Maternal Depression and Food Insecurity during Pregnancy among Oregon Women

by

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A Thesis

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List of Abbreviations

ACOG	American College of Obstetricians and Gynecologists
AIDS	Acquired Immunodeficiency Syndrome
APNCU	Adequacy of Prenatal Care Utilization Index
BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
DHS	Department of Human Services
FPL	Federal Poverty Level
HIV	Human Immunodeficiency Virus
IPV	Intimate Partner Violence
OR	Odds Ratio
NH	Non-Hispanic
PRAMS	Pregnancy Risk Assessment Monitoring System
SPSS	Statistical Package for the Social Sciences
SUDAAN	Survey Data Analysis
USDA	United States Department of Food and Agriculture
WIC	Special Supplementary Nutrition Program for Women, Infants, and Children

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Abstract

Background

Food insecurity refers to the limited or uncertain ability to acquire food. Often associated with hunger, food insecurity has also been shown to have negative effects on the health of adults. In general, outcomes such as disease management and obesity worsen when an individual is food insecure. These effects may even differ by gender, having a greater impact on adult women compared to adult men. It has been hypothesized that food insecurity may have similar negative effects on mental health outcomes such as anxiety and depression.

Pregnancy represents a period of dramatic physical change and specialized nutritional requirements for women. It may also mark a period of unique challenges in relation to food insecurity. Food insecurity during pregnancy has previously been associated with several adverse outcomes. One particular effect may be antenatal depression, or depression that occurs during pregnancy. This study tests the hypothesis that women who are food insecure during pregnancy are more likely to experience antenatal depression.

Methods

This study used data from the 2005 Oregon Pregnancy Risk Assessment Monitoring System (PRAMS) to study the association between food insecurity during pregnancy and antenatal depressive symptoms. Oregon PRAMS sampled 2806 women and had a total of 1915 respondents. The un-weighted response rate for PRAMS was 68.2%, and the weighted response rate was 75.6%. Preliminary analysis indicated an association between a measure of food insecurity and one measure of antenatal depressive symptoms. This study sought to further explore this association. Food

insecurity was measured using a single item that assessed food access during the 12 months prior to delivery, asking: “During the 12 months before your new baby was born, did you ever eat less than you felt you should because there wasn’t enough money to buy food?” Antenatal depressive symptoms were measured using two items on the PRAMS questionnaire: “While you were pregnant, how often did you feel down, depressed, or hopeless?” and “While you were pregnant, how often did you have little interest or pleasure in doing things?” Women who answered “Always” or “Often” to either question were categorized as having had antenatal depression. Logistic regression analysis was used to examine the association between food insecurity and depressive symptoms, as well as between food insecurity and other independent risk factors for food insecurity. Hierarchical stepwise logistic regression was then used to determine the association between food insecurity and depression, while controlling for additional risk factors. All analyses used weighted data to account for the complex sampling design utilized by PRAMS.

Results

In univariate logistic analysis, antenatal depressive symptoms were significantly associated with food insecurity during pregnancy (OR 3.56, 95% CI 2.18, 5.80; $p < 0.001$). When controlling for additional risk factors, women with depressive symptoms were more likely to be food insecure than those without symptoms (OR 1.84, 95% CI 0.92, 3.67), but the association was not statistically significant. Food insecurity was also associated with lower household income, participation in the WIC program, residence in a rural county, experiencing intimate partner violence perpetrated by an ex-partner, and several stressful life events including homelessness.

Discussion

This study found a significant association between antenatal depressive symptoms and food insecurity during pregnancy. Additional study is needed to determine if antenatal depression is a contributing factors in the development of food insecurity, or if food insecurity during pregnancy produces antenatal depression. Programs focused on addressing food insecurity may benefit from including strategies to recognize and treat depression during pregnancy. Since food insecurity is a complex issue involving many factors, additional studies are also needed to investigate how social and cultural elements influence the risk of food insecurity and what impact they may have on its association with antenatal depression. This research could be very useful for identifying women most at risk for food insecurity and its related adverse health outcomes.

Introduction

Food Insecurity

Food insecurity is the condition of having limited or uncertain access to sufficient amounts of nutritionally adequate and safe foods[1]. Often associated with hunger, food insecurity represents a widespread challenge to the health of the public. The United States Department of Agriculture estimates that at least 11 percent of U.S. households (or approximately 35.5 million people) experienced food insecurity in 2005[1]. The concern over this condition is so great, that reducing food insecurity has been identified as an objective of the *Healthy People 2010* guidelines[2].

Current research suggests that food insecurity may be associated with a number of adverse health outcomes. Food insecure adults have been shown to maintain a lower mean intake of dietary nutrients than those who are food secure[3]. In particular, dietary intake of calcium has been found to be significantly lower in food insecure individuals, compared food secure adults[4]. Food insecurity has also been associated with an increased incidence of chronic disease and poor disease management[5]. One recent study reported that food insecure adults living with HIV/AIDS infections experience an increase in difficulties related to care[6].

Other authors have shown that food insecure women experience increased levels of overweight and obesity. Repeated analyses have found that mean body mass index (BMI) is significantly higher in women who are food insecure[3, 5, 7]. An analysis of a national sample of women even noted a possible dose-response relationship between overweight BMI and level of food insecurity, with 34% of food secure women classified

as overweight compared with 41% of those who were "mildly" food insecure, and 52% of those "moderately" food insecure[7].

Adult women may suffer from other poor health outcomes related to food insecurity, more so than men. In addition to reduced intake of dietary nutrients, food insecure women have also been shown to consume decreased amounts of fruits and vegetables in their diets[3]. Some investigations of dietary patterns within food insecure households have noted that these foods are among the first to be sacrificed when women are threatened with hunger[3].

Pregnancy represents a period of dramatic physical change and specialized nutritional requirements for women[8]. Research suggests that pregnancy may also mark a cycle of distinctive challenges related to food insecurity. Within the current literature, there is evidence to indicate pregnant women experience unique outcomes as a result of food insecure status. An analysis performed on a small cohort of pregnant women noted a significant association between food insecurity and the delivery of low birth weight neonates[9]. Additional examination of food insecurity in new mothers has also demonstrated a significant association with an increased risk of certain birth defects[10]. Taken together, these studies suggest that food insecurity may have a host of effects on pregnant women and their offspring. Additional research may determine if food insecurity is associated with other aspects of pregnancy.

Antenatal Depression

Depression is one of several mood disorders presenting a challenge to mental health professionals today. The National Institute of Mental Health estimates that nearly 18 million U.S. adults will experience a form of depression during a given year[11]. One

topic that has generated considerable concern is perinatal depression, or depression that occurs during or immediately following pregnancy. An increasing number of studies have suggested that the experience of depression during this period may have a number of effects on the mental and physical health of women and their children[12, 13].

Antenatal depression refers to the occurrence of depression during pregnancy. Although estimates of the prevalence of antenatal depression vary, it is reported that between 8.5 and 11 percent of women experience a depressive episode during pregnancy[14]. As is the case with food insecurity, a growing body of literature suggests that antenatal depression may have serious effects on maternal and child health. In particular, depressive symptoms during pregnancy have been associated with poor weight gain and increased alcohol and tobacco use in women[15]. Further, both of these factors, along with depressive symptoms have been associated with low birth weight and intrauterine growth restriction in infants[13, 16, 17]. Additional studies will reveal if antenatal depression has other impacts on the health of women and their offspring.

Food Insecurity and Antenatal Depression

Few studies have directly examined the relationship between food insecurity and antenatal depression. However, the results of several investigations suggest that food insecurity is associated with depression in adult women. For instance, a cross-sectional analysis of California women performed by Kaiser et al. found that those who suffered from household food insecurity were more likely to report bouts of poor mental health, sadness, and depression that interfered with daily activities[18]. These findings are similar to those of a larger cross-sectional investigation performed by Casey et al.[12]. In this study, researchers surveyed mothers with young children living in six major U.S. cities.

Out of over five thousand study subjects, those who reported household food insecurity were nearly three times more likely to have a positive depression screening than mothers who were food secure. Although these cross-sectional studies are limited by their inability to determine the direction of the association, they do provide clear evidence that food insecurity is related to depression.

Two additional studies of female welfare recipients further serve to highlight this association. The first study, performed by Seifert et al., examined food insecurity among White and African American women living in Michigan counties[19]. Study participants were assessed in 1997, and again in 1998. Women who reported food insecurity at either one or both assessments were more likely to meet the diagnostic criteria for major depressive disorder, even when controlling for factors related to socioeconomic status and physical health. In the second study, Heflin et al. re-assessed the same cohort at a third point in time[20]. Researchers found that the association between food insecurity and positive depression screening remained significant, despite controlling for factors known to increase the risk of depression.

Despite the evidence of an association between food insecurity and depression in women, investigations of food secure status and antenatal depression have been limited. One investigation conducted by Laraia et al. assessed a cohort of lower and middle-income North Carolina women during pregnancy[21]. As in the previous studies, investigators found that measure of psychological health varied by food insecure status. Women deemed marginally food insecure were more likely to score positively for depressive symptoms than those who were fully food secure (OR: 1.58, 95% CI 1.27—2.00). Those women who were deemed food insecure (a more severe status than the

marginally food insecure group) were nearly twice a likely as fully food secure women to report a positive score for depressive symptoms (OR: 1.87, 95% CI 1.40—2.51). These finding suggest that food insecurity is not only associated with depressive symptoms during pregnancy, but may also behave in a dose-response manner in pregnant women.

There is still much to learn about how food insecurity impacts the experience of depression during pregnancy. With little exception, current studies do not address the strength of the association between antenatal depression and food insecurity. Further, little is known about how other factors may affect this relationship. Additional investigation into this topic may reveal useful information about how food insecurity and depression are related, and what factors, if any, may be important to that relationship.

Risk Factors for Food Insecurity

Household Income

Perhaps the most commonly identified risk factor for food insecurity is low household income. While exact figures vary, it is estimated that 36.6 percent of households that fall below the federal poverty level (FPL) experience some form of food insecurity[22]. Throughout the literature, income in relation to the FPL has been used as a common marker for determining the risk of food insecurity. An analysis performed by Donald Rose noted a dramatic difference in the rate of food insecurity based upon reported income. Approximately 16% of households earning less than 50% FPL were food insecure, compared with less than 1% of households earning over 185% FPL[4]. In addition, several other studies support the assertion that food insecurity is strongly determined by household income[18, 21].

