FOOD INSECURITY AND HUNGER AMONG PEOPLE WITH DISABILITIES IN OREGON, 2005-2006: DISABILITY TYPE AND NUMBER OF DISABILITIES AS CORRELATES OF INTEREST

by

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CERTIFICATE OF APPROVAL

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LIST OF ABBREVIATIONS

ADA - Americans with Disabilities Act (1990)

BRFSS - Behavioral Risk Factor Surveillance System

BMI - Body Mass Index

CDC - Centers for Disease Control and Prevention

CHS - Center for Health Statistics

CI - Confidence intervals

DSS - Disproportionate stratified sampling

FPL - Federal Poverty Level

HL - Hosmer and Lemeshow

LACT2 - BRFSS variable that codes for whether participants self-report a limitation due to a physical, mental, or emotional health problem

LHLTHPRO - BRFSS variable that codes for whether participants self-report use of special equipment such as a wheelchair, special bed, or special phone

LLNATA - set BRFSS variables that indicate participants' self-reported disability type (physical, LLNATAPH; sensory, LLNATAS; cognitive, LLNATAC; psychiatric/emotional health-related, LLNATAPS; or something else, LLNATASO.)

MEPS - Medical Expenditure Panel Survey

NH - Non-Hispanic

OFB - Oregon Food Bank

OHRT - Oregon Hunger Relief Taskforce

OHSU - Oregon Health & Science University

OODH - Oregon Office on Disability and Health

OR - Odds Ratio

PWD - People with disabilities

PWOD - People without disabilities

SPSS - Statistical Package for Social Science

USCB - United States Census Bureau

USDA - United States Department of Agriculture
USDA-ERS - United States Department of Agriculture's Economic Research Service

**Other abbreviations used in tables defined in footnotes.*

The general problem may be stated as follows:
Having given the number of instances respectively in which things are thus and so, in which they are thus and not so, in which they are so and not thus, and in which they are neither thus nor so, it is required to eliminate the general quantitative relativity inhering in the mere thingness of things, and to determine the special quantitative relativity subsisting between the thusness and the soness of the things.

MH Dolittle (1887)

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ABSTRACT

BACKGROUND

Food insecurity, the limited or uncertain availability of nutritionally adequate and safe food, is known to disproportionately affect households with members with disabilities. A subset of these households experience hunger, the more extreme form of food insecurity characterized by reduced intake of food, disrupted eating patterns, and the inability to afford to buy more food. Food insecurity is known to negatively affect the health of adults. Adults with disabilities experience greater threats to their health, in terms of optimization and maintenance, often as a result of chronic conditions and/or difficulties they experience accessing health care, including transportation and communication barriers. Food insecurity is perceived as an additional barrier to achieving wellness in people with disabilities. This study examines differences in food insecurity and hunger between people with and without disabilities in the context of other demographic variables. Additionally, the study analyzes experiences of food insecurity and hunger among subgroups of people with disabilities.

METHODS

In order to elaborate upon characteristics of disability within the household in relation to food insecurity and hunger, a cross-sectional analysis of data from 2005-2006 Oregon Behavioral Risk Factor Surveillance System (BRFSS) was carried out. BRFSS, a population-based telephone survey, provides self-reported information on health behaviors, health risks, and health status. The BRFSS includes disability identifiers. In 2005 and 2006, the Oregon BRFSS asked for the nature of the disability: physical, sensory, cognitive, or psychiatric/emotional health-related. A total of 2,016 respondents identified themselves as persons with disabilities; physical type was cited as the predominant single disability type. In 2005 and 2006, a hunger

module was also included in the BRFSS for the purposes of identifying food insecurity in the state. Both the outcomes of food insecurity and hunger were generated from the six-item hunger module.

Univariate analysis preceded multiple logistic regression to provide adequate descriptive statistics and facilitate effective model building. Multivariate logistic regression analysis determined whether the experience of food insecurity and hunger differed by presence of disability, disability type, and number of disabilities while accounting for race/ethnicity, income, employment status, age, gender, education, and other extenuating factors relating to the household. The principal expectation was that food insecurity and hunger would be higher amongst individuals with disabilities compared to individuals without disabilities. Additionally, it was expected that individuals living with multiple disability types would have experienced greater food insecurity and hunger compared to individuals with a single disability.

RESULTS

In univariate analysis, people with disabilities were twice as likely to have experienced food insecurity (p=0.000) and four times as likely to experience hunger (p=0.000) compared to people without disabilities. Among people with disabilities, cognitive type and psychiatric type had greater odds of experiencing food insecurity (OR 2.61 and 3.50, respectively) and hunger (OR 4.56 and 4.38, respectively) compared to physical type. Individuals with multiple disabilities were also more likely to have experienced food insecurity and hunger compared to individuals with a single disability type (OR 1.83 and 2.61, respectively).

Multivariate analysis revealed important correlates of food insecurity and hunger including income, employment, age, county of residence, gender, race, and self-reported health

status, though these associations varied between outcomes and disability correlates assessed. Several interactions were identified affecting age, gender, and health status.

CONCLUSION

This study describes a range of factors associated with food insecurity and hunger and elaborates on the relationship between these outcomes and disability. Programs focused on addressing food insecurity may benefit from including strategies that alert individuals with disabilities of such services. Disability is a complex issue involving many factors; additional studies are needed to investigate social and environmental elements to enhance accessibility of paths to health and well-being. Future projects may assess food-stamp programs, food bank services, and other food service programs and facilities for accessibility by people with disabilities.

INTRODUCTION

Background on Disability

Disability, as described in the Americans with Disabilities Act (ADA) of 1990, is a physical or mental impairment that substantially limits one or more major life activities of an individual (ADA 2005). The ADA guarantees civil rights protections to individuals with disabilities and facilitates the inclusion and participation of these individuals in all aspects of society. With the increasing recognition and conceptualization of disability as a complex experience involving the interaction between the person and the environment (Drum et al., 2009), significant implications for public health arise. Foremost, disability, when defined purely as a physical or mental impairment or condition, cannot solely account for an individual's health. In fact, good to excellent quality of life is experienced by people with serious and persistent disabilities – as documented in an insightful article by Albrecht and Devlieger, entitled "The Disability Paradox" (2000). Other pertinent public health issues include the effective measurement of disability in a population, and the proper identification of health determinants in this population. Addressing unique barriers encountered by people with certain types of disabilities is also important. Some public health research has centered on assessing need, the impact on health, and social perceptions of certain disabilities (Eddy et al., 2008; Malone et. al., 2005; Premeax et al., 2004; Sinclair et al. 2008; Wishik et al., 1956).

In "Americans with Disabilities: 2005," the Unites States Census Bureau reported that 28.3 million people aged 15 and older had disabilities in one domain[1]- 2.7 million in communication[2], 20.8 million in physical[3], and 4.9 million in mental[4] (USCB, 2008). Roughly

[1] A domain refers to one of three disability categories created by the US Census to classify types of functional and activity limitations.
[2] The communication domain includes individuals who reported sensory impairments and speech disorders.

14 million had disabilities in two domains and about 4.7 million had disabilities in all three. Thus, while the nature of disability may be categorized, individuals with disabilities often live with more than one type of disability. Furthermore, people with disabilities may be more disposed to preventable health conditions and morbidities and experience a "thinner margin of health" than the general population (Drum et al., 2005). Health problems may be further exacerbated by difficulties with accessing health care and the building blocks of a healthy life (e.g. exercise opportunities, high quality nutrition, social interaction, meaningful employment) (Drum et al., 2009).

Current estimates indicate that people with disability constitute a sizable portion of the nation's population. According to nationwide surveillance of states, D.C., and territories the estimated prevalence of adults who report activity limitations due to physical, mental or emotional problems was 20.4% in 2008; up from 16.4% in 2001 (CDC, 2008). That is to say, 1 out of 5 persons in the United States is currently living with a disability. In "Disability and American Families: 2000" the United States Census Bureau found that nearly 29% of families in the US (approximately 21 million families) had at least one member with a disability while 13 million families have a householder[5] with a disability (USCB, 2005). The report indicated that families with disabilities differed substantially from other families in terms of socioeconomics (e.g. family householders with disabilities were less likely to be employed or own their own residence; families with disabilities experienced 5% higher poverty rates). Recent analysis of

[3] The physical domain includes individuals who use special equipment such as a wheelchair, cane or walker. It also includes individuals who report difficulty walking a ¼ of a mile, climbing a flight of stairs, lifting 10 lbs., grasping objects, and getting in and out of bed. Conditions such as arthritis, back/spine problems, cancer, cerebral palsy, paralysis, stroke, missing limbs, respiratory problems, and other activity limiting conditions are included in this domain (USCB, 2008).

[4] The mental domain includes individuals reporting learning disabilities, developmental disabilities, cognitive impairments, psychiatric or psychological impairments, and emotional conditions. It also includes individuals who have difficulty managing money/bills (USCB, 2008).

[5] Householder refers to the person, or one of the people, in whose name the housing unit is owned or rented. If there is no such person, any adult member, excluding roomers, borders, or paid employees (USCB, 2005).

Medical Expenditure Panel Survey (MEPS) data indicated that people with disabilities, from 1996 through 2004, consistently had higher annual total healthcare expenditures, out-of-pocket spending on healthcare, and burden (which was calculated as the percentage of family income used for out-of-pocket spending) compared to people without disabilities, after adjusting for health status and demographic and socioeconomic factors (Mitra et al. 2008). Investigators reasoned that these circumstances plausibly affect this population's health and standard of living (Mitra et al. 2008).

Oregon population demographics describe a number of people living with disabilities. According to BRFSS data, the prevalence of Oregonians who reported limitations due to physical, mental, or emotional problems and/or use of special equipment due to a health condition was estimated at 25.6% in 2008 (Horner-Johnson, 2009). This number indicates that people with disabilities make up a significant portion of the state's population. Studies in Oregon have indicated that individuals with disabilities have less access to health care and preventive services, and health-promoting activities compared to others (Horner-Johnson et al., 2006; Cardinal et al., 2003; Austin, 2003). Accurate descriptions of the magnitude and nature of problems people with disabilities face in Oregon are needed to inform and refine state policies affecting this population.

