I have regular meals.	☐	☐	☐	☐	☐
4. I feel it is okay to eat food that I like.	☐	☐	☐	☐	☐
5. I experiment with new food and learn to like it.	☐	☐	☐	☐	☐
6. If the situation demands, I can "make do" by eating food I don't much care for.	☐	☐	☐	☐	☐
7. I eat a wide variety of foods.	☐	☐	☐	☐	☐
8. I am comfortable with my enjoyment of food and eating.	☐	☐	☐	☐	☐
9. I trust myself to eat enough for me.	☐	☐	☐	☐	☐
10. I eat as much as I am hungry for.	☐	☐	☐	☐	☐
11. I tune in to food and pay attention to eating.	☐	☐	☐	☐	☐
12. I make time to eat.	☐	☐	☐	☐	☐
13. I eat until I feel satisfied.	☐	☐	☐	☐	☐
14. I enjoy food and eating.	☐	☐	☐	☐	☐
15. I consider what is good for me when I eat.	☐	☐	☐	☐	☐
16. I plan for feeding myself.	☐	☐	☐	☐	☐

Nutrition Locus of Control

Rate your agreement with the following statements on a scale of 1 to 6, with 1 indicating 'Strongly Disagree' and 6 indicating 'Strongly Agree.'

	Strongly Disagree					**Strongly Agree**
1. I generally try to choose healthy foods.	1	2	3	4	5	6
2. I believe that I have a responsibility to choose foods that are good for me.	1	2	3	4	5	6
3. I would be willing to change the way I eat if it was better for me.	1	2	3	4	5	6
4. Usually I eat whatever I feel like without thinking whether its nutritious.	1	2	3	4	5	6
5. It would be simply a matter of luck if I happened to get healthy food every day.	1	2	3	4	5	6
6. I do not think what I eat will affect my health.	1	2	3	4	5	6
7. I would eat a healthier diet if I could afford it.	1	2	3	4	5	6
8. There is not much I can do to change my eating habits.	1	2	3	4	5	6

Fetal Health Locus of Control

Rate the following statements on a scale of 1 to 5, with 1 indicating 'Strongly Disagree' and 5 indicating 'Strongly Agree.'

	Strongly Disagree	Disagree	Don't Know	Agree	Strongly Agree
1. By attending prenatal classes taught by competent health professionals, I can greatly increase the odds of having a healthy, normal baby.	1	2	3	4	5
2. My unborn child's health can be seriously affected by my dietary intake during pregnancy.	1	2	3	4	5
3. If I get sick during pregnancy, consulting my doctor is the best thing I can do to protect the health of my unborn child.	1	2	3	4	5
4. Learning how to care for myself before I become pregnant helps my child to be born healthy.	1	2	3	4	5
5. What I do right up to the time that my baby is born can affect my baby's health.	1	2	3	4	5
6. Before becoming pregnant, I would learn what specific things I should do and not do during pregnancy in order to have a healthy, normal baby.	1	2	3	4	5
7. Even if I take excellent care of myself when I am pregnant, fate will determine whether my child is born normal or abnormal.	1	2	3	4	5
8. If my baby is unhealthy or abnormal, nature intended it to be that way.	1	2	3	4	5
9. No matter what I do when I am pregnant, the laws of nature will determine whether or not my child will be normal.	1	2	3	4	5
10. God will determine the health of my child.	1	2	3	4	5
11. Fate determines the health of my unborn child.	1	2	3	4	5
12. Having a miscarriage means to me that my baby was not destined to live.	1	2	3	4	5
13. My baby will be born healthy only if I do everything my doctor tells me to do during my pregnancy.	1	2	3	4	5
14. The care I receive from health professionals is what is responsible for the health of my unborn child.	1	2	3	4	5
15. Health professionals are responsible for the health of my unborn child.	1	2	3	4	5
16. Doctors and nurses are the only ones who are competent to give me advice concerning my behavior during pregnancy.	1	2	3	4	5
17. My baby's health is in the hands of of health professionals.	1	2	3	4	5
18. Only qualified health professionals can tell me what I should and should not do when I am pregnant.	1	2	3	4	5

