# Food Insecurity During Pregnancy and Its Relation to Birth Weight

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## List of Common Abbreviations

| | |
|---|---|
| CA | California |
| CDC | Centers For Disease Control and Prevention |
| CI | Confidence Interval |
| DHS | Department of Humans Services |
| HBW | High Birth Weight |
| HFS | High Food Security |
| HFSS | Household Food Security Survey |
| IOM | Institute of Medicine |
| g | grams |
| LBW | Low Birth Weight |
| LGA | Large for Gestational Age |
| LFS | Low Food Security |
| MFS | Marginal Food Security |
| MIHA | Maternal Infant Health Assessment |
| NH | non-Hispanic |
| OR | Odds Ratio |
| PedNSS | Pregnancy Nutrition Surveillance Survey |
| RDA | Recommended Daily Allowance |
| SGA | Small for Gestational Age |
| SES | Socio-economic Status |
| U.S. | United States |
| USDA | United States Department of Agriculture |

| | |
|---|---|
| WIC | Women Infant and Children |
| VLBW | Very Low Birth Weight |
| VLFS | Very Low Food Security |

## Abstract

Food security is defined as steady access to sufficient nutritious foods to lead an active and healthy life. Food insecurity exists whenever the availability of nutritionally adequate and safe food or the ability to acquire acceptable foods in socially acceptable ways is limited or uncertain. While the prevalence and impact of household food insecurity is beginning to be assessed with adults and children, the prevalence and effect on pregnancy has not been fully explored. In women, food insecurity has been associated with obesity and decreased dietary intake of key macronutrients and micronutrients. In pregnant women it has been well documented that poor nutrition and inappropriate weight gain during pregnancy affects the health of the fetus and mother. Birth weight is a major determinant of mortality, morbidity and disability in infancy and childhood. The relationship between food insecurity during pregnancy and birth weight has not been examined. The goal of this study was to determine the prevalence of food insecurity during pregnancy and to identify if food insecurity during pregnancy is an independent predictor of birthing a low birth weight (LBW) or high birth weight (HBW) infant. It was hypothesized that women who report to having experienced household food insecurity during pregnancy were more likely to give birth to an LBW or HBW infant.

Data from the 2005 California Maternal Infant Health Assessment (MIHA) survey data were first analyzed to determine the overall prevalence of food insecurity in the pregnant population, and to determine if household food insecurity during pregnancy was a predictor of giving birth to a LBW or HBW infant. Additional analysis was conducted to explore if the prevalence of food insecurity experienced by pregnant women who demonstrated characteristics predictive of LBW or HBW were significantly different than

women without the predictive characteristics. Finally, maternal characteristics that were predictors of birth weight were investigated to determine if they had similar independent predictability in the study population.

Of the 3,635 women sampled from the 2005 MIHA survey the prevalence of food insecurity experienced during pregnancy showed to be higher than that of the general population. Food insecurity investigated as a binary variable did not independently predict LBW or HBW, however when food insecurity was broken down into a categorical variable, women who experienced the most severe level of food insecurity during pregnancy had a significantly higher likelihood (OR 1.75 95% CI 1.0-3.06) of birthing a LBW infant compared to women who experienced food security. This finding partially supports the hypothesis of this study. In addition many of the maternal risk factors for birthing a LBW or HBW infant were positively associated with food insecurity. Therefore, women who experience food insecurity during pregnancy may be a high-risk population for poor birth outcomes due to the numerous overlapping characteristics associated with both food insecurity and abnormal birth weight. Given the result of the present study, further investigations are warranted to determine the relationship between birth weight and food insecurity experienced during pregnancy.

## ***Chapter 1. Introduction***

Nutrition during pregnancy is regarded as an important contributor to both maternal and child health and the quality along with the quantity of the diet is crucial for optimal health.[1] Diverse maternal food consumption is essential for providing the appropriate ratios of carbohydrate, protein, and fat along with the vitamin and mineral requirements for the growing fetus. The availability of fetal macro and micronutrients is associated with the mother's prepregnancy nutritional and health status as well as her diet during pregnancy.[1-7] The position statement of the American Dietetic Association (ADA) describes guidelines for a healthy pregnancy, recommending "appropriate weight gain; consumption of a variety of foods in accordance with the Food Guide Pyramid; appropriate and timely vitamin and mineral supplementation; avoidance of alcohol, tobacco, and other harmful substances; and safe food-handling."[8]

The ADA advises that calorie needs during pregnancy increase on average 300 kcal/day; however, the amount of calories should be tailored to the individual based on prepregnancy body mass index (BMI), rate of weight gain, maternal age, and physiological appetite. Increased energy requirements during pregnancy are due to the increased work of the heart, increased respiration, formation of breast tissue, uterine muscle expansion, placental growth, and fetal growth.[7, 10]

The pregnant woman can meet maternal and fetal nutritional needs with the consumption of a well-balanced diet composed of 55% to 60% of calories coming from complex and unrefined sources of carbohydrates; roughly 25% to 30% of total calories from lean protein; and the remaining 20% of calories from fat sources.[8, 9] The fat calories should come mainly from essential fatty acids and polyunsaturated fatty acids (linoleic

acid and alpha linolenic acid).[9, 10] For example, fetal brain and retinal development require docoshexaenoic acid (DHA), a long chain polyunsaturated fatty acid found in mainly in fish oil.[11]

In addition to macronutrients, micronutrients are also needed. Each fetal organ has a set of minerals and vitamins that play a role in the development or function of that organ.[12, 13] Table 1-1 shows selected minerals and vitamins paired with the associated fetal organs. Both excesses and deficiencies of these micronutrients can affect proper development.[13]

Table 1-1. Selected minerals and vitamins that play a role in fetal organ development

| Organ | Mineral | Vitamin |
|---|---|---|
| Liver | Fe, Se, Cu, Zn [13, 14] | A, B12, choline, folic acid [16 17] |
| Heart | Cu, Zn [13, 14] | A, B12, D [16 17] |
| Kidney | Fe, Zn [13, 14] | A [16, 17] |
| Brain | Fe, Cu, Zn, I [13, 14] | A, folic acid, B12, [16, 17] B6, biotin,[18, 19] |
| Lung | Cu, Zn [13, 14] | A [16, 17] |
| Bone | Ca, Mg [15] | D, [16, 17] E, C [18 19] |
| Pancreas | | D [16, 17] |

The importance of dietary intake for the pregnant woman cannot be overstated. Not only is nutrient composition crucial but the timing of adequate intake in each trimester also plays a role in the proper formation of fetal organs and tissues.[8, 20] The

pregnant woman's body increases blood volume to supply the fetus with glucose and nutrients and increases absorption of key minerals such as iron and calcium.[8, 12] The mother also experiences increased insulin resistance, increased circulating blood lipids, and alterations in protein and amino acid metabolism.[10] However, if the mother is not consuming an adequate diet in the early stages of fetal organ development the body restricts nutrients aimed at the fetus in favor of maternal requirements and placental needs.[4, 10, 20]

In adults food insecurity has been associated with poor intake of nutrient-dense foods and an imbalance of micronutrients and macronutrients, along with obesity and depression. The risk for food insecurity has been shown to increase with poverty, the number of children in a household, in single women head of households, and among racial/ethnic minority groups. All of the above characteristics have also been associated with poor birth outcomes. Therefore, experiencing food insecurity during pregnancy could reduce fetal nutrition and impede proper growth; abnormal birth weight is a particularly concerning outcome.

## ***Chapter 2. Background and Significance***

### Food Insecurity

Food security is defined as steady access to sufficient nutritious foods to allow the individual to lead an active and healthy life. Conversely, "food insecurity exists whenever the availability of nutritionally adequate and safe food or the ability to acquire acceptable foods in socially acceptable ways is limited or uncertain."[21]

Standardized survey modules initiated by the United States Food Security Measurement Project measure food insecurity. The measurement project was organized in response to the National Nutrition Monitoring and Related Research Act of 1990 (NNMRR). [22] The foundation for the survey modules was developed by the U.S. Department of Agriculture (USDA), along with the Food and Nutrition Services (FNS), the U.S. Census Bureau's Current Population Survey (CPS), and other government agencies. The CPS Food Security Supplement[23] was the original product of the collaboration and was piloted in the 1995 CPS. The current tool is an 18-item "core module;" however, subsets of the 18 questions have been selected and validated for different populations.[24] For example, an abbreviated 6-item module was used in the present study; additional information related to the 6-item module will be discussed in the methods section of this work.

The U.S. Food Economic Research Service (ERS) and the USDA define hunger as, "The uneasy or painful sensation caused by a lack of food. The recurrent and involuntary lack of access to food . . . [which] may produce malnutrition over time."[21] Prior to 2006, the defined levels of food security included the experience of hunger. In 2003-06, a panel given the responsibility to review the U.S. Department of Agriculture's

Measurement of Food Insecurity and Hunger carried out an assessment of the definitions for the levels of food insecurity. [25] Recommended revisions of the definitions were made to specify varying degrees of food insecurity and to define hunger separately. The recommendations suggested that hunger is experienced on an individual level and the physical and psychosocial consequences of hunger can be experienced as a result of food insecurity. The distinction was made that food insecurity is experienced on a household level and measured by household, as opposed to hunger, which can be an individual experience. The panel concluded that there should be a separate tool to measure hunger; such a tool has not been developed but is under investigation.

The 2006 defined levels of food insecurity do not include hunger in the classification. The previous definitions "food insecurity without hunger" and "food insecurity with hunger" have been replaced with "low food security" and "very low food security," respectively. The following definitions are referenced from the m ERS/USDA report on Food Insecurity in the United States.[26] Classifications of food security status in a household range from high food security to very low food security. The four levels are:

1. "High food security (HFS)—Households had no problems, or anxiety about, consistently accessing adequate food."[22]
2. "Marginal food security (MFS)—Households had problems at times, or anxiety about, accessing adequate food, but the quality, variety, and quantity of their food intake were not substantially reduced."[22]
3. "Low food security (LFS)—Households reduced the quality, variety, and desirability of their diets, but the quantity of food intake and normal eating patterns were not substantially disrupted."[22]

4. “Very low food security (VLFS)—At times during the year, eating patterns of one or more household members were disrupted and food intake reduced because the household lacked money and other resources for food.”[22]

The ERS report clarifies that when reporting food insecurity, the USDA describes households with HFS or MFS as food secure and those with LFS or VLFS as food insecure. The specific identification of the level of food security is based on the household’s responses to questions on the food insecurity modules related to food availability and behaviors associated with food intake and food resources.[22, 24] Each question refers to the last 12 months and defines a lack of resources as the explanation for the behavior or experience of food insecurity. For example, a response of "we couldn't afford more food," or "there was not enough money for food” suggests that food insecurity resulted from a deficiency in financial or other resources associated with acquiring enough food. The range of severity experienced by the food-insecure household is identified through the content of each question. The questions are ordered so that the first question indicates the least severe level of food security and the last question indicates the most severe level of food insecurity (Appendix A: MIHA Survey, questions 64-66).

Households that report two or more affirmatives on the 6-item module are classified as "food insecure." Households are classified as having “very low food security” if they report 5 or more affirmatives on the 6-item module.[22, 24] The specifications and details of how food security was measured in the present study will be discussed in the methods section. The difference in reporting of the households with low food security and that of very low food security is defined by access to food and food

intake. Low food security in the household does not necessarily indicate reduced food intake, but an actual problem of food availability, whereas households with very low food security may experience inadequate food intake and disordered eating problems as a result of a lack of resources for food.[22]

*Prevalence of Food Insecurity and Measure of Diet Quality*

The U.S. Food Assistance and Nutrition Research Report revealed that 11% of all households experienced food insecurity in 2005. The prevalence of VLFS in U.S. households has remained steady at 3.9% since 2003.[22] Food insecurity encompasses households that are either experiencing LFS or VLFS.

According to the 2005 Economic and Research Report, "two thirds of food-insecure households avoided substantial reductions or disruptions in food intake, in many cases by relying on a few basic foods and reducing variety in their diets,"[22] therefore possibly decreasing the quality and nutrient density of their diet. The 2005 Dietary Guidelines for Americans defines foods as having high nutrient density if they contain "substantial amounts of key nutrients in relation to the dietary energy they provide."[27] The "energy density of foods and beverages is defined as the available energy per unit weight (kJ/g)."[28] Hence, a food could be energy dense but not nutrient dense and visa-versa.

The interpretation of the food insecurity scale does not measure the nutrient density of the diet. However, according to the report *Household Food Security in the United States, 2005,* it can be inferred that households that have lower food security have nutritionally less adequate diets than households that have higher food security.[22]

## Risks for Food Insecurity

*Poverty*

Poverty is a risk factor for experiencing food insecurity. Among the 12.6 million U.S. households who experienced food insecurity at some time during the year 2005, 36% were below the federal poverty line.[29] In 2002 (the most recent report), women aged 18 years and older made up 61% of the population below the federal poverty line and women ages 18 to 24 had the highest rate of poverty.[30] In 2005, the U.S. Census Bureau revealed that households headed by single females are more likely to live in poverty than households headed by single males—28.7% vs. 13%, respectively.[29] Women who experience poverty may be at a greater risk for food insecurity, hunger, and the negative consequences associated with inadequate food supply and overall health. In addition, because women of childbearing age (18-24 years of age) have the highest rates of poverty, they could be particularly vulnerable to experiencing food insecurity during pregnancy.

*Women with children in the household*

Mothers who have children living in the household are more likely to experience food insecurity than mothers without children living in the household. Additionally, the risk for household food insecurity has been shown to increase as the number of children in a household increases.[29, 31] Overall, 30.8% of households with children under age 18 with a single female head of household experienced food insecurity in 2005, compared to a household with a male head, where food insecurity was 17.9%. The 2005 data also

revealed that 8.7% of single women with children have reported VLFS compared to 5.5% of single men with children.[22]

*Race/Ethnicity*

Among women 18-24 years of age, 21.4% of non-Hispanic (NH) African American women and 20.1% of Hispanic women experienced poverty in 2002 (the most recent year reported).[30] Additionally, the risk of experiencing food insecurity is associated with racial/ethnic minority group membership. In 2005 household food insecurity rates of NH European American, NH African American, and Hispanics were 8.2%, 22.4% and 17.9% respectively.[22] Among single women with children VLFS was experienced by 8.6% of NH African American households and in 5.3% of Hispanic households in 2005.[22]

## Impact of Food Insecurity

*Impact of Food Insecurity: The Pregnant Woman*

Although the impact of food insecurity is beginning to be assessed among women and the general population, its prevalence and effect on pregnancy has not been fully explored. Laraia et al. explains in a recent study that little is known about the "predictors and correlations of food insecurity within the pregnant population, because nutrient demands are different during pregnancy with suggested increased intakes of most vitamins and minerals."[32] To meet the desired gestational weight gain, dietary suggestions include nutrient-dense foods that are often expensive.[27, 32, 33] In order to account for the increased energy needs of the mother, the household may experience

more financial restriction in their food budget,[32] possibly decreasing the quality of the diet and availability of balanced meals. Laraia et al. studied the prevalence and predictors of food insecurity among pregnant women in medium to low-income households. The researchers found that psychosocial factors, along with socioeconomic and demographic indicators were associated with food insecruity.[32] To date, this is the only study that has looked at the predictors of food insecurity within the pregnant population.

The additional studies discussed below were done on populations that did not exclusively focus on food insecure pregnant women. However, the findings give evidence for the dietary deficiencies, health conditions, and behaviors that exist when food insecurity and or poverty is experienced.

Fruit and vegetable intake is decreased in the diets of women with food insecurity;[31] furthermore, micronutrient intake among women of childbearing age is decreased when food insecurity is experienced.[34] Food insecurity is significantly associated with low intakes of energy, vitamin E, B-6 (pyridoxine), B-1 (thiamin), B-3 (niacin), vitamin C, vitamin A, B-9 (folic acid), iron and magnesium.[34-36] Dixon et al. observed from the Third National Health and Nutrition Examination Survey that calcium intake among food insecure adults 20 to 59 years of age was significantly lower than the RDA.[36] Associations have also been found between maternal food insecurity and a deprivation of a variety of foods, along with consistently reduced intake of food.[37, 38]

In a recent study, George and colleagues discussed findings related to adverse maternal lifestyle/dietary alterations experienced by low-income women. Such disparities included restricted time, role challenges, taste changes; decreased intakes of folate, zinc, and B-12; modifications in dieting attitudes, habits, and weight variations.[39] George et al.

identified that limited food choices available to pregnant, low-income, women may affect the overall quality and variation of their diet.[39] In addition, low-income mothers have been shown to compromise their own nutritional intake in order to preserve the adequacy of their children's diets.[40]

There are federal programs that address the need for additional nutrition during pregnancy that are aimed at assisting low-income women. The most notable example is the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), which has existed since 1974 and is administered at the federal level by the Food and Nutrition Service of the USDA. The following population qualifies for WIC resources: women who are pregnant or postpartum, infants, and children up to age 5 with a household income at or below 185% of the U.S. Poverty Income Guidelines who meet state residency requirements and are determined to be at "nutrition risk". Individuals who participate, or have family members who participate, in the Food Stamp Program, Medicaid, or Temporary Assistance for Needy Families automatically meet the income requirement for WIC assistance.