Background on Food Insecurity and Hunger

Nutritional status is one indicator of wellness and can be used as an important health monitoring gauge (Polit et al., 2000; Starkey et al., 1999). The deprivation of basic needs such as food is associated with nutrient deficiencies (Kendall et al., 1996; Sidel et al., 1997; Rose and Oliveira 1997; Lee and Frongillo, 2001), poor health outcomes (Hampton, 2007; Lee and

Frongillo, 2001), depression (Huddleston-Casas et al., 2008), obesity (Adams et al., 2003), chronic illness (Seligman et al., 2007), cognitive impairment (Gao et al., 2009; Walker et al., 2007; Alaimo et al., 2001) and risk of developmental problems in children (Jacobs et al., 2008; Cook et al., 2006).

Food security for a household means access by all members at all times to enough food for an active, healthy life (USDA, 2008). On the other hand, food insecurity is a condition that results from insufficient household resources and refers to the limited or uncertain access to nutritionally adequate and safe foods (Nord et al., 2008). The food security status of a household lies on a continuum which ranges from being food secure to experiencing very low food security within the home (i.e. reduced food intake or hunger) (USDA, 2008). Food security scales are designed to identify occasional or episodic occurrences of insecurity (USDA, 2008). The questions used to assess a household's food security status ask whether the condition was experienced at any point in the last 12 months. Typically, a household is identified as food insecure if they report they worry about food running out before they can buy more, the food they bought did not last and they did not have the money to buy more food, and they cannot afford to eat balanced meals (USDA, 2008). Furthermore, a study by Kendall et al. demonstrated that the frequency of fruit and vegetable consumption decreased with increasing severity of food insecurity (1996). Investigators stipulate that this was likely the result of resource constraints that limited a household from routinely acquiring such foods.

Access at all times to enough food for an active and healthy lifestyle is necessary for a population to be healthy and well-nourished. The 2007 national prevalence of food insecurity was estimated at 11.1% of all households in the US (Nord et al., 2008). Improvements in food insecurity were observed from 2004 to 2005; however, this appears to be limited to households

with children (Nord et al., 2006). No statistically significant change in food insecurity was observed in households without children (Nord et al., 2006). Households with annual incomes below 185% of the federal poverty line (FPL) experience more than 5 times the prevalence of food insecurity than households with higher income. However, it has also been observed that households with incomes well above the poverty line experience food insecurity and even hunger while many low-income households (including two-thirds of those with incomes below the FPL) report food security (Nord et al., 2006). This suggests that income alone does not account for all potential risk factors (e.g. job loss, death, divorce, access to transportation, neighborhood characteristics, and other factors that pose difficulties to accessing good food). For example, research in the United Kingdom has increasingly centered on food deserts – areas of cities where cheap, nutritious food is not easily obtainable and car-less residents tend to depend on corner shops where prices are high, food items are commonly processed, and the selection of fruit and vegetables is poor or non-existent (cited in Wrigley 2002). Thus, the issue of food insecurity warrants the consideration of environmental barriers in influencing diet.

In 2001, Oregon was considered to have the highest rates of severe food insecurity or hunger in the nation (6.2% in 1998-2000), nearly double the hunger rate of the other 49 states (3.3% US rate) (Edwards and Weber, 2003). At that time, Oregon had had the highest hunger rates compared to all other states for four out of five years. Furthermore, Oregon's two-parent families and households with no unemployed adult or with at least one full-time, year-round worker consistently have hunger rates 2 to 3 percentage points higher than their counterparts in the rest of the US (Edwards and Weber, 2003). Most of the differences between Oregon and the rest of the US appear to be a result of higher rates of hunger among all demographic groups in

Oregon and not because of higher proportions of high hunger-risk[6] households (Edwards and Weber, 2003). Oregon experienced a statistically significant drop in the rate of food insecurity with hunger from 1996 to 2005 but that improvement was short-lived – the state is currently ranked 3rd in the nation for hunger at 5.5% (Nord et al., 2006). This represents about 1,454,000 households in Oregon that, during a given year, found themselves cutting sizes of meals, going without meals, and/or eating less than they knew was good for them. The prevalence of food insecurity alone also dropped from 14.2% in 1996-1998 to 12.4% in 2005-2007 (Nord et al., 2006). Despite the decrease, the fact remains that 1 in 8 households in Oregon still experience food insecurity.

The Oregon Hunger Relief Taskforce and the Oregon Food Bank agree that hunger is primarily an issue of household finances (OHRT, 2007; OFB, 2008). Sixty-six percent of Oregonian food stamp recipients said their food stamp benefits lasted two weeks or less and only 8% said they lasted the entire month (OFB, 2008). These statistics appear to support the conclusion drawn by the Department of Planning, Public Policy and Management at the University of Oregon that the Oregon Food Stamp Program is not effectively meeting needs of the poor (Hunger, 2000).

Disability as a Potential Risk Factor

Research suggests that disability substantially increases the risk of food insecurity in a household (OFB, 2008; Nord, 2007; Adams et. al., 2007). National population-based data indicate that 29% of all low-income households with very low food insecurity in the US have a member unable to work because of a disability (Nord, 2007). Furthermore, studies suggest

[6] High risk groups include single-parent households, unemployed householders, households having less than a high school diploma, households in urban areas, and Hispanic or African-American households.

people with disabilities (PWD) are more likely than others to experience material hardships (She & Livermore, 2006). A possible explanation for food insecurity in this population is that PWD have the added burden of health expenses that may deflect distribution of their limited financial resources away from basic needs such as food (Mitra, et al., 2008; She & Livermore, 2006). If so, PWD may trade-off food quality for food quantity in order to ward off hunger and in effort at cost-effectiveness because stomach-filling, processed foods that are carbohydrate rich but nutrient poor tend to be less expensive than healthier, fresher, more nutrient rich foods. Other factors that may contribute to food insecurity in PWD are lack of (accessible) transportation services and assistance in food preparation (Drach et al., 2007; Rimmer, 1999; Keller, 2006).

Mark Nord, for the United States Department of Agriculture's Economic Research Service (USDA-ERS), conducted a study to assess how effectively the US Government's domestic nutrition assistance programs met the needs of their target populations (Nord, 2007). He found that disability was an important risk factor for food insecurity and that more than one in four households experienced work-limiting disability. Work-limiting disability, in addition to reducing or preventing employment of the disabled individual and incurring burdensome medical costs and other expenses, can reduce the work opportunities and hours of other adult caretakers in the household. Nord concluded that low-income households[7] with very low food security (that is, households experiencing both food insecurity and hunger) included a disproportionately large percentage of households with adult members who were disabled.

A 2005 study by Adams et al. estimated the prevalence of food insecurity among Oregonians with disabilities at 23.1% compared to 12.0% among other Oregonians (Adams et al., 2007). Results from the Hunger Factors Assessment Survey, conducted by the Oregon Food

[7] Low-income households characterized with annual incomes less than 130% below the poverty line. In 2005, when the data used in this study were collected, the poverty line for a household of four made up of two adults and two children was $19,806 (Nord, 2007).

Bank, indicated that 22% of adult recipients of emergency food boxes were individuals with disabilities (OFB, 2008). In a separate study in Baltimore, Maryland, Klesges and colleagues reported that elderly women with disabilities had financial difficulties acquiring food (Klesges et al., 2001). Specifically, poorer performance on walking speed and worse disease status, measured as the number of medical conditions, among their sample of elderly women with disabilities were associated with greater likelihood of financial difficulty acquiring food.

Other Demographic Risk Factors

A number of investigators have identified income as the strongest correlate of food insecurity (Alaimo et al., 2001; Nord, 2007; Klesges et al., 2001; Drach et al., 2007). However, income alone cannot adequately explain why certain individuals disproportionately experience food insecurity and hunger compared to others (Rose, 1999). Research conducted by Marco and Thornburn (2008) describes other socioeconomic factors specifically correlated with food insecurity among Oregon residents. In addition to annual household incomes of less than $20,000, these included low educational attainment levels, unemployment, lack of homeownership, use of food banks, and use of Social Security Insurance (SSI, a major source of disability income).

Various other demographic and household characteristics have been associated with food insecurity and hunger; these include race/ethnicity, gender, age and marital status of householders, the number of adults living in the same household, location of household (e.g. rural versus urban). Nationally, food insecurity and hunger were highly prevalent among households headed by single women, women or men living alone, and households residing in metropolitan areas (Nord et al., 2006 & 2008). Additionally, national estimates indicate that

Black and Hispanic households disproportionately experience food insecurity compared to a Non-Hispanic White referent household (Nord et al., 2006 & 2008). Food insecurity and hunger were least prevalent among married couples with children, multi-adult households without children, and households with elderly persons (Nord et al., 2006 & 2008). With regard to age, however, although national reports indicate that prevalence of food insecurity and hunger are frequently lowest among households with elderly persons (with estimates slightly higher for elderly living alone) (Nord et al., 2006 & 2008), investigators such as Lee and Frongillo (2001), Klesges et al. (2006), and Quandt et al. (2001) indicate that elderly persons remain at risk for food insecurity and associated health impacts.

Few studies are available that focus on adult health status in association with household food insecurity and hunger. One such study was conducted by Stuff et al. among a low-income population in the rural Mississippi Delta Region (2004). They report that adults in food insecure households were more likely to rate their health as poor or fair and scored significantly lower in the physical and mental health assessments. A separate study by Lee and Frongillo indicated that food insecure elderly persons have poorer dietary intake, nutritional status, and health status (2001). Similarly, Seifert and colleagues found food insufficiency to be associated with poor/fair self-rated health, physical limitations, and major depression (2001). Other studies have (Heiflin et al., 2005; Klesges et al., 2001). Seligman et al. (2007), Adams et al. (2003 & 2007), and Olson and Strawderman (2008) have reported on the association of obesity and food insecurity. Seligman et. al. examined the relationship of food insecurity and obesity among people with diabetes, while Adams and colleagues studied the association of food insecurity with obesity in relation to disability (2007). Results of the prospective study conducted by Olson and Strawderman suggest that “obesity appears to lead to food insecurity rather than the converse”

(2008). In their assessment of rural childbearing women, investigators observed that obesity in early pregnancy was associated with an increased risk of food insecurity at 2 years postpartum. Thus, cross-sectional observations of an association between obesity and food insecurity may be the result of obese individuals being at increased risk of becoming food insecure.