USDA Food Security Survey

Considering the past 12 months, rate your agreement with the following statements:

1. We worried whether our food would run out before we got money to buy more.

_____ Often _____ Sometimes _____ Never

2. The food that we bought just didn't last and we didn't have money to get more.

_____ Often _____ Sometimes _____ Never

3. What food aid resources have you or your family members received in the past 12 months? (Check all that apply):

_____ SNAP
_____ TANF
_____ WIC
_____ School Breakfast
_____ School Lunch
_____ School Summer Meals
_____ Food Bank
_____ Congregate Meals
_____ Emergency Food Package
_____ Other (please specify: _____)
_____ None of the above

Demographics and Brief Medical History

Age _____

Race (check all that apply)
- ___ American Indian/Alaskan Native
- ___ Asian American
- ___ Black/African American
- ___ Pacific Islander
- ___ White/Caucasian
- ___ Unknown/Decline to state

Ethnicity (choose one)
- ___ Hispanic
- ___ Non-Hispanic
- ___ Unknown/Decline to state

Highest Level of Education (choose one)
- ___ High school diploma or equivalency (GED)
- ___ Associate degree (junior college)
- ___ Bachelor's degree
- ___ Master's degree
- ___ Doctorate degree
- ___ Profession (MD, JD, DDS, etc.)
- ___ Other, specify _____
- ___ None of the above (less than high school)

Annual Household Income
- ___ Less than $25,000
- ___ $25,000 - $50,000
- ___ $50,000 - $100,000
- ___ $100,000 - $200,000
- ___ More than $200,000
- ___ Unknown/Decline to state

Estimated week of pregnancy (gestation) _____

Alcohol Consumption: During the 3 months before you became pregnant, did you drink alcohol? (If no, skip to next question)
- ___ No
- ___ Yes

During the 3 months before you became pregnant, how many alcoholic drinks did you have in an average week?
- ___ Less than 1 drink a week
- ___ 1 to 3 drinks a week
- ___ 4 to 6 drinks a week
- ___ 7 to 13 drinks a week
- ___ 14 drinks or more a week

Smoking Habits: During the 3 months before you became pregnant, did you smoke cigarettes (including electronic cigarettes)? (If no, skip to next question)

___ No
___ Yes

How many cigarettes did you smoke per day, on average?

___ 0 to 4
___ 5 to 14
___ 15 to 24
___ 25 to 34
___ More than 35

Health History

Is this your first pregnancy? (If yes, skip to next question)

___ No (How many pregnancies have you had before this one? ____)
___ Yes

Has a health care provider even told you that you had any of the following health conditions? (Check all that apply)

___ Pre-diabetes
___ Type 1 diabetes
___ Type 2 diabetes
___ Gestational diabetes
___ High blood pressure or hypertension

Have you received information about nutrition during pregnancy from your Ob/Gyn?

___Yes
___ No

During your pregnancy, have you met with a dietitian at the Center for Women's Health?

___ Yes
___ No

Appendix C: Glossary of Terms

Developmental Origins of Health and Disease: a paradigm that focuses on how environmental factors acting during the phase of developmental plasticity interact with genotypic variation to change the capacity of the organism to cope with its environment later in life

Developmental Plasticity: neuronal changes brought about by environmental interactions including in utero undernutrition

Eating Competence: an alternative method for delivering nutrition education that is focused on the enjoyment of food rather than strict adherence to dietary guidelines; a dietary philosophy that focuses on creating harmony between what a person desires to eat based on personal pleasure and what a person should eat to promote positive health outcomes

Eating Competent: being positive, comfortable and flexible with eating and matter-of-fact and reliable about getting enough to eat of enjoyable and nourishing food; determined by having a score ≥ 32.0 on the eating competence Satter Inventory (ecSI 2.0)