However, WIC is not an entitlement program and only receives a specific amount of funding authorized by Congress each year. Since funding is finite not all women who are eligible receive WIC assistance. For example, a pregnant woman who is not receiving WIC due to limited government funds, but is eligible for the food stamp program, defined as having an income of less than 130% of the federal poverty level, does not obtain additional resources until after her child is born.[22] The WIC eligibility guidelines state that priority for WIC is given to those within the WIC target population who are considered to be "nutritionally at risk." At "nutrition risk" is determined by a healthcare

professional and includes two types of risk: 1) medically based risks such as anemia, underweight, overweight, history of pregnancy complications or poor pregnancy outcomes; and 2) dietary risks such as failure to meet the dietary guidelines or inappropriate nutrition practices. According to the 2006 United States Centers for Disease Control's (CDC) Pregnancy Nutrition Surveillance Survey (PedNSS: measures and identifies health indicators of nutritional status for high-risk children at the national, state, and local levels), 31.3% of the nation's high-risk pregnant population were enrolled in WIC during their first trimester, 35.0% in the second trimester, and 18.1% in the third trimester.[41] The statistics reveal that a large percent of high-risk, eligible women are not receiving WIC benefits. Therefore, despite the increased nutrient needs of the mother she is not always in a position to obtain supplementary nutrition due to restraints on resources (government and household) and on eligibility for assistance.

In addition to compromised diet quality, food insecurity has been linked with other adverse health outcomes, along with poor control of chronic disease states such as diabetes.[42-44] Self-perceived overall health status was reported as fair or poor in a number of studies looking at food insecurity in adult populations.[44-47]

In the low-income female population, food insecurity is associated with weight management issues.[48] Overweight and obesity are significantly higher for women in food-insecure households compared to women in food-secure households.[31, 35, 36, 49-51] The prevalence of overweight increases with increasing severity of food insecurity.[31] This seems to be explained by a binge-like eating pattern, and the replacement of nutrient-dense foods with high caloric choices.[33, 48, 52, 53] Further, a lack of physical activity and

numerous lifestyle exercise barriers have been reported by food insecure women,[48] which could also contribute to difficulty with weight management.

Food insecurity has also been associated with poor mental health and psychosocial factors in women,[47, 54, 55] which may place them at risk for job instability, poor coping skills, and further inability to acquire enough nutrient-dense foods.[55] As stated earlier, one study has found a significant association between food insecurity experienced among pregnant women and psychosocial factors and socioeconomic indicators.[32] Provided that food insecurity is associated with low socioeconomic status (SES), behaviors reported by individuals classified as experiencing low SES may also be reported in populations experiencing food insecurity. For example, smoking, illicit drug use, alcohol use, and other addictions have been associated with poverty and low SES.[56, 57] Food insecurity has also directly been linked to increased stress levels, anxiety, and depression in mothers.[58]

Despite the numerous associations found between food insecurity and health conditions and behaviors in the adult population, there have been minimal investigations done with the pregnant population. Inferences could be made with the experiences of the general population and the pregnant women; however, the prevalence of food insecurity and its specific impact on the pregnant population is an area of research that needs attention. An additional area of interest is how food insecurity, when experienced during pregnancy, may impact the fetus.

*Impact of Food Insecurity: The Fetus*

Very little research has examined how food insecurity may affect the fetus. Given that nutrient and energy demands during pregnancy are increased, a decrease in the amount and quality of food available could substantially impede the proper development of the fetus.

Reduced intake of nutrient-dense foods and an imbalance of micronutrients and macronutrients, during pregnancy have been shown to lead to poor fetal nutrition and improper growth. [4, 6, 13, 20] In a thorough meta-analysis Keen et al. reported an association between the consumption of a poor diet and an increased risk for poor birth outcomes.[7] Experiencing food insecurity in addition to the normal demands of daily living could promote pregnancy complications that could potentially compromise birth outcomes.

The first trimester of pregnancy is a crucial time for development of the fetal organs. Congenital malformations of the fetus[59] and neural tube defects have been linked to the health of the mother in the first trimester.[60] Malnutrition in the first trimester directly affects fetal brain development.[60] It is well understood that folic acid is a critical nutrient in neural tube development, which takes place in the early stages of pregnancy.[61, 62] A less than optimal intake of folic acid and other key nutrients during the first couple of weeks following conception may be a consequence of an unplanned pregnancy. Unintended pregnancy is most prevalent in the early and late stages of fertility and among poor unmarried women.[63] In pregnancies that are unplanned, mothers are more likely to receive little or no preconception and prenatal care,[63] therefore increasing the risk for less than optimal health for the fetus. Poor unmarried women are at a greater risk than others

for experiencing food insecurity. Experiencing food insecurity during pregnancy may be a risk factor contributing to poor birth outcomes.

To date, one study has looked at how food insecurity may affect birth outcomes.[64] The researchers found maternal food insecurity to be associated with increased risk of certain birth defects; specifically a higher level of food insecurity increased the risk of cleft palate, d-transposition of the great arteries, tetralogy of Fallot, spina bifida, and anencephaly.[64] Food insecurity could contribute to a decrease in key nutrients important for the development of the fetal neural tube and associated areas.

There have been no studies to date that have investigated the impact of food insecurity on birth weight. However, the impact of poor nutrition and inadequate dietary intake on birth outcomes has been studied to a great degree. Based on these studies, it is possible to conclude that food insecurity may contribute to undesirable birth weight.

## Birth Weight: An Indicator of Health

Birth weight is used world wide to measure fetal nutritional and health status as well as neonatal and infant mortality.[65, 66] Inappropriate size at birth has been found to increase the risk for a number of adverse health outcomes and disease states in childhood and into adulthood.[67] In 2005, a range of 8.2% to 9.4% of live births in the United States were low birth weight (LBW), defined at less than 5 pounds, 8 ounces (~2,500 g).[41, 67] In the same year, 6.6% of live births in the U.S. were high birth weight (HBW), defined as 8 pounds, 8 ounces (4000g).[41]

The PedNSS addresses the spectrum of birth weights [41] and defines the following birth weight categories: very low birth weight (<1500 g, VLBW), low birth weight (1500

- <2500 g, LBW), normal birth weight (2500 - <4000 g), and high birth weight (>4000 g, HBW). Large for gestational age (LGA) is also a term used to describe infants born at a weight for gestational age that exceeds the 90$^{th}$ percentile. Macrosomic infants are defined as birth weight greater than 4500g.[12, 68] Small for gestational age (SGA) infants are newborns weighing less than the 10$^{th}$ percentile for gestational age.[12]

Numerous studies have examined complications resulting from birth weight mainly looking at LBW, VLBW, and preterm births. However, birth weights on the higher end of the scale (LGA, HBW) have also been addressed by authors who have investigated the relationship between health and a wide range of birth weights.[69-72]

Birth weight is associated with numerous child disabilities and educational learning hindrances.[66] Specifically, HBW and LBW are related to poor early cognitive development, mental tests scores, and late adolescent cognitive function when combined with social class.[73] Specifically, LBW is associated with lower mean IQ scores, decreased standard cognitive scores, and memory difficulties.[74-77] Despite recent advances in neonatal care, LBW and preterm infants have increased neurodevelopmental, motor, and sensory delay compared to full term and appropriate size for gestational age infants.[78-83]

Physical complications are also a consequence of LBW. Poor lung function and risk for COPD in childhood have been linked with LBW.[84-86] Numerous studies have shown an increased risk of cerebral palsy with LBW.[87-90] Adverse health outcomes in childhood, defined as higher rates of hospital admissions (related to pneumonia, various respiratory viruses, and diarrhea) within the first two years of life are also associated with LBW.[91-93]

In addition, obesity and the development of hypertension and diabetes in childhood have also been linked with LBW.[71, 94, 95] Childhood obesity has been shown to be associated with coronary heart disease and adult obesity[96] as well as contributing to the risk for other child and adult diseases.[97, 98]

HBW is also associated with infant health and health throughout childhood and into adulthood. A 2007 meta analysis discussed the increased prevalence of HBW infants in the past two decades and addressed the short- and long-term risks associated with a birth weight >4000g.[99] The short-term effects on the infant include birth trauma, shoulder dystocia, fetal hypoxia[100] higher death rates,[101] and more than double the risk of hypoglycemia, hyperbilrubinemia, and being transferred to the neonatal intensive care unit.[102] Risks associated with HBW in childhood include: overweight, metabolic syndrome, asthma, and hypertension.[70, 71, 103-106] Numerous childhood complications associated with LBW or HBW may persist into adulthood; hence, an individual born outside the normal birth weight range may experience a continued compromised quality of life.

## Factors Associated with Birth Weight

### *Developmental Origins of Adult Disease*

The evidence suggests that birth weight has an important connection with neonatal and infant health and has been associated with adult onset diseases. Predisposition for developing adult onset diseases may be established before birth.[6, 70, 107-110] Barker's Developmental Origins of Adult Disease hypothesis suggests that the environment in which the fetus grows may be responsible for the long-term health of the

fetus into adulthood.[111] As proposed by Barker, changes in fetal nutrition could contribute to altered cell division during critical stages of development and compromise formation of fetal organs.[111]

The theory specifically addresses the chronic diseases of adults that have been associated with intrauterine growth, fetal nutrition, and weight at birth.[107] A number of researchers have explored this theory and found that a variety of adult diseases are related to birth weight. Follow up studies based on the Dutch famine of 1944-1945 demonstrated that adults who were exposed to under nutrition during their first trimester of intrauterine growth, and/or were LBW, experienced a higher rate of obesity and abdominal fatness than adults who did not experience under nutrition.[3, 108, 112, 113] Adults born at HBW were also shown to have increased rates of obesity[112, 114] and type 2 diabetes.[115] Additionally an inverse relationship between the following adult diseases and birth weight have been reported: lung function/lung disease,[84, 85, 116] type 2 diabetes and impaired glucose tolerance,[107, 108, 113, 117, 118] coronary artery disease and cerebral vascular disease,[107, 119] and hypertension.[107, 118, 120] The risk for breast cancer has been shown be increased for women born either LBW or HBW.[121, 122] The risk for testicular cancer has been shown to be increased for men born at LBW,[123, 124] whereas the risk for prostate cancer[125, 126] has been shown to be increased for men born at HBW.

Predispositions for adult diseases associated with obesity, such as cardiovascular disease, type 2, diabetes, hypertension, and with metabolic syndrome are of great interest given the current obesity epidemic that affects all age and race/ethnicity groups in the U.S. population. Obesity and chronic diseases compromise quality of life and increases morbidity and mortality.[127, 128] As discussed above, food insecurity is associated with

deficits in key nutrient intake and dietary balance. Therefore, maternal food insecurity may contribute to the development of numerous later health complications and chronic diseases by compromising fetal nutrition and the infant's size at birth.

*Maternal diabetes or high blood sugars-glycemic control*

The intrauterine environment has been linked with fetal growth and development specifically related to children of mothers with diabetes. Exposure to hyperglycemic environment in the uterus, related to maternal insulin resistance, obesity, and gestational diabetes mellitus, is linked to fetal overgrowth among all ethnic groups,[129] increasing the likelihood that the offspring will become overweight and develop type 2 diabetes later in life.[70-72, 94, 95, 104] Decreased maternal insulin sensitivity associated with gestational diabetes and maternal obesity is linked to macrosomia and a decrease in fat free mass in the fetus,[130] predisposing the fetus for obesity and glucose intolerances in childhood.

Longitudinal studies of Pima Indian children who are known for their high rates of diabetes demonstrated that LBW and HBW, exposure to diabetes in the uterus, and maternal obesity are major factors in the development of childhood type 2 diabetes and hypertension.[95] In women with diabetes dietary modifications can alter the production of glucose and other metabolic fuels (amino acids, triglycerides, FFA, ketones) that are transported to the fetus and that correlate with fetal growth[131, 132] thereby affecting birth weight.[131, 133-135] The literature also suggests a similar connection between glucose concentration and fetal growth in pregnancies that are not complicated by maternal diabetes or obesity.[131, 133-136] That is, even when the mother does not have diabetes or is not obese, the infant is still impacted by variances in glucose delivery in utero.

Because food insecurity has been related to poor management of type 2 diabetes and obesity, experiencing food insecurity during pregnancy may contribute to undesirable metabolic function in the fetus and mother. The consequences of this could contribute to numerous short- and long-term maternal health complications along with compromising birth weight.

*Maternal prepregnancy weight and gestational weight gain*

Maternal weight status during and prior to pregnancy has a direct impact on the long and short-term health of the fetus and birth outcomes. For example, recent findings have shown that among low-income children, maternal obesity in the first trimester is related to double the risk of obesity at 2 to 4 years of age.[137] Obesity during and before pregnancy has been linked to gestational diabetes[130], caesarean deliveries and complications during delivery, macrosomia and HBW,[68, 99] and congenital defects.[99] Being underweight or having inadequate weight gain during pregnancy has been shown to increase the risk for giving birth to LBW infants.[8]

The timing of the weight gain is also crucial to proper intrauterine growth of the fetus,[8] as identified in the Dutch famine studies.[138] Evidence from the US population shows that excessive weight gain (weight gains of 30 to 34 pounds for overweight women and 15 to 19 pounds for very overweight or obese women) during pregnancy place the baby at higher risk of being HBW or macrosomic.[139] As addressed above, food insecurity has been linked to obesity and difficulty with weight management in women; therefore, food insecurity during pregnancy could contribute to poor birth weight via difficulty with desirable weight balance during gestation.

*Maternal mental and physical health*

The mental as well as the physical health of the mother has been linked to birth outcomes and specifically pre-term birth and LBW of the infant. Mood disorders during pregnancy have been shown to affect the health of the mother on a number of levels. Women with depression may loose their appetite, decrease their level of prenatal care,[59] and have increased use of alcohol or illicit drugs,[56, 140, 141] all indirectly affecting the health of the fetus. Smoking[142-147] and alcohol use[59, 140, 141] during pregnancy have consistently been associated with LBW.

Maternal anxiety and stress have independently been associated with adverse pregnancy outcomes such as preterm birth and LBW.[55, 148, 149] Because all commonly used psychoactive medications cross the placenta, using pharmacotherapy to treat mood disorders during pregnancy is the subject of a controversy. Due to the possible adverse effects on the fetus, specifically administering psychotropic drugs during the first trimester, the time when the fetal organs develop, has been shown to cause cognitive malformations in the fetus.[59] As discussed earlier there are many psychosocial disorders associated with food insecurity among pregnant women, [32] hence when food insecurity is present during pregnancy the fetus may be at further risk for poor birth weight.

*Race/Ethnicity*

Another factor that impacts birth weight is the race/ethnicity of the mother. The 2005 U.S. statistics on the total number of births for each racial/ethnic minority group membership revealed that among NH African American women and Hispanic women the highest percent of births were born to women aged 18-24.[67] Several studies have

examined the relationship between birth weight and racial and ethnic minority group membership. Comparisons of effects of maternal glucose level on different racial/ethnic groups and birth weight have shown that the risk for LGA infants is significantly greater for NH African American women compared to NH white (European American) women.[131] Differences in pregnancy outcomes and in birth weight between Hispanic (Latina) women and NH white (European American) women have also been shown. According to the 2005 vital statistics report, NH African American mothers have had the highest rate of LBW, VLBW, preterm birth and caesarean delivery since 1990 when compared with all other races.[67]

The U.S. 2005 vital statistics reports revealed that the prevalence rate of diabetes during pregnancy was similar across all races, with a range between 3.6% and 3.9%. NH African American women had the lowest rate at 3.6%, Hispanic (Latina) women had a rate of 3.8%, and NH white (European American) women had a rate of 3.7%.[67] The only race/ethnicities that fell outside the range were NH Puerto Rican women (4.7%), NH American Indian/Alaskan Native women (6.2%) and NH Asian/Pacific Islander (API) women (6.3%).[67] However, the reason for the increased risk of altered pregnancy outcomes for ethnic minority groups has been principally unexplained.[150-152] The many health disparities discussed above may lead to further undesirable birth outcomes among racial and ethnic minorities particularly if food insecurity is experienced during pregnancy.

*Socio-economic status (SES)*

Along with the strong evidence associating birth weight with numerous adult diseases and adverse health outcomes, birth weight has also been linked with compromised social economic status (SES).[153] Low SES is a leading risk factor for compromised birth weight and poor pregnancy outcomes. In addition, a number of risk factors for abnormal size at birth are evidenced in women with low SES. For example, smoking has been shown to be more prevalent in women with a lower SES.[153] Low SES may increase the risk for experiencing food insecurity. Food insecurity combined with low SES may contribute to a higher risk for birthing a LBW or HBW infant.

*Recent Findings on Parental Characteristics and Behaviors*

A variety of other maternal characteristics have consistently been shown to have a relationship to birth weight, including maternal age,[154, 155] gestational age,[156, 157] and parity[154, 158] A 2007 publication in the *Journal of Human Reproduction* solidified many of the well-established associations of these factors with birth weight as well as with describing a relationship with previously studied predictors of birth weight.[69] Using the Nurses' Mothers' Cohort, with a final sample of 37,802, the authors found birth weight to be positively associated with gestational age, and maternal birth weight, height, prepregnancy BMI, weight gain, diabetes, and milk consumption during pregnancy. Birth weight was negatively associated with maternal smoking and coffee consumption during pregnancy, maternal infertility, and maternal occupation.

In summary, the above findings provide a strong foundation for the study at hand in regards to the covariates that have shown to be consistent predictors of birth weight

and may be important covariates to consider in the analysis of the association of birth weight with food insecurity.

## Purpose of Study

Up until now, only one study has looked at how food insecurity affects birth outcomes—in that study, the researchers investigated birth defects and did not look at birth weight.[64] The current study examines the prevalence of household food insecurity during pregnancy and explores the relationship between food insecurity and birth weight at either end of the birth weight spectrum (LBW and HBW). Specifically, the U.S. HFSS 6-item short module in the 2005 California Maternal Infant Health Assessment (MIHA) surveillance tool was used as a means for identifying women at increased risk for food insecurity and delivery of an LBW or HBW infant.

In addition, no studies to date have clarified the prevalence of household food insecurity among pregnant women who may be at risk for birthing an infant outside the normal birth weight range. Therefore, exploratory investigation of this sample population is warranted to estimate the prevalence of food insecurity experienced by women with risk factors for birthing a LBW or HBW infant.

Hypothesis: Women who reported household food insecurity during pregnancy are more likely to deliver a LBW or HBW infant.