BRFSS Disability and Hunger Modules

Many of the relationships described above can be examined cross-sectionally through analysis of existing population-based data. The Centers for Disease Control and Prevention (CDC) conduct an annual telephone health survey called the Behavioral Risk Factor Surveillance System (BRFSS) in every state and U.S. territory. State health agencies coordinate with the CDC to conduct the survey throughout the year. As a population-based survey, BRFSS helps to monitor modifiable risk factors for chronic diseases and other leading causes of death, identify demographic differences and trends in health behaviors, address emerging public health concerns, and aid in the formulation of policy and legislation for health initiatives (CHS, 2009). Each state is able to supplement the core survey provided by CDC. Core items generally remain unchanged to permit comparisons with other states. The BRFSS Core contains disability identifiers. Disability is assigned to an individual reporting limitations "in any activities, because of physical, mental, or emotional problems," and/or the required "use of special equipment, such as a wheelchair, a special bed, or a special telephone" (CDC-Disability, 2005).

States periodically add supplemental questions to aid in identifying the state's emerging public health issues. In 2001, Oregon added a set of hunger questions, based on recommendations by the USDA, to identify those in the state burdened with food insecurity and

hunger. The Hunger Module, available on Version A in 2005 and Version C in 2006 of the Oregon BRFSS, consists of six questions (CDC-Hunger, 2005):

1. "The food that we bought just didn't last, and we didn't have money to get more." Was this statement often, sometimes, or never true in the last 12 months.
2. "We couldn't afford balanced meals." Was this statement often, sometimes, or never true in the last 12 months.
3. In the last 12 months, did you or other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?
4. How often did this happen?
5. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?
6. In the last 12 months, were you ever hungry but didn't eat because you couldn't afford enough food?

Food insecurity is assigned to households with representatives that answer "Yes" to two out of the six questions above. Hunger is assigned to households with representatives that answer "Yes" to five out of the six questions above.

Since 1994, the partnership between the CDC and the Oregon Office on Disability and Health (OODH) has enabled funding for state-specific concerns on disability and health. In both 2005 and 2006, the Oregon BRFSS survey asked about the nature of an individual's self-reported disability (physical, sensory, cognitive, or psychiatric/emotional).

This study aims to provide findings that may be useful to future development and implementation of Oregon's food stamp, nutrition outreach, emergency food assistance, and seasonal food service programs. People with disabilities are often less visible, undercounted, underrepresented, and underserved. Previous research has shown that food insecurity and hunger are predominantly associated with low-income households, particularly those with members reporting work-limiting disabilities. No present study has yet explored the association between food security or hunger and disability type and number of disabilities in Oregon. This study will describe the association and distribution of disability and food insecurity throughout Oregon as well as describe the experience of food insecurity across disabilities. Using demographic and disability-relevant data supplied by the Oregon BRFSS, this study hopes to provide some assistance in improving Oregon's food insecurity and hunger crisis.

SPECIFIC AIMS

This cross-sectional analysis of BRFSS (2005-2006 merge) is being conducted to:

1. Classify disability, disability type, multiple disability experience, food insecurity and hunger in Oregon.
    - Disability is assigned to any respondent (aged 18 years or older) who cites a limitation due to a physical, mental, or emotional health problem (BRFSS variable: LACT2); indicates use of special equipment, such as a wheelchair, special bed or special telephone, for any health problem (BRFSS variable: LHLTHPRO); or both.
    - Determine type or condition of self-reported disability (LLNATA variables).
    - Determine multiple conditions of disability from number of described physical, sensory, cognitive, or psychiatric/emotional conditions.
    - Food insecurity is assigned to any household in which the BRFSS respondent answered “yes” to at least two of six questions in the Hunger Module.
    - Hunger is assigned to any household in which the BRFSS respondent answered “yes” to at least five out of six question in the Hunger Module.
2. Assess food insecurity and hunger in relation to disability, disability type, number of disabilities, and covariates (such as race/ethnicity, gender, age, income, employment status, household size, and area of residence) through univariate analysis.
3. Subsequently assess associations in multivariate logistic regression models.

METHODS

Oregon BRFSS

This study uses data collected in 2005 and 2006 by the Oregon Behavioral Risk Factor Surveillance System (BRFSS). BRFSS is a state-based system of telephone surveys that collects data on health risk behaviors, established by the Centers for Disease Control and Prevention (CDC) and implemented by state health departments. BRFSS data is able to identify emerging public health concerns and monitor trends in health behaviors in adults. In Oregon, BRFSS is administered and maintained by the Department of Human Services, Public Health Division: Office of Disease Prevention & Epidemiology, Center for Health Statistics. Data are collected and sent to the CDC at the end of each month for routine data processing.

The Oregon BRFSS collects preventive health practices and risk behaviors linked to chronic and communicable diseases. Demographic and socioeconomic variations are also identified when monitoring trends in health-related behaviors. BRFSS data allow for the assessment of specific demographic subpopulations within Oregon, such as people with disabilities. This study will use data from Version A and Version C, from the 2005 and 2006 BRFSS survey years, respectively, to determine the prevalence of food insecurity and hunger between people with and without disabilities and explore potential correlates of food insecurity and hunger with disability type (physical, sensory, cognitive, and psychiatric or emotional health-related) and number of disabilities.

BRFSS Subject Selection

Sampling Strategy

The Oregon BRFSS surveys adults 18 years and older from the state's civilian and non-institutionalized population. Adults are identified as potential survey participants by random digit dial of their household telephone numbers. A disproportionate stratified sampling (DSS) design differentiates between areas of high-density (which is likely to include residential but unlisted phone numbers) and highest-density (which has a large proportion of listed numbers available).[8] Telephone numbers in the highest-density stratum are sampled at the highest rate.

Weighting Methodology

When data are used without weights, each record counts the same as any other record – as it would in a simple random sampling design. Because of the difference in probability of selection, and to adjust for telephone non-coverage and non-response, data are weighted to produce population estimates. BRFSS data are weighted to account for the probability of selection of a telephone number, the number of adults in a household, and the number of phones in a household. This base sampling weight is followed by poststratification of age-by-sex or age-by-sex-by-race/ethnicity (using the overall population of a state) to obtain final weight. Weight variables are calculated by the CDC.

Final Interview

The final disposition of a BRFSS survey may be regarded as complete or partially complete. Partially completed surveys are those that have obtained data on "sex and three or more questions from age, race, Hispanic origin, marital status, education, employment status, county code" (with a response other than *Don't Know/Not Sure* or *Refused*)[9]. Completed surveys

[8] http://www.dhs.state.or.us/dhs/ph/chs/brfs/brfssum.shtml
[9] OR BRFSS 2006 READ ME

meet the criteria for a partial complete and indicate that interview was completed through the last question. If a selected respondent begins the interview but stops before questions regarding age, race, and sex are asked, the interview is classified as "terminated within questionnaire" if the respondent cannot be reached by subsequent calls. If a selected respondent is unable to communicate because of a language barrier or because of physical or mental impairment, the respondent is considered ineligible for BRFSS.

Inclusion Criteria

For the purposes of this project, respondents were selected if they received a complete or partially complete disposition code after being interviewed with Version A from 2005 BRFSS or Version C from 2006 BRFSS. Both versions contain questions regarding the outcomes of interest, food insecurity and hunger (in Hunger Module), and the main correlate variables, disability type and number of disabilities (supplemental question in Disability Module). Combined data from version A and C, from 2005 and 2006 BRFSS years, respectively, contained a total of 6,968 respondents.

Data Management

The Institutional Review Board (IRB) of Oregon Health and Science University (OHSU) exempted this study from review on June 25, 2009. Use of Oregon BRFSS data from 2005 and 2006 was approved by the Center for Health Statistics Researchers' Review Committee on July 14, 2009. BRFSS data for 2005 and 2006 were obtained through an available database at the Oregon Office on Disability and Health (OODH) at OHSU. Data were de-identified prior to receipt by OODH. Data were initially available in SPSS (Statistical Package for Social Science). Survey years 2005 and 2006 were merged using SPSS, retaining only those variables needed for

analysis. Although analysis was restricted to only two versions in the new dataset, subsetting the data was avoided. The complete dataset (i.e. all respondent records) was preserved to maintain correct weighting strategy and variance estimation for DSS survey design. After merge, data were imported into STATA version 10 (STATA Corporation) to conduct statistical analysis.

Variable Coding

Outcome Variables

Two outcomes were of interest to this study – food insecurity and hunger. Both variables were identified with the Hunger Module and described household circumstances over the last 12 months. Food insecurity in a household was ascertained by at least two affirmative answers given by a respondent to the six items within the Hunger Module. Data were available for 6,749 respondents on this outcome variable (representing 98.6% of the weighted dataset, Version A (2005) and Version C (2006) only). Hunger in a household was determined when respondents answered "yes" to five out of the six hunger questions. Data were available for 6,735 respondents on this outcome variable (representing 98.4% of the weighted dataset, Version A (2005) and Version C (2006) only). Respondents who answered "yes" to one or fewer questions were considered to live in food secure households. Both outcome variables (labeled "foodins" and "hunger") were coded as "0=no" and "1=yes" for contingency table analysis and for use as binary dependent variables in logistic regression analysis. Respondents with missing values or those that refused to answer hunger questions were excluded from analysis.

Correlates of Interest

Self-reported disability status was ascertained from two items in the Disability Module from the core BRFSS survey – "Are you limited in any way, in any activities, because of physical, mental, or emotional problems?" and "Do you now have any health problem that requires you to use special equipment, such as a cane, a wheelchair, a special bed, or a special telephone?" (Labeled as LACT2 and LHLTHPRO, respectively, in the obtained BRFSS dataset). If a "yes" response was provided to one or both of these items, the respondent was considered to have a disability. This general disability variable (labeled as "disab") was coded "0=no" and "1=yes" for crosstab analysis and logistic regression.