Education

Previous studies have noted a number of demographic factors that are common to food insecure households. In general, adults in food insecure homes are more likely to have lower educational attainment than the food secure[4]. Laraia et al reported that 59.6 percent of food insecure individuals had completed less than 12 years of education, compared with only 40.4 percent of those who had completed at least 12 years or more[21]. Kaiser et al reported similar findings, with the highest rates of food insecurity found among those with less than 9 years of schooling[18]. Similar findings have been reported in other studies as well as overviews of food insecurity[23,]

Race and Ethnicity

Race and ethnicity have also been cited as common risk factors for food insecurity. In general, households that are headed by Black (non-Hispanic) and Hispanic adults are more likely to suffer form food insecurity compared to other households. Although exact figures vary from study to study, it is estimated that these households experience food insecurity as much as 3 times more often than other households[23]. In a 2006 position statement, the American Dietetic Association reported that 23.7% of African American and 21.7% of Hispanic homes were food insecure, compared with 8.6% of White households and 11.1% of all other homes[5]. Repeated studies have been consistent with these findings, suggesting that race and ethnicity are important indicators for the risk of food insecurity[21, 23].

Marital Status

Marital status has also been identified as a risk factor for food insecurity. Households headed by a single adult are more likely to experience food insecurity than

others. In particular, homes headed by single females are at greater risk for food insecurity. An analysis of data from the third National Health and Nutrition Examination Survey (NHANES III) revealed that households comprised of single females and children are nearly twice as likely to report inadequate food intake as all other households (OR 1.9, 95% CI 1.4—2.5)[24]. The risk of food insecurity has been estimated to be even larger for single parents in certain rural communities. One analysis performed by Olson et al found that single parent households were over three times more likely to be food insecure than those with two parents (OR 3.71 95% CI 1.36—10.14)[25]. These findings, along with those of several other studies suggest that food secure status may by heavily influenced by the marital status of adults in a household[4, 12, 20].

Geographic location

A household's proximity to metropolitan locations may also be an important risk factor for food insecurity. Geographic location has been shown to influence the quality and availability of food[26]. Distance from urban centers can therefore be an important factor in predicting food insecurity. According to the U.S. Department of Agriculture, the percentage of food insecure households is slightly lower in metropolitan areas compared to other locations (10.7% vs. 12.0%)[22]. In addition, food insecurity has also been shown to vary by region across the United States. In general, the highest rates of food insecurity in the have been observed in the southern US[22]. However, fewer studies have focused on populations in the Pacific Northwest.

Additional Risk Factors

Current research has also identified a number of additional factors that may serve as indicators for food insecurity. For example, households with a history of stressful life

circumstances such as homelessness have been shown to be significantly more likely to experience food insecurity than other households[20]. In addition, history of domestic violence has been associated with both food insecurity and mental health status in women[20]. Finally, food insecure households are far more likely than food secure households to participate in public assistance programs such as the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)[23]. Although this last finding is hardly surprising, it does provide an additional factor by which food insecure individuals can be identified.

Specific Aims

The data used in this study comes from the 2005 Oregon Pregnancy Risk Assessment Monitoring System (PRAMS). A preliminary analysis of these data identified several risk factors for food insecurity during pregnancy. Among these risk factors was a measure of antenatal depressive symptoms.

Using a modified measure of depressive symptoms, this study aims to further describe the association between food insecurity and antenatal depression in new mothers. The primary objective of this study was to test the hypothesis that antenatal depressive symptoms would be positively associated with the report of food insecurity. Using data from this population-based survey, this study also sought to identify what role additional risk factors for food insecurity played in the association between food insecure status and antenatal depressive symptoms.

Food Insecurity and antenatal depression are serious problems that affect the health and welfare of women and their children. Both conditions are associated with numerous adverse health outcomes. Although limited information exists about the

relationship between these conditions, more study is needed to understand how they act together. Information provided by this study could prove useful in determining how antenatal depression and food insecurity can best be addressed by public health services within the state of Oregon.

Methods

Oregon PRAMS

This project uses data collected through the 2005 Oregon Pregnancy Risk Assessment Monitoring System (PRAMS). PRAMS is an epidemiologic surveillance program maintained by the Centers for Disease Control and Prevention (CDC) and implemented by participating state health departments. The PRAMS program is responsible for the collection of data that assesses maternal behaviors and experiences occurring before, during, and after pregnancy[27]. In Oregon, PRAMS is administered by the Department of Human Services, Public Health Division, Office of Family Health. Oregon has contributed to the CDC PRAMS database since 2002.

Subject Selection

The Oregon PRAMS surveys new mothers who have given birth within the last 2 to 4 months[28]. Participants are selected on a monthly basis from a stratified random sample of the state's birth certificate records. In 2005, Oregon PRAMS participants were selected based upon six sampling strata including non-Hispanic White (child of normal birth weight), non-Hispanic white (child of low birth weight), non-Hispanic African American, non-Hispanic Asian/Pacific Islander, non-Hispanic American Indian/Alaska Native, and Hispanic. The mother's race/ethnicity and child's birth weight are determined by the information provided on the child's birth certificate. All resident Oregon women who gave birth in Oregon during the sampling period were eligible for participation.

Selected mothers are initially contacted via an introduction letter, which explains the purpose of PRAMS and how surveillance information will be used. This letter is followed by a questionnaire packet, which includes the survey, a cover letter with

instructions, and an informed consent information sheet. Oregon PRAMS does not require participants to submit a signed consent form. Rather, consent is assumed when a participant returns a completed questionnaire[28].

Selected mothers who do not respond to the initial questionnaire packet are sent a reminder, followed by a second packet. Those who do not respond to the final mailed packet within seven to ten days are contacted by telephone. Selected women may be contacted by telephone up to 15 times in an attempt to reach them. Verbal consent is obtained from all participants who complete telephone interviews[28].

The 2005 Oregon PRAMS survey was designed as an eighty-item self-administered questionnaire. Both the written survey and the interview ask the same questions. Oregon PRAMS questionnaires and interviews were completed in either English or Spanish. A complete copy of the 2005 Oregon PRAMS survey is included in Appendix B.

PRAMS Weighting Methodology

PRAMS employs several complex weighting mechanisms in order to adjust for aspects of the subject selection methods. Because PRAMS oversamples for maternal race and ethnicity, a sampling weight is applied to the data. In the 2005 Oregon PRAMS, the sampling weight was calculated to also account for oversampling based on low birth weight.

Participation in Oregon PRAMS may vary based on additional maternal characteristics. That is, some women who share common traits may by less likely to respond to the survey than others. Because of this, a nonresponse weight is used to compensate for non-participation. Nonresponse weights are typically based on common

demographic characteristics within each sampling stratum that are identified after the data has been collected and non-respondents have been compared to respondents.

Finally, participation in the Oregon PRAMS can also be affected by characteristics of the sampling scheme. That is, some women may be less likely than others to participate because they were not covered by the sampling frame. This situation can occur when there are accidental duplications in the birth certificate records. Duplicate records can lead to missing files in the group of selected participants. To adjust for women who may have been omitted in this fashion, a non-coverage weight is calculated and applied to the data. Factors that are related to non-coverage are identified by the CDC once all of the PRAMS data has been collected. For a detailed description of PRAMS weighting methodology, please refer to http://www.cdc.gov/prams/methodology.htm.

Variable Coding

Outcome

Food insecurity was designated as the outcome for this analysis. The 2005 Oregon PRAMS contained a single item evaluating food insecurity. The question, "During the 12 months before your new baby was born, did you ever eat less than you felt you should because there wasn't enough money to buy food?" included two possible responses (either "Yes" or "No"). Any participant who reported an affirmative answer was deemed food insecure. Those who reported a negative answer were considered food secure.

As described in Table 1, the PRAMS measure of food insecurity closely resembles an item included on the United States Department of Agriculture's *U.S. Household Food Security Survey*[29]. The USDA uses this survey model to evaluate behaviors and conditions that measure the severity of food insecurity within a

household[29]. The survey was developed using information provided by previous investigations of food insecurity. The survey items were then applied to data from the 1995 Current Population Survey (CPS), a project of the U.S. Census Bureau[29, 30]. Further analysis of CPS for subsequent years has indicated that the food security measures provide a stable and robust evaluation of food insecurity in the US population[29]. The *U.S Household Food Security Survey* is now a widely accepted tool used for assessing food insecurity. Multiple studies, including those which examine food insecurity in pregnant women, have adopted the use of this model[9, 21, 31]. Table 10, included in Appendix A, describes the questions used in the USDA survey.

One of the most commonly used versions of the USDA survey is a 6-item assessment. The survey items are designed to assess for increasingly severe indicators of food insecurity. In theory, a household that answers affirmatively to latter items on the scale would be more food insecure than a household that answered affirmatively only to the previous items[32]. Further, households that gave affirmative responses to latter items would be more likely to give affirmative responses to previous items, due to the increasingly severe nature of the measures[29]. The PRAMS food security measure corresponds to the fifth question on the 6-item survey. Although the scale items were not designed to be used individually, the PRAMS question does represent a measure of reduced food intake, which, in turn, is an important food insecurity indicator. Based on the scoring mechanism suggested by the USDA, an affirmative response to even one of the survey measures can be used to indicate a household that is either food insecure or at risk of being food insecure[29]. This suggests that the individual PRAMS question can be

used to assess food insecurity in this study. A table describing the USDA scoring mechanism is included on Table 11 in Appendix A.

Table 1 describes the PRAMS and USDA food intake measures, along with the possible responses for each question. For logistic regression analysis, the food insecurity variable was coded as "0 = No" and "1 = Yes." For crosstab analysis, the variable was coded "1 = No" and "2 = Yes."

Table 1. Oregon PRAMS and USDA measures of reduced food intake

Survey Measure	Question	Possible Responses
2005 Oregon PRAMS	During the ***12 months before your new baby was born***, did you ever eat less than you felt you should because there wasn't enough money to buy food?	Yes No
Household Food Security Survey	During the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?	Yes No Don't Know

Predictor Measures

The 2005 Oregon PRAMS assessed respondents for numerous experiences and behaviors related to pregnancy and birth outcomes. In addition to this information, the PRAMS dataset is also linked to data from the original birth certificate files that were used to identify participants[28]. This linkage provides a wealth of information about individual respondents, including demographic and clinical data. This analysis used information from both the PRAMS survey and birth certificate files to describe food insecurity.