Aims:

1) To determine the overall prevalence of household food insecurity in the pregnant population.
2) To investigate whether household food insecurity predicts giving birth to an LBW or HBW infant.
3) To explore the prevalence of household food insecurity among pregnant women with characteristics previously shown to be risk factors for birthing an infant outside the normal birth weight range.
4) To validate the data used in the present study as representative of the larger US population, specifically by testing whether established predictors of abnormal birth weight in the general population also predict abnormal birth weight in the present study population.

It is critical for the public health community to understand the prevalence of food insecurity in the pregnant population due to the possible negative consequences to the health of the infant and the mother. Experiencing food insecurity during pregnancy may be a modifiable risk factor for giving birth to an infant outside the normal birth weight range. It is important for public health professionals to identify the modifiable maternal health conditions and behaviors experienced by food-insecure women that are risk factors for birthing an LBW or HBW infant. Understanding the relationship between maternal food insecurity and birth weight may be used to provide support and target interventions to improve maternal health and pregnancy outcome.

**Study Population: Demographics of California**

Data from the 2005 Maternal and Infant Health Assessment Survey (MIHA) were used to address the study aims. The subjects in the present study were all residents of California at the time of completing the survey and had given birth to live infants in CA in 2005. The MIHA Survey will be discussed further in the methods section.

CA provides a representative population because the state has a vast demographic spread and great representation of many ethnic and socioeconomic groups. It is the most populous of all the United States, currently totaling 12% of the nation's population, and has the fastest-growing Hispanic population in the nation. In 2003, NH whites comprised 47% of CA's population, followed by Hispanics (32%), NH Asian/Pacific Islanders (12%), NH African Americans (7%), and NH American Indian/Alaska Natives (1%).[159]

In 2003, 41% of CA residents over the age of five spoke a language other than English at home, compared to 18% nationwide. Most often the language spoken is Spanish; however, a variety of Asian and Pacific Island languages are also spoken.[159]

CA's average rate of household food insecurity for 2004-2006 was 10.9%, close to the national average of 11.3%. On average, 3.7% of CA residents experienced VLFS compared to the national average of 3.9%.[160]

According to the 2005 PedNSS and the National Vital Statistics for California a range of 6.9% to 7.2% of live births were LBW [41, 67] While 8.1% of live births were HBW. [41] The 2005 national range for LBW births was 8.2% to 9.4% and 6.6% for HBW births.[41]

## *Chapter 3. Methods*

### Overview of Maternal Infant Health Assessment Survey

This cross-sectional study was performed using data drawn from the 2005 California Maternal and Infant Health Assessment Survey (MIHA).

The CA MIHA survey is a community needs assessment and monitoring survey designed to gather information representative of English- and Spanish-speaking CA women aged 15 years or older who gave birth to a live infant. The project is a collaboration of the Maternal and Child Health Branch of the California Department of Health Services and researchers at the University of California, San Francisco (see Appendix A: MIHA survey questionnaire). The MIHA survey was started in 1999 and is administered annually through mail/telephone services. The population-based survey is modeled on the CDC's Pregnancy Risk Assessment Monitoring System (PRAMS). The survey asks women about their experiences before, during, and after pregnancy and gathers information about pregnancy outcomes. Survey topics include domestic violence, maternal mental health, breastfeeding, income and economic hardship, maternal education, food security, and WIC participation.

The MIHA survey sampling frame is obtained via CA birth certificates, which provide information regarding demographics and infant birth weight. The birth certificate data are collected using routine practices for CA vital records.

### MIHA Sampling Methods and Stratification

The MIHA survey was distributed to eligible women who met the following criteria: had given birth to live infants (singleton, twins, or triplets) in California during

February through May of the 2005 survey year; were a California resident; and were aged 15 years and older. Participants were selected using a stratified random sampling method from birth certificates of infants born in CA between February through May, of 2005.

The sampling frame was stratified by region of residence, NH African American race vs. all others, and less than 12 years of education vs. 12 or more years of education. Stratification by NH African American race was carried out to allow for over-sampling of NH African American women. Region of residence in CA and education level of the mother were stratified for sampling to achieve a balanced representation of the population.

Women who were selected from the birth certificate were mailed a letter to introduce the survey when they were 8 to 12 weeks postpartum. Language-appropriate (Spanish or English) MIHA surveys were sent 10 to 14 weeks postpartum based on the women's response to the introduction letter.

**Strategies to address non-response**

Multiple strategies were applied to address non-response. Women who did not respond to the MIHA survey were followed up using reminder postcards and second mailings. If mailings failed, telephone follow-up of non-responders was then performed. Women were contacted up to 5 months after the initial mailing (7 months postpartum). Women who completed the MIHA survey received $10.00 in acknowledgement of their time to complete the survey, plus the opportunity to participate in a raffle for $250.00 (4 winners).

Sample size adjustments were made by changing sampling rates to ensure adequate numbers of responses from groups who were least likely to respond based on past years' data. Adjustments were made for predicted non-response by NH African American race, years of education, maternal age, and type of insurance coverage.

## Weighting Process

To account for the stratification and sample size adjustments, the MIHA data were weighted to estimate how a random sample of women who recently gave birth might have answered the survey, and to reflect the actual population of CA. The MIHA analysis was weighted for over-sampling of NH African Americans and variables related to non-response.

## Obtaining MIHA Data in the Present Study

Oregon Health and Science University received a de-identified MIHA data set to ensure confidentiality of the participants. Both the Institutional Review Board (IRB) of the California Department of Health Services and Oregon Health and Science University approved the study.

## Measuring Food Insecurity

*Food Insecurity measurement tools*

Food insecurity was measured using the abbreviated 6-item module developed by the United States (U.S.) Food Security Measurement Project. The 6-item module was included in the MIHA survey and serves as the basis for analysis of food insecurity in the

present study. The 6-item module has been shown to approximate closely the three main categories of the food-security-status measure; "high food security," "low food security," and "very low food security." The 6-item subset contains the six indicators that were identified to be a good approximation for measuring food insecurity.[161] The specificity and sensitivity of the 6-item module has been shown to be comparable to the 18-item module.[162]

*Guide to Measuring Household Food Security – 2000*

The Guide to Measuring Household Food Security[24, 161, 163] is considered to be the "most authoritative and accessible resource on how to measure household food security. It provides detailed guidance for researchers on how to use the survey module to measure food security, food insecurity, and hunger. Statistics from surveys that use these methods are directly comparable to published national statistics."[22] Methods defined in the guide were utilized to identify food insecurity in the study population based on responses to the 6-item module in the MIHA Survey.

## Inclusion Criteria

In addition to the inclusion criteria specified by the MIHA survey, the current analysis included only women with singleton births. This exclusion was made due to the high prevalence of LBW associated with multiple births (plurality).[164] Ninety-eight percent of the 2005 MIHA cohort reported "single" for plurality on the birth certificate. Additionally, women who had missing data for the food insecurity questions in the

MIHA survey were excluded. Ninety-eight percent of the women with singleton births had complete data for the food insecurity variables.

## Analytic Outcome Variables

There were two outcomes of interest for the variable birth weight in the present study; LBW (<2500g) and HBW (≥4000g). For descriptive purposes only, and to observe the frequencies of the birth weight categories within each level of household food security, birth weight data was scaled into 5 levels (Table B-1). The categories for birth weight, were modeled after a recent study from the Nurses' Mother's Cohort[69]

## Analytic Independent Variables

*Defining Household Food Security*

The main predictor of interest was household food security (see Appendix A: MIHA Survey Questionnaire, questions 64-66). Using the methods in *The Guide to Measuring Household Food Security,*[161] the following criteria were used to determine household food security.

The first two food security questions asked on the MIHA survey were: During your most recent pregnancy, was the following often, sometimes, or never true for you? (64. A) "The food that I bought just didn't last and I didn't have money to get more" and (64. B) " I couldn't afford to eat balanced meals." The questions were scored as affirmative if the respondent answered "often true" or "sometimes true." If the response was "never" they were scored as negative.

Answers of “yes” to the following questions were considered affirmative and negative if the answer was “no”: (65. A) “During your pregnancy, did you ever cut the size of your meals or skip meals because there wasn’t enough money for food?”, (66. A) “During your pregnancy, did you ever eat less than you felt you should because there wasn’t enough money to buy food?”, and (66. B) “During your pregnancy, were you ever hungry but didn’t eat because you couldn’t afford enough food?”. (65. B) “How often did this happen to you?” is asked after the first of the three questions listed above. The response was affirmative if the answer was “almost every month,” or “some months but not almost every month.” The response was considered negative if the answer was “1 or 2 months”, “don’t know”, or the question was not answered because the response to the previous associated question was “no” or “don’t know”. If more than three items were missing, the household was scored as missing for the food security variables. As discussed earlier (see Inclusion Criteria), the response “don’t know” and missing responses were removed from analysis. However, if the answer was “no” to the question (65. A) “During your pregnancy, did you ever cut the size of your meals or skip meals because there wasn’t enough money for food?” the directions were to skip the next question of (65. B) “During your pregnancy, did you ever eat less than you felt you should because there wasn’t enough money to buy food?” Women who skipped question 65. B were not excluded from the analysis.

A household was considered to have high food security if the number of affirmative responses was 0 and to have marginal food security with 1 affirmative. Low household food security was determined if there were 2, 3, or 4 affirmatives, and very low food

security was determined with 5, or 6 affirmatives. Shown below is the number of affirmatives, the associated food security status level, and the final reporting status:

Table 3-1. Number of affirmative answers related to the food insecurity questions and defined level of food security.

| Number of affirmatives | Food Security Status Level | Food Security Reporting status |
|---|---|---|
| 0 | High Food security | Food secure |
| 1 | Marginal Food security | Food secure |
| 2 | Low food security | Food insecure |
| 3 | Low food security | Food insecure |
| 4 | Low food security | Food insecure |
| 5 | Very low food security | Food insecure |
| 6 | Very low food security | Food insecure |

Food Security was analyzed as both a categorical variable and a binary variable.

The categorical food security variable included the four levels of household food security (HFS, MFS, LFS, and VLFS). The four-category variable was used to examine whether significant differences occur between women of different demographic characteristics and to explore behaviors and health conditions that a woman may experience leading up to food insecurity. Collapsing HFS and MFS to represent food secure and collapsing LFS and VLFS to represent food insecure created a binary variable. As discussed in the Background section of the study, for reporting purposes LFS and VLFS are often combined to define household food insecurity.

*Other Independent Variables*

In addition to the food security variables, other predictor variables for birth weight were included in the study based on a priori research. Covariates were investigated based on their ability to predict LBW or HBW in addition to their potential associations with level of food security. Variables were broken up into demographic data, knowledge and health conditions, and pregnancy intention. Variables that were obtained from the birth certificate were: maternal age, gestational age, and total number of live births (parity). Variables that came from the women's responses to the MIHA survey included: maternal race-ethnicity, prepregnancy BMI (kilograms per square meter), education level, smoked during third trimester, previous LBW, high blood pressure during pregnancy, high blood sugar during pregnancy, depression during pregnancy, living with someone or married at the time of most recent birth, and WIC enrollment during pregnancy.

*Maternal age* was kept as a continuous variable measured in years. *Gestational age* was originally reported in days and was recoded into >36 weeks or ≤36 weeks, defined as term and preterm, respectively.[12] Full term (> 36 weeks) was the referent group. Total *number of live births*, defined as parity, was kept as a continuous variable.

The *Maternal Race-ethnicity* variable was taken from question 55.A in the MIHA Survey, "What Ethnic or racial group do you consider yourself? Check all that apply." Below are the response options with the associated abbreviation label in parentheses:

- African-American, Black, or African—(NH African American)
- American Indian, Native American, Eskimo or Aleut—(NH American Indian)

- Asian, Asian-American or Pacific Islander (for example, Chinese, Filipino, Japanese, Korean, Vietnamese, or people from India or another Asian country)—(NH API)
- Latino, Hispanic, Chicano, Mexican or Mexican-American, Central American, or other Latin American—(Latina)
- White, Caucasian, or European, including people from Spain or the Middle East—(NH European American)
- Some other group—(Other)

Following the above question was MIHA question 55.B, which asked, "If you chose more than one group, please write in the name of the group you identify with the most." Or the participant could check the box "I identify equally with all the groups I checked." If the respondent wrote in her race/ethnicity it was added to one of the above options.

*Prepregnancy BMI* was calculated from the weight and height ($kg/m^2$) from MIHA questions 8.A and 9, respectively. The continuous BMI value calculated was then categorized into underweight (<19.8), normal weight (19.8-26.0), overweight (26.1-29.0), and obese (>29.0) for this analysis; Using the Institute of Medicine's (IOM) recommended ranges for prepregnancy BMI.[165]

The variable *education* was taken from MIHA question 58, asking, "What is the highest grade or year of school you've completed?" For the following response options, abbreviated labels are shown in parentheses;

- $8^{th}$ grade or less—($<8^{th}$ grade)
- Some high school, but I did not graduate—(Some high school)
- High school (or I got a GED)—(High school or equiv.)

- Some college or junior college, but I did not graduate from a four-year college—(Some college)
- College graduate (from a four-year college or university)—(College Grad)
- Never went to school (collapsed into 8$^{th}$ grade or less category due to small cell size; total of n=16 or <0.4%)

"Marital status" was obtained form MIHA question 60, "At the time your baby was born, what was your marital status?" This question was converted into a binary variable by collapsing the categories bulleted below to create a variable, living with someone or not living with someone:

- Married—(living with someone)
- Living with someone like we were married, but not legally married—(living with someone)
- Separated, divorced, or widowed—(not living with someone)
- Single or never married—(not living with someone).

It was important to know if the woman was living with someone or single due to the higher prevalence of household food insecurity in single-parent households, particularly with women as the head of the household. "Marital status" was redefined because a woman who was living with someone but not married would have been in the "unmarried" category but might have experienced quite a different level of support that a separated or single woman. Therefore, a new variable was created to represent *living with someone or married during pregnancy* versus *not living with someone or not married.*

*Smoked in 3$^{rd}$ trimester* was obtained from MIHA question 35.C, "During the last 3 months of your pregnancy, how many cigarettes or packs of cigarettes did you smoke

on an average day?" If the participant filled in the number of cigarette or packs smoked per day or checked less than one cigarette per day, the response was coded as "yes." A response of "I didn't smoke at all during the last 3 months of my pregnancy," was coded as "no."

The remaining MIHA variables in the analysis were binary and were coded based on the respondent's answer of "yes" or "no". The covariates examined included: *high blood pressure during pregnancy* and *high blood sugar (diabetes) during pregnancy* from MIHA questions 12.C and 12.E, *feel depressed during pregnancy* from MIHA question 28, *Previous LBW birth* from MIHA question 3, and *WIC enrollment during pregnancy* from MIHA question 63.A.

**Statistical Analysis**

Analyses were carried out using SPSS version 16.0, Complex Sample Module (CSM) and SUDANN version 9.01. Use of these programs makes it possible to take MIHA's complex sampling design into consideration. The descriptives, cross-tabulation, Pearson chi-square, and one-way ANOVA were performed on the weighted data. The Complex Samples option was used to perform weighted analysis, including the univariate logistic regressions. All results were reported using the above procedures.

Cross-tabulation was carried out for all independent analytic variables against the categorical food security variable (HFS, LFS, MFS, VLFS), the binary food security variable (food secure vs. food insecure), and the variables LBW and HBW. All categorical variables were assessed for adequacy of cell size for analysis. Associations and significant differences between groups were evaluated using Pearson chi-square tests

for the categorical/binary variables, and one-way ANOVA for the continuous variables. Univariate logistic regression analysis was done with each covariate as an independent variable and LBW or HBW as the outcome variable. Odds ratios (OR) and 95% confidence interval (CI) for independent relationships with the outcome of interest were obtained from the univariate analysis.

The primary objective for the univariate analysis was to obtain unadjusted ORs for food insecurity levels and birth weight (LBW and HBW). A p-value of <.05 was considered statistically significant for Pearson chi-square test, one-way ANOVA, and univariate analyses. P-values that were significant are shaded in the associated results tables located in Appendix B.

## ***Chapter 4. Results***

In 2005, MIHA surveys were sent to 5179 randomly selected women who had recently given birth. The overall response rate for the 2005 survey year was 71.63% (n=3704). After excluding cases with missing data on MIHA food security questions and non-singleton births, the final sample size in the study was 3634.

For analysis, food security was investigated as a binary variable but also was also analyzed as a four category variable for the purpose of exploring the range of food insecurity across the four levels. Table B-1 displays the behaviors and demographics of women in the MIHA survey by the four levels of food security (Appendix B). As described in the background and methods sections of this study, HFS and MFS are considered food secure, while LFS and VLFS are defined as food insecure. Table B-2 (Appendix B) shows the results for the analysis of the binary food insecurity variable by the behaviors and demographic characteristics of women in the MIHA survey. The results below are discussed in binary terms (Table B-2) unless important differences existed between the four levels of food security (Table B-1), which will be further addressed.

The mean ages of the food secure and the food insecure women were 27.2 years ($\pm$6.2) vs. 26.4 years ($\pm$ 5.9), respectively (Table B-2). Almost 73% of the women reported HFS, 9.5% reported MFS, 12.5% experienced LFS, and 4.9% reported VLFS (Table B-1). Overall 17.5% of the women were food insecure (Table B-2). As shown in Table B-2, a total of 6.4% of the women gave birth to LBW infants, 9.5% to HBW infants, and 84% gave birth to infants within the normal birth weight range (2500-3999g). Of the women who birthed LBW infants, 21.7% were food insecure. Fourteen and half

percent of the women who gave birth to a HBW infant were food insecure. While there was no statistical difference in birth weight category by the four-category food security variable (p=0.37, Table B-1) or between birth weight and food insecurity as a binary variable (p=0.23, Table B-2), it is interesting to note that the women who delivered LBW infants had the greatest prevalence of food insecurity and women who delivered HBW infants had the lowest prevalence of food insecurity.