Epigenetics: changes in gene expression brought about by environmental factors

Fetal Health Locus of Control: whether an individual believes the health of her offspring is related to her own health-related behaviors or external factors

Fetal Programming: concept that asserts that environmental factors than an embryo or fetus is exposed to in utero can reset physiological parameters that may affect the offspring for life

Food Security: physical and economic access to sufficient, safe and nutritious foods that meets the dietary needs and food preferences for an active and healthy lifestyle

Nutrition Locus of Control: whether an individual believes her health outcomes are related to personal dietary choices or external factors

Overnutrition: consuming an excess of calories beyond the body's physiological requirements; abnormal or excessive fat accumulation that may impair health, which typically results in overweight or obesity

Prudent Dietary Pattern: a diet characterized by greater intake of fruits, vegetables and low-fat dairy products

Social Learning Theory: the concept that an expected effect or outcome of a behavior influences the motivation of people to engage in that behavior

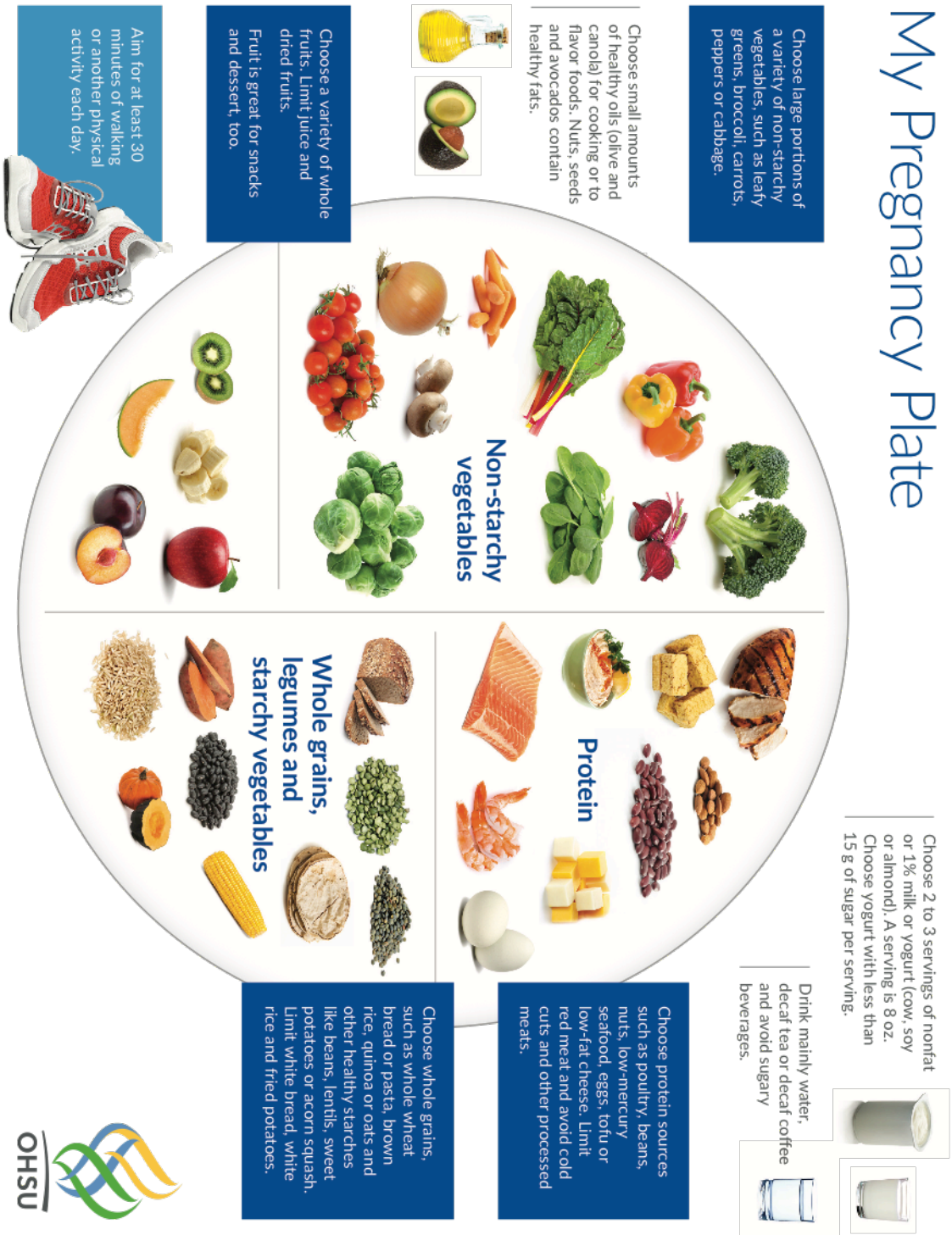
Transtheoretical Model (also known as Stages of Change): the theory that an individual's motivation to change is influenced by where they are currently at on a hierarchy between pre-contemplation, contemplation, preparation, action and maintenance