Predictors Derived from Oregon PRAMS

The predictors measured on the 2005 Oregon PRAMS used in this analysis included antenatal depressive symptoms, annual pre-pregnancy household income, enrollment in the Special Supplemental Nutrition Program for Women, Infants, and

Children (WIC), pregnancy intention, stressful life circumstances, intimate partner violence during pregnancy, pre-pregnancy maternal body mass index (BMI), tobacco use during pregnancy, and alcohol consumption during pregnancy.

Antenatal depressive symptoms were measured using two items on the PRAMS questionnaire. The first question asked, "While you were pregnant, how often did you feel down, depressed, or hopeless?" The second question asked, "While you were pregnant, how often did you have little interest or pleasure in doing things?" Possible responses for both questions included "Always," "Often," "Sometimes," "Rarely," or "Never." For this analysis, answers of "Always" or "Often" were considered a positive report of depressive symptoms. Answers of "Sometimes," "Rarely," and "Never" were considered a negative report of depressive symptoms. All respondents who provided a positive answer to either one or both of the questions were considered to have experienced antenatal depressive symptoms. All respondents who provided negative answers to both of the questions were considered to have been free of antenatal depressive symptoms. Women who were missing responses for the antenatal depressive measures were dropped from the analysis.

The PRAMS measures for depressive symptoms are based on the 2-item depression module of the Patient Health Questionnaire, or PHQ-2. Previous studies have supported the use of this two-item model as a screening tool for depressive symptoms. An analysis conducted by Whooley et al. found that the two-question case-finding instrument could identify major depression with a sensitivity of 96% (95% CI 90%—99%) and specificity of 57% (95% CI 53%—62%)[33]. Further, Kroenke et al. found that when the screening questions were completed as a self-administered survey, the presence

of depressive disorders could be detected with a sensitivity of 83% and a specificity of 90%[34]. Overall, the two-question model compares favorably with longer assessments, and has been found to be more effective than single-item screening tools[33,35].

Annual household income was divided into categories based upon percentage of the federal poverty threshold (% FPL), which is published by the Department of Health and Human Services. Because the 2005 Oregon PRAMS asks respondents about income in the year prior to giving birth, percentages of the FPL were based upon guidelines for 2004. All participants who reported an annual income were classified as earning either 0%—99 % FPL, 100%—184% FPL, or 185% FPL and greater. Cutoff points for each category were based upon their significance to public programs. In particular the Oregon WIC program requires that participants have incomes less than 185% FPL[36]. In addition, the Oregon Food Stamp program requires that participants have a net monthly income less than 100% FPL[37].

Pregnancy intention was measured using responses to the question, "Thinking back to just before you got pregnant with your new baby, how did you feel about becoming pregnant?" Women who reported either "I wanted to be pregnant sooner" or "I wanted to be pregnant then" were considered to have intended pregnancies. Women who reported either "I wanted to be pregnant later" or "I didn't want to be pregnant then or at any time in the future" were considered to have unintended pregnancies.

Stressful life circumstances were measured using a series of questions that assessed thirteen events that may have occurred during the 12 months prior to giving birth. Some of the circumstances included on the survey were serious illness of a close family member, separation or divorce, homelessness, increased arguments with a

husband or partner, and the loss of a job by either the mother or her husband or partner. All of the stressful life circumstance measures included "Yes" or "No" as possible responses. For this analysis, all responses were coded as "1 = No" and "2 = Yes." Table 2 describes the stressful life measures.

Table 2. Stress Life Circumstance Measures, 2005 Oregon PRAMS

Circumstance
A close family member was very sick and had to go to the hospital
I got separated or divorced from my husband or partner
I moved to a new address
I was homeless
My husband or partner lost his job
I lost my job even though I wanted to go on working
I argued with my husband or partner more than usual
My husband or partner said that he didn't want me to be pregnant
I had a lot of bills I couldn't pay
I was in a physical fight
My husband or partner or I went to jail
Someone very close to me a bad problem with drinking or drugs
Someone very close to me died

Intimate partner violence (IPV) during pregnancy was measured using two questions included on the PRAMS survey. The first asks, "During you most recent pregnancy, did an ex-husband or ex-partner push, hit, slap, kick, choke, or physically hurt you in any other way?" the second question asks, "During you most recent pregnancy, were you physically hurt in any way by you husband or partner?" Possible responses for both questions were either "Yes" or "No." For this analysis, these questions were considered individually, each treated as a separate measure of IPV.

For this project, measures of tobacco use and alcohol consumption were drawn from PRAMS questions which assessed substance use during pregnancy. Oregon PRAMS asked respondents if they had used cigarettes during the previous two years. Those who responded affirmatively were asked to estimate the frequency of tobacco use before pregnancy, during the final three months of pregnancy, and during the period since they had given birth. The survey used similar methods to assess for alcohol consumption. Those who reported any use of tobacco during the final three months of pregnancy were categorized as having used tobacco while pregnant. Similarly, those who reported any alcohol use during the final three months of pregnancy were categorized as having consumed alcohol during pregnancy.

Participation in the WIC program was determined from the question, "During your most recent pregnancy were you on WIC (the Special Supplemental Nutrition Program for Women, Infants, and Children)?" Maternal body mass index (BMI) was calculated using the respondent's self-reported height and pre-pregnancy body weight. Maternal BMI was then divided into four categories based on criteria published by the National Institutes of Health[38].

Table 3 includes a complete list of PRAMS variables used in this study, along with their original response options and recoded categories.

Table 3. Predictor variables derived from 2005 Oregon PRAMS

PRAMS Measure	Possible Responses	Coding for Analysis
Antenatal Depressive Symptoms -Depressed Mood - Little Interest of Pleasure	-Always -Often -Sometimes -Rarely -Never	Always/Often = Yes Sometimes/Rarely/Never = No
Annual Household Income—Pre-pregnancy	-Less than $10,000 -$10,000—$14,999 -$15,000—$19,999 -$20,000—$24,999 -$25,000—$34,999 -$35,000—$49,999 -$50,000 or more	0%—99% FPL 100%—184% FPL 185% FPL and greater
WIC Participation	-No -Yes	1 = No 2 = Yes
Pregnancy Intention	-I wanted to be pregnant sooner -I wanted to be pregnant later -I wanted to be pregnant then -I didn't want to be pregnant then or at any time in the future	1 = Intended 2 = Unintended
Stressful Life Circumstances	-No -Yes	1 = No 2 = Yes
Intimate Partner Violence—During Pregnancy, Current Husband or Partner	-No -Yes	1 = No 2 = Yes
Intimate Partner Violence—During Pregnancy, Ex-Husband or Ex-Partner	-No -Yes	1 = No 2 = Yes
Body Mass Index—Pre-pregnancy	Calculated from self-reported height and pre-pregnancy weight	1 = Normal weight 2 = Under weight 3 = Overweight 4 = Obese
Tobacco Use During the Last 3 Months of Pregnancy	-41 cigarettes or more -21 to 40 cigarettes -11 to 20 cigarettes -6 to 10 cigarettes -1 to 5 cigarettes -Less than 1 cigarette -None (0 cigarettes)	1 = No tobacco use 2 = Any tobacco use
Alcohol Consumption During the Last 3 Months of Pregnancy	-14 drinks or more a week -7 to 13 drinks a week -4 to 6 drinks a week -1 to 3 drinks a week -Less than 1 drink a week -I didn't drink then	1 = No alcohol consumption 2 = Any alcohol consumption

Predictors Derived from Birth Certificate Information

Predictor measures drawn from birth certificate information used in this study included maternal age, maternal race/ethnicity, education, marital status, and county type. A measure of prenatal care adequacy was also calculated using information provided in birth certificate files. Table 4 describes the birth certificate variables used in this analysis, including their coding.

Information regarding maternal age (in years) was originally available as a continuous variable in the dataset. However, initial analysis revealed a nonlinear trend between age and the log odds of food insecurity. To improve the ease of analysis, this information was recoded as a categorical variable. Maternal age was separated into five categories: less than 22 years, 22—25 years, 26—29 years, 30—34 years, and 35 years and older. Age categories were constructed to result in sufficient sample size in each group.

Maternal race/ethnicity was separated into five categories: Hispanic, non-Hispanic White, non-Hispanic African American, non-Hispanic Asian/Pacific Islander, and non-Hispanic American Indian/Alaska Native. Maternal education, although originally presented as a continuous variable, was recoded as a categorical variable with four groups: less than 12 years, 12 years (high school graduate), 13—16 years (some college or college graduate), and 17 years or more. Marital status information was available as a dichotomous categorical variable, with subjects classified as either "Married/Separated" or "Unmarried/Divorced/Annulled/Widowed."

Information regarding the respondent's county of residence was taken from the birth certificate file. These counties were then classified into county types as either

"rural" or "urban." County classification was based upon population density for 2001. Counties that had fewer than 60 people per square mile were classified as rural, while all other counties were considered urban. Rural counties included Baker, Clatsop, Coos, Crook, Curry, Deschutes, Douglas, Gilliam, Grant, Harney, Hood River, Jefferson, Josephine, Klamath, Lake, Lincoln, Linn, Malheur, Morrow, Sherman, Tillamook, Umatilla, Union, Wallowa, Wasco, and Wheeler. Urban counties included Benton, Clackamas, Columbia, Jackson, Lane, Marion, Multnomah, Polk, Washington, and Yamhill.

Finally, the adequacy of prenatal care was calculated using information regarding the initiation and frequency of prenatal care visits. Classification for adequacy of care was based on the Adequacy of Prenatal Care Utilization (APNCU) Index described by Kotelchuck[39]. This index determines adequacy of care by accounting for the month in which prenatal care was initiated, as well as the number of prenatal visits each women received. The index assumes that the earlier prenatal care was initiated, the more adequate the care. Further, the number of prenatal care visits is compared to the number of expected visits, based on standards developed by the American College of Obstetricians and Gynecologists (ACOG). The adequacy of care improves as the number of visits received approaches the number of expected visits. Adequacy of care is divided into five categories: no prenatal care, inadequate care, intermediate care, adequate care, and intensive care. For this analysis, prenatal care adequacy was treated as a dichotomous variable, with respondents who received adequate or intensive care grouped into one category, and women who received no care, inadequate care, or intermediate care, in another.