In Versions A and C, from 2005 and 2006 BRFSS, respectively, the core Disability Module was supplemented with a question regarding the nature of the activity limitation or disability. Respondents were allowed to choose one or more of the 5 possible responses to the question "What is the nature of this condition?": physical (LLNATAPH), sensory (LLNATASE), cognitive (LLNATAC), psychiatric or emotional health-related (LLNATAPS), or something else (LLNATASO). Since multiple categorical responses were possible, a "distotal" variable was created to indicate whether a particular respondent identified 0, 1, 2, 3, or 4 types of disability. The variable, "distype," was created based on the disab variable (i.e. if disab=0 then distype=0) and the classification of the responses given to the supplemental disability question. "Distype" was made mutually exclusive by controlling for the number of responses (i.e. only if distotal=1) and the nature of disability (i.e. if LLNATAPH=1). Thus distype=1 if distotal=1 and LLNATAPH=1, distype=2 if distotal=1 and LLNATASE=1, and so on. Respondents who described disability type as something else (LLNATASO=1), or don't know (LLNATADK=1)

and those who refused to answer (LLNATAR=1) were not assessed categorically in the distype variable. Ultimately, these respondents were excluded from analysis.

The distotal variable was also used to create another variable, labeled "numdis," which would enable the assessment of food insecurity and hunger between individuals reporting none (distotal=0), one (distotal=1), and multiple disabilities (distotal≥2). Because people indicating "something else" as their disability type were excluded, *numdis* represents a smaller population estimate of disability than the *disab* variable (23.6% vs. 24.7%). Additionally, because *distype*, only includes those with a single type of disability, this variable represents fewer individuals with disabilities than the general *disab* variable (22.4% vs. 24.7%). In all variables the number of respondents without a disability remains fixed. In order to assess the association of food insecurity and hunger within the subset of those reporting some disability, a new variable (labeled "within") was modeled after the distype variable but excluded people without disabilities and placed respondents reporting a single physical nature of disability as the reference group (within=1). Similarly, "within2" was created to assess outcome associations between those living with one (within2=1) versus multiple disabilities (within2=2).

Other Covariates

Potential covariates were selected based on the results of previous studies (Adams et al. 2003 & 2007; Alaimo et al. 2001; Drach et al. 2009; Edwards et al. 2003; Klesges et al. 2001; Nord et al. 2006 & 2008; She and Livermore 2006; Stuff et al. 2004). After examination of frequency distributions, some variables were recoded into broader categories more appropriate for the subset of respondents. This was necessary to achieve more evenly distributed categories or to eliminate small cell sizes. For example, race and ethnicity categories were collapsed into

two groups: 1) Non-Hispanic (NH) Whites, and 2) All Others (which included NH Blacks, NH Asians, NH Pacific Islanders, NH American Indian/Alaskan Natives, Hispanics, and persons of multiple races). Table 1 lists the final categorization of independent variables and their coding used in statistical analysis. The Source column indicates whether variables were used in original BRFSS formatting, were reformatted (recoded or collapsed), or newly created from multiple BRFSS variables.

Table 1. Summary of Independent Variables.

Variable	Source	Label	Additional Information	Coding for Analysis
Disability	New	disab	Any respondent who reports an activity limitation (due to physical, mental, or emotional problems), use of special equipment (for a health problem), or both.	0=No 1=Yes
Disability Type	New	distype	Respondents reporting disability status and providing categorization of health condition as physical, sensory, cognitive, or psychiatric.	0=None 1=Physical 2=Sensory 3=Cognitive 4=Psychiatric
Within Disability Type	New	within	Consisting only of respondents with disabilities and providing description of type of disability	1=Physical 2=Sensory 3=Cognitive 4=Psychiatric
Number of Disabilities	New	numdis	Based on number of categories identified when asked "What is the nature of your health condition?"	0=None 1=One 2=Multiple
One vs Multiple Disabilities	New	within2	Based on numdis variable but excluding respondents without disabilities	1=One 2=Multiple
Age	BRFSS	AGE	During model building process, age was assessed as continuous variable to facilitate entry into logistic regression. Age was then assessed in varying formats to generate best fit models. Descriptive statistics include assessments of both continuous and categorical age variables.	Continuous (Years)
Gender	BRFSS	SEX		1=Male 2=Female
Race/Ethnicity	Recoded	race2	NH Black, NH Asian, NH Pacific Islander, NH American Indian/Alaska Native, NH other, Hispanic, and Multiple race respondents collapsed into one category: "All Others"	1=Non-Hispanic White 2=All Others
Income	Recoded	income	Annual Household Income	1=$25,000 2= less than $25,000
Employment	Recoded	employ	"Employed" includes respondents employed for wages and those who are self-employed. "Unemployed" includes respondents unable to work and those out of work (less than one year and more than one year).	0=Employed 1=Unemployed
Education	Recoded	educa	Highest level of educational attainment	1=Some College or higher 2= High School or less
Marital Status	Recoded	marital	"Never married" category includes respondents never married and respondents belonging to an unmarried couple	1=Married 2=Divorced/Widowed/Separated 3=Never Married

Table 1. Summary of Independent Variables continued.

Number of Adults in Household	Recoded	numadult		0=Two adults 1=One adult 2=More than two Adults
Metro vs NonMetro Areas	Recoded	metro	Generated from BRFSS variable CTYCODE. Metropolitan and Nonmetropolitan counties identified through the Rural Policy Research Institutute (http://www.rupri.org/Forms/Oregon.pdf)	1=non-metro 2=metro
Tri-Counties vs Other Western vs Eastern Counties	Recoded	west	Generated from BRFSS variable CTYCODE. "Tri-Counties" include Multnomah, Washington, and Clackamas. "Other Counties" include all other counties west of the Cascade Range.	1=Tri- Counties 2=Other Western Counties
Self-Reported Health Status	Recoded	hstatus	Possible responses included: -Excellent -Very Good -Good -Fair -Poor	1=Excellent/Very Good/Good 2=Fair/Poor
Obesity	Recoded	bmi	Dichotomized into obese and not obese	1=less than 30 kg/m^2 2=equal to or more than 30 kg/m^2

Statistical Analysis

In order to appropriately assess the relationship between food insecurity and hunger across disability type, survey weights for Versions A and C, from the 2005 and 2006 BRFSS, respectively, were needed. The sampling weight "sampwt" was created for this study and conditioned so that data for Version A in 2005 corresponded to the CDC-generated weight variable specific for Version A and data for Version C in 2006 corresponded to the CDC-generated weight variable specific for Version C.

To account for Oregon BRFSS sampling strategy, data was weighted according to conditioned sampling weight, primary sampling units, and geographic stratum.

Descriptive Statistics

Unweighted frequencies were reported to indicate number of BRFSS respondents. Weighted data were used for all parts of the statistical analysis. STATA is equipped to appropriately estimate data by specifying the sampling design using `svyset` followed by estimation using the `svy:` command syntax. Frequency distributions and cross tabulations (that take into account BRFSS survey sampling design) were examined between each independent variable and both outcome variables. Population prevalence estimates of disability and disability type in Oregon were assessed with frequency distributions. Cross tabulations were then generated to assess demographic and socioeconomic variation between people with and without disabilities. Cross tabulations were also used to determine the distribution of food insecurity and hunger by disability, disability type, number of disabilities, and other independent variables.

Univariate Analysis

Simple logistic regression models were constructed to examine significant risk factors for food insecurity in Oregon, taking into account BRFSS survey design. The same was done for the more extreme outcome, hunger. All disability variables (disab, distype, within, numdis, within2) were assessed separately. STATA commands were defined so as to obtain (unadjusted) odds ratios, confidence intervals, and p-values from Wald F statistics for the associations examined.

All correlate variables with a p-value of ≤ 0.20 were retained for inclusion into a multivariate logistic regression model.

Multivariate Analysis

Disability variables were highly correlated with one another and were automatically dropped from the model by the STATA program due to colinearity. As a result, disability variables were assessed separately for association with each outcome (i.e. they were not included within the same multivariate model).

STATA does not allow for automated model selection processes, such as forward or backward stepwise selection techniques, when accounting for complex survey design. The STATA Corporation recommends a model building technique called "planned backwards block stepwise regression" or "hierarchical stepwise regression" to adequately assess complex survey data. For additional information about this technique, refer to http://www.stata.com/support/faqs/stat/stepsvy.html.

Model fit was assessed with the Hosmer & Lemeshow (HL) goodness-of-fit test statistic. Because survey data are not independently and identically distributed, this survey post estimation test was developed specifically to estimate the F-adjusted mean residual of a design-based logistic regression model. The `svylogitgof` ado-file is available at http://www.stata-journal.com/software/sj6-1/st0099/svylogitgof.ado.

Model Building

To begin the procedure, correlate variables were arranged into logical groupings according to certain demographic attributes they measured. For example, based on prior research, annual household income and employment remain significant socioeconomic factors in predicting food insecurity. Based on the objectives of this study and the perception of disability

as a demographic characteristic,[10] disability was also included in this group. Additional groupings were ordered according to expected significance to food insecurity and hunger (based on previous studies). Table 2 depicts the construction and ranking of correlate groupings. These groups were then added in full to a multivariate model according to their perceived importance. All multivariate models took into account complex BRFSS design.

Once full models were constructed, the significance of the last group (i.e. the least important group) was tested with the p-value from a Wald statistic. Correlate groupings were assessed with Bonferroni adjusted p values (refer to Table 2 for referent Bonferroni thresholds). If the test was not significant relative to the Bonferroni correction, the entire group was discarded and covariates were not subsequently reintroduced. If the group was significant despite the Bonferroni adjustment, the entire group was kept in the model. These steps were applied to all remaining groups, from least to most important. After all groups were tested and groups that tested insignificant removed, the same procedure was applied to each individual covariate from those expected to be of least importance to those expected to be of most importance to the outcome. This process resembled a backwards selection method. Appendix A provides summaries of the step by step process of how final models were obtained. Covariates that did not meet alpha of 0.05 were dropped from further analysis with the exception of one main correlate of interest, *within2*. When assessing outcomes in the context of one versus multiple disabilities, the *within2* variable had to be re-introduced into the main effects model due to lack of a significant Wald statistic. Re-introduction of other covariates, such as marital status, number of adults in household, and educational attainment level, did not occur.

Prior to establishing a main effects model, the importance of each variable in the preliminary multiple logistic regression model was verified using the Wald statistic. Variables

[10] Don Lollar http://www.accessiblesociety.org/topics/demographics-identity/census2000.htm

that did not test significant were dropped and a new model was fit. Main effects models were comprised of significant parameters only. Main effects models were estimated with HL goodness of fit tests. In some instances, additional variables were eliminated to simplify model and improve goodness of fit. Please refer to Appendix A for more detail on model building processes.