Ultra-Processed Food: formulations mostly of cheap industrial sources of dietary energy and nutrients plus additives, using a series of processes which altogether are energy dense, high in unhealthy types of fat, refined starches, free sugars and salt, and poor sources of protein, dietary fiber and micronutrients

Undernutrition: not consuming enough calories and essential nutrients to meet the body's physiological demands

Western Dietary Pattern: a diet characterized by higher intake of salt, sugar and fat

Appendix D: My Pregnancy Plate



Healthy snack ideas

When you are pregnant, you need about 300 extra calories each day starting in the second trimester. This is not really that much. It equals one large snack or two smaller snacks a day.

LARGE SNACK

1 slice whole wheat bread

+

1 Tbsp peanut butter

+

1 medium apple

OR

TWO SMALL SNACKS

1 cup cubed melon

+

12 almonds

AND

6 oz. low-fat yogurt

What about sweets?

You may be wondering whether there is room for cookies, candy, ice cream or other sweets in your pregnancy diet. You can eat sweets, but not every day. The goal is to use My Pregnancy Plate as your guide for healthy eating, be physically active and satisfy your sweet tooth with an occasional treat. This balance will help you achieve the recommended weight gain below.

Recommended weight gain during pregnancy based on pre-pregnancy weight

Pre-pregnancy weight	Recommended weight gain	Recommended rate of weight gain after first trimester
Underweight (BMI <18.9 kg/m2)	28–40 lbs	5.0 lbs/month
Normal weight (BMI: 18.9-24.9 kg/m2)	25–35 lbs	4.0 lbs/month
Overweight (BMI: 25-29.9 kg/m2)	15–25 lbs	2.6 lbs/month
Obese (BMI > 30 kg/m2)	11–20 lbs	2.0 lbs/month

Food safety

Here are some tips for safe food handling:

- Wash your hands before preparing food and eating.
- Wash fresh produce thoroughly before eating.
- Cook food thoroughly, especially eggs and foods made with eggs, meat, poultry and seafood.

Avoid the following:

- Raw fish, especially shellfish and sushi
- Unpasteurized milk, juice and soft cheeses such as feta, bleu cheese, brie and queso blanco. Soft cheeses made from pasteurized milk are fine.
- Raw sprouts
- Herbal supplements and herbal teas, until you check with your provider
- Swordfish, tilefish, king mackerel and shark, due to high mercury content

Do include a source of DHA. This is a type of fat called “omega-3” that is very important for your baby’s healthy brain and eye development. Omega-3 fat is especially important from 20 weeks of pregnancy until you are done breastfeeding. Experts recommend that pregnant and nursing women get 300 mg of DHA every day.

The best sources of DHA are wild albacore tuna (make sure it says “troll-caught”) and wild salmon. These types of fish are safe for pregnant women. If you don’t eat fish, you can get DHA by taking fish oil capsules. Take enough to get 300 mg of DHA each day. If you don’t eat animal products, you can take DHA capsules made from algae.