Prepregnancy BMI results showed that roughly 20% of women sampled from the MIHA survey were obese, 12.4% were overweight, 11.5% were underweight, and over half were considered normal weight (56.2%) (Table B-1). Obese women had a statistically significant higher rate of food insecurity (24.3%) (Table B-2) and VLFS (7.6%) compared to the other BMI categories (Table B-1). Eighteen percent of overweight women experienced food insecurity, while underweight women were the least likely to be food insecure (12.2%), followed by women who were normal weight (13.7%) (Table B-2).

As shown in Table B-2 NH American Indian women had the highest rate of food insecurity at 33.3%; however, due to the small sample size for NH American Indian women the results may be unstable and difficult to interpret. Latina women reported the second highest rate of food insecurity at 24.6% followed by NH African American women, who reported a rate of 19.7% (Table B-2). NH European American women had the lowest rate of food insecurity at 7.8%. NH API women experienced food security at levels similar to NH European American women, with a rate of 8.0% (Table B-2).

Over 28% of the women reported high school completion, and another 25.1% reported having graduated from college (Table B-2). The highest rates of food insecurity

were reported by women with some high school (32.3%) and those with less than eighth grade education (28.7%). Only 2.6% of women who graduated from college were food insecure. As education level increased, the percent of women experiencing food insecurity decreased.

Roughly 86% of the women gave birth to infants greater than or equal to 37 weeks gestation and 13.8% delivered preterm infants (Table B-2); in other words, the majority of the women carried their pregnancies to term. The prevalence of food insecurity was positively related to prematurity at birth. Almost 21% of the women who delivered preterm births were food insecure, compared to a 16.8% rate of food insecurity for women who did not have a preterm birth ($p=0.018$, Table B-2).

While the majority of women did not smoke in their third trimester, there was a significant difference found between the prevalence of food insecurity among smokers and nonsmokers. Food insecurity was positively associated with smoking in the third trimester. Twenty-nine percent of women who smoked were food insecure while 16.8% of women who did not smoke were food insecure (Table B-2).

Only 5.5% (Table B-2) of the women reported having previously given birth to an LBW infant but they had almost twice the rate of experiencing food insecurity (27%) compared to the women who reported having had no previous LBW infant (16.9%). The results of the Pearson chi-square analysis showed that food insecurity was positively related to previously giving birth to a LBW infant ($p<0.001$, Table B-2).

Results of the one-way ANOVA showed that on average, women who reported food insecurity reported more births compared to women who were food secure; the difference in the number of births reported was significantly different ($p<0.001$, Table B-

2). The mean number of live births reported by women with VLFS, LFS, MFS, and HFS was 2.5 (±1.5), 2.2 (±1.2), 2.1 (±1.4), and 2.0 (±1.1), respectively. As the number of births reported increased, the level of food insecurity also increased (Table B-1).

Over 21% of women who had high blood pressure during pregnancy were food insecure, which was significantly different (p=0.013) than the 16.8% rate of food insecurity among women who did not have high blood pressure (Table B-2). Of the 9.3% of women who had "high blood sugar (diabetes)" during pregnancy, 20.8% were food insecure, compared to a 16.8% rate of food insecurity among women without "high blood sugar (diabetes)" (p=0.043, Table B-2). Pearson chi-square analysis showed a positive relationship between food insecurity and "high blood sugar (diabetes)" and between high blood pressure. A greater percent of women who had high blood pressure and or "high blood sugar (diabetes)" during pregnancy were food insecure compared to women who did not have one or both of the health conditions.

Food insecurity was positively related to depression during pregnancy. Over 28% of the women reported having experienced depression during pregnancy. Women who reported depression had twice the rate of food insecurity, at 30.7%, compared to women with no reported depression, with a 12.1% rate of food insecurity (Table B-2).

Food insecurity was also positively related to WIC participation during pregnancy. More than half of the women were enrolled in WIC during pregnancy (54.2%), and 28.4% of the women enrolled in WIC reported being food insecure during pregnancy. Women who recorded not having been enrolled in WIC had a 4.6% rate of food insecurity (Table B-2).

Over two-thirds of the women (85.5%) reported living with someone or being married during pregnancy. Single women had almost double the rate of food insecurity at 29.6%, compared to the 15.4 % of women who were living with someone or were married.

When Pearson chi-square analysis was carried out with food security as a binary variable, the percent of women who experienced food insecurity was significantly higher at the 0.05 level for all of the demographic variables, behavior variables, and health conditions variables except in regards to birth weight category which was the only variable that was not associated with food insecurity (Table B-2). When Pearson chi-square analysis was done to investigate the relationships between food security as a four-category variable with each demographic variable, behavior variable, and health condition variable the relationships were significant ($p<.05$) for all variables except in regards to gestational age, "high blood sugar (diabetes)," high blood pressure, and the birth weight categories. However, where the difference or association between each level of the four categories of food insecurity were not in this analysis; it can only be inferred that there was significant difference between at least one level of food insecurity and the associated variable.

Differences in demographics and behaviors between women who recently gave birth to an LBW or HBW infant are shown in Table B-3 (Appendix B). The percents of women within each subpopulation who birthed an LBW or HBW infant are shown in addition to the associated odds ratio (OR). All of the variables in Table B-1 were investigated in a univariate logistic regression as independent predictors of giving birth to

an LBW or HBW infant. There were a number of variables that independently predicted LBW and or HBW (significant OR, p <.05 are shaded).

Positive independent predictors of LBW included VLFS, underweight BMI category, smoking during the third trimester, previous LBW birth, and high blood pressure during pregnancy. NH African American and NH American Indian race/ethnicity and gestational age less than or equal to 36 weeks were also positive predictors of LBW. The remaining variables were not statistically significant predictors of LBW (Table B-3).

A BMI indicative of obesity before pregnancy was the only positive predictor of HBW as shown in Table B-3. Negative independent predictors of HBW included NH African American, NH API, and Latina racial or ethnic group membership; underweight BMI category; gestational age less than or equal to 36 weeks; previous LBW birth; depression during pregnancy; living with someone or married during pregnancy; and WIC enrollment during pregnancy. The remaining variables were not significant predictors of HBW (Table B-3).

## ***Chapter 5. Discussion***

The first aim of the study was to determine the overall prevalence of household food insecurity in the pregnant population. Among the women in the 2005 California MIHA survey, 12.5% experienced LFS, 4.9% reported VLFS, 9.5% reported MFS, and about 73% reported HFS. Overall, pregnant women (in the MIHA survey) had higher rates of LFS and VLFS compared to both CA residents (7.2% LFS, 3.7% VLFS) and the national averages (7.4% LFS, 3.9% VLFS) for 2004-2006 (Table B-3). When binary analysis of the food security variable was carried out to describe the prevalence of food insecurity, 17.5% of the MIHA women experienced food insecurity (Table B-3). The findings suggest that pregnant women with singleton births may experience a higher rate of household food insecurity compared to the average population.

Understanding how food insecurity was related to birth weight required a thorough description of the population. Therefore, it was also important to clarify the prevalence of infants born LBW or HBW in the present population. Within the cohort, 6.4%, of the women gave birth to a LBW infant and 9.5% gave birth to a HBW infant. The 2005 PedNSS revealed that the national rate of LBW and HBW was 9.4% and 6.6% respectively, while CA results for the PedNSS showed a 7.2% rate of LBW and an 8.1% rate of HBW. The women were all CA residents at the time of completing the survey and the present results showed consistency with the state of CA. The deviation from the national level could be due to a number of factors related to data collection and regionallity of the sample within CA. Overall, it appears that women in the study were a good representation of the women in the CA population.

There were no significant relationships found between the prevalence of food insecurity and birth weight category, but it is important to note that women who gave birth to an LBW infant had a higher prevalence of food insecurity (21.6%) than women who gave birth to a HBW infant (14.5%) (Table B-1, Table B-2). This pattern suggests that the prevalence of food insecurity may increase as birth weight decreases, although the relationship was not significant in the present analysis, further investigations are warranted given the preliminary results.

The hypothesis of the study was that women who reported household food insecurity during pregnancy would be more likely to give birth to an LBW or HBW infant. The second aim of the study tested the hypothesis by investigating whether household food insecurity predicted giving birth to a LBW or HBW infant. Women who were food insecure were found to be no more or less likely to give birth to an LBW or HBW infant (Table B-3). However, when looking at food insecurity as a categorical variable, VLFS was a significant independent predictor of LBW. This finding partially supports the hypothesis and suggests that it may be a reduction in the quantity of maternal food intake, along with decrease in the variety, and quality of the maternal diet that affects birth weight.

VLFS is the level of food insecurity at which the household may experience altered eating patterns and an actual reduction in quantity of food intake due to a lack of resources. Birth weight may not be measurably impacted until the quantity and quality of the diet is reduced and maternal eating patterns are altered, as evidenced by VLFS being the only statistically significant predictor of LBW. Intervention should occur when a pregnant woman is experiencing LFS or even MFS in an effort to prevent experiencing

VLFS. The key point is that identifying pregnant women at risk for developing food insecurity and intervening as soon as possible may lead to long-term health benefits for the mother and infant.

The third aim of the study was to determine the prevalence of household food insecurity among pregnant women with maternal characteristics previously shown to be risk factors for birthing an infant outside the normal birth weight range. The fourth aim was to validate the data used in the present study as representative of the larger US population, specifically by testing whether established predictors of abnormal birth weight in the general population also predicted abnormal birth weight in the present study population. For the purpose of discussion, the third and fourth aims will be addressed as each relates to the other. The following demographic characteristics, behaviors, and health conditions will be addressed: maternal race/ethnicity, income, living with someone during pregnancy, prepregnancy BMI, gestational age, smoking during pregnancy, depression during pregnancy, previously birthing an LBW infant, high blood pressure, high blood sugar, WIC participation during pregnancy, and parity.

Many of the maternal characteristics investigated in the study were chosen because they had been shown to be predictors of birth weight in existing literature. However, the study was unique because it examined the a priori predictors of birth weight in women who experienced different levels of food insecurity. The results showed similar findings to the existing literature for many of the predictors of birth weight, which provided validity to the sample population and to the overall study results. In addition, the results demonstrated that among pregnant women with characteristics previously

shown to be predictive of low or high birth weight, a higher rate of food insecurity was experienced compared to women without the characteristics.

*Race/ethnicity*

Women of racial and ethnic minorities experienced significant differences with food insecurity and birth weight. The results are similar to the national rates of food insecurity in which racial/ethnic minority group membership is a strong predictor for a woman experiencing food insecurity and birthing an infant outside the normal birth weight range.[22, 67]

The study showed that American Indian women had the highest rate of food insecurity (33.3%) and had the greatest likelihood of giving birth to an LBW infant (OR=5.4). NH African American women were 2.5 times more likely (OR= 2.5, 95% CI 1.67-3.83) than NH European American women to have an LBW infant and had the third highest rate of food insecurity (19.7%, Table B-2). NH African American women were almost half as likely to give birth to a HBW infant compared to NH European American women (OR=0.48 95% CI .30-.76). The results of the study demonstrate that NH African American women experienced a higher level of food insecurity during pregnancy and may be a population at risk for giving birth to an LBW infant but may have less of a risk for birthing a HBW infant.

Similar to NH African American women, Latina women (OR=0.75, 95% CI 0.57-0.97) and NH API women (OR=0.60, 95% CI 0.38-0.94) were also less likely to give birth to a HBW infant compared to NH European American women (Table B-3). Latina women had the highest rate of VLFS (7.2%, Table B-1) and the third highest rate of

overall food insecurity at 24.6% (Table B-2) and API women had one of the lowest rates of food insecurity at 8.0% (Table B-2). Given the results of the study and national reports, racial/ethnic minority group membership appears to be a critical demographic characteristic that could place a pregnant woman at higher risk for food insecurity and for birthing an LBW or HBW infant.

*Income*

Income is also an important demographic characteristic contributing to the risk of experiencing household food insecurity.[22] Education was chosen in the study as a surrogate for income. Other studies have taken this approach due to the high correlation of income level with education.[64] Significant differences were found between education level ($p<.001$) and rate of food security (Table B-2). Overall, as the level of education decreased the prevalence of food insecurity increased. Given that education level was used as a measure of income, the results are similar to national reports showing that women living in poverty have the highest rate of food insecurity.[22] Consistent with other studies, pregnant women with a low income appear to be at high risk for experiencing food insecurity.[32]

Interestingly, in the univariate analysis education was not a predictor of LBW or HBW. However, the rate of having a HBW infant appeared to increase with level of education and having an LBW infant appeared to increase with decreased level of education. Equating education to income and SES, the present findings are not consistent with other studies demonstrating that SES is one of the leading risk factors for LBW.[153] Given that diet quality is compromised quite significantly among low-income pregnant

women,[39] and that food insecurity is more prevalent among low-income pregnant women, food insecurity may still impact birth weight. In addition, single pregnant women who are heads of households may be at an even greater risk of experiencing food insecurity and of birthing infants at abnormal birth weights.

*Single or living with someone during pregnancy*

At the national level, single women heads of households have the highest rate of living in poverty[30] and have the highest rate of experiencing food insecurity.[22] While living with someone during pregnancy related to income was not investigated, it was found that women who were single during pregnancy had double the rate of food insecurity (LFS 20.7%, VLFS 8.9%, Table B-1) (food insecure 29.6%, Table B-2) compared to women who were living with someone or married.

Women with a partner, married or otherwise, were no more or less likely to give birth to an LBW infant but were less likely to give birth to a HBW infant (OR=0.56 95% CI 0.37-0.83) (Table B-3). Overall, it appears that being single during pregnancy is not a risk factor for having a LBW or HBW, but that it is positively associated with food insecurity.

*Prepregnany BMI*

Maternal weight and prepregnancy BMI are characteristics that have short- and long-term health implications for the mother and infant.[8, 166] Obesity has been shown to be associated with food insecurity in women[31, 35, 36, 49-51] but the link between prepregnancy BMI and food insecurity has not been reported. In the study, it appeared

that as food insecurity decreased prepregnancy BMI decreased. Women who had a BMI indicative of underweight before pregnancy had the lowest prevalence of food insecurity (12.2%, Table B-2) compared to other BMI categories. Women who had a BMI indicative of obesity before pregnancy had significantly higher rates of food insecurity (24.3%, Table B-2) compared to women in the other BMI categories. The findings suggest that pregnant women who are obese before pregnancy may have a higher prevalence of food insecurity compared to women who are not obese prepregnancy.

Obesity during pregnancy compromises the health of the fetus on many levels and places the infant at risk for HBW, macrosomia, congenital defects, and Type 1 and 2 diabetes.[8, 70, 99, 137] Obese women were 78% (OR=1.78, 95% CI 1.34-2.34) more likely to give birth to a HBW infant than normal weight women (Table B-3). Women who were underweight prepregnancy were 55% (OR= 1.55 95% CI 1.02-2.34) more likely to give birth to an LBW infant compared to normal weight women. The findings are consistent with other studies that have shown underweight to be a risk factor for birthing an LBW infant.[8] Underweight women were less likely ( OR=0.34 95% CI 0.19-0.62) to have a HBW infant compared to normal weight women (Table B-3).

Overall, the present study results support past research revealing that prepregnancy BMI is related to birth weight.[8, 69, 99, 166] Despite the fact that underweight women have a lower prevalence of food insecurity, they have a greater likelihood of having an LBW infant, and food-insecure women have a higher likelihood of having an LBW infant. The HBW infants born to obese food insecure women may be overfed and undernourished and the LBW infants born to women who are not obese but food insecure may be underfed and undernourished.

Intervention aimed toward decreasing maternal food insecurity may directly impact LBW birth weight outcomes and indirectly impact HBW outcomes by reducing maternal prepregnancy obesity. Under-nutrition during pregnancy, defined by maternal VLFS, could directly affect birth weight by increasing a women's likelihood of birthing an LBW infant. Food insecurity could indirectly affect birth weight via prepregnancy obesity. Women who are obese and food insecure may be a population at risk for abnormal birth weight outcomes. In order to decrease obesity among food insecure pregnant women, it is crucial to investigate what is lacking in the food-insecure diet.

*Gestational age/ preterm birth*

Women with a preterm birth may be a population at risk for experiencing higher levels of food insecurity. This study's findings revealed that infants born at less than 36 weeks (preterm) were 45% (OR=0.45, 95% CI 0.06-0.10) less likely to be HBW (Table B-3). Infants born prematurely were over 12 times as likely (OR= 12.05, 95% CI 8.97-16.19) to be LBW than infants born at term (Table B-3). This result is not surprising given that infants who have a shorter gestational period are at risk for being SGA and LBW.[156, 157] Food-insecurity status was significantly different between the women who gave birth to term and preterm infants (p=0.018) (Table B-2). The results show consistency with past research on birth weight and gestational age. Based on these findings, one cannot assume that there is a causal relationship between preterm birth and food insecurity; however, it can be observed that the prevalence of food insecurity is higher in women with a preterm infant.

*Smoking during pregnancy*

Women who smoke during pregnancy may also be a population at increased risk of experiencing food insecurity. There have been numerous studies that have shown smoking during pregnancy to have a direct impact on reduced fetal growth and later health consequences.[142-147] Smoking status was defined as smoking during the third trimester because fetal lung development takes place in the final weeks of pregnancy[7, 84] and it was suggested that women who smoked during the final trimester were more likely to have smoked throughout their whole pregnancy than women who reported smoking during the first trimester. Women who reported smoking in the third trimester were found to be over two times as likely (OR=2.23, 95% CI 1.32-3.78) to give birth to an LBW infant than nonsmokers (Table B-3). Food insecurity in the study was also the highest among women who smoked (Table B-2). Women who are food insecure and smoke could therefore have a number of overlapping risk factors for poor birth outcomes.