Table 4. Predictor variables derived from birth certificate data

Birth Certificate Measure	Possible Responses	Coding for Analysis
Maternal Age	Continuous	1 = < 22 years 2 = 22—25 years 3 = 26—29 years 4 = 30—34 years 5 = 35 years and older
Maternal Race/Ethnicity	-White (NH) -Hispanic -African American (NH) -Asian/Pacific Islander (NH) -American Indian/Alaska Native (NH)	1 = White 2 = Hispanic 3 = African American 4 = Asian/Pacific Islander 5 = American Indian/Alaska Native
Maternal Education	Continuous	1 = < 12 years 2 = 12 years 3 = 13—16 years 4 = 17 years or more
Marital Status	-Married/Separated -Single/Divorced/Annulled	1 = Married 2 = Unmarried
County Type	All Oregon Counties	1 = Rural 2 = Urban
Prenatal Care Adequacy	-Intensive -Adequate -Intermediate -Inadequate -None	1 = Adequate/Intensive 2=None/Inadequate/Intermediate

Data Management

Duties related to cleaning and editing of PRAMS data files, including the correction of errors and inconsistencies, are the responsibility of state health departments. For the 2005 Oregon PRAMS, the Department of Human Services (DHS) performed all data entry verification and telephone interview monitoring (as all telephone interviews were performed by a hired contractor). The data files were then checked for consistency thorough an automated process at the CDC. Finally, the CDC created the Oregon PRAMS analysis file, complete with analysis weights. This file was then provided to Oregon DHS.

For this project, I acquired the PRAMS analysis file in an SPSS (Statistical Package for the Social Sciences) format. This file was later converted into STATA format, to allow for additional analysis. All analysis for this project was performed using SPSS 15.0 (SPSS Inc.), SUDAAN 9 (Research Triangle Institute), and STATA 10 (STATA Corporation) software packages. Because Oregon PRAMS responses do not contain personal identifying information, The Institutional Review Board of Oregon Health and Science University exempted this project from review.

Statistical Analysis

Descriptive Analysis

Weighted data was used for all parts of the statistical analysis. The prevalence of the outcome and predictor variables was initially assessed with frequency distributions. Cross tabulations were then generated to determine the number of respondents who reported food insecurity within each of the predictor categories. Additional cross tabulations were constructed to examine the distribution of respondents who reported both food insecurity and antenatal depression within categories based on maternal age, maternal race/ethnicity, maternal education, and household income. These cross tabulations were examined to determine if there were sufficient cell counts within each of the variable categories.

Univariate Analysis

A simple logistic regression model was constructed to examine the association between food insecurity and antenatal depressive symptoms. Additional models were also constructed to determine odds ratios (ORs) for the associations between food insecurity and the remaining predictor variables. In addition to odds ratios, confidence intervals

(CIs) and p-values from Wald F statistics were also examined to determine the significance of the associations between food insecurity and the predictor variables.

Predictors which demonstrated a significant association with food insecurity (based on p-values ≤ 0.05), were eligible for inclusion in a multivariate model. In this analysis, all excluded variables had a p-value greater than 0.20.

Multivariate Analysis

Multivariate analysis was conducted using a hierarchical stepwise regression technique. To begin this procedure, predictor variables were arranged into groups based on the qualities they measured. For example, all variables that measured stressful life circumstances were considered a single group. Similarly, demographic factors such as race, education, and age, were also considered a single group. Once these groups were constructed, they were ranked based on their suspected importance to food insecurity. Groups that contained factors that were believed to have strong association with food insecurity (based on previous literature) were considered more important than groups with variables that were believed to have weaker associations with food insecurity. These groups were then added into a multivariate model based on their suspected order of importance to food insecurity. The least important groups of variables were added into the model last. Once a multivariate model had been constructed, the significance of the least important group of variables was examined using the p-value from a Wald F statistic. If the test indicated that the group was significant (with a p-value of ≤ 0.1), it was kept in the model. However, if the group was not significant, it was dropped from the model. This testing procedure was then applied to the remaining groups, from least important to the most important.

For this analysis, the variable group containing demographic characteristics such as maternal age, race/ethnicity, and education were considered to be the most important set of factors. A group containing maternal marital status and county type were second most important, followed by the group containing household income and WIC participation. The fourth group consisted of the pregnancy intention, pre-natal care adequacy, and tobacco use measures, while the final group contained stressful life circumstances and intimate partner violence.

Once all the groups had been tested, and all groups with insufficient significance had been removed, the remaining individual predictors were then examined. For this analysis, individual predictor variables were removed from the model using a backwards selection technique. The least significant variable was removed based on its p-value (at the 0.1 level of significance). Although some predictor variables such as maternal age and race failed to demonstrate a significant association based on the selection criteria, they were included in the final model because of their significance in previously describe literature. The variable group including pregnancy intention, prenatal care adequacy, and smoking was not re-introduced to the model for this analysis.

All multivariate analysis was performed using STATA 10. Because survey data such as the 2005 Oregon PRAMS employs complex weighting methods, and the number of degrees of freedom may be bound by the number of clusters in such cluster-sampled data, STATA does not allow for the use of either forward or backward stepwise selection procedures with survey data[40]. The STATA Corporation has proposed the hierarchical stepwise regression method as an appropriate model-building technique for complex

survey data. For additional information regarding this procedure, please refer to http://www.stata.com/support/faqs/stat/stepsvy.html.

Assessment for Confounding

Once the multivariable model was complete, all of the individual predictors that demonstrated a significant association with food insecurity were further assessed for possible confounding of the association between food insecurity and antenatal depressive symptoms. In order to do this, logistic regression models containing antenatal depressive symptoms and one additional factor were constructed. As in the previous univariate and multivariate analysis, food insecurity was used as the outcome variable for these models. Factors that significantly altered the association between food insecurity and antenatal depressive symptoms (determined by a greater than 10% change in OR) were considered possible confounders in that association. These possible confounders were then added to the multivariate model to determine their overall effect.

Results

Summary

The 2005 Oregon PRAMS sampled 2806 women and had a total of 1915 respondents. The un-weighted response rate for PRAMS was 68.2%, while the weighted response rate was 75.6%. All of the percentages reported here are weighted. The majority of women in this sample were less than 35 years old (87.1%), had at least 12 years of education (81.2%), and were married (67.0%). Most respondents also had intended pregnancies (62.1%), lived in urban counties (74.8%), and earned household incomes less than 185% of the federal poverty level (51.0%). Nearly 56% of women were normal weight (with a BMI between 18.5 and 24.9). The most commonly reported stressful life events included moving to a new home (40.5%), having trouble paying bills (24.5%), and having more frequent arguments with a husband or partner (22.2%). Most respondents received either adequate or intensive prenatal care (71.5%) and did not use tobacco or alcohol during pregnancy (86.3% and 93.5%, respectively). Approximately 41.2% of women in the sample were enrolled in the WIC program during their pregnancy.

Maternal Age

Information about maternal age was available for all 1915 PRAMS respondents. Out of the total sample, 15.2% of women (347) were less than 22 years old, 23.9% (446) were between 22 and 25, 25.0% (429) were between the ages of 26 and 29, 23.1% (417) were between 30 and 34, and 12.9% (276) were 35 years and older.

Maternal Race/ethnicity

Race/ethnicity data was available for 1910 respondents. Of that group, 70.6% were categorized as non-Hispanic White, 20.3% were Hispanic, 5.5% were non-Hispanic

Asian/Pacific Islander, 1.6% were non-Hispanic American Indian/Alaska Native, and approximately 2.1% were non-Hispanic African American. Information regarding race could not be obtained for 5 respondents.

Maternal Education

Information regarding education was available for all 1915 respondents. The majority of women in this sample had at least 12 years of education. A total of 445 women (18.8%) attended school for less than 12 years. Approximately 30.9% had only completed 12 years. Of the remaining respondents, 655 (36.8% of the total sample) had completed between 1 and 4 years of college. An additional 241 women (13.5%) had completed 17 years of school or more.

Marital Status

Information regarding marital status was available for all but one participant. A total of 1194 women (67%) were either married or separated at the time their child's birth certificate was filed. The remaining 720 respondents (33%) were classified as either single, divorced, widowed, or annulled.

Household Income

Approximately 91.3% of respondents (1749) reported household income for the year prior to giving birth. Of those women, the majority reported earning incomes less than 185% of the federal poverty level. A total of 618 women (29%) earned less than 100% of the FPL, while 388 women (20.1%) earned between 100% and 184% of the FPL. The remaining 743 respondents (approximately 51%) lived in households with incomes at 185% of the FPL or greater.

Pregnancy Intention

A total of 1884 women reported information about the intendedness of their pregnancies. Approximately 62.1% of that group (1110 women) indicated that their pregnancies had been intended. The remaining 37.9% (774 women) reported that their pregnancies had been unintended.

County Type

Information regarding county of residence was available for all PRAMS respondents. A total of 1463 women (74.8%) lived in Oregon counties that were designated as urban. The remaining 452 women (25.2%) lived in rural counties.

Body Mass Index

A total of 1728 women provided information about their height and pre-pregnancy body weight. Of these women, 55.8% (901) were categorized as having a normal body mass index (BMI). Approximately 3.1% of respondents (75 women) were underweight. A total of 413 women (23.6%) were classified as overweight, while the remaining 339 respondents (17.6%) were obese.

Intimate Partner Violence

Information regarding intimate partner violence was available for approximately 89% of the total sample. The majority of women who responded to these questions did not experience intimate partner violence during their pregnancies. Only 72 women (1.9% of the total sample) reported victimization by a current husband or partner. Approximately 1.5% of women in the sample (83 respondents) reported victimization by an ex-husband or ex-partner during their pregnancies.

Prenatal Care Adequacy

Measures of prenatal care adequacy were calculated for all 1915 PRAMS respondents. Based on responses to the survey questions, a total of 1319 women (71.5%) were categorized as having received adequate or intensive prenatal care. The remaining 596 women (28.5%) were considered to have received either no prenatal care, inadequate care, or intermediate care.

Stressful Life Circumstances

Between 98.1% and 97.3% of women provided information about stressful life circumstances. Out of the total sample, 22.1% (410) had family members with a serious illness, 9.2% (199) became separated or divorced from their partner, 40.5% (778) moved to a new address, 6.2% (148) were homeless, 13.9% (264) had a husband or partner who lost a job, 9.3% (206) lost their own jobs even though they wanted to keep working, 22.2% (449) argued with their husband or partner more than usual, 8.0% (161) had a husband or partner say that they did not want the respondent to be pregnant, 24.5% (516) had difficulties paying bills, and 2.9% (75) were in a physical fight. In approximately 5.6% of cases, the respondent, her husband, or partner went to jail. A total of 285 women (15.6%) had a close associate who experienced a problem with drugs or alcohol. Nearly 16.2% of respondents experienced the death of someone close to them.