Table 2. Correlate Variable Grouping for Model Building Process

Rank	Correlate Grouping	Bonferroni Significance level
1	Disability Variable[§] Annual Household Income Employment	0.0166
2	Education Race Age Gender	0.0125
3	Health Status Obesity	0.025
4	Marital Status Number Adults	0.025
5[¥]	Metropolitan County Residence Western County Residence	0.025

§Due to high degree of correlation, disability variables (overall disability, disability type, and number of disabilities) assessed separately.

¥ Last Grouping only for model assessing correlates for HUNGER in Oregon.

Assessment for interactions

Main effects models were assessed for possible interactions. Interactions were kept if 1) they contained sufficient cell size; 2) they improved overall fit of the model; and 3) parameter estimates were precise. Meaningful interpretations of the odds ratios for interactions were derived from regression coefficients obtained from subtracting the referent logistic equation from that of the subcategory of interest within a variable.

Cross Classification of Correlates

Cell sizes were preferable if they contained an unweighted count of at least 20 respondents. However, as analysis progressed, cell sizes were increasingly restricted and models with interaction terms were becoming fairly unstable. As an alternative approach to assessing interaction effects, a series of cross classifications was carried out to prevent premature elimination of potential interaction effects. New categorical terms, involving the cross tabulation of a disability variable and various demographic characteristics, were generated. The referent group reflected the referent groups of the derivative variables. For example, a cross classification term involving disability and gender would have four mutually exclusive subcategories (Males without Disabilities, Males with Disabilities, Females without Disabilities, and Females with Disabilities), with Males without Disabilities the referent category. Cross classification terms were entered into a model to test whether the particular interaction could be supported in this simplified format. Furthermore, because the STATA program automatically adjusts for colinearity in the model by dropping collinear terms, the new cross classification terms were not juxtaposed with the original variables from which they were derived. This alternative approach was used to assess multivariate models because cross classification yields parsimonious sets of parameters that eliminate confounding and effect modification and because subcategories with relatively sparse cell counts are easily locatable.

Results

Sample Characteristics

A total of 2,016 respondents to the 2005 and 2006 Oregon BRFSS identified themselves as people with disabilities, representing 1,351,583 Oregonians (weighted percent of BRFSS respondents, 24.7%). Among people with disabilities, 93% reported having a single disability and 7% reported having more than one disability. Among people reporting a single type of disability, 83% indicated a physical disability, 2.8% indicated a sensory disability, 8.4% indicated a cognitive disability, and 5.8% indicated a psychiatric or emotional-health related disability. Raw and weighted disability characteristics are listed in Table 3.

Initial steps in this analysis compared people with and without disabilities. Statistics obtained demonstrated people with and without disabilities were relatively evenly distributed by race/ethnicity and between Tri-County and other county residence. Discrepancies were seen among people with and without disabilities in the following demographics: age, educational attainment, annual household income, employment, marital status, number of adults in household, self-reported health status, and obesity. There was also a difference in the number of male and female BRFSS respondents in people with disabilities compared to people without disabilities. Weighted demographic distributions of sample characteristics are shown in Table 4.

Examination of 2005 and 2006 BRFSS data revealed high rates of food insecurity and hunger in Oregon. In 2005, BRFSS respondents indicated that 15.6% of the state's population had experienced food insecurity and that 5.7% had experienced hunger at some point in the last 12 months. Data from 2006 showed a slight reduction in the prevalence of food insecurity at 12.3% and hunger at 4.3%. To better understand Oregon's experience with food insecurity and

hunger, the distribution of these variables was then examined according to demographic characteristics (Table 5).

Disability was considered a characteristic of Oregon's population demographics (Table 5). Disproportionate prevalence estimates of food insecurity were as expected. A substantially higher proportion of people with disabilities reported experiences with food insecurity (22%) and hunger (11%) compared to people without disabilities (11% and 3%, respectively). However, there were several notable differences in the experience of food insecurity and hunger within the disability subpopulation. Higher proportions of individuals reporting cognitive and psychiatric disabilities experienced food insecurity and hunger than was the case for other disabilities. Similarly, people living with more than one disability had a higher prevalence of food insecurity and hunger compared to individuals reporting a single disability.

Table 3. Self-reported Characteristics of Oregonians with Disabilities

Characteristic	n	Population Estimate (%)
Disability		
Any limitation due to a physical, mental, or emotional impairment	1881	23.1
Use of special equipment (such as a wheelchair, special bed, or special telephone)	655	7.1
Activity limitation, special equipment need, or both	2016	24.7
Disability Type		
Physical Only	1400	18.6
Sensory Only	60	0.6
Cognitive Only	181	1.9
Psychiatric or Emotional Health-Related Only	93	1.3
Number of Disabilities		
One	1734	22.0
Multiple	142	1.6

Table 4. Demographic and health-related characteristics of the people with and without disabilities in Oregon, BRFSS 2005-2006. Estimates are weighted percentages.

Characteristic	People without Disabilities	People with Disabilities	p value*
Population Size in Oregon (%)	75.3	24.7	--
Gender(%)			
Male	50.2	46.1	
Female	49.8	53.9	0.0243
Mean Age (years)	33.8	43.8	< 0.0001
Age groups (%)			
18-34	35.5	16.2	
35-54	37.5	39.4	
55+	27.0	44.4	<0.0001
Race/Ethnicity			
Non-Hispanic White	84.1	86.9	
All Others	15.9	13.1	0.0556
Education (%)			
High School or Less	37.0	42.1	
Some College or Higher	63.0	57.8	0.0021
Income (%)			
Less than $25,000	24.2	42.4	
$25,000 +	75.7	57.6	<0.0001
Employment			
Employed	63.7	39.5	
Not Employed	6.8	25.6	<0.0001
Marital Status			
Married	61.3	54.2	
Divorced/Windowed/Separated	14.5	28.4	
Never Married	24.2	17.3	<0.0001
Number of Adults in Household			
Less than Two Adults	14.3	25.7	
Two Adults	60.7	57.0	
More than Two adults	25.0	17.2	<0.0001
Metropolitian Area Residence			
Metro	75.2	70.6	
Non-Metro	24.8	29.4	0.0034
County of Residence			
Tri-County Area	25.9	24.6	

Other Counties	74.1	75.4	0.4784
Health Status			
Excellent/Very Good/Good	93.2	60.8	
Fair/Poor	6.8	39.2	<0.0001
Obesity			
BMI ≥ 30 kg/m^2	19.8	32.9	<0.0001

* P values based on Pearson's Chi-squared statistics corrected for survey design with second-order correction of Rao and Scott, 1984.

Table 5. Food Insecurity and Hunger in Oregon by Disability Characteristics and other demographic factors, BRFSS 2005-2006. Population estimates reported as percentages.

Characteristic	Food Insecurity	Hunger
Year(%)		
2005	15.6	5.7
2006	12.3	4.3
Self-Reported Disability(%)		
No	11.2	2.9
Yes	21.8	11.1
Disability Type(%)		
None	11.2	2.9
Physical	17.8	7.6
Sensory	8.1	1.1
Cognitive	36.2	27.4
Psychiatric	43.2	26.6
Number of Disabilities(%)		
None	11.2	2.9
One	20.6	10.2
Multiple	32.2	22.9
Gender(%)		
Male	12.1	4.1
Female	15.6	5.0
Mean Age Reporting Outcome (years)	37.8	39.7
Age group (%)		
55+	5.0	1.6
35-54	15.3	6.9
18-34	21.3	6.0
Race(%)		
NH White	10.3	3.8
All Others	34.0	11.5
Income(%)		
$25,000+	6.4	1.3
<$25,000	31.9	13.2
Employment(%)		
Employed	12.8	4.2
Unemployed	34.4	16.1
Education(%)		
Some College or Higher	9.9	3.6
HS orLess than HS	20.5	7.2
Marital Status(%)		
Married	9.2	3.3
Divorced/Widowed/Separated	19.4	8.6
Never Married	22.0	6.4
Number of Adults in Household(%)		
Two Adults	10.9	3.4
Less than Two Adults	18.5	7.4
More than Two Adults	18.3	7.1
Metropolitan Area Residence(%)	13.2	4.1
Metro County	14.12	5.3

Non-Metro County		
County Residence(%)		
Tri-CountyArea	14.7	6.1
Other Counties	13.6	4.6
Health Status(%)		
Excellent/Very Good/Good	11.3	3.2
Fair/Poor	28.8	14.8
Obesity(%)		
< 30 kg/m^2	11.6	3.5
≥ 30 kg/m^2	18.7	8.3

Logistic Regression Analysis

Univariate Analysis

In univariate analyses, all demographic characteristics were assessed for their association with food insecurity and hunger. All variables were found to be significant at $p \leq 0.20$ and were subsequently considered for multivariate analysis. Table 6 describes the associations between outcome and correlate variables, including unadjusted odds ratios (OR), 95% confidence intervals (CI), and p-values.

In summary, individuals who reported being out of work, having a high school level education or less, or making less than $25,000 annually were at increased risk for food insecurity and hunger than those employed, who attended some college, or with incomes of $25,000 or higher. Also, race/ethnicity groups other than Non-Hispanic White were more likely to belong to households that were food insecure or hungry. On the other hand, the continuous age variable demonstrated an inverse relationship with the outcomes; individuals that were aged 55 years were less likely to report experience with food insecurity or hunger. Also, univariate analysis showed that residents of non-metropolitan areas and counties other than Multnomah, Washington, and Clackamas were less likely to have experienced hunger.

When assessing for risk associated with disability variables, analyses found that individuals with disabilities were significantly more likely to have experienced food insecurity

(OR 2.21) or hunger (OR 4.22) than individuals without disabilities. Similarly, individuals with cognitive or psychiatric disabilities or individuals with more than one disability had greater odds of experiencing food insecurity and hunger than individuals with other disabilities or individuals with a single disability.

Table 6. Univariate Associations of Food Insecurity and Hunger with Disability Variables and Other Covariates, BRFSS 2005-2006.