*Depression during pregnancy*

Food insecurity among women who reported depression during pregnancy was significantly ($p<0.001$) higher than in women who did not report having had depression during pregnancy (Table B-2). Alcohol or illicit drug use has been shown to be higher in women experiencing depression.[56, 140, 141] and alcohol or illicit drug use can directly affect the birth weight of the infant.[59, 140, 141] Women in the study who reported depression in pregnancy were 72% (OR=0.72 95% CI 0.55-0.96) less likely to have an HBW infant compared to women without depression, and although not statistically significant, women who reported depression during pregnancy were 32% (OR=1.32, 95% CI 0.99-1.78) more

likely to give birth to an LBW infant (Table B-3). Women with depression had almost three times the rate of food insecurity compared to women without depression. The results cannot indicate that depression may increase the risk for food insecurity or that food insecurity many increase the risk for depression. However, other studies have shown that depression is related to food insecurity experienced during pregnancy.[32] Negative effects on the fetus that may result from maternal depression include an increased risk for birth defects and decreased maternal food intake.[132, 147, 167]Therefore, maternal depression may further compromise fetal health when food insecurity is experienced.

*Previous LBW infant*

The present study results showed that previously giving birth to an LBW infant was one of the strongest positive predictors of LBW (OR=6.64, 95% CI 4.63-9.51) (Table B-3). Women who previously gave birth to an LBW infant were less likely than others to have an HBW infant (OR=0.38, 95% CI 0.17-0.81) (Table B-3). Additionally, food insecurity was significantly higher ($p<.001$) in women with a previous LBW birth (Table B-2). Women in the study who had a previous LBW infant had a higher prevalence of food insecurity and were at increased risk for giving birth to another LBW infant. Although causation cannot be assumed, the findings suggest that addressing maternal food insecurity may help to reduce the risk of birthing an LBW infant.

*High blood pressure and high blood sugar (diabetes) during pregnancy*

A large number of studies have explored the relationship between diabetes and birth outcomes[70-72, 94, 95, 104, 130] and high blood pressure and birth weight.[8] The study

found maternal food insecurity to be experienced at an increased rate among women with the above conditions. Consistent with existing research, high blood pressure was found to be a significant predictor of LBW (OR=3.04, 95% CI 2.18-4.24) (Table B-3). Women in the study reporting high blood pressure during pregnancy had a significantly higher rate of food insecurity than other women (p=0.013, Table B-2). Additionally, women who reported having had "high blood sugar (diabetes)" during pregnancy had a higher prevalence of food insecurity than other women (p=0.043, Table B-2). However "high blood sugar (diabetes)" during pregnancy was not a significant predictor of LBW or HBW (Table B-3). The outcomes suggest no predictive application for "high blood sugar (diabetes)" during pregnancy and birth weight but do suggest that women with "high blood sugar (diabetes)" during pregnancy experience an increased rate of food insecurity. High blood sugar, diabetes, and high blood pressure are all modifiable risk factors for undesirable birth weight. The prevalence of food insecurity among women with these health conditions and their relationship to birth weight may be a potential avenue for future study and intervention.

*WIC enrollment during pregnancy*

National WIC reports have demonstrated that the prevalence of LBW is significantly lower for women who were enrolled in WIC during pregnancy.[168] The prevalence of HBW is currently not documented in the biannual reports that WIC publishes, which may be an area for future research. Women in the study who were enrolled in WIC during pregnancy were no more or less likely to have an LBW infant compared with other women (OR=1.21, 95% CI 0.91-1.60), but were less likely to give

birth to an HBW infant (OR=0.66 95% CI 0.52-0.83) (Table B-3). Despite the fact that the study showed no difference in the risk of birthing a LBW infant with WIC enrollment during pregnancy, the national statistics indicate that WIC is positively influencing birth weight.[168] Serving women with food insecurity could be one possible factor contributing to the decreased rates of LBW infants in the WIC population.

The *Household Food Security in the United States, 2005* document reported that 39.5% of women who participated in WIC were food insecure and 10.2% had VLFS.[22] In addition, a recent review demonstrated that WIC recipients are at a higher nutritional risk than non-WIC recipients,[169] solidifying the fact that WIC is serving those most in need. WIC participants in the study appear to have a lower prevalence of food insecurity than the national average, which could be due to the fact that the sample size included only pregnant women and the national sample included all women and children receiving WIC resources. Women in the study who were enrolled in WIC during pregnancy had a significantly higher level of food insecurity (LFS 20.5%, VLFS 8.0%, Table B-1) (food insecurity 28.4%, Table B-2) compared with women not enrolled in WIC. This is a positive finding suggesting that a portion of women at nutritional risk are being assisted. It appears from the results and national reports that a higher percent of women enrolled in WIC are food insecure than women not enrolled in WIC, but the question remains whether WIC is alleviating stressors around food resources and decreasing food insecurity. Given that a large percent of the WIC recipients are food insecure, the WIC program may be a key player in alleviating and influencing the prevalence of food insecurity during pregnancy and further impacting birth weight.

*Parity*

The number of children in the household may also increase the risk for a women experiencing food insecurity and in turn possibly affect the birth weight of the infant. The findings in the present study are consistent with other studies showing that the number of children in the household increases the risk for experiencing food insecurity.[29, 31] Parity has also been shown to be a predictor of birth weight.[154, 158] Women with greater than 2.2 births were 11% (OR=1.11, 95% CI 1.02-1.22) more likely to give birth to an HBW infant than women with less than 2.2 births (Table B-3). Parity was also significantly associated ($p<.001$) with food insecurity; as the number of births that a woman reported increased, the rate of food insecurity also increased (Table B-2). Causation cannot be determined from the study, but because women with more than two births seem to be at a higher risk for food insecurity, decreasing the prevalence of food insecurity may help to ease extra stressors. By alleviating the possible stressors related to food insecurity, the birth weight of additional infants might be positively affected for women with more than two births.

Overall, a number of maternal demographic characteristics, behaviors, and health conditions investigated in this study were shown to have statistically higher levels of food insecurity compared to women with different demographic characteristics who did not exhibit the behavior or health conditions. In addition, a number of the same demographic characteristics, behaviors, and health conditions were found to be negative and positive predictors of LBW or HBW. The findings point toward the idea that decreasing food insecurity may indirectly improve birth weight.

It is critical for the public health community to understand the relationship of food insecurity and pregnancy outcome due to the numerous overlapping demographic characteristics, health conditions, and behaviors associated with both food insecurity and poor pregnancy outcomes. Poor mental, physical, and emotional health of the mother directly affects the birth weight of her infant, and poor birth weight directly affects the overall health of the infant. A better understanding of the relationship between food insecurity and birth weight will make it possible to develop targeted interventions needed to reduce or prevent food insecurity during pregnancy and improve maternal health and pregnancy outcome.

## ***Chapter 6. Strengths and Future Direction***

This study asks a valuable question regarding how the birth weight of an infant may be influenced by characteristics of women who are food insecure. The prevalence of food insecurity in the pregnant population was explored along with the ability of food insecurity to predict birth weight. To date, no other studies have investigated the impacts of food insecurity on birth weight or the prevalence of food insecurity among women at risk for birthing an abnormal birth weight infant.

One of the strengths of the study included the use of the MIHA Survey. The comprehensive nature of the MIHA dataset and the application of a well-validated tool to clarify food insecurity provided a unique opportunity to explore the prevalence of food insecurity and its affect on birth weight. The most current guidelines were used to define and report on the status of food insecurity in the population.[22, 161] Future studies should

use the U.S. HFSS 6-item module because it can be administered in a wide variety of settings and be compared across the nation.

Federal and state programs such as the Food Stamp Program and WIC can use food security data to incorporate strategies to meet the unmet needs of the at-risk pregnant population. Not surprisingly, results from the present study and results from national reports [22] showed that women enrolled in WIC during pregnancy had higher rates of food insecurity than women not enrolled in WIC. Overall, food-insecure households seem to make use of state and local emergency food resources more than federal programs. [22]

Future research could focus on how to decrease the rate of food insecurity by addressing the resources available in the federal and state programs. Measuring the impact of decreasing rates of food insecurity on birth weight could then be studied. The current study did not investigate the rate of food insecurity among pregnant women who received food stamps or emergency food from kitchens and pantries. Further studies are needed to specifically identify the prevalence of food insecurity among pregnant women enrolled in existing state and federal programs. This would help to determine if the programs are meeting the needs of pregnant women at nutritional risk and are contributing to improved birth weight.

Meal planning, additional nutrition education, financial budgeting, and community networking may be ways in which the local community could allocate resources to address inconsistent food intake among women experiencing food insecurity. Despite the numerous programs and services presently available, avocation for more outreach and awareness of the prevalence and negative consequences of food insecurity

in the pregnant population is needed. In order to intervene and improve pregnancy outcomes, studies are needed to determine the prevalence of macronutrient and micronutrient deficiencies for which the food-insecure pregnant woman may be at risk. Therefore, if a pregnant woman is identified as food insecure, nutrition and public health professionals could then target the intake of specific nutrients that have been shown to be deficient in the food insecure pregnant population.

The association of food insecurity with obesity has been identified and studied over the past decade. In addition to being consistent with previous studies, it was observed that the rate of obesity was highest among women reporting to have experienced food insecurity during pregnancy. One direction for future research is investigating the long- and short-term effects of food insecurity on the endocrine system and gain more insight into the risk of obesity related to food insecurity in children and adults and its long-term metabolic consequences.

The results of this study may be used to provide a foundation for future analysis of the prevalence rates of food insecurity among women at risk of birthing LBW OR HBW infants. The study found that the prevalence of food insecurity was significantly higher among pregnant women with certain demographic characteristics, behaviors, and health conditions previously found to be associated with birth weight. The U.S. HFSS 6-item or 18-item food security measurement module may provide a way to identify women at an increased risk for birthing an LBW or HBW infant. Local clinics, nutrition professionals, public health experts, and healthcare facilities, along with state and federal agencies, may benefit from utilizing a single survey that measures household food security and risk for undesirable birth weight.

Birth weight is used as an overall measure of birth outcomes and as an indicator of infant health. Given the numerous short- and long-term health complications and disease states associated with LBW and HBW, it is crucial that the public health community strives to increase the percent of birth weights within the normal range (2500-3999 g). Little is known about how food insecurity is related to birth outcomes, but further study of food insecurity has a wealth of potential for predicting maternal and child health outcomes. Future studies are needed to investigate whether food security status is a useful indicator for predicting poor birth outcomes. Improving maternal food security during pregnancy is an area where intervention could potentially have grand effects on overall national health.

## ***Chapter 7. Limitations***

There were a number of limitations in the present study—limitations due to the actual MIHA survey, birth certificate recording, and the limitations that were the result of the statistical analysis.

According to the MIHA researchers, the following are recognized study limitations of the MIHA survey. The format and administration of the survey as a mixed mode type, (mail and telephone) may limit the number and complexity of the questions. In addition, pregnant women may answer questions differently with a mixed mode questioner due to social pressure of not wanting to report accurate behavioral and environmental problems such as smoking, drinking, drug use, or poor eating patterns. All of these behaviors may harm the infant so the mother may not feel comfortable when answering questions about these issues. According to CDC findings, women who respond

to similar surveys by mail are more likely to report drinking, homelessness, and smoking than if they are contacted via the phone.[170] Despite multiple strategies to address non-response, bias may still be present due to the diversity, low literacy, language barrier, and region of the sampling frame. The above limitations might have made it more difficult to see a relationship between behaviors or risk factors and birth outcomes.

Another possible area of bias could be due to the retrospective survey design. Women completed the surveys 10-14 weeks postpartum, which could have affected their ability to recall their time during pregnancy. Additionally, because of the possible temporal relationship between food insecurity or birth weight and the covariates analyzed, causation cannot be determined.

Given that the survey is mailed with a telephone follow-up, it does not reach women who are homeless or not at a stable address (although efforts are made to find women who have moved to different addresses). The actual rate of food insecurity could be underestimated; in addition, the national and state reported rates could also be affected by this limitation.

Despite the large sample size of MIHA, some variables had inadequate numbers for analyzing the given variable and its relationship with food insecurity and or birth weight. Women who reported American Indian for race and ethnicity represented less than 0.5% of the population, which resulted in a very small cell size. Due to the lack of representation, results from the analysis of the American Indian women may have been unstable and difficult to interpret.

A larger sample size may also have allowed for more detectable differences between the four levels of food insecurity and the associated variables. It was difficult in

the present study to identify where the significant differences occurred between the levels of food security. Cross-tabulations comparison between each level of food insecurity with each variable was difficult to carry out due to the sample size. The significant p-values observed for the four levels of food security (Table B-1) only indicated that there was significant difference between at least one of the levels. Future analysis and investigation of the variables would be ideal with a larger sample size and would benefit from the separation of the food-security phenotypes. However, cross-tabulation of food security with food insecurity as a binary variable resulted in numerous significant differences between the demographic, behavioral, and health conditions variables. The results of the binary analysis revealed that this way of investigating food security was more appropriate than a categorical analysis, given the available sample size.

The objective of the study was to investigate food insecurity as an unadjusted predictor of LBW or HBW. Exploration of the odds of birthing an LBW or HBW infant in women experiencing different levels of household food insecurity after adjusting for a priori predictors of LBW and HBW in multiple regression models may have reduced confounding and made it easier to interpret results. Future studies would benefit from multivariate analysis based on the preliminary findings. Collapsing some of the covariates into binary variables or dropping some of the covariates might also lead to a larger cell size and a better interpretation of the analysis. Further studies may also benefit from investigating food insecurity as a continuous variable on a scale, which may increase the power for detecting significant differences between the levels. In addition, it may be beneficial for researchers to look at birth weight as a continuous variable. A

greater statistical significance may be found due to a decrease in the parameter restrictions present with the binary outcome variable.

Making general claims based on the results of the study may be limited by the demographics of California. The ability to apply the results to the national population is contingent on continued analysis at the state and local levels.

## ***Chapter 8. Conclusion***

The main objective of the study was to identify the overall prevalence of food insecurity among pregnant women. Food insecurity experienced in the pregnant population appeared to be higher than that of the general population. The hypothesis was that women who reported having experienced household food insecurity during pregnancy would be more likely to give birth to an LBW or HBW infant. The hypothesis was partially supported by VLFS being a significant predictor of LBW. Women who experienced VLFS during pregnancy were 75% more likely to give birth to an LBW infant (OR 1.75 95% CI 1.0-3.06) compared to women who experienced HFS. Food insecurity as a binary variable was also analyzed as an independent predictor of LBW or HBW but no significant findings were observed.

To date, no other study has looked at food insecurity as a predictor of birth weight. Given the significance of the preliminary analysis related to the predictability of VLFS and birth weight, additional studies are needed to investigate whether food insecurity is related to birth weight after accounting for confounding variables.

The maternal characteristics that were investigated had been shown to be established predictors and risk factors for abnormal birth weight. Similar results were observed with past research related to maternal risk factors that predicted LBW or HBW. The consistency with previous research validates the quality of the sample population. However, the study was unique in that the prevalence of food insecurity was investigated among a priori maternal predictors of birth weight. Until now, no study has investigated the prevalence of food insecurity experienced by women who were at high risk for birthing an infant outside the normal birth weight range. Further research is warranted

due to the observation that a number of maternal characteristics were found to be positively associated with food insecurity.

Despite the minimal findings that food insecurity predicts birth weight, women who experience food insecurity during pregnancy may still be a high-risk population for poor birth outcomes due to the numerous overlapping characteristics discussed here. In order to fully understand the relationship between food insecurity and birth weight, future studies are needed to address the possible confounding variables. Improving food insecurity may partially decrease the prevalence of abnormal birth weight infants. Strategies to assure quality diets and adequate intake for pregnant women who experience food insecurity need to be investigated by federal, state and local food assistance programs. Nutrition and public health professionals have a responsibility to identify the appropriate nutrient and dietary needs for the pregnant food-insecure woman in addition to the ideal time to offer intervention. The importance of nutrition during pregnancy cannot be emphasized enough. Additional research should focus on the accessibility of adequate quantity and quality of nutrient-dense foods for pregnant woman at risk for birthing an infant with abnormal birth weight. Healthy birth weight may be key in reducing chronic diseases of adulthood, and promoting better health for the individual and community at local, state, and national levels.

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Appendix A: MIHA Survey Questionnaire

**2005**

# MIHA

Maternal and Infant Health Assessment

"For healthier mothers and babies"

Survey Research Center • University of California at Berkeley

- Please try to answer each question.
- Most questions are answered by checking a box or writing a number or a few words on a line.
- Never check more than one box, except where it says **"Check all that apply."**
- Sometimes we ask you to skip a question. An arrow will tell you what question to answer next, like this:

  ☒ Yes → **Skip to question 1** O No

- If none of the boxes is just right for you, please check the one that fits you the best. If you can, write us a note telling us more.
- If you need help with the survey or want to do it by telephone, call **Toni Clark toll-free at 1-800-342-9229.**

The last page of the survey asks for your mailing address so we can send you a check for **$10** to say "thank you." Be sure to fill it out. Then please mail this survey back to us in the enclosed envelope. No stamps are needed.

**Please read this before starting.**

- It's your choice whether or not to do the survey.
- Your answers will be kept **confidential**.
- Whether or not you answer the survey questions will **not** affect your health care or any benefits you may get.
- You can skip questions you don't want to answer.
- If you have any questions, call **Toni Clark toll-free at 1-800-342-9229**.

**Thank you!**

**INTRODUCTION**

1. What is today's date?

   _____ _____, _____
   month date year

2. When was your most recent baby born?

   _____ _____, _____
   month date year

   **We call this birth your MOST RECENT BIRTH or PREGNANCY.**

3. **Not counting your most recent birth**, did you ever have a baby that weighed less than 5 pounds, 8 ounces (2½ kilos) at birth?

   [1]O Yes

   [2]O No

4. **Not counting your most recent birth**, did you ever have a baby that was born prematurely (before you reached 37 weeks of pregnancy)?