WIC Participation

Information regarding WIC participation was available for 1897 women. Of that sample, 983 women (41.2% of the total) were enrolled in the WIC program during pregnancy. A total of 914 women (58.8%) reported that they had not participated in the program.

Tobacco Use

Tobacco use was assessed in 1865 respondents. A total of 248 women (13.7%) used tobacco during the final three months of their pregnancies. The remaining 1617 respondents (86.3%) reported no tobacco use during the same period of time.

Alcohol Consumption

Information regarding alcohol consumption was available for 1860 women. Of that sample, 122 respondents (6.5%) consumed alcohol during the final three months of their pregnancies. A total of 1738 women (93.5%) reported that they did not use alcohol during that period of time.

Antenatal Depressive Symptoms

Out of the total PRAMS sample, 1853 women provided information about antenatal depressive symptoms. A total of 416 women (18.1%) experienced depressive symptoms during pregnancy. Approximately 81.9% of respondents (n = 1437) reported no depressive symptoms during the same period. Response data was missing from a total of 62 women (3.2%).

Food Insecurity

Of the 1915 PRAMS respondents, 1864 women (97.3%) provided information regarding food insecurity. Of those women, 217 (10.5%) reported food insecurity in the 12 months prior to giving birth. The majority of women in the sample (89.5%) reported no food insecurity during the same period. Responses were missing for 51 women (2.6%).

Food Insecurity by Maternal Characteristics

The proportion of women who experienced food insecurity varied by each of the predictor categories considered in this analysis. Table 5 describes the number and weighted percentage of food insecure women by maternal characteristics.

Table 5. Food Insecurity by Maternal Characteristics, Oregon PRAMS, 2005

Characteristic	n	Percent Food Insecure (Weighted)
Maternal Age		
< 22 y	347	19.0%
22—25 y	446	15.5%
26—29 y	429	8.1%
30—34 y	417	7.4%
35+ y	276	1.9%
Maternal Race/Ethnicity		
American Indian/Alaska Native, non-Hispanic	260	21.2%
African American, non-Hispanic	229	18.6%
Hispanic	438	14.9%
White, non-Hispanic	680	9.4%
Asian/Pacific Islander, non-Hispanic	303	3.6%
Maternal Education		
< 12 y	445	16.5%
12 y	574	15.6%
13—16 y	655	5.5%
17+ y	241	4.4%
Household Income		
0%—99% FPL	618	22.2%
100%—184% FPL	388	17.6%
185% + FPL	743	0.9%
Marital Status		
Unmarried	720	21.0%
Married	1194	5.4%
County Type		
Rural	452	14.9%
Urban	1463	9.0%
Pregnancy Intention		
Unintended	774	15.3%
Intended	1110	7.7%
Antenatal Depressive Symptoms		
Symptoms	416	23.2%
No Symptoms	1437	7.8%

Table 5 (Continued). Food Insecurity by Maternal Characteristics

Characteristic	n	Percent Food Insecure (Weighted)
Prenatal Care Adequacy		
None/Inadequate/Intermediate	596	15.6%
Adequate/Intensive	1319	8.5%
WIC Participation		
Participant	914	19.9%
Non-Participant	983	2.6%
Alcohol Consumption		
Any consumption	122	12.3%
No consumption	1738	10.3%
Tobacco Use		
Any use	248	22.9%
No use	1617	8.6%
IPV— By Current Husband or Partner		
Violence	72	21.0%
No violence	1627	9.8%
IPV—By Ex-Husband/Partner		
Violence	83	31.5%
No violence	1611	9.8%
Body Mass Index		
Underweight (< 18.5)	75	0.5%
Normal Weight (18.5—24.9)	901	4.8%
Overweight (25—29.9)	413	2.7%
Obese (> 30)	339	2.2%
Stressful Life Circumstances		
A close family member was ill	410	12.7%
Separation or divorce	199	32.0%
Moved to a new address	778	15.5%
Homeless	148	40.3%
Husband of partner lost job	264	29.4%
Mother lost job	206	30.2%
Argued more frequently	449	23.2%
Husband/Partner said he didn't want pregnancy	161	30.2%
Difficulty paying bills	516	28.4%
Physical fight	75	40.3%
Mother or Husband/Partner went to jail	114	39.2%
Someone close had a drug/alcohol problem	285	27.5%
Someone close died	337	19.0%

Univariate Analysis

In univariate logistic analysis, the positive report of antenatal depressive symptoms was significantly associated with food insecurity. Food insecurity was also significantly associated with maternal age, maternal race/ethnicity, maternal education, marital status, household income, county type, pregnancy intention, prenatal care adequacy, WIC participation, tobacco use, and intimate partner violence perpetrated by an ex-husband or ex-partner. In addition, food insecurity was significantly associated with several stressful life indicators including separation or divorce, moving to a new address, homelessness, loss of a job by a husband or partner, loss of work for the respondent, frequent arguments with a husband or partner, having a husband or partner declare that they did not want the respondent to be pregnant, difficulty paying bills, physical fights, having either the respondent or her partner go to jail, having a close associate with a drug or alcohol problem, and experiencing the death of someone close. Food insecurity was not significantly associated with alcohol consumption, body mass index, having a close family member who was ill, and intimate partner violence perpetrated by a current husband or partner.

Table 6 describes the associations between food insecurity and the predictor variables, including ORs, 95% CIs, and p-values.

Women who experienced symptoms of antenatal depression were significantly more likely to experience food insecurity in the year prior to giving birth. Younger women were more likely to be food insecure than older women, while women who identified as Asian/Pacific Islander were less likely to be food insecure than women of other races. The odds of food insecurity were greater for women with fewer years of

education and lower household incomes. Women who were unmarried, lived in rural counties, or participated in the WIC program had significantly higher likelihoods of being food insecure. In addition, women who had unintended pregnancies, used tobacco, and received inadequate prenatal care reported significantly greater levels of food insecurity. With the exception of having an ill family member, women who reported any of the stressful life circumstances were more likely to be food insecure than those who did not. Finally, women who experienced intimate partner violence at the hands of an ex-husband or partner were more likely to be food insecure. The same association was not significant for women who experienced IPV at the hands of a current partner.

Table 6. Univariate Logistic Associations between Food Insecurity and Maternal Factors, 2005 Oregon PRAMS

Characteristic	Odds Ratio (95% CI)	p-value
Antenatal Depressive Symptoms		
Symptoms	3.56 (2.18, 5.80)	<0.001
No symptoms	Referent	
Maternal Age		
<22 y	11.66 (4.80, 28.29)	<0.001
22—25 y	9.09 (3.87, 21.35)	<0.001
26—29 y	4.36 (1.75, 10.90)	0.002
30—34 y	3.95 (1.56, 9.96)	0.004
35+	Referent	
Maternal Race/Ethnicity		
American Indian/Alaska Native, non-Hispanic	7.25 (3.46, 15.19)	<0.001
African American, non-Hispanic	6.13 (2.88, 13.07)	0.007
Hispanic	4.72 (2.29, 9.75)	<0.001
White, non-Hispanic	2.8 (1.32, 5.93)	<0.001
Asian/Pacific Islander, non-Hispanic	Referent	
Maternal Education		
<12 y	4.33 (1.41, 13.20)	0.680
12 y	4.06 (1.31, 12.57)	0.015
13—16 y	1.28 (0.40, 4.20)	0.011
17+ y	Referent	
Marital Status		
Unmarried	4.67 (2.88, 7.58)	<0.001
Married	Referent	
Household Income		
0%—99%	30.01 (9.82, 91.65)	<0.001
100%—184%	22.53 (6.98, 72.64)	<0.001
185%+ FPL	Referent	
County type		
Rural	1.76 (1.05, 2.94)	0.031
Urban	Referent	
Pregnancy Intention		
Unintended	2.16 (1.35, 3.47)	0.001
Intended	Referent	
Prenatal Care Adequacy		
None/Inadequate/Intermediate	2.00 (1.25, 3.21)	0.004
Adequate/Intensive	Referent	
Body Mass Index		
Underweight (< 18.5)	2.25 (0.64, 7.95)	0.207
Overweight (18.5—24.9)	1.36 (0.75, 2.49)	0.307
Obese (25—29.9)	1.53 (0.80, 2.94)	0.198
Normal (> 30)	Referent	
WIC Participation, during pregnancy		
Participant	8.50 (4.62, 15.62)	<0.001
Non-Participant	Referent	
Tobacco Use, during pregnancy		
Any use	3.15 (1.79, 5.55)	<0.001
No use	Referent	

Table 6 (Continued). Univariate Logistic Associations between Food Insecurity and Maternal Factors

Characteristic	Odds Ratio (95% CI)	p-value
Alcohol Consumption, during pregnancy		
Any use	1.22 (0.48, 3.11)	0.42
No use	Referent	
IPV—By Ex-Husband/Partner		
Violence	4.25 (1.24, 14.60)	0.022
No violence	Referent	
IPV—By Husband/Partner		
Violence	2.42 (0.63, 9.36)	0.20
No violence	Referent	
Stressful Life Circumstances		
Separation or divorce		
Yes	5.31 (2.99, 9.45)	<0.001
No	Referent	
Moved to a new address		
Yes	2.36 (1.48, 3.77)	<0.001
No	Referent	
Homeless		
Yes	7.16 (3.86, 13.25)	<0.001
No	Referent	
Husband of partner lost job		
Yes	5.28 (3.15, 8.85)	<0.001
No	Referent	
Mother lost job		
Yes	4.80 (2.72, 8.49)	<0.001
No	Referent	
Argued more frequently		
Yes	4.20 (2.60, 6.80)	<0.001
No	Referent	
Husband/Partner didn't want pregnancy		
Yes	4.55 (2.47, 8.38)	<0.001
No	Referent	
Difficulty paying bills		
Yes	8.56 (5.12, 14.30)	<0.001
No	Referent	
Physical fights		
Yes	6.47 (2.69, 15.59)	<0.001
No	Referent	
Mother or Husband/Partner went to jail		
Yes	6.83 (3.34, 13.96)	<0.001
No	Referent	
Someone close had a drug/alcohol problem		
Yes	4.82 (2.88, 8.07)	<0.001
No	Referent	
Someone close died		
Yes	2.49 (1.46, 4.26)	0.001
No	Referent	

Table 6 (Continued). Univariate Logistic Associations between Food Insecurity and Maternal Factors

Characteristic	Odds Ratio (95% CI)	p-value
A family member was ill		
Yes	1.36 (0.79, 2.35)	0.27
No	Referent	

Multivariate Logistic Analysis

All predictors that were significantly associated with food insecurity in univariate analysis were considered for inclusion in the multivariate model. Table 7 describes the variable groupings used for the initial step of the hierarchical selection procedure, and their assigned level of importance.