	Food Insecurity		Hunger	
Characteristic	**Odds Ratio (95% CI)**	**p-value**	**Odds Ratio (95% CI)**	**p-value**
Disability				
No	Referent	-	Referent	-
Yes	2.21 (1.80-2.72)	< 0.001	4.22(2.96-6.01)	< 0.001
Within Disability Type				
Physical	Referent	-	Referent	-
Sensory	0.41(0.12-1.37)	0.147	0.14(0.03-0.60)	0.008
Cognitive	2.62(1.46-4.67)	0.001	4.56(2.20-9.43)	< 0.001
Psychiatric	3.51(1.99-6.17)	< 0.001	4.38(2.30-8.34)	< 0.001
Within Number of Disabilities				
One	Referent	-	Referent	-
Multiple	1.83(1.09-3.08)	0.022	2.61(1.48-4.62)	0.001
Age (continuous)	0.96(0.95-0.97)	< 0.001	0.98(0.97-0.98)	< 0.001
Age Groups				
55+	Referent	-	Referent	-
35-54	3.40(2.68-4.31)	0.000	4.49(3.07-6.56)	0.000
18-34	5.08(3.93-6.57)	0.000	3.90(2.56-5.95)	0.000
Gender				
Male	Referent	-	Referent	-
Female	1.35(1.09-1.67)	0.006	1.47(1.02-2.12)	0.038
Race/Ethnicity				
Non-Hispanic White	Referent	-	Referent	-
All others	4.48(3.49-5.75)	< 0.001	3.31(2.19-5.01)	< 0.001
Education				
Some College or Higher	Referent	-	Referent	-
High School or Less	2.35(1.91-2.89)	< 0.001	2.10(1.51-2.93)	< 0.001
Income				
$25,000+	Referent	-	Referent	-
Less than $25,000	6.87(5.46-8.65)	< 0.001	11.40(7.79-16.69)	< 0.001
Employment				
Employed	Referent	-	Referent	-
Not Employed	3.56(2.73-4.66)	< 0.001	4.42(3.03-6.45)	< 0.001
Marital Status				
Married	Referent	-	Referent	-
Divorced/Windowed/Separated	2.39(1.87-3.07)	< 0.001	2.74(1.81-4.15)	< 0.001
Never Married	2.79(2.16-3.60)	< 0.001	2.00(1.32-3.02)	0.001
Number of Adults in Household				
Two-headed household	Referent	-	Referent	-
Single-headed household	1.86(1.53-2.26)	< 0.001	2.23(1.68-2.97)	<0.001
> Two adults in household	1.84(1.38-2.45)	< 0.001	2.16(1.35-3.45)	0.001

County of Residence				
Tri-County (MUL, WSH, CLK)	Referent	-	Referent	-
Other Counties	0.91(0.72-1.14)	0.404	0.75(0.53-1.11)	0.160
Metropolitan Area Residence				
Non-Metropolitan	Referent	-	Referent	-
Metropolitan	1.08(0.86-1.34)	0.504	1.29(0.92-1.81)	0.144
Health Status				
Excellent/Very Good/Good	Referent	-	Referent	-
Fair/Poor	3.18(2.53-3.99)	< 0.001	5.17(3.66-7.32)	< 0.001
Obesity				
BMI<30 kg/m2	Referent	-	Referent	-
BMI ≥ 30 kg/m2	1.75(1.39-2.22)	< 0.001	2.49(1.72-3.61)	< 0.001

Multivariate Models

Food Insecurity and Disability

Construction of the main effects model was described earlier (refer to Tables 2 and Appendix A). The model with all variables included was not a good fit to the data (Age-adjusted model: HL Wald F=9.54, p= 1.598e-14). The possibility of enhancing model fit was explored by dropping one correlate at a time from the model, from least to most important variable, and conducting a HL goodness of fit test. This process ultimately led to removal of the age variable. Prior to the elimination of the age variable, the model was rigorously assessed with alternative formatting of the variable. Specifically, the age variable was transformed into: 1) categorical age groups (55+ years, 35-54 years, 18-34 years); 2) a squared variable; 3) a restricted variable (i.e. model explored subpopulation of individuals aged 70 and younger; 60 and younger; 50 and younger; 35 and older; 45 and older; and 55 and older); and 4) cross classification of categorical age groups and disability. While each version of the age variable remained significant, the overall fit of the model was poor. The distribution of age by disability and gender in the presence of food insecurity is illustrated in Figure 1 and shows that individuals without disabilities experience food insecurity at relatively younger ages than individuals with disabilities. Based on relationships depicted in Figure 1, various interactions involving age and disability or gender were explored but none improved model fit. After age was dropped, the

variable for obesity subsequently lost statistical significance and was also deleted. Model fit was consequently improved.

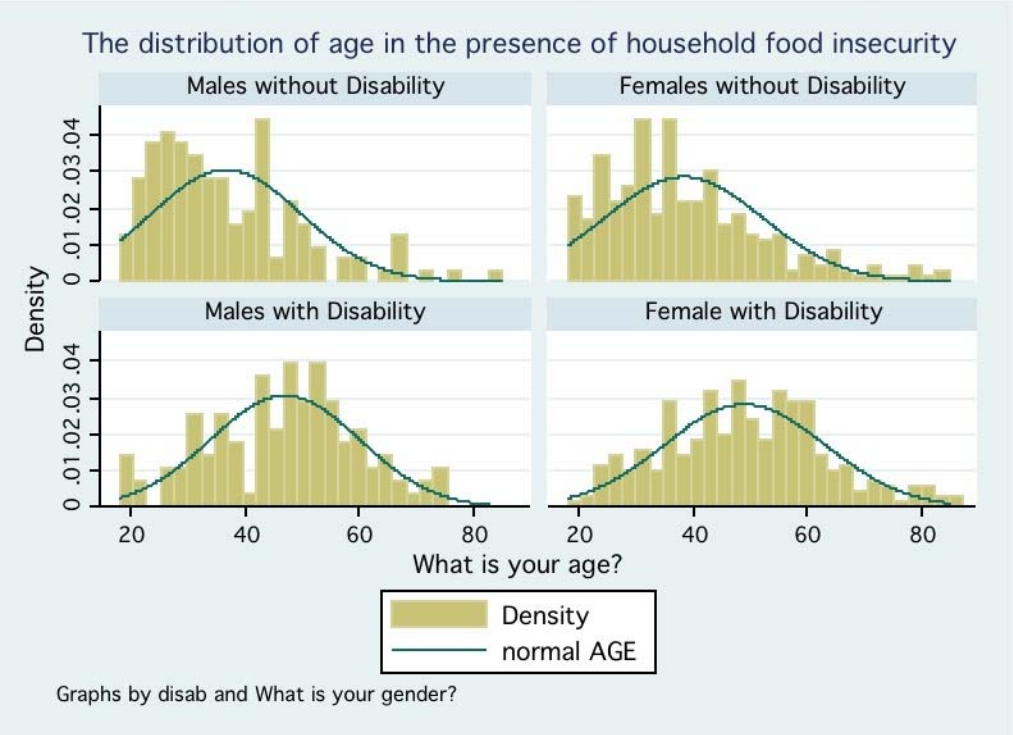

Figure 1. The distribution of age by disability and gender in the presence of household food insecurity in Oregon, 2005-2006.

After adjusting for income, employment, gender, race, and health status, the multivariate model found disability to increase the odds of food insecurity in a household by a factor of 1.53. This main effects model provided a reasonably good fit (HL Wald F=1.053, p=0.394). Further assessment for effects revealed a significant interaction involving employment and disability (p=0.001). Cross classification was carried out to better examine the interaction effect. Cell counts were inspected and found to contain sufficient observations. The model demonstrated that individuals with disabilities had greater odds of experiencing food insecurity compared to employed individuals without disabilities. In comparison to the employed, non-disabled

reference group, individuals with disabilities who were employed had 83% greater odds of food insecurity while unemployed people with disabilities had 141% greater odds. Model fit remained satisfactory with the inclusion of the interaction (HL Wald F=0.806, p=0.611). All terms were significant in the final model. Refer to Table 7 for results.

Table 7. Multivariate logistic regression modeling results for the association between disability and food insecurity in Oregon, 2005-2006 BRFSS.

FOOD INSECURITY						
	Age-Adjusted Model		*Main Effects Model*		*Model with Cross-Classification*	
Variable	**OR(95%CI)**	**p value**	**OR(95%CI)**	**p value**	**OR(95%CI)**	**P value**
Disability						
No	Referent	--	Referent	--	--	--
Yes	1.99(1.36-2.89)	< 0.001	1.53(1.07-2.18)	0.019		
Income						
$25,000+	Referent	--	Referent	--	Referent	--
<$25,000	3.95(2.83-5.50)	< 0.001	4.78(3.48-6.56)	< 0.001	4.85(3.56-6.61)	< 0.001
Employment						
Employed	Referent	--	Referent	--	--	--
Not Employed	1.99(1.29-3.08)	0.002	1.77(1.13-2.77)	0.012		
Age						
	0.96(0.95-0.97)	< 0.001	Dropped	--	Dropped	--
Race						
NH White	Referent	--	Referent	--	Referent	--
All Others	2.33(1.59-3.43)	< 0.001	2.54(1.77-3.65)	< 0.001	2.50(1.75-3.59)	< 0.001
Gender						
Male	Referent	--	Referent	--	Referent	--
Female	1.51(1.12-2.04)	0.007	1.54(1.16-2.05)	0.003	1.53(1.15-2.03)	0.003
Health status						
Excellent/Very Good/Good	Referent	--	Referent	--	Referent	--
Fair/Poor	1.73(1.11-2.70)	0.015	1.67(1.13-2.47)	0.010	1.75(1.19-2.57)	0.004
Obesity						
BMI<30 kg/m2	Referent	--	--	--	--	--
BMI ≥ 30 kg/m2	1.39(1.02-1.89)	0.035				
Effect of disability by employment*						
EWOD	--	--	--	--	Referent	--
EWD					1.83(1.27-2.62)	0.001
UWOD					2.34(1.20-4.56)	0.012
UWD					2.41(1.58-3.70)	<0.001
HL Wald F (p value)	**9.549(1.598e-14)**		**1.053(0.394)**		**0.806(0.611)**	

* E(employed), U(unemployed), WOD (without disability), WD (with disability)

Hunger and Disability

When assessing for correlates of hunger, the demographic variables for gender and race were not included because of non-significance in the model building process (Appendix A). As in the previous model, age was eliminated to improve model fit. Figure 2 depicts the distribution

of age by disability and hunger. Age appears normally distributed among people without disabilities and without experience of hunger in the household. As expected the age distribution for people with disabilities is skewed towards older age. However, among individuals experiencing hunger, the distribution of age is skewed left – more so for people without disabilities than people with disabilities. As was described previously, analyses tested various scenarios for a model with age but none were found to improve model fit and age was ultimately eliminated.