   [1]O Yes

   [2]O No

5. **Before you got pregnant for this recent birth**, did a doctor/nurse ever tell you that you had high blood pressure (hypertension)?

   [1]O Yes

   [2]O No

6. **Just before you got pregnant for your most recent birth**, did you have a particular doctor, nurse, or clinic that you usually went to if you wanted health care?

   [1]O Yes

   [2]O No

7. **Just before you got pregnant**, were you taking multivitamins or folic acid?

   [1]O Yes, I took them every day or almost every day

   [2]O Yes, I took them sometimes

   [3]O No, I never took multivitamins or folic acid just before I got pregnant

8. A. **Just before you got pregnant**, how much did you weigh?

   _____ pounds **OR** _____ kilos

   B. How many pounds or kilos did you gain **during your most recent pregnancy**?

   _____ pounds **OR** _____ kilos

9. How tall are you without shoes?

   _____ feet and _____ inches

   **OR** _____ meters and _____ centimeters

10. A. How would you rate your health **just <u>before</u> you got pregnant**?

   [1]O Excellent

   [2]O Good

   [3]O Fair

   [4]O Poor

   B. How would you rate your health **<u>during</u> your most recent pregnancy**?

   [1]O Excellent

   [2]O Good

   [3]O Fair

   [4]O Poor

11. About how many weeks **or** months pregnant were you when you were sure that you were pregnant? (For example, you used a home pregnancy test, a doctor or nurse said you were pregnant, or you just knew for sure.)

_____ week(s) **OR** _____ month(s)

12. Did you have any of these health problems during your most recent pregnancy?

| | Yes, I had that problem | No, I didn't have that problem |
|---|---|---|
| A. Labor pains more than 3 weeks before your baby was due (preterm or early labor) | 1 O | 2 O |
| B. Water broke more than 3 weeks before your baby was due (premature rupture of membranes) | O | O |
| C. High blood pressure | O | O |
| D. Pre-eclampsia, eclampsia or toxemia | O | O |
| E. High blood sugar (diabetes) | O | O |
| F. Problems with the placenta (like abruptio placenta, placenta previa, low-lying placenta) | O | O |
| G. Cervix had to be sewn shut (cerclage, incompetent cervix) | O | O |
| H. Kidney or bladder (urinary tract) infection | O | O |
| I. You were injured in a car accident | O | O |
| J. Other health problem (**Please tell us:** _____) | O | O |

13. Here is a list of some problems women may have with their teeth or mouth. For each one, please tell us if you had that problem during your most recent pregnancy.

| | Yes, I had that problem | No, I didn't have that problem |
|---|---|---|
| A. I had a toothache ..... | 1O | 2O |
| B. I had a loose tooth ..... | O | O |
| C. My gums bled a lot ..... | O | O |
| D. I had painful, red or swollen gums ..... | O | O |
| E. I had cavities that needed to be filled ..... | O | O |
| F. I had to have a tooth pulled ..... | O | O |
| G. Other ..... (**Please tell us:** _____ _____) | O | O |

14. During your most recent pregnancy, did you visit a dentist or dental clinic?

1O Yes → **Skip to question 16 on next page**

2O No

15. What was the MAIN reason you did not go to a dentist or dental clinic? (**Please check only one.**)

1O I didn't need to go

2O I didn't think of it

3O I didn't have dental insurance, or it cost too much

4O I don't like going to the dentist

5O I was too busy

6O My doctor or nurse told me not to go to the dentist during pregnancy

7O Someone in my dentist's office told me to wait until after my pregnancy

8O I read or heard somewhere else that it wasn't safe to go to the dentist during pregnancy

9O Other (**Please tell us:**

_____)

16. A. When you got pregnant, were you using any birth control method to prevent pregnancy – like birth control pills, condoms, shots, rhythm, withdrawal, or some other method?

1O Yes, all the time → **Skip to question 18 on next page**

2O Yes, sometimes

3O No

B. If you weren't using birth control all the time, was that because you wanted to get pregnant or was there some other reason?

1O I wanted to get pregnant → **Skip to question 18 on next page**

2O Some other reason

17. Here is a list of reasons why a woman might not always use a birth control method to prevent pregnancy. For each one, please tell us if it was a reason for you.

| | Yes, it was a reason | No, it wasn't a reason |
|---|---|---|
| A. I didn't think I was going to have sex | [1] O | [2] O |
| B. I didn't think I could get pregnant | O | O |
| C. I ran out of the birth control method I was using | O | O |
| D. I couldn't get an appointment to get birth control when I needed it | O | O |
| E. I didn't want to have the side effects that birth control can cause | O | O |
| F. I was afraid birth control was bad for my health | O | O |
| G. My husband or partner did not want to use birth control | O | O |
| H. I couldn't afford to pay for birth control or my insurance wouldn't cover it | O | O |
| I. Birth control is against my religion | O | O |
| J. No special reason, I just didn't | O | O |
| K. Some other reason | O | |

(**Please tell us:** _____

_____

_____)

5

Now, we have a few questions about prenatal care. By "prenatal care," we mean health care for pregnancy.

18. Did you get <u>any</u> prenatal care during your most recent pregnancy? (Please do not count a visit just for a pregnancy test.)

[1]O Yes

[2]O No

19. A. About how many weeks **or** months pregnant were you when you <u>first tried</u> to make an appointment to get prenatal care? (Please do not count an appointment just for a pregnancy test.)

_____ weeks **OR** _____ months

[x]O I never tried to make a prenatal care appointment

B. And how many weeks **or** months pregnant were you when you <u>had</u> your first prenatal care visit? (Please do not count a visit just for a pregnancy test.)

_____ weeks **OR** _____ months

[x]O I never had prenatal care

20. A. Did you get prenatal care as early in your pregnancy as you wanted?

[1]O Yes

[2]O No

[3]O I did not want prenatal care

B. Overall, how important do you think it was to the people closest to you that you got prenatal care during your most recent pregnancy?

[1]O Very important

[2]O Somewhat important

[3]O Not too important

[4]O Not at all important

[5]O I'm not sure

21. Here is a list of problems some women can have getting prenatal care. For each one, please tell us if it was a problem for you.

| | Yes, it was <u>a problem</u> | No, it wasn't <u>a problem</u> |
|---|---|---|
| A. I didn't know I could get Medi-Cal for prenatal care | [1]O | [2]O |
| B. I had problems finding a place that would accept my insurance or Medi-Cal | O | O |
| C. I didn't know where to go for prenatal care ..... | O | O |
| D. I had problems getting through on the phone to make an appointment ..... | O | O |
| E. I had problems getting an appointment at a time or date that was good for me | O | O |
| F. I had no way to get to the clinic or office ..... | O | O |
| G. There was no one to take care of my children ..... | O | O |
| H. I had too many other problems to deal with ..... | O | O |
| I. Any other problems getting prenatal care? ..... | O | O |

(**Please tell us:** _____
_____)

22. During any of your prenatal care visits, did a doctor, nurse or other health care worker talk with you about how HIV (the virus that causes AIDS) could affect a baby?

[1]O Yes

[2]O No

[3]O I never had prenatal care

23. A. At any time during your most recent pregnancy or delivery, did you have a test for HIV (the virus that causes AIDS)?

[1]O Yes → **Skip to question 24**

[2]O No

[3]O I don't remember

B. Here are a few reasons why some women do not have an HIV test during their pregnancies. For each one, please tell us if it was a reason you did not have an HIV test during your most recent pregnancy.

| | Yes, it was a reason | No, it wasn't a reason |
|---|---|---|
| a. I was not offered the test | [1]O | [2]O |
| b. I did not think I had HIV | O | O |
| c. I had an HIV test before I was pregnant and did not think I needed another one | O | O |
| d. I wanted to have the test but had problems getting it done | O | O |
| e. I was not sure I wanted to know the result | O | O |
| f. Other (**Please tell us:** _____) | O | O |

24. A. During your pregnancy, did a doctor, nurse, or midwife offer you a test to see if your baby might have a birth defect? (Birth defect tests include Expanded AFP, amniocentesis, chorionic villi sampling [CVS], or another test.)

[1]O Yes

[2]O No → **Skip to question 26 on next page**

[3]O I don't remember/I'm not sure

B. And, did you choose to have a test for birth defects?

[1]O Yes

[2]O No → **Skip to question 25 below**

C. What test did you have?
**Check all that apply**.

[1]O AFP or expanded AFP testing

[2]O Amniocentesis (amnio)

[3]O Chorionic villus sampling (CVS)

[4]O NT, nuchal translucency

[5]O Other (**Please tell us:** _____
_____)

[6]O I wanted to have the test but had problems getting it done

[7]O I'm not sure

**→ Now, skip to question 26 on next page**

25. Why did you choose <u>not</u> to have a test?
**Check all that apply.**

[a]O I was afraid it might hurt my baby

[b]O I did not want to know the results

[c]O My partner or family did not want me to have a test

[d]O I would not do anything differently if I knew my baby had a birth defect

[e]O Other (**Please tell us:** _____

_____)

Now, we have a few questions about your feelings and experiences just before or during your pregnancy.

26.A. Thinking back to just before you got pregnant, how did you feel about getting pregnant?

[1]O I wanted to get pregnant then
→ **Skip to question 27**

[2]O I wanted to get pregnant later

[3]O I didn't want to get pregnant then or in the future → **Skip to question 27**

[4]O I wasn't sure what I wanted
→ **Skip to question 27**

B. About how much longer did you want to wait until you became pregnant?

[1]O 1 to 12 months

[2]O 13 to 24 months (1 to 2 years)

[3]O 2 to 5 years

[4]O More than 5 years

[5]O I wasn't sure

27. And how did you feel when you found out you really were pregnant?

[1]O Very happy

[2]O Somewhat happy

[3]O Somewhat unhappy

[4]O Very unhappy

[5]O I wasn't sure how I felt

28. During your pregnancy, did you feel very blue, sad, or depressed for more than two weeks at a time?

[1]O Yes

[2]O No

29. A. During your pregnancy, did a doctor, nurse or midwife ever ask you if you were feeling blue, sad, or depressed?

[1]O Yes

[2]O No → **Skip to question 30**

[3]O Don't remember → **Skip to question 30**

B. During your pregnancy, did a doctor, nurse or midwife refer you to a counselor who helps people who are feeling blue, sad, or depressed ?

[1]O Yes

[2]O No

30. A. During your pregnancy, did you have someone you could turn to if you needed practical help, like getting a ride somewhere, or help with shopping or cooking a meal?

[1]O Yes

[2]O No

B. During your pregnancy, did you have someone you could turn to if you needed someone to comfort or listen to you?

[1]O Yes

[2]O No

31. Here are a few things that might happen to some women during their pregnancies. Please tell us if any of these things happened to you during your most recent pregnancy.

| | Yes | No |
|---|---|---|
| A. A close family member was very sick and had to be hospitalized | 1O | 2O |
| B. I got separated or divorced from my partner | O | O |
| C. I moved to a new address | O | O |
| D. I was homeless (for example, had to sleep outside, in a car, or in a homeless shelter) | O | O |
| E. My husband or partner lost his job | O | O |
| F. I lost my job even though I wanted to go on working | O | O |
| G. I argued with my husband or partner more than usual | O | O |
| H. My husband or partner said he didn't want me to be pregnant | O | O |
| I. I had a lot of bills I couldn't pay | O | O |
| J. I was in a physical fight | O | O |
| K. My partner or I went to jail | O | O |
| L. Someone very close to me had a bad problem with drinking or drugs | O | O |
| M. Someone very close to me died | O | O |

32. During your most recent pregnancy, how safe did you feel your neighborhood or home was from crime?

1O Very safe

2O Somewhat safe

3O Somewhat unsafe

4O Very unsafe

The next questions are about relationships with intimate partners. By "partner" we mean *current* or *former* husband, partner, boyfriend or girlfriend. Please remember that all the information in this survey is completely confidential.

33. A. <u>During</u> your most recent pregnancy, were you ever frightened for the safety of yourself, your family, or your friends because of the anger or threats of your partner?

[1]O Yes

[2]O No

B. <u>During</u> your most recent pregnancy, did your partner try to control most or all of your daily activities? For example, controlling who you talked to or where you could go.

[1]O Yes

[2]O No

34. A. <u>During</u> your most recent pregnancy, did your partner push, hit, slap, kick, choke, or physically hurt you in any way?

[1]O Yes

[2]O No

B. In the 12 months <u>before</u> you got pregnant, did your partner push, hit, slap, kick, choke, or physically hurt you in any way?

[1]O Yes

[2]O No

35. A. Have you smoked any cigarettes in the past 2 years?

[1] O Yes

[2] O No → **Skip to question 36 on this page**

B. During the *first* 3 months of your pregnancy, how many cigarettes or packs of cigarettes did you smoke on an average day? (A pack has 20 cigarettes.)

_____ cigarettes **OR** ____ packs

[1] O Less than one cigarette a day

[2] O I didn't smoke at all during the first 3 months of my pregnancy

C. During the *last* 3 months of your pregnancy, how many cigarettes or packs of cigarettes did you smoke on an average day? (A pack has 20 cigarettes.)

_____ cigarettes **OR** ____ packs

[1] O Less than one cigarette a day

[2] O I didn't smoke at all during the last 3 months of my pregnancy

36. The next two questions are about drinking alcohol. By "alcohol" we mean any kind of drink with alcohol in it -- including beer, wine, wine cooler, hard liquor, or a mixed drink made with hard liquor.

A. During the *first* 3 months of your pregnancy, about how many drinks with alcohol did you have in an average week? A drink is one glass of wine, one wine cooler, one can or bottle of beer, one shot of liquor, or one mixed drink.

[1] O I didn't drink at all during the first 3 months of my pregnancy

[2] O Less than one drink per week

[3] O 1 to 3 per week

[4] O 4 to 6 per week

[5] O 7 or more drinks per week

B. During the *last* 3 months of your pregnancy, about how many drinks with alcohol did you have in an average week?

[1] O I didn't drink at all during the last 3 months of my pregnancy

[2] O Less than one drink per week

[3] O 1 to 3 per week

[4] O 4 to 6 per week

[5] O 7 or more drinks per week

Now, we have a few questions about your health insurance coverage during pregnancy.

37. During your most recent pregnancy, did you have Medi-Cal (or a health plan that Medi-Cal paid for)?

[1]O Yes

[2]O No → **Skip to question 40 below**

38. Did you have Medi-Cal (or a health plan that Medi-Cal paid for) before you got pregnant?

[1]O Yes → **Skip to question 42 on next page**

[2]O No

39. A. About how many weeks **or** months pregnant were you when you first *applied* for Medi-Cal?

_____ weeks **OR** _____ months

B. And about how many weeks **or** months pregnant were you when you knew that you had Medi-Cal (or a health plan that Medi-Cal paid for)?

_____ weeks **OR** _____ months

→ **Now skip to question 41**

40. A. Did you ever try to apply for Medi-Cal during this pregnancy?

[1]O Yes

[2]O No → **Skip to question 42 on next page**

B. About how many weeks **or** months pregnant were you when you first *tried* to apply for Medi-Cal?

_____ weeks **OR** _____ months

41. Here is a list of some problems that people can have in applying for Medi-Cal. For each one, please tell us if it was a problem for you.

| | Yes, it was a problem | No, it wasn't a problem |
|---|---|---|
| A. I didn't know how to apply or where to go ..... | 1O | 2O |
| B. It was hard to get through on the phone to Medi-Cal or a Medi-Cal worker | O | O |
| C. The people I spoke with at Medi-Cal were rude or not very helpful ..... | O | O |
| D. I had no way to get to the Medi-Cal office..... | O | O |
| E. It was hard to fill out the forms or get all the papers they wanted ..... | O | O |
| F. I was afraid I might have to pay back Medi-Cal later | O | O |
| G. I was afraid applying for Medi-Cal could get in the way of becoming a permanent resident or citizen, or bringing family to the U.S. ..... | O | O |
| H. Some other reason ..... | O | O |

(**Please tell us:**

_____

_____

_____)

42. A. During your most recent pregnancy, were you covered by private insurance or some other health plan that paid for prenatal care? Please do <u>not</u> include Medi-Cal or a health plan paid for by Medi-Cal.

1O Yes

2O No → **Skip to question 43**

B. What was the name of that private insurance or health plan?

_____

C. Did that coverage start before or after you got pregnant?

1O Before → **Skip to question 43**

2O After

D. About how many weeks **or** months pregnant were you when that coverage began?

_____ weeks **OR** _____ months

43. Right now, are you covered by Medi-Cal, private insurance, or some other health plan for your own health care?

[1]O Yes

[2]O No

44. A. Since your most recent birth, was there any time when you needed to see a doctor or nurse for your own medical care but didn't go because you couldn't afford to pay for it?

[1]O Yes

[2]O No

B. Since your most recent birth, have you had a post-partum check-up (the medical check-up that is done about 6 weeks after a woman gives birth)?

[1]O Yes

[2]O No

**THE REST OF THE SURVEY ASKS ABOUT YOUR MOST RECENT BIRTH.**

(If you had twins or triplets, please answer these next questions about the baby that was born first.)

45. Is your baby alive now?

[1]O Yes

Is he/she living with you now?

[1]O Yes → **Go to question 46**

[2]O No → **Skip to question 55 on page 13**

[2]O No **Please accept our deepest sympathy.**

When did your baby die?

_____ _____, _____
(month) (day) (year)

→ **Please skip to question 55 on page 13**

46. A. Right now, is your baby covered by Medi-Cal, private insurance, or some other health plan for his/her health care?

[1]O Yes

[2]O No, my baby is uninsured
→ **Skip to question 47 below**

[3]O I don't know
→ **Skip to question 47 below**

B. What kind of coverage does your baby have?

[1]O Medi-Cal

[2]O A health plan paid for by Medi-Cal

[3]O Private insurance

[4]O Healthy Families

[5]O Other (**Please tell us:** _____
_____)

C. About how many weeks **or** months old was your baby when his or her own Medi-Cal, private insurance, Healthy Families, or other coverage began?