Table 7. Predictor Variable Grouping for Hierarchical Stepwise Regression

Group Rank	Predictor Grouping
1	Maternal Age Race/Ethnicity Education
2	Marital Status County Type
3	Household Income WIC Participation
4	Pregnancy Intention Prenatal Care Adequacy Tobacco Use
5	Intimate Partner Violence Stressful Life Circumstances

In multivariate logistic analysis, the group consisting of pregnancy intention, prenatal care adequacy, and tobacco use was not significantly associated with food insecurity, and was thus, dropped from the model. The group of demographic characteristics including maternal age, race/ethnicity, and education were also not significantly associated with food insecurity. However, because the importance of these

factors had been demonstrated in previous literature, it was decided that this group would be included in the final model. The group was removed from the model for the assessment of individual predictors, and then re-introduced once the selection was complete.

The first individual predictor to be removed from the model was loss of work by the respondent ($p = 0.958$), followed by divorce/separation ($p = 0.73$). Moving to a new address ($p = 0.563$) was the next to be dropped, followed by physical fights ($p = 0.439$) and marital status ($p = 0.315$). Finally, drug and alcohol abuse by a close associate ($p = 0.238$) and having a husband/partner declare that he didn't want the respondent to be pregnant ($p = 0.176$) were dropped from the model.

Throughout the variable selection process, the association between food insecurity and antenatal depressive symptoms fluctuated in level of significance. Although the association remained significant with the removal of most dropped variables, there were instances when the relationship became insignificant based upon the selection criteria. For example, removal of the "moving to a new location" variable caused the association between antenatal depressive symptoms and food insecurity to lose significance (p-value = 0.107). A similar trend was observed when the variable regarding drug use by a close associate was removed. Table 8 describes the changes that occurred during the variable selection process, beginning with the initial multivariate stage and ending with the model prior to the addition of maternal age, race, and education (including odds ratios and p-values).

The final model included antenatal depressive symptoms, household income, WIC participation, intimate partner violence perpetrated by an ex-husband or partner,

county type, homelessness, loss of a job by a husband or partner, frequent arguments, difficulty paying bills, having the respondent or her husband/partner go to jail, and experiencing the death of a close associate. In addition, maternal age, race/ethnicity, and education were included in the model. Table 9 describes this model, including ORs, 95% CIs, and p-values.

Maternal age, like race/ethnicity and education, was not significantly associated with food insecurity at the outset of the variable selection procedure. However, when these three variables were re-introduced to the final model, there was a significant association between food insecurity and maternal age ($p = 0.081$). Further, the addition of the age, race, and education variables increased the significance of the association between food insecurity and antenatal depressive symptoms, resulting in a change of p-value from 0.093 to 0.084.

Table 8. Step-by-Step Summary of Multiple Logistic Regression Model Odds Ratios and p-values

Characteristic	Stage 1 OR, (p-value)	Stage 2 OR, (p-value)	Stage 3 OR, (p-value)	Stage 4 OR, (p-value)	Stage 5 OR, (p-value)	Stage 6 OR, (p-value)	Stage 7 OR, (p-value)	Stage 8 OR, (p-value)
Antenatal Depressive Symptoms	1.81, (0.098)	1.83 (0.90)	1.84 (0.091)	1.77 (0.107)	1.76 (0.113)	1.79 (0.096)	1.77 (0.101)	1.77 (0.093)
Household Income	(0.012)	(0.012)	(0.012)	(0.011)	(0.012)	(0.007)	(0.006)	(0.006)
100%—184% FPL	6.01	6.00	6.03	6.03	5.92	6.39	6.66	6.85
0%—99% FPL	3.51	3.50	3.56	3.58	3.56	3.98	4.15	4.21
WIC Participation	2.99 (0.006)	2.98 (0.005)	2.95 (0.006)	2.97 (0.005)	3.04 (0.005)	3.01 (0.006)	2.99 (0.009)	2.98 (0.010)
County type	1.95 (0.058)	1.96 (0.058)	1.93 (0.065)	1.90 (0.073)	1.92 (0.069)	1.92 (0.067)	1.91 (0.065)	1.89 (0.068)
IPV (ex-husband or ex-partner)	0.30 (0.094)	0.29 (0.092)	0.31 (0.101)	0.30 (0.093)	0.23 (0.044)	0.24 (0.050)	0.24 (0.049)	0.26 (0.073)
Homelessness	2.04 (0.109)	2.11 (0.087)	2.11 (0.087)	2.24 (0.059)	2.15 (0.072)	2.22 (0.062)	2.23 (0.049)	2.49 (0.022)
Husband/Partner lost job	1.88 (0.094)	1.92 (0.083)	1.95 (0.073)	2.00 (0.62)	2.00 (0.061)	2.04 (0.058)	2.18 (0.038)	2.20 (0.034)
Frequent arguments	1.49 (0.270)	1.47 (0.284)	1.49 (0.264)	1.57 (0.184)	1.54 (0.195)	1.55 (0.189)	1.67 (0.109)	1.81 (0.057)
Difficulty paying bills	2.92 (0.003)	2.94 (0.002)	3.01 (0.001)	3.04 (0.001)	3.00 (0.001)	2.98 (0.001)	3.02 (0.001)	3.10 (0.001)
Respondent or Husband/Partner went to jail	2.58 (0.052)	2.58 (0.052)	2.61 (0.044)	2.65 (0.038)	2.54 (0.044)	2.69 (0.034)	3.18 (0.012)	3.04 (0.017)
Someone close died	2.13 (0.053)	2.09 (0.058)	2.09 (0.055)	2.10 (0.52)	2.06 (0.058)	2.10 (0.049)	2.19 (0.036)	2.18 (0.032)
Husband/Partner didn't want pregnancy	1.70 (0.227)	1.71 (0.211)	1.73 (0.204)	1.67 (0.233)	1.65 (0.243)	1.72 (0.216)	1.80 (0.179)	
Someone close had a drug/alcohol problem	1.62 (0.193)	1.60 (0.207)	1.58 (0.219)	1.55 (0.243)	1.54 (0.249)	1.57 (0.238)		
Marital Status	1.34 (0.408)	1.34 (0.410)	1.37 (0.356)	1.39 (0.320)	1.39 (0.315)			
Respondent was in a physical fight	0.64 (0.391)	0.64 (0.390)	0.65 (0.398)	0.67 (0.439)				
Moved to a new address	1.26 (0.510)	1.23 (0.543)	1.22 (0.563)					
Divorce or separation	1.16 (0.716)	1.15 (0.730)						
Respondent lost job	0.98 (0.958)							

Table 9. Associations between Food Insecurity and Maternal Factors, Multivariable Model, 2005 Oregon PRAMS

Characteristic	Multivariate Odds Ratio (95% CI)	p-value
Antenatal Depressive Symptoms		
Symptoms	1.84 (0.92, 3.67)	0.084
No Symptoms	Referent	
Household Income		0.021
0%—99% FPL	3.67 (1.62, 14.50)	
100%—184% FPL	6.05 (1.62, 22.61)	
185% + FPL	Referent	
WIC Participation, during pregnancy		0.018
Yes	2.84 (1.20, 6.74)	
No	Referent	
County Type		0.041
Rural	2.14 (1.03, 4.42)	
Urban	Referent	
Intimate Partner Violence (by ex-husband or partner)		0.086
Yes	0.31 (0.79, 1.18)	
No	Referent	
Homelessness		0.115
Yes	1.94 (0.85, 4.44)	
No	Referent	
Husband/Partner Lost Job		0.029
Yes	2.23 (1.09, 4.56)	
No	Referent	
Frequent Arguments		0.075
Yes	1.78 (0.94, 3.34)	
No	Referent	
Difficulty Paying Bills		0.001
Yes	3.59 (1.75, 7.37)	
No	Referent	
Respondent or Husband/Partner Went to Jail		0.043
Yes	2.90 (1.03, 8.12)	
No	Referent	
Someone Close Died		0.062
Yes	2.09 (0.96, 4.51)	
No	Referent	
Maternal Age		0.081
< 22 y	3.14 (0.98, 10.05)	
22—25 y	4.18 (1.51, 11.59)	
26—29 y	1.81 (0.63, 5.22)	
30—34 y	2.32 (0.81, 6.65)	
35+ y	Referent	
Education		0.41
<12 y	0.36 (0.093, 1.43)	
12 y	0.40 (0.10, 1.54)	
13—16 y	0.29 (0.07, 1.25)	
17+ y	Referent	

Table 9 Continued. Associations between Food Insecurity and Maternal Factors, Multivariable Model, 2005 Oregon PRAMS

Characteristic	Multivariate Odds Ratio (95% CI)	p-value
Race/Ethnicity		0.76
African American, non-Hispanic	1.39 (0.49, 3.99)	
American Indian/Alaska Native, non-Hispanic	1.27 (0.45, 3.55)	
White, non-Hispanic	0.98 (0.38, 2.54)	
Hispanic	1.50 (0.57, 3.94)	
Asian/Pacific Islander, non-Hispanic	Referent	

Assessment for Confounding

Additional analysis of the predictor variables indicated a number of factors that may serve as confounders in the association between food insecurity and antenatal depressive symptoms. Some of the variables that demonstrated a sizable change in this association had already been included in the multivariable model. These variables included maternal age, education, household income, WIC participation, homelessness, frequent arguments, loss of a job by a husband/partner, difficulty paying bills, and having the respondent or her partner spend time in jail. Other factors that were included in the multivariable model did not demonstrate a significant effect on the association between food insecurity and depressive symptoms. These factors included county type, the death of a close associate, and intimate partner violence perpetrated by an ex-husband or ex-partner.

Several factors that were not significant in multivariate analysis also demonstrated change in the association between food insecurity and antenatal depressive symptoms. These factors included marital status, pregnancy intention, tobacco use, divorce or separation, loss of work by the respondent, engaging in physical fights, having a close associate with a drug or alcohol problem, and having a husband/partner declare that he did not want the respondent to be pregnant. To determine the effect of these potential

confounders on the overall association between depressive symptoms and food insecurity, each individual predictor was added to the multivariable model. Inclusion of some of these variables (including tobacco use, divorce, physical fights, drug/alcohol abuse by someone close, and having a husband/partner not want the pregnancy) caused very small changes in the odds ratio and p-values for the food insecurity/depressive symptoms association. The addition of marital status and loss of work by the respondent did cause antenatal depressive symptoms to lose significance in the model. Further, the addition of pregnancy intention had the opposite effect, leading to increased significance for depressive symptoms in the overall model. Despite these observed changes, the overall effects of the potential confounders on the association between antenatal depression and food insecurity were small, resulting in a less than 10% change in the odds ratio. The decision was made to exclude these factors from the final multivariable model.