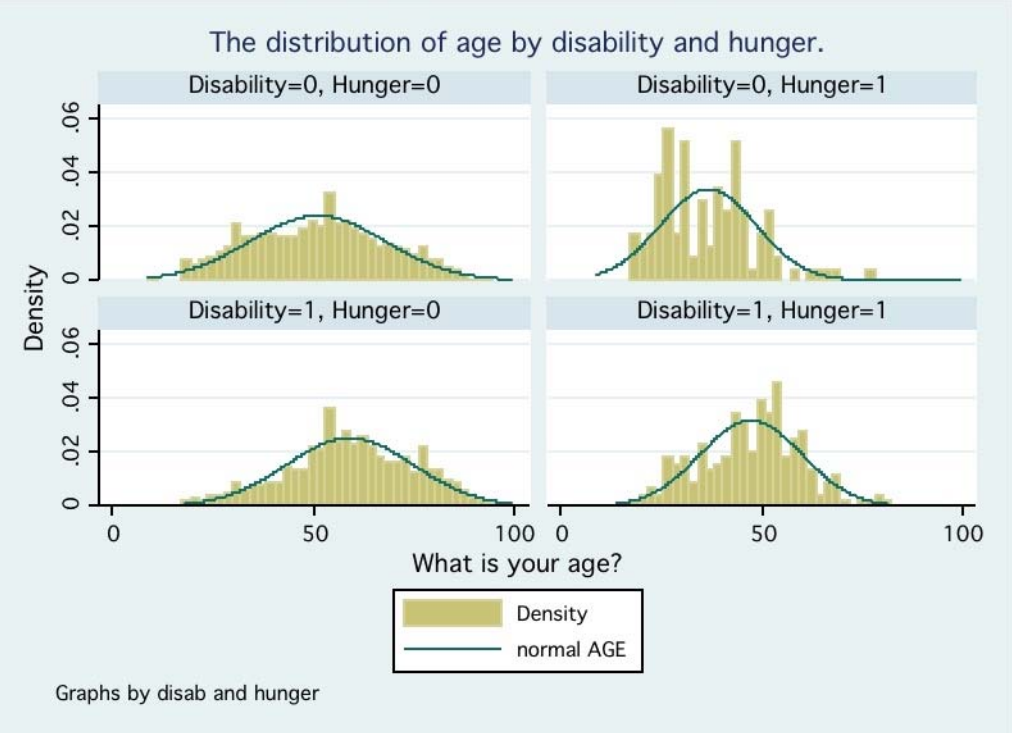

Figure 2. The distribution of age by disability and hunger in Oregon, 2005-2006.

When controlling for income, employment, health status, obesity, and metro area residence, disability increased the odds of hunger in a household by 2.11. This main effects model demonstrated good fit (HL Wald F=0.185, p=0.996). Assessment for interactions revealed an interaction of metropolitan county residence and disability (p=0.007). When the interaction was included in the model, the variable for disability demonstrated non-significance

for the referent disability category (95% CI: 0.97-30.13). In order to determine whether the model could support the interaction, the cross classification of disability and metro residence was coded into a single variable. Cell counts were inspected and found to contain adequate cell sizes. Inclusion of this cross classification term did not affect statistical significance of other main effects. However, it was observed that the combined effect of the disability variable (OR 2.11) and the metropolitan county variable (OR 2.23) in the main effects model was smaller than the effect of the disability-county cross classification term (metropolitan residents with disabilities, OR 5.97).

The model revealed that both individuals with and without disabilities had higher odds of experiencing hunger if they cited residence in a metropolitan county instead of a non-metropolitan county. Specifically, among people without disabilities, residence in a metropolitan county was observed to have three times the odds for hunger as residence in a non-metropolitan county (OR 3.11, 95% CI:1.37-7.03). Among people with disabilities only, it was found that metropolitan county residents experienced 85% greater odds for hunger than residents of non-metropolitan counties (OR 1.85, 95% CI: 1.11-3.09). However, it was noted that the disability effect may be larger among non-metropolitan residents. In non-metropolitan counties, individuals with disabilities had greater than three times the odds of experiencing hunger in their households than individuals without disabilities (OR 3.22, 95% CI: 2.65-13.45). In comparison, in metropolitan counties , residents with disabilities reported 1.92 the odds of experiencing hunger (95%CI: 1.09-3.38) as residents without disabilities. The final model provided a good fit to the data (HL Wald F=0.595, p=0.802). Refer to Table 8 for results.

Table 8. Multivariate logistic regression modeling results for the association between disability and hunger in Oregon, 2005-2006 BRFSS.

HUNGER	*Age-Adjusted Model*		*Main Effects Model*		*Model with Cross-Classification*	
Variable	**OR(95%CI)**	**p value**	**OR(95%CI)**	**p value**	**OR(95%CI)**	**p value**
Disability						
No	Referent	--	Referent	--	--	--
Yes	2.45(1.44-4.17)	0.001	2.11(1.27-3.49)	0.004		
Income						
$25,000+	Referent	--	Referent	--	Referent	--
<$25,000	7.69(4.75-12.46)	< 0.001	8.69(5.46-13.81)	< 0.001	8.74(5.48-13.93)	< 0.001
Employment						
Employed	Referent	--	Referent	--	Referent	--
Not Employed	1.86(1.19-2.90)	0.007	1.70(1.10-2.64)	0.017	1.68(1.08-2.60)	0.021
Age						
	0.98(0.96-0.99)	0.011	Dropped	--	Dropped	--
Health status						
Excellent/Very	Referent	--	Referent	--	Referent	--
Good/Good	2.00(1.19-3.37)	0.009	1.91(1.14-3.21)	0.014	1.90(1.13-3.18)	0.015
Fair/Poor						
Obesity						
BMI<30 kg/m2	Referent	--	Referent	--	Referent	--
BMI ≥ 30 kg/m2	1.73(1.13-2.67)	0.012	1.66(1.09-2.51)	0.017	1.68(1.11-2.55)	0.014
Metro Residence						
Non-metro	Referent	--	Referent	--	--	--
Metro	2.14(1.39-3.28)	0.001	2.23(1.45-3.42)	< 0.001		
Effect of disability by county residence						
No Disability (NM)	--	--	--	--	Referent	--
Disability (NM)					3.11(1.37-7.03)	0.006
No Disability (M)					3.22(1.37-7.57)	0.007
Disability (M)					5.97(2.65-13.45)	< 0.001
Wald F (p value)	**3790.701(0)**		**0.185(0.996)**		**0.595(0.802)**	

*NM(non-metropolitan), M(metropolitan)

Food Insecurity and Disability Type

Subsequent analysis was conducted to assess whether food insecurity and hunger were disproportionately experienced by individuals within the disability subpopulation; results are presented in Tables 9 through 12. The assessment for interactions revealed noteworthy effects, particularly by disability characteristic.

Food insecurity was shown to be disproportionately experienced across types of disability (Table 9). Initially the main effects model depicted psychiatric type only as significantly different from physical type (p=0.007). Furthermore, because age did not impair model fit, it

was included in the main effects model and revealed that an inverse relationship existed between increasing age and the experience of food insecurity in a household. After the main effects model was assessed for interactions, it was observed that categorical age groups (55+ years, 35-54 years, 18-34 years) interacted significantly with disability type. However, with the inclusion of the interaction term, STATA dropped several subcategories due to collinearity. In order to explore whether this interaction term could be supported by the model, age group and disability type were cross classified into a single variable. This approach allowed the model to depict the interaction effects between age and disability type. Cell counts were inspected and are reported in Table 9. All age-disability type subcategories (except those involving sensory type) had greater odds of food insecurity relative to individuals with physical disability type aged 55 years or older. The highest estimated odds for food insecurity was observed among psychiatric type aged 35-54 years (OR 11.75); in fact, the odds for food insecurity among individuals with psychiatric disabilities appears to peak at this age category, followed by a decrease in odds for ages 18-34 years (OR 10.14).

When assessing for differences between physical and other disability types within other age group categories (35-54 yrs and 18-34 yrs), it was revealed that psychiatric type aged 35-54 years had three times greater odds of food insecurity than physical type within the same age range (OR 3.00, 95% CI: 1.46-6.18, p=0.003); nearly 50% of individuals with psychiatric disability in the 35-54 age range reported food insecurity compared to 25% of individuals with physical disability type in the same age range. A difference was not observed among the youngest age group (p=0.247). Compared to physical disability, other disability types (cognitive and sensory) did not show significant differences in the odds of food insecurity when comparing within an individual age group.

When assessing differences between age groups within a single disability type, an inverse trend in the association with the outcome was observed. For example, among psychiatric type only, the age group 55 and older reported less household food insecurity than the age group ranging 35-54 years; in other words, individuals with psychiatric disabilities aged 35-54 yrs experienced 3.58 times the odds of food insecurity in comparison to their older counterparts (95% CI 1.22-10.52; p=0.020). A similar trend was observed between age groups among individuals with cognitive disability; ages 55 and older experienced less household food insecurity than ages 35-54 (OR 0.19, 95% CI: 0.07-0.54), p=0.002). The final model (HL Wald F=0.990, p=0.446) demonstrated good fit, compared to the main effects model (Wald F=1.253, p=0.258).

Table 9. Multiple logistic regression modeling for the association between disability type and food insecurity among Oregonians with disabilities, 2005-2006 BRFSS.