[x]O His/her coverage began at birth

_____ weeks **OR** _____ months

47. Since your new baby was born, was there any time when you needed health care for your baby but didn't get it because you couldn't afford to pay for it?

[1]O Yes

[2]O No

48. Since your new baby was born, have you ever breast fed him/her at all (even once)?

[1]O Yes

[2]O No → **Skip to question 52**

49. A. When your baby was two days old, how were you feeding him/her?

[1]O Breast milk only

[2]O Both breast milk and formula

[3]O Formula only

B. When your baby was two months old, how were you feeding him/her?

[1]O Breast milk only

[2]O Mostly breast milk

[3]O Formula only → **Skip to question 51 below**

[4]O Mostly formula

[5]O Other (**Please tell us**: _____)

50. A. Are you still breast feeding your baby?

[1]O Yes

[2]O No → **Skip to question 51 below**

B. Have you ever given your baby formula, even once?

[1]O Yes → **Skip to question 52**

[2]O No → **Skip to question 53**

51. How old was your baby when you stopped breast feeding him/her?

_____ days **OR** _____ weeks **OR** _____ months

52. Babies are given formula for different reasons. Why was your baby given formula for the *first* time? **Check all that apply.**

[a]O I did not make enough milk

[b]O I needed to go back to work or school

[c]O Breast feeding was too painful for me

[d]O I did not like breast feeding in public or breast feeding embarrassed me

[e]O My baby did not breast feed well

[f]O A doctor or nurse recommended using formula

[g]O I wanted my partner or others to be able to feed the baby sometimes

[h]O I thought formula would be easier or more convenient

[i]O I wanted my baby to sleep longer at night

[j]O Other (**Please tell me**: _____)

53. Before your baby was two months old, what food or drinks had he or she ever had, even once (other than breast milk or formula)? **Check all that apply.**

[a]O Cereal

[b]O Tea

[c]O Juice

[d]O Water, sugar water, or glucose

[e]O Other foods or drinks (**Please tell us:** _____)

[f]O Nothing, my baby has only had breast milk or formula

54. How do you put your new baby down to sleep *most* of the time? **Check only one answer.**

[1]O On his/her side

[2]O On his/her back

[3]O On his/her stomach

**OTHER QUESTIONS**

These next few questions give us a general idea of the different backgrounds of people who have taken part in this important survey. Again, please remember that we will not share any information you give us.

55. A. What ethnic or racial group(s) do you consider yourself? **Check all that apply.**

[1]O African-American, Black, or African

[2]O American Indian, Native American, Eskimo or Aleut

[3]O Asian, Asian-American or Pacific Islander (For example, Chinese, Filipino, Japanese, Korean, Vietnamese, or people from India or another Asian country)

[4]O Latino, Hispanic, Chicano, Mexican or Mexican-American, Central American, or other Latin American

[5]O White, Caucasian, or European (including people from Spain or the Middle East)

[6]O Some other group *(***Please tell us:** _____)

B. If you chose more than one group, please write in the name of the group you identify with the **most**:

I identify most with: _____

[x]O I identify equally with all the groups I checked

56. A. In what country were you born?

[1]O United States → **Skip to question 57**

[2]O Other country (**Which country:** _____)

B. In what year did you start living in the U.S.? _____

57. What language do you usually speak at home? If you speak more than one, please choose the one you use **most** often.

[1]O English

[2]O Spanish

[3]O English and Spanish equally

[4]O Asian language (**Please tell us:** _____)

[5]O Some other language (**Please tell us:** _____)

58. What is the highest grade or year of school you've completed?

[1]O I never went to school

[2]O 8th grade or less

[3]O Some high school, but I did not graduate

[4]O High school (or I got a GED)

[5]O Some college or junior college, but I did not graduate from a four-year college

[6]O College graduate (from a four-year college or university) or more

59. Thinking back to who you lived with when you were about 13 years old, what was the highest grade or year of school completed by your mother, father or main guardian? **If you lived with more than one parent or guardian, please tell us about the one who had the most education.**

[1]O Never went to school

[2]O 8th grade or less

[3]O Some high school, but did not graduate

[4]O High school (or got a GED)

[5]O Some college or junior college, but did not graduate from a four-year college

[6]O College graduate (from a four-year college or university) or more

[7]O I don't know

60. At the time your baby was born, what was your marital status?

[1]O Married

[2]O Living with someone like we were married, but not legally married

[3]O Separated, divorced, or widowed

[4]O Single (never married)

61. Here are some statements that people use to describe themselves. How strongly do you agree or disagree with how well the following statements describe you?

| | Strongly Agree | Agree | Disagree | Strongly Disagree |
|---|---|---|---|---|
| A. There is really no way I can solve some of the problems I have | [1]O | [2]O | [3]O | [4]O |
| B. Sometimes I feel that I'm being pushed around in life | O | O | O | O |
| C. I have little control over the things that happen to me | O | O | O | O |
| D. I can do just about anything I really set my mind to do | O | O | O | O |
| E. I often feel helpless in dealing with the problems of life | O | O | O | O |
| F. What happens to me in the future mostly depends on me | O | O | O | O |
| G. There is little I can do to change many of the important things in my life | O | O | O | O |

62. Below is a list of the ways you might have felt in the past week. Please tell us how often you have felt this way during the past week.

| During the past week: | Hardly ever | Some of the time | Most of the time |
|---|---|---|---|
| A. I did not feel like eating; my appetite was poor | [1]O | [2]O | [3]O |
| B. I felt depressed | O | O | O |
| C. I felt that everything I did was an effort | O | O | O |
| D. My sleep was restless | O | O | O |
| E. I was happy | O | O | O |
| F. I felt lonely | O | O | O |
| G. People were unfriendly | O | O | O |
| H. I enjoyed life | O | O | O |

| | | | |
|---|---|---|---|
| I. I felt sad ..... | O | O | O |
| J. I felt that people disliked me ..... | O | O | O |
| K. I could not "get going" ..... | O | O | O |

Now, we have just a few more questions. These are about food and money.

63. A. Were you on WIC at any time during your most recent pregnancy? (WIC is the Women, Infants and Children supplementary food program)

[1]O Yes

[2]O No

B. Have either you or your new baby been on WIC since he/she was born?

[1]O Yes

[2]O No

Please read each statement below and tell us whether the statement was OFTEN, SOMETIMES, or NEVER true for you during your most recent pregnancy.

64. A. "The food that I bought just didn't last, and I didn't have money to get more." During your most recent pregnancy, was that often, sometimes, or never true for you?

[1]O Often true

[2]O Sometimes true

[3]O Never true

[4]O Don't know

B. "I couldn't afford to eat balanced meals." During your most recent pregnancy, was that often, sometimes, or never true for you?

[1]O Often true

[2]O Sometimes true

[3]O Never true

[4]O Don't know

65. A. During your pregnancy, did you ever cut the size of your meals or skip meals because there wasn't enough money for food?

[1] O Yes

[2] O No → **Skip to question 66**

[3] O Don't know → **Skip to question 66**

B. How often did this happen?

[1] O Almost every month

[2] O Some months but not almost every month

[3] O 1 or 2 months

[4] O Don't know

66. A. During your pregnancy, did you ever eat less than you felt you should because there wasn't enough money to buy food?

[1] O Yes

[2] O No

[3] O Don't know

B. During your pregnancy, were you ever hungry but didn't eat because you couldn't afford enough food?

[1] O Yes

[2] O No

[3] O Don't know

67. A. What was your total family income in 2004 **before taxes**? Please mark one box below that includes your total family income, including your income and the income of your husband or partner (if living with you in 2004) and your children.

Please include income from all sources, including jobs, welfare, Disability, Unemployment, child support, interest, dividends, and support from family members.

FOR THE YEAR 2004

[1] O $0 to $12,000

[2] O $12,001 to $16,000

[3] O $16,001 to $19,000

[4] O $19,001 to $22,000

[5] O $22,001 to $25,000

[6] O $25,001 to $28,000

[7] O $28,001 to $31,000

[8] O $31,001 to $38,000

[9] O $38,001 to $44,000

[10] O $44,001 to $47,000

[11] O $47,001 to $50,000

[12] O $50,001 to $57,000

[13] O $57,001 to $63,000

[14] O $63,001 to $66,000

[15] O $66,001 to $76,000

[16] O $76,001 to $85,000

[17] O $85,001 to $88,000

[18] O $88,001 to $101,000

[19] O $101,001 to $114,000

[20]O $114,001 or more

B. If you can't choose one of the previous categories, please tell us your average monthly income in 2004 before taxes.

$_____ per month

68. Thinking back to 2004 --before your new baby was born--how many people lived on this income?

_____ total number of people

69. In general, during your most recent pregnancy, how hard was it for you and your family to live on the income you had?

[1]O Very hard

[2]O Somewhat hard

[3]O Not too hard

[4]O Not hard at all

70. Overall, how would you describe the time during your pregnancy? **Check the best answer.**

[1]O One of the happiest times of my life

[2]O A happy time with few problems

[3]O A moderately hard time

[4]O A very hard time

[5]O One of the worst times of my life

**Thank you for answering these questions. Your answers will help us to improve the health of mothers and babies.**

**Please go to the next page.**

This page will be removed when we receive the survey.

71. We want to send you a check for $10 to thank you for your help with this important study. To make sure our records are correct and that the check will reach you, please fill in your name and address.

Name: _____

Address: _____ Apt # _____

_____ _____ _____
City State Zip code

Only check this box if you do not want to participate in the raffle for $250.

O Please do not enter me in the raffle for $250.

72. We hope to do another survey when your baby is a year old. The next survey will be shorter and you'll receive a gift if you decide to take part. As with this survey, whether you take part in the next survey is completely up to you.

A. If we do another survey a few months from now, may we contact you? (Even if you say yes now, you can change your mind and decide not to take part later on.)

[1]O Yes [2]O No → **Skip to question 73 on next page**

***The information below is only to contact you for the next survey.***

B. What is your current home phone number?

(_____) _____

C. What is your current work phone number?

(_____) _____ [0]O I am not employed

D. In case you move or we are not able to reach you, please give us the name, address, and phone number of two people who don't live with you and who will always know how to reach you.

Person #1:

Name: _____

Address: _____ Apt # _____

_____ _____ _____
City State Zip code

Phone number: (_____) _____

How is this person related to you?

_____

Person #2:

Name: _____

Address: _____ Apt # _____

_____ _____ _____
City State Zip code

Phone number: (_____) _____

How is this person related to you?

_____

73. If there is anything else you want to tell us about the health of mothers and babies in California, or about this survey, please write it here.

This page will be removed when we receive the survey.

## Thank you very much for your help

Now please mail this survey back to us in the enclosed envelope.
You don't need stamps.

Appendix B: Table B-1. Demographic and behavioral characteristics of women with recent births compared by level of household food security: HFS (n=2652), MFS (n=347), LFS (n=456), and VLFS (n=178), California MIHA 2005

(Pearson Chi-sq analysis with significant differences highlighted)

| | | Food Security | | | | Food Insecurity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | HFS | | MFS | | LFS | | VLFS | | |
| | Total, weighted n | n^ | weighted % | n^ | weighted % | n^ | weighted % | n^ | weighted % | |
| | 3634 | 2652 | 73.0% | 347 | 9.5% | 456 | 12.5% | 178 | 4.9% | 100% |
| **DEMOGRAPHICS (Catigorical variables)** | | | | | | | | | | **p-value** |
| Birth Weight category (g) [BC] | | | | | | | | | | |
| <2500 | 232 (6.4%) | 157 | 67.7% | 25 | 10.9% | 32 | 13.8% | 18 | 7.6% | 100% |
| 2500-2999 | 534 (14.7%) | 381 | 71.3% | 53 | 9.9% | 70 | 13.1% | 30 | 5.7% | 100% |
| 3000-3499 | 1370 (37.7%) | 1000 | 73.0% | 136 | 10.0% | 163 | 11.9% | 70 | 5.1% | 100% |
| 3500-3999 | 1151 (31.7%) | 843 | 73.2% | 107 | 9.3% | 151 | 13.1% | 50 | 4.4% | 100% |
| **≥4000** | 346 (9.5%) | 271 | 78.2% | 26 | 7.4% | 40 | 11.5% | 10 | 2.9% | 100% 0.37 |
| **Total, n** | 3633 (100%) | 2652 | | 347 | | 456 | | 178 | | |
| Maternal Race-ethnicity [MIHA] | | | | | | | | | | |
| African American | 174 (4.8%) | 121 | 70.0% | 18 | 10.4% | 22 | 12.5% | 12 | 7.1% | 100% |
| American Indian | 18 (0.5%) | 11 | 60.3% | 1 | 4.3% | 4 | 19.5% | 3 | 15.6% | 100% |
| API | 363 (10.1%) | 308 | 84.9% | 26 | 7.0% | 23 | 6.3% | 6 | 1.8% | 100% |
| European American | 1160 (32.3%) | 993 | 85.6% | 76 | 6.5% | 67 | 5.8% | 24 | 2.1% | 100% |
| Latina | 1793 (50%) | 1143 | 63.8% | 209 | 11.6% | 313 | 17.5% | 128 | 7.2% | 100% |
| Other | 89 (2.5%) | 58 | 65.5% | 14 | 15.5% | 13 | 15.2% | 3 | 3.8% | 100% <.001 |
| **Total, n** | 3596 (100%) | 2634 | | 344 | | 442 | | 176 | | |
| Prepregnancy BMI kg/m$^2$* | | | | | | | | | | |
| Underweigh t (<19.8) | 376 (11.5%) | 293 | 78.0% | 37 | 9.7% | 30 | 8.0% | 16 | 4.2% | 100% |
| Normal (19.8-26.0) | 1836(56.2%) | 1420 | 77.4% | 165 | 9.0% | 184 | 10.0% | 66 | 3.6% | 100% |
| Overweight (26.1-29.0) | 406 (12.4%) | 298 | 73.3% | 36 | 8.8% | 53 | 13.1% | 20 | 4.9% | 100% |
| Obese (>29.0) | 649 (19.9%) | 421 | 64.9% | 70 | 10.8% | 109 | 16.8% | 49 | 7.6% | 100% <.001 |
| Total, n | 3267 (100%) | 2432 | | 308 | | 376 | | 151 | | |
| Education [MIHA] | | | | | | | | | | |
| <8th | 272 (7.6%) | 176 | 64.5% | 18 | 6.7% | 58 | 21.4% | 20 | 7.4% | 100% |
| Some high school | 452 (12.6%) | 236 | 52.2% | 70 | 15.5% | 105 | 23.2% | 41 | 9.3% | 100% |
| High school or equiv. | 1018 (28.3%) | 659 | 64.7% | 124 | 12.2% | 176 | 17.3% | 59 | 5.9% | 100% |
| Some college | 949 (26.4%) | 722 | 76.1% | 91 | 9.6% | 92 | 9.7% | 44 | 4.6% | 100% |
| College Grad | 907(25.2%) | 842 | 92.8% | 42 | 4.9% | 17 | 1.9% | 7 | 0.8% | 100% <.001 |
| Total, n | 3598(100%) | 2635 | | 345 | | 448 | | 171 | | |
| Gestational age <**36 weeks** [BC] | | | | | | | | | | |
| No | 3133(86.2%) | 2307 | 73.6% | 296 | 9.4% | 384 | 12.3% | 146 | 4.7% | 100% |
| (preterm) Yes | 501(13.8%) | 346 | 69.1% | 51 | 10.2% | 72 | 20.8% | 32 | 6.4% | 100% 0.13 |
| Total, n | 3634(100%) | 2653 | | 347 | | 456 | | 178 | | |
| **KNOWLEDGE and HEALTH CONDITIONS** | | | | | | | | | | |
| Smoked in 3rd Trimester [MIHA] | | | | | | | | | | |
| No | 3420(96.1%) | 2531 | 74.0% | 316 | 9.2% | 416 | 12.2% | 157 | 4.6% | 100% |
| Yes | 139 (3.9%) | 74 | 53.2% | 25 | 18.0% | 26 | 18.7% | 14 | 10.1% | 100% <.001 |
| Total, n | 3559 (100%) | 2605 | | 341 | | 442 | | 171 | | |
| Previous LBW birth [MIHA] | | | | | | | | | | |
| No | 3423 (94.5%) | 2518 | 73.6% | 328 | 9.6% | 419 | 12.3% | 158 | 4.6% | 100% |
| Yes | 200 (5.5) | 127 | 63.3% | 19 | 9.7% | 34 | 16.9% | 20 | 10.1% | 100% 0.018 |
| Total, n | 3623 | 2645 | | 347 | | 453 | | 178 | | |
| High blood presure during preg. [MIHA] | | | | | | | | | | |
| No | 3197 (89.2%) | 2365 | 74.0% | 299 | 9.4% | 384 | 12.0% | 149 | 4.7% | 100% |
| Yes | 387 (10.8%) | 260 | 67.2% | 44 | 11.3% | 60 | 15.4% | 24 | 6.1% | 100% 0.088 |
| Total, n | 3584 (100%) | 2625 | | 343 | | 444 | | 173 | | |
| High blood sugar during preg. [MIHA] | | | | | | | | | | |
| (Diabetes) No | 3261 (90.8%) | 2399 | 73.6% | 313 | 9.6% | 391 | 12.0% | 158 | 4.9% | 100% |
| Yes | 332 (9.3%) | 234 | 70.3% | 30 | 9.0% | 50 | 15.2% | 19 | 5.6% | 100% 0.468 |
| Total, n | 3594 (100%) | 2633 | | 343 | | 441 | | 177 | | |
| Feel depressed during preg. [MIHA] | | | | | | | | | | |
| No | 2597 (72.1%) | 2058 | 79.3% | 223 | 8.6% | 247 | 9.5% | 67 | 2.6% | 100% |
| Yes | 1015 (28.1%) | 579 | 57.1% | 124 | 12.2% | 203 | 20.0% | 109 | 10.7% | 100% <.001 |
| Total, n | 3611 (100%) | 2637 | | 347 | | 450 | | 176 | | |
| Living w/someone/married during preg. [MIHA] | | | | | | | | | | |
| No | 524 (14.5%) | 303 | 57.7% | 67 | 12.8% | 108 | 20.7% | 47 | 8.9% | 100% |
| Yes | 3078 (85.5%) | 2326 | 75.6% | 278 | 9.0% | 342 | 11.1% | 132 | 4.3% | 100% <.001 |
| Total, n | 3602 (100%) | 2629 | | 345 | | 450 | | 179 | | |
| **PREGANCY INTENTION** | | | | | | | | | | |
| WIC enrollment during preg. [MIHA] | | | | | | | | | | |
| No | 1654 (45.8% | 1505 | 91.0% | 73 | 4.4% | 54 | 3.3% | 22 | 1.4% | 100% |
| Yes | 1958 (54.2%) | 1126 | 57.5% | 275 | 14.0% | 401 | 20.5% | 156 | 8.0% | 100% <.001 |
| Total, n | 3612 (100%) | 2631 | | 348 | | 455 | | 178 | | |

(Oneway ANOVA analysis with significant differences highlighted)

| | | HFS | | MFS | | LFS | | VLFS | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | n^ | means ± SD | n^ | means ± SD | n^ | means ± SD | n^ | means ± SD | p-value |
| **DEMOGRAPHICS (Continous variables)** | | | | | | | | | | |
| Maternal Age (years) [BC] | | | | | | | | | | <.001 |
| **Total, n** | 3634 | 2653 | 28.8 ± 6.2 | 347 | 25.5 ± 6.2 | 456 | 25.8 ± 5.6 | 178 | 28.8 ± 6.2 | |
| Total number of live births (parity) [BC] | | | 2.0 ± 1.1 | | 2.1 ± 1.4 | | 2.2 ± 1.2 | | 2.5 ± 1.5 | <.001 |
| Total, n | 3633 | 2652 | | 347 | | 456 | | 178 | | |

* Shaded p-values are significant at the .05 level. Total number of HFS is <2652, MFS is <347, LFS is <456, and VLFS is <179 due to missing data and rounding numbers may not add to 100%. BC Birth certificate data. MIHA MIHA data. n^ weighted number of respondents excluding missing and those who did not know or respond. BMI* Calculated BMI from MIHA data based on IOM prepregnancy BMI categories. WIC** Special Supplemental Nutrition Program for Women, Infants and Children.