Discussion

This study of Oregon women found that the experience of antenatal depressive symptoms was positively associated with food insecurity during pregnancy. This association remained positive when controlling for maternal factors including county of residence, stressful life circumstances, intimate partner violence, age, race, and education, although it was not statistically significant.

Comparison with Previous Findings

Prevalence of Food Insecurity

The prevalence of food insecurity in this study was 10.5%. This is very similar to the 2005 national prevalence estimated by the United States Department of Agriculture, which was approximately 11%[1]. Although estimates reported in previous studies vary greatly (ranging from 7.6% to nearly 25%)[19, 41], the findings of this study were most consistent with those of other investigations which examined food insecurity in pregnant women[21].

Prevalence of Depressive Symptoms during Pregnancy

Nearly 22% of Oregon PRAMS respondents reported that they had experienced depressive symptoms during pregnancy. Although there are few good estimates for the number of women who experience antenatal depressive symptoms, these results are similar to estimates of antenatal depressive symptoms seen in previous studies. For instance, an analysis of Swedish women performed by Josefsson et al. found that approximately 17% of women experienced depressive symptoms during late pregnancy[42]. Further, an investigation conducted by Lee et al. estimated that the prevalence of

antenatal depressive symptoms was between 18.9% and 22.1% during in Chinese women living in Hong Kong[43].

Risk Factors for Food Insecurity

The results of this study were also consistent with existing literature in regards to risk factors for food insecurity. In the 2005 Oregon PRAMS sample, household income, WIC participation, county of residence, and stressful life circumstances were all significant predictors of food insecurity. Multiple studies support these findings. For example, most investigations have asserted that food insecurity is strongly associated with low household income and poverty status. Previous investigations performed by Alaimo et al, Laraia et al, Heflin et al, and Siefert et al, found that income was one of the strongest indicators of food insecurity in adults[19, 20, 21, 23]. Laraia et al also noted that food insecure women were significantly more likely to participate in food assistance programs, such as WIC, during pregnancy[21]. Further, a study conducted by Tolman and Rosen demonstrated that women who experienced domestic violence were at an increased risk for food insecurity[44]. Additional investigations have also identified rural residence, and stressful life circumstances as important risk factors for food insecurity[21, 41, 44].

Although many of the results of this study were consistent with existing literature, there were some instances in which our findings conflicted with those of previous investigations. These studies found that:

1. When controlling for multiple characteristics, race/ethnicity was a significant risk factor for food insecurity in adult women[18].
2. Food insecurity was significantly associated with educational attainment[18, 21, 23].

This study found that race and education were independent risk factors for food insecurity. However, when multivariate analysis was used to control for additional variables, the overall associations between these factors and food insecurity were no longer significant. Further, neither the race nor the education variables demonstrated any significance with food insecurity within individual categories in multivariate analysis (e.g., non-Hispanic African American vs. non-Hispanic White or 12 years of education vs. 17+ years of education). Although these factors were included in the final multivariable model, their small effect and lack of significance does not support the findings described above.

The lack of association between these demographic measures and food insecurity may have been observed for several reasons. For example, it is possible that the inclusion of both household income and county of residence may have masked the effect of these factors. Conversely, the results of this analysis may also imply that these particular demographic factors simply have less influence on food insecurity than other maternal characteristics, such as stress, county of residence, and depressive symptoms.

The presence of intimate partner violence in the final model is of interest because of the fact that it is limited to violence perpetrated by a former husband or partner. Intimate partner violence at the hands of a current husband or partner was not significantly associated with food insecurity in univariate analysis. This lack of association may have been the result of small sample size, as only 83 women in the sample reported this form of abuse. The effect may also have been due to respondent confusion about the survey question. If women who were abused during pregnancy by a partner whom they were no longer with at the time of the survey, they may have

mistakenly reported IPV by a "former" partner. This sort of mistake would have resulted in the misclassification of IPV, and could have affected the measure's ability to predict food insecurity. Although it is possible that IPV perpetrated by a former partner is a better predictor of food insecurity than IPV perpetrated by a current partner, these alternative explanations remain a possibility.

Association between Food Insecurity and Depressive Symptoms

In this study, the odds of being food insecure were approximately 84% greater for women who reported depressive symptoms compared to those without symptoms. These results were consistent with the findings of several previous investigations which examined the association between food insecurity and depressive symptoms. Overall, previous studies have demonstrated that there is a significant association between the report of food insecurity and depressive symptoms. This observation has remained true for various populations of adults. For example, Laraia et al. found that the odds of food insecurity in pregnant women were significantly greater in those who also scored high for depressive symptoms, compared to those with low depression scores (OR 1.87, 95% CI 1.40—2.51)[21]. Similar associations have also been observed in studies of low income women and welfare recipients with young children[12, 19, 20, 41]. Ultimately, the findings of this study provide additional support to the conclusion that there is an association between food insecurity and depression.

The composition of the final multivariable model revealed several insights into the association between food insecurity and antenatal depressive symptoms. Overall, depressive symptoms were stronger predictors of food insecurity in the 12 months before delivery than a woman's race and educational attainment. This association remained

despite adjustment for strong food insecurity risk factors including income and public assistance. However, measures of stressful life circumstances such as homelessness demonstrated even greater ability to predict food insecurity. These indicators represented measures of multiple kinds of stress, including financial stress, traumatic stress, emotional stress, and partner-related stress. Of the four areas of stress measured by PRAMS, both the financial and traumatic stress categories had the greatest number of variables in the final model. The observed associations leave one to wonder if factors which impact these areas of stress can have an influence over if and how a women experiences food insecurity. And what, if any, effect would this have on relationship between depressive symptoms and food insecurity?

The Association between Food Insecurity and Antenatal Depression

As with this study, many previous investigations have used cross-sectional data to investigate the association between food insecurity and depressive symptoms. Because of the characteristics of these data, it is impossible to definitively determine causal inference. That is, it is difficult to say whether depressive symptoms lead to food insecurity, or if food insecurity predisposes a woman to depression or depressive symptoms. Researchers have taken both views, and in the process, proposed a number of theories about how food insecurity and depressive symptoms relate to one another.

Depression as a Risk Factor for Food Insecurity

There are several proposed reasons why depression and its symptoms might cause women to become food insecure. One suggestion is that mental health problems like depression may impede a woman's ability to acquire food. In particular, women who suffer from depression may have greater difficulty maintaining employment, making it

more difficult to earn income[41]. This notion has support from several investigations, which have linked depression to decreases in job performance. One overview conducted by Lerner and Henke reported that individuals with either depressive disorder or depressive symptoms were more likely to be unemployed, have a greater number of absences from work, and have poorer at-work job performance[45]. These decreases in employment and job performance may result in the loss of much needed income, leading to a reduced ability to purchase food. In the 2005 Oregon PRAMS sample, women who reported losing their jobs were significantly more likely to be food insecure, and more likely to have depressive symptoms, than women who did not lose their jobs. Although we cannot determine whether job loss in this sample was influenced by depressive symptoms, the relation of the two factors is interesting in light of previous research.

In addition to threatening an individual's source of income, depressive disorders may also cause food insecurity by diverting household resources away from food purchases[25]. Stuff et al. suggest that poor physical and mental health can necessitate the use of household expenses for other items and services, decreasing the amount of money available to purchase food[46]. Treatment for depressive disorders, when sought, can be a considerable expense, placing strain on patients and their families. An analysis performed by Von Korff et al noted that the cost of an initial psychiatric consultation could run as high as $120 in 1996 [47]. If patients do not have health care coverage to alleviate some of the costs of treatment, they may be forced to use greater proportions of their own incomes. This in turn can reduce the amount of resources available for food purchases. In this study, it was not possible to assess for use of mental health services. However, difficulties related to the cost of mental health treatment remain a possible explanation

for the association between food insecurity and depressive symptoms in the Oregon PRAMS population.

Depression may also increase the risk for food insecurity by reducing a woman's willingness to seek out resources when she is experiencing food insecurity. One of the defining characteristics of depressive disorders is anhedonia, the loss of interest or pleasure in activities[33]. Some suggest that this loss of interest may affect a woman's motivation not only to engage in activities that generate income, but to also seek out help with acquiring sufficient amounts of food. Reduced motivation may ultimately lead to insufficient food intake and food insecurity. Although this study did assess respondents for anhedonia, one cannot say what effect it may have had on a woman's food seeking behaviors during pregnancy.

Another reason some have suggested that depression may lead to food insecurity is the notion that depression may affect an individual's coping behaviors. Women who suffer from mental health problems may face greater difficulties in adapting to, and meeting the challenges of poverty. In particular, women who face these problems may have less knowledge of how to plan nutritionally adequate meals using affordable ingredients[41]. Forced to rely on more expensive food options, women may experience periods of limited resources and food insecurity. Because this study used only one measure of food insecurity adapted from the *US Household Food Security Survey,* determining the frequency and self-reported reasons for food insecurity was not possible. However, one must consider difficulties related to coping strategies a possible explanation for the association between food insecurity and depressive symptoms.

Food Insecurity as a Risk Factor for Depression

Although previous studies have proposed a number of ways in which depression can lead to food insecurity, the likelihood of the reverse causal relationship remains a possibility. Several studies have examined this topic under the assumption that food insecurity may be a contributing factor in the development of depressive disorders.

One of the ways in which food insecurity could lead to depression is through its potential effect as a stressful life circumstance. Stressful life events have been associated with depressive disorders in previous investigations[48]. Some investigators suggest that food insecurity may represent another stressor that can potentially trigger depressive symptoms[20, 41]. Both Siefert et al. and Heflin et al. considered this possibility in their investigations of food insecurity and mental health in women. These authors theorized that food insecurity could initiate self-blame, and reduce an individual's sense of self-mastery[41]. It is thought that these feelings, over time, could eventually lead to the development of depression. Due to the nature of the data used in these studies, the authors could not determine the direction of the association between food insecurity and depression. In this study, the use of PRAMS data precludes the examination of self-mastery. However, the results of the univariate analysis suggest that there are very strong associations between food insecurity and many stressful life events. Although the appropriateness of such a method is unknown, it is possible that food insecurity may be treated as a stressful life event in future analyses.

In addition to affecting an individual's sense of control and self-mastery, food insecurity may also contribute to depression through nutrient deprivation. Food insecurity has previously been associated with reduced nutrient intake in adults[3, 49]. In general, the

lack of regular access to quality food forces some individuals to maintain diets that are deficient for key nutrients such as vitamin C, vitamin D, calcium, and niacin[3, 50]. These deficiencies may have an effect on the development of mood disorders. A review conducted by Berk et al. found several studies which demonstrated a strong association between vitamin D deficiency and increased risk for depressive symptoms in adults with Seasonal Affective Disorder[50]. Additional study is needed to determine if nutrient deficiencies have a similar effect on women who are pregnant.

Strengths and Limitations

This analysis used data from the 2005 Oregon Pregnancy Risk Assessment Monitoring System. Due to the nature of PRAMS data, this study enjoys several strengths. Perhaps most important, is the population-based nature of the PRAMS sample. By surveying a representative sample of the state's population, the results of this study may be generalized to women throughout the state. This method allows for increased confidence that the results drawn from Oregon PRAMS capture the experience of food insecurity and antenatal depression in women who give birth in Oregon.

Another strength of this study is the fact that its results were consistent with previous findings related to food insecurity and depression. Both the findings of the univariate and multivariate analyses indicated that the association between food insecurity and depressive symptoms was of similar strength and significance as those witnessed in other investigations. Further, the multivariate analysis adjusted for several known risk factors of food insecurity, reducing the likelihood that the association between food insecurity and depressive symptoms could be affected by a commonly identified confounder.

A third strength of this study is the variety of measures evaluated by the Oregon PRAMS. The 2005 Oregon PRAMS provided information about a wealth of topics concerning feelings, experiences, and behaviors related to pregnancy. This allowed for greater choice in the kinds of factors examined. Unlike some scales which are focused solely on food insecurity, PRAMS data allowed for assessment of substance use, stressful life circumstances, physical abuse, and several other indicators known to be associated with an individual's ability to access food. Ultimately, PRAMS data provided an opportunity to assess food insecurity and many of its possible predictive factors.

Despite these strengths, this study also has several limitations. As discussed earlier, Oregon PRAMS consists of cross-sectional data. Because of this fact, the results of this study cannot be used to determine causal inference. As with studies described in existing literature, one cannot say, in this case, if antenatal depressive symptoms are truly a cause or an effect of food insecurity during pregnancy. Although it is clear that food insecurity does not contribute to factors such as maternal race, its relationship to other factors is uncertain. Despite this fact, the knowledge of risk factors and associations identified in this study may provide future benefit to research seeking to establish causal relationships.

A second limitation of this study involves the use of the PRAMS food insecurity measure. Although the PRAMS question assesses a fairly serious aspect of food insecurity, it lacks the ability to provide a full picture of this complex issue. Unlike commonly used multiple-item surveys, the PRAMS measure cannot describe the nutritional adequacy of the subject's diet or gather information about the social acceptability of the subject's food acquisition methods. Although the information

gathered through Oregon PRAMS is useful for identifying those who have difficulties paying for food, it is not a suitable tool for addressing the dietary and social concerns that also define food insecurity.

The food insecurity measure also presents difficulty in that it covers the 12 months prior to delivery and does not assess the frequency of the condition. Although food insecurity is, for many, a chronic problem, it is possible that a person may experience only a single, temporary, bout of difficulty accessing food (cite). Due to the precise wording of the PRAMS measure, it is possible that both those with chronic and rare experiences with hunger may be classified as food insecure. While this possibility is somewhat diminished by the severity of the question, the amount of time covered is still problematic. It is possible that some food insecure women only experienced the condition prior to their pregnancies. If these women experienced depressive symptoms only during their pregnancy, then those symptoms could not have caused their food insecurity. Whether this actually occurred in the PRAMS sample is unknown, and there are no ways to determine the likelihood of such an event. This study assumes that the majority of women who experience food insecurity would have faced these difficulties for at least part of their pregnancies.

Another possible limitation of this study is the effect of reporting bias. Oregon PRAMS assessed participants for a wide variety of pregnancy-related topics, some of which may be considered sensitive. It is possible that participants were less willing to report behaviors that may have been judge to be socially unacceptable. This may be especially true of women who completed telephone interviews rather than written surveys, as those women would have had to disclose information to a live interviewer. In

this study, which examined factors closely related to poverty, substance use, and domestic violence, it is possible that the frequency of certain behaviors have been underestimated. However, there is no evidence to suggest that this bias would have differentially affected food secure and food insecure women. While food insecurity itself may have been under-reported, there is nothing to suggest that subjects would answer other questions more or less truthfully based on the experience of food insecurity. Any misclassification of this kind would most likely have resulted in underestimation of behaviors across the entire PRAMS sample. Further, reporting bias would not have affected the estimates of measures derived from birth certificate information such as county of residence and maternal race.

Public Health Implications

This study provides support for the assertion that antenatal depressive symptoms are an important determinant for food insecurity during pregnancy in this sample of Oregon women. Despite the limitations of this analysis, the results have several important implications for reducing the burden of food insecurity and antenatal depression.

The results of this analysis suggest that increased consideration of food insecurity and antenatal depression could be of use to programs and clinicians that provide services to pregnant women. Programs that address food insecurity should be aware that depression might be an issue for pregnant women who seek their services. Similarly, health professionals should be aware that pregnant women might have difficulties with depressive symptoms, as well as trouble accessing food. Greater efforts should be made to ensure that clinicians are aware of the screening tools and resources available to alleviate these burdens. Current recommendations proposed by the American College of

Obstetricians and Gynecologists suggest that women who seek prenatal care should be screened for depression and nutritional difficulties at least once every trimester[51]. The association between food insecurity during pregnancy and antenatal depressive symptoms described in this study support these suggestions.

Despite current efforts, food insecurity remains a challenge for women living in Oregon. The results of this study suggest that there is a need for increased development and expansion of food programs, especially in rural communities. Women living in rural areas may face greater challenges in terms of accessing food, due to the limited availability of food sources. Additional funding for food programs in these regions could help improve nutrition and overall health, while reducing the risk of adverse health outcomes associated with food insecurity.

One possible way to improve access to food is through expansion of the Food Stamp Program. Currently, nearly 434,000 people living in Oregon participate in the Food Stamp Program[37]. These participants account for 83% of those eligible for the program. In 2007, the Oregon Center for Public Policy estimated that increasing participation to 88% of eligible households would provide assistance to an additional 26,000 Oregonians[52]. In addition, previous expansions in eligibility (based on household income and total assets) have demonstrated the ability to increase access and participation in the program[52]. Further expansion of these criteria may allow access to additional low-income households. Similarly, expansion in eligibility and participation in the Oregon WIC Program could directly improve food insecurity during pregnancy for women in the state.

Another possible measure for improving access to food involves support for the Oregon Food Bank. Increasing local, state, and federal grants for the Food Bank could improve the availability of emergency food resources throughout Oregon and southwest Washington.

Future Studies

Future studies are needed to determine the precise relationship between food insecurity and its associated risk factors. In particular, it will be important to determine if antenatal depression contributes to the development of this condition. This kind of analysis will require longitudinal data, which can trace food insecurity and related factors over time. Such studies may also wish to examine what role life stresses play in the relationship between food insecurity and depression.

There is also a need for studies that examine the long term effects of food insecurity on the health of children. Previous studies have noted an association between food insecurity in pregnant women and adverse health outcomes in their offspring. In particular, increased risks of certain birth defects, diabetes, and heart disease have been found in the children of women who experienced food insecurity during pregnancy [10, 53]. Additional investigation may reveal other potential health outcomes related to food secure status.

Oregon PRAMS is currently in the process of collecting follow-up information from women who participated in the survey. These data are being gathered from participants approximately two-years after the dates of their initial responses. Analysis of this information may be useful in determining if food insecurity during pregnancy has long-term effects on the mental health status of women, and if depressive symptoms

persist in women two years after pregnancy. The data may also determine if food insecurity is associated with health outcomes in their children.

Summary and Conclusions

This study found that in univariate analysis, women who reported antenatal depressive symptoms were significantly more likely to have experienced food insecurity during pregnancy. Although a similar association was found in multivariate logistic analysis, it was not statistically significant. The association between food insecurity and antenatal depression is supported by previous investigations that have examined pregnant women, as well as women with young children.

Due to the cross-sectional nature of PRAMS data, the findings of this study cannot be used to determine the direction of the association between food insecurity and antenatal depression. The experience of antenatal depression may influence the development of food insecurity though impacts on employment, coping behaviors, and distribution of household resources. Similarly, food insecurity may also influence antenatal depression through impacts on feelings of self-worth and nutritional deficiencies. More study is needed to determine the exact nature of this relationship.

The findings of this study suggest that there is a need for improved understanding of the burden of both food insecurity and antenatal depression. Both public programs as well as clinicians can benefit from a greater understanding of how these factors affect pregnant women. Future study is needed to determine what effects food insecurity may have on the long-term health of women as well as their children.

Appendix A

Table 10. The U.S Household Food Security Survey, Six–item Version

Question	Possible Responses
The food that I bought just didn't last and we didn't have money to get more	Often true Sometimes true Never true Don't know/refused
We couldn't afford to eat balanced meals	Often true Sometimes true Never true Don't know/refused
In the 12 months, since last (current month), did you ever cut the size of your meals or skip meals because there wasn't enough money for food?	Yes No Don't know
If yes to question 3, How often did this happen?	Almost every month Some months but not every month Only 1 or 2 months Don't know
In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?	Yes No Don't know
In the last 12 months, were you ever hungry but didn't eat because there wasn't enough money for food?	Yes No Don't know

Table 11. Scale for Classifying Household by Food Security Status Level, from the USDA Guide to Measuring Household Food Insecurity and Hunger

Conditions/Experiences/Behaviors Indicative of Food Insecurity and Hunger: (sequential set of increasingly severe indicators)				
No such indications: ***Presumed food secure***	One or two indications: ***At-risk***	Multiple indications: ***Few or no hunger indicators***	More and more severe, indications: ***Multiple indicators of adult hunger***	Many indications, including: ***Child hunger indicators and more severe adult hunger indicators***

Appendix B

2005 Oregon Pregnancy Risk Assessment Monitoring System
Questionnaire

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