Appendix B: Table B-2. Demographic and behavior characteristics of women with recent births compared by food security status: Food Secure (n=2999), Food Insecure (n=634), California MIHA 2005

| (Pearson Chi-sq analysis with significant differences Shaded) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Food Secure | | Food Insecure | | |
| | Total, weighted n | n^ | weighted% | n^ | weighted% | | |
| | 3634 | 2999 | 82.5% | 635 | 17.5% | 100% | |
| DEMOGRAPHICS (Catigorical variables) | | | | | | | p-value |
| Birth Weight category (g) [BC] | | | | | | | |
| <2500 | 232 (6.4%) | 182 | 78.4% | 50 | 21.6% | 100% | |
| 2500-2999 | 534 (14.7%) | 434 | 81.3% | 100 | 18.7% | 100% | |
| 3000-3499 | 1371 (37.7%) | 1137 | 82.9% | 234 | 17.1% | 100% | |
| 3500-3999 | 1152 (31.7%) | 951 | 82.6% | 201 | 17.4% | 100% | |
| ≥4000 | 346 (9.5%) | 296 | 85.5% | 50 | 14.5% | 100% | 0.23 |
| Total, n | 3635 (100%) | 3000 | | 635 | | | |
| Maternal Race-ethnicity [MIHA] | | | | | | | |
| African American | 173 (4.8%) | 139 | 80.3% | 34 | 19.7% | 100% | |
| American Indian | 18 (0.5%) | 12 | 66.7% | 6 | 33.3% | 100% | |
| API | 363 (10.1%) | 334 | 92.0% | 29 | 8.0% | 100% | |
| European American | 1160 (32.3%) | 1069 | 92.2% | 91 | 7.8% | 100% | |
| Latina | 1793 (50%) | 1352 | 75.4% | 441 | 24.6% | 100% | |
| Other | 89 (2.5%) | 72 | 80.9% | 17 | 19.1% | 100% | <.001 |
| Total, n | 3596 (100%) | 2978 | | 618 | | | |
| Prepregnancy BMI kg/m$^2$* | | | | | | | |
| Underweight (<19.8) | 376 (11.5%) | 330 | 87.8% | 46 | 12.2% | 100% | |
| Normal (19.8-26.0) | 1836(56.2%) | 1585 | 86.3% | 251 | 13.7% | 100% | |
| Overweight (26.1-29.0) | 407 (12.5%) | 334 | 82.1% | 73 | 17.9% | 100% | |
| Obese (>29.0) | 649 (19.9%) | 491 | 75.7% | 158 | 24.3% | 100% | <.001 |
| Total, n | 3268 (100%) | 2740 | | 528 | | | |
| Education [MIHA] | | | | | | | |
| <8th | 272 (7.6%) | 194 | 71.3% | 78 | 28.7% | 100% | |
| Some high school | 452 (12.6%) | 306 | 67.7% | 146 | 32.3% | 100% | |
| High school or equiv. | 1017 (28.2%) | 782 | 76.9% | 235 | 23.1% | 100% | |
| Some college | 948 (26.2%) | 813 | 85.8% | 135 | 14.2% | 100% | |
| College Grad | 907(25.1%) | 883 | 97.4% | 24 | 2.6% | 100% | <.001 |
| Total, n | 3598(100%) | 2978 | | 618 | | | |
| Gestational age <36 weeks [BC] | | | | | | | |
| No | 3133(86.2%) | 2603 | 83.1% | 530 | 16.9% | 100% | |
| (preterm) Yes | 502(13.8%) | 397 | 79.1% | 105 | 20.9% | 100% | 0.018 |
| Total, n | 3635(100%) | 3000 | | 635 | | | |
| KNOWLEDGE and HEALTH CONDITIONS | | | | | | | |
| Smoked in 3rd Trimester [MIHA] | | | | | | | |
| No | 3420(96.1%) | 2847 | 83.2% | 573 | 16.8% | 100% | |
| Yes | 138 (3.9%) | 98 | 71.0% | 40 | 29.0% | 100% | <.001 |
| Total, n | 3558 (100%) | 2945 | | 613 | | | |
| Previous LBW birth [MIHA] | | | | | | | |
| No | 3424 (94.5%) | 2846 | 83.1% | 578 | 16.9% | 100% | |
| Yes | 200 (5.5) | 146 | 73.0% | 54 | 27.0% | 100% | <.001 |
| Total, n | 3623 | 2992 | | 632 | | | |
| High blood presure during preg. [MIHA] | | | | | | | |
| No | 3197 (89.2%) | 2664 | 83.3% | 533 | 16.7% | 100% | |
| Yes | 387 (10.8%) | 304 | 78.6% | 83 | 21.4% | 100% | 0.013 |
| Total, n | 3584 (100%) | 2968 | | 616 | | | |
| High blood sugar during preg. [MIHA] | | | | | | | |
| (Diabetes) No | 3261 (90.8%) | 2712 | 83.2% | 549 | 16.8% | 100% | |
| Yes | 332 (9.3%) | 263 | 79.2% | 69 | 20.8% | 100% | 0.043 |
| Total, n | 3594 (100%) | 2975 | | 618 | | | |
| Feel depressed during preg. [MIHA] | | | | | | | |
| No | 2597 (72.1%) | 2281 | 87.9% | 314 | 12.1% | 100% | |
| Yes | 1015 (28.1%) | 703 | 69.3% | 313 | 30.7% | 100% | <.001 |
| Total, n | 3611 (100%) | 2984 | | 627 | | | |
| Living w/someone/married during preg. [MIHA] | | | | | | | |
| No | 524 (14.5%) | 369 | 70.4% | 155 | 29.6% | 100% | |
| Yes | 3078 (85.5%) | 2604 | 84.6% | 474 | 15.4% | 100% | <.001 |
| Total, n | 3602 (100%) | 2973 | | 629 | | | |
| PREGANCY INTENTION | | | | | | | |
| WIC enrollment during preg. [MIHA] | | | | | | | |
| No | 1654 (45.8% | 1578 | 95.4% | 76 | 4.6% | 100% | |
| Yes | 1958 (54.2%) | 1401 | 71.6% | 557 | 28.4% | 100% | <.001 |
| Total, n | 3612 (100%) | 2979 | | 633 | | | |

| (Oneway ANOVA analysis with significant differences highlighted) | | | | | | |
|---|---|---|---|---|---|---|
| | | Food Secure | | Food Insecure | | |
| | | n^ | means ± SD | n^ | means ± SD | p-value |
| DEMOGRAPHICS (Continous variables) | | | | | | |
| Maternal Age (years) [BC] | | | | | | <.001 |
| Total, n | 3634 | 3000 | 27.2 ± 6.2 | 634 | 26.4 ± 5.9 | |
| Total number of live births (parity) [BC] | | | 2.1 ± 1.3 | | 2.4 ± 1.4 | <.001 |
| Total, n | 3633 | 2999 | | 634 | | |

*Shaded p-values are significant at the .05 level. Total number of food secure is <2999, and food insecure is <635, due to missing data and rounding, numbers may not add to 100%. BC Birth certificate data. MIHA MIHA data, n^ weighted number of respondents excluding missing and those who did not know or respond. BMI* Calculated BMI from MIHA data based on IOM prepregnancy BMI categories. WIC** Special Supplemental Nutrition Program for Women, Infants and Children.

Appendix B: Table B-3. Univariate logistic regression, comparing OR of LBW (n=232) to HBW (n=347) by selected maternal characteristics of women with recent births, California MIHA,2005

| Characteristic | LBW weighted n (%) | LBW (<2500g) OR weighted (95% CI) p<=0.05 highlighted | HBW weighted n (%) | HBW (>=4000g) OR weighted (95% CI) p<=0.05 highlighted | Normal birth weight (2500-3999g) | Total n |
|---|---|---|---|---|---|---|
| Total, n | 3634 (232) 6.4% | | (347) 9.5% | | 3055 (84.07%) | 3634 |
| **Demographics** | | | | | | |
| **Food Security Status: Catagorical**[MIHA] | | | | | | |
| High Food Security | 157 (5.9%) | referent | 271 (10.2%) | referent | 83.90% | 100% |
| Marginal Food Security | 25 (7.2%) | 1.24 (.79-1.95) | 26 (7.5%) | 0.71 (0.45-1.1) | 85.30% | 100% |
| Low Food Security | 32 (7.0%) | 1.20 (0.80-1.82) | 40 (8.8%) | 0.84 (0.58-1.22) | 84.20% | 100% |
| Very Low Food Security | 18 (10.1%) | 1.75 (1.0-3.06) | 10 (0.6%) | 0.53 (0.26-1.05) | 89.40% | 100% |
| **Food Security Status: Binary**[MIHA] | | | | | | |
| Food Secure | 182 (6.1%) | referent | 297 (9.9%) | referent | 84.00% | 100% |
| Food Insecure | 50 (7.9%) | 1.32 (0.93-1.86) | 50 (7.9%) | 0.78 (0.55-1.08) | 84.40% | 100% |
| Maternal Race-ethnicity [MIHA] | | | | | | |
| African American | 21 (12.1%) | 2.50 (1.67-3.83) | 10 (5.7%) | 0.48 (0.30-0.76) | 82.20% | 100% |
| American Indian | 4 (22.2.%) | 5.40 (1.68-17.40) | 2 (11.1%) | 1.12 (0.31-4.69) | 66.70% | 100% |
| API | 27 (7.4%) | 1.51 (0.92-2.48) | 26 (7.2%) | 0.60 (0.38-0.94) | 85.40% | 100% |
| European American | 60 (5.2%) | referent | 135 (11.6%) | referent | 83.20% | 100% |
| Latina | 110 (6.1%) | 1. 20 (0.85-1.69) | 160 (8.9%) | 0.75 (0.57-0.97) | 85.00% | 100% |
| Other | 7 (7.9%) | 1.65 (0.74-3.71) | 9 (10.1%) | 0.83 (0.40-1.75) | 82% | 100% |
| Prepregnancy BMI kg/m$^{2*}$ | | | | | | |
| Underweight (<19.8) | 35 (9.3%) | 1.55 (1.02-2.34) | 12 (3.2%) | 0.34 (0.19-0.62) | 87.50% | 100% |
| Normal (19.8-26.0) | 115 (6.3%) | referent | 167 (9.1%) | referent | 84.60% | 100% |
| Overweight (26.1-29.0) | 17 (4.2%) | 0.67 (0.41-1.10) | 43 (10.6%) | 1.21 (0.83-1.74) | 85.20% | 100% |
| Obese (>29.0) | 42 (6.5%) | 1.02 (0.70-1.49) | 98 (15.1%) | 1.78 (1.34-2.34) | 78.40% | 100% |
| Education [MIHA] | | | | | | |
| <8th | 12 (4.4%) | 0.69 (0.33- 1.34) | 23 (8.5%) | 1.01(0.60- 1.68) | 87.10% | 100% |
| Some high school | 37 (8.2%) | 1.25 (0.80-1.96) | 37 (8.2%) | 0.95 (0.62-1.56) | 83.60% | 100% |
| High school or equiv. | 67 (6.6%) | referent | 87 (8.5%) | referent | 84.90% | 100% |
| Some college | 59 (6.2%) | 0.94 (0.65-1.37) | 96 (10.1%) | 1.20 (0.87-1.65) | 83.70% | 100% |
| College Grad | 55 (6.1%) | 0.91 (0.62-1.32) | 101 (11.1%) | 1.34 (0.98-1.84) | 82.80% | 100% |
| Gestational age **<36 weeks** [BC] | | | | | | |
| No | 95 (3.0%) | referent | 322 (10.3%) | referent | 86.70% | 100% |
| (preterm) Yes | 137 (27.3%) | 12.05 (8.97-16.19) | 24 (4.8%) | 0.45 (0.29-0.71) | 67.90% | 100% |
| **KNOWLEDGE and HEALTH CONDITIONS** | | | | | | |
| Smoked in 3rd Trimester[MIHA] | | | | | | |
| No | 209 (6.1%) | referent | 331 (9.7%) | referent | 84.20% | 100% |
| Yes | 17 (12.2%) | 2.23 (1.32-3.76) | 7 (5.0%) | 0.50 (0.22-1.15) | 82.80% | 100% |
| Previous LBW birth[MIHA] | | | | | | |
| No | 179 (5.2%) | referent | 336 (9.8%) | referent | 85.00% | 100% |
| Yes | 53 (26.5%) | 6.64 (4.63-9.51) | 9 (4.5%) | 0.38 (0.17-0.81) | 69.00% | 100% |
| High blood pressure during preg.[MIHA] | | | | | | |
| No | 174 (5.4%) | referent | 297 (9.3%) | referent | 85.30% | 100% |
| Yes | 57 (14.7%) | 3.04 (2.18-4.24) | 44 (11.4%) | 1.243 (0.86-1.76) | 73.90% | 100% |
| High blood sugar during preg.[MIHA] | | | | | | |
| (Diabetes) No | 202 (8.4%) | referent | 307 (12.8%) | referent | 78.80% | 100% |
| Yes | 27 (8.1%) | 1.33 (.085-2.08) | 33 (9.9%) | 1.09 (0.74-1.61) | 82.00% | 100% |
| Feel depressed during preg.[MIHA] | | | | | | |
| No | 152 (5.9%) | referent | 268 (10.3%) | referent | 83.80% | 100% |
| Yes | 79 (7.8%) | 1.32 (0.99-1.78) | 77 (7.6%) | 0.72 (0.55-0.96) | 84.60% | 100% |
| Living w/someone/married during preg.[MIHA] | | | | | | |
| No | 43 (8.2%) | referent | 31 (5.9%) | referent | 85.90% | 100% |
| Yes | 188 (6.1%) | 1.41 (0.99-2.01) | 314 (10.2%) | 0.56 (0.37-0.83) | 83.70% | 100% |
| **PREGNANCY INTENTION** | | | | | | |
| WIC enrollment during preg.[MIHA] | | | | | | |
| No | 96 (5.8%) | referent | 190 (11.5%) | referent | 82.70% | 100% |
| Yes | 135 (6.9%) | 1.21 (0.91-1.60) | 154 (7.9%) | 0.66 (0.52-0.83) | 85.20% | 100% |

| Characteristic | LBW means ± SD | LBW (<2500g) OR weighted (95% CI) p<=0.05 highlighted | HBW means ± SD | HBW (>=4000g) OR weighted (95% CI) p<=0.05 highlighted |
|---|---|---|---|---|
| **DEMOGRAPHICS (Continuous variables)** | | | | |
| Maternal Age (years) [BC] | 27.9 + 6.2 | 1.02 (0.99-1.05) | 28.6 ± 6.1 | 1.02 (1.00-1.04) |
| Total number of live births (parity)[BC] | 2.1 + 1.4 | 1.01 (0.89-1.15) | 2.22 + 1.3 | 1.11 (1.02-1.22) |

*The shaded p-values are significant at the .05 level. Total number of LBW is <232, and HBW<347due to missing data and rounding numbers may not add to 100%. BC Birth certificate data. MIHA MIHA data, n^ weighted number of respondents excluding missing and those who did not know or respond. BMI* Calculated BMI from MIHA data based on IOM prepregnancy BMI categories. WIC** Special Supplemental Nutrition Program for Women, Infants and Children.