FOOD INSECURITY				
	Main Effects Model		*Model with Cross Classification*	
Variable	**OR(95%CI)**	**p value**	**OR(95%CI)**	**P value**
Within Disability Type				
Physical Only	Referent	--	--	--
Sensory Only	0.77(0.19-3.13)	0.717		
Cognitive Only	1.30(0.76-2.23)	0.326		
Psychiatric Only	2.40(1.28-4.51)	0.007		
Income				
$25,000+	Referent	--	Referent	--
<$25,000	5.55(3.60-8.54)	< 0.001	5.61(3.64-8.64)	< 0.001
Race				
NH White	Referent	--	Referent	--
All Others	2.56(1.41-4.67)	0.002	2.42(1.35-4.33)	0.003
Age				
	0.96(0.94-0.97)	< 0.001	--	--
Health Status				
Excellent/Very Good/Good	Referent	--	Referent	--
Fair/Poor	2.31(1.51-3.52)	< 0.001	2.16(1.43-3.27)	< 0.001
Effect of disability type by age group (n)§				
55+ yrs				
Physical (850)	--	--	Referent	--
Sensory (46)			1.96(0.48-8.02)	0.346
Cognitive (107)			1.08(0.53-2.23)	0.829
Psychiatric (29)			3.27(1.31-8.19)	0.011
35-54 yrs				
Physical (450)			3.92(2.45-6.26)	< 0.001
Sensory (10)			*	*
Cognitive (53)			5.61(2.34-13.43)	< 0.001
Psychiatric (47)			11.75(5.63-24.54)	< 0.001
18-34 yrs				
Physical (100)			4.48(2.11-9.54)	<0.001
Sensory (4)φ			0.71(0.07-6.63)	0.766
Cognitive (21)			8.49(2.71-26.58)	<0.001
Psychiatric (17)			10.14(2.81-36.63)	<0.001
Wald F (p value)	**1.253(0.258)**		**0.990(0.446)**	

*Category dropped because there were no respondents with sensory disability aged 35-54 years reporting food insecurity.

§ n represents number of unweighted observations.

φ Note the very small cell size of the subcategory.

Hunger and Disability Type

As a result of model building process (Appendix A, Tables D1 & D2), and strict adherence to bonferroni adjusted alpha levels, all but three variables were eliminated prior to entry into the main effects model for hunger in the context of disability. Goodness of fit test indicated that model was a good fit for the data (HL Wald F=0.077, p=0.999). The main effects model demonstrated hunger in the household was disproportionately experienced by both cognitive type and psychiatric type (OR 2.45 and 3.45, respectively) compared to physical type. The strong associations of income and employment, as in prior analyses, remain apparent in the model. Individuals with annual household incomes of less than 25,000 are over seven times as likely to experience hunger as individuals with annual incomes of 25,000 or more. Unemployed individuals have twice the odds of experiencing hunger as employed individuals. Refer to Table 10 for final model results.

Table 10. Multiple logistic regression modeling for the association between disability type and hunger among Oregonians with disability, 2005-2006 BRFSS.

HUNGER		
Variable	**OR(95%CI)**	**p value**
Disability Type		
Physical Only	Referent	--
Sensory Only	0.31(0.07-1.40)	0.128
Cognitive Only	2.45(1.21-4.96)	0.013
Psychiatric Only	3.45(1.65-7.20)	0.001
Income		
$25,000+	Referent	--
<$25,000	7.68(3.76-15.66)	< 0.001
Employment		
Employed	Referent	--
Not Employed	2.15(1.24-3.73)	0.006
Wald F (p value)	**0.077 (0.999)**	

Food Insecurity and Number of Disabilities

Based on findings from previous models, age was included as categorical variable (age group: 55+, 35-54, 18-34) when examining number of disabilities. The *within2* variable (number of disabilities) had to be re-introduced to the model, and contributed non-significantly to the main effects models for food insecurity (p=0.519). Nevertheless, the main effects model demonstrated goodness of fit (HL Wald F=1.357, p=0.203). Further analysis uncovered an interaction involving health status and number of disabilities; the variables were cross classified into a single variable. Inclusion of this cross classification term allowed other variables of income, race, and age group to remain significant. The final model provided a good fit to the data (HL Wald F=1.381, p=0.191). The final model revealed that individuals with either single or multiple disabilities reporting poor health had greater odds of experiencing food insecurity compared to individuals with a single disability reporting excellent/very good/good health. Table 11 provides a more detailed explanation of the results.

Table 11. Multiple logistic regression modeling for the association between number of disabilities and food insecurity among Oregonians with disabilities, 2005-2006 BRFSS.

FOOD INSECURITY				
	Main Effects Model		*Model with Cross Classification*	
Variable	**OR(95%CI)**	**p value**	**OR(95%CI)**	**P value**
Number of Disabilities				
Single	Referent	--	--	--
Multiple	1.24(0.65-2.36)	0.519		
Income				
$25,000+	Referent	--	Referent	--
<$25,000	6.04(4.02-9.06)	< 0.001	6.07(4.04-9.13)	< 0.001
Race				
NH White	Referent	--	Referent	--
All Others	2.42(1.40-4.19)	0.002	2.42(1.40-4.17)	<0.002
Age group (years)				
55+	Referent	--	Referent	--
35-54	3.94(2.68-5.81)	< 0.001	3.95(2.68-5.81)	< 0.001
18-34	4.43(2.44-8.01)	< 0.001	4.42(2.44-8.00)	< 0.001
Health Status				
Excellent/Very Good/Good	Referent	--	--	--
Fair/Poor	2.12(1.43-3.12)	< 0.001		
Effect of Number of Disabilities by Health Status (n)§				
E/VG/G* Single (1042)	--	--	Referent	--
E/VG/G Multiple(55)φ			1.05(0.36-3.25)	0.931
Fair/Poor Single (692)			2.08(1.39-3.12)	< 0.001
Fair/Poor Multiple (87)			2.80(1.24-6.31)	0.013
Wald F (p value)	**1.357(0.203)**		**1.381(0.191)**	

*EVG (Excellent/Very Good/Good self-reported health status).
§ n represents number of unweighted observations.
φ Out of 55, only 8 individuals in this subcategory reported experience with food insecurity.

Hunger and Number of Disabilities

Again, age was included as categorical variable (age group: 55+, 35-54, 18-34) when examining number of disabilities. The *within2* variable was once again non-significant (p=0.224). Although the correlate of interest (number of disabilities) in the main effects model for hunger did not demonstrate significance, the model was assessed to have a good fit for the data (HL Wald F=1.357, p=0.203). Further analysis was pursued to explore possible interactions involving number of disabilities.

The main effects model revealed that females disproportionately experience hunger compared to males (OR 2.18, p=0.003). Gender exclusive models were created to mitigate possible confounding, particularly given the discrepancy between male and female BRFSS respondents with disabilities. In the female only model, income was retained as a correlate but employment was dropped because of non-significance. Furthermore, the female only model revealed an interaction involving age group and number of disabilities. In a cross classification of the age group and disability number variables, it was observed that females 55 years and older experienced greater odds of hunger if they experienced multiple disability types rather than a single type (OR 5.49, p=0.010). Also, in females with either single or multiple disabilities, younger age groups experienced greater odds of hunger compared to the referent older age group, 55+ years.

To assess whether income may have been a modifying factor, household income distribution among females with single or multiple disability type was looked at. In women in the oldest (55 years +) and youngest (18-34 years) age categories, income did not significantly differ between women with single or multiple disability types (p=0.4538 and p=0.6137, respectively). In the age range of 35-54 years, 65% of women with multiple disability types reported low-income annual household earnings (less than $25,000) compared to 39% of women with single disability type (p=0.0111).

A threshold event (similar to the one described in Table 9) was also observed. Specifically, the odds of hunger for females with multiple disabilities was estimated at an OR of 5.49 at age 55 years or older (p=0.010), an OR of 10.39 for ages 35-54 years (p<0.001), and 1.65 for ages 18-34 years (p=0.686). Similarly, the estimated odds of hunger among females with single disabilities decreased from ages 35-54 years (OR 5.60) to ages 18-34 years (OR 3.49).

In the male only model, age did not demonstrate significance but was retained to improve model fit. Unlike the female only model, the male model did not detect a difference in hunger between single and multiple disability experience (p=0.926). Furthermore, male sample size impeded adequate exploration of interactions involving number of disabilities. However, given the available dataset, income (p<0.001) and employment (p=0.008) were found to be significant correlates of hunger in males with disabilities. Refer to Table 12 for more details.

Table 12. Multiple logistic regression modeling for the association between number of disabilities and hunger among Oregonians with disabilities, 2005-2006 BRFSS.

HUNGER						
	Main Effects Model		*Female Only; with Cross Classification*		*Male Only**	
Variable	**OR(95%CI)**	**p value**	**OR(95%CI)**	**P value**	**OR(95%CI)**	**P value**
Within Number of Disabilities						
One	Referent	--	--	--	Referent	--
Multiple	1.64(0.74-3.64)	0.224			1.06(0.27-4.15)	0.926
Income						
$25,000+	Referent	--	Referent	--	Referent	--
<$25,000	8.23(4.15-16.33)	< 0.001	9.82(4.60-21.00)	< 0.001	10.58(3.04-36.85)	< 0.001
Employment						
Employed	Referent	--	Dropped	--	Referent	--
Not Employed	2.72(1.55-4.76)	< 0.001			6.55(1.63-26.38)	0.008
Age						
55+	Referent	--	--	--	Referent	--
35-54	2.13(1.25-3.64)	0.005			2.02(0.79-5.19)	0.143
18-34	2.05(0.95-4.42)	0.066			2.57(0.76-8.67)	0.129
Gender						
Male	Referent	--	--	--	--	--
Female	2.18(1.31-3.60)	0.003				
Effect of number of disabilities by age group						
55+ yrs						
Single	--		Referent	--	--	--
Multiple			5.49(1.50-20.08)	0.010		
35-54 yrs						
Single			5.60(3.11-10.08)	< 0.001		
Multiple			10.39(3.72-28.96)	< 0.001		
18-34 yrs						
Single			3.49(1.53-7.96)	0.003		
Multiple			1.65(0.14-19.08)	0.686		
Wald F (p value)	**1.860(0.054)**		**0.919(0.507)**		**1.771(0.069)**	

* 51 male respondents with imputed number of disabilities reported experience with hunger; 6 males with multiple disabilities report experience with hunger.

DISCUSSION

Through the use of Oregon BRFSS data from the 2005 and 2006 survey years, this study provides population-based prevalence estimates and correlates for food insecurity and hunger experienced by people with disabilities in Oregon. Twenty-two percent of individuals with disabilities in Oregon report having experienced food insecurity at some point in the last twelve months in their household. Eleven percent of individuals with disabilities also report experiencing hunger, the more extreme form of food insecurity in which food consumption is reduced, meals are skipped, and monies are not available for the purchase of more food. Both food insecurity and hunger were found to vary with disability type, number of disabilities, and other demographics, suggesting that patterns for these outcomes may be unique to certain subpopulations.

Comparison with Previous Studies

Prevalence Estimates

The prevalence of food insecurity in a household estimated by this study was 15.6% in 2005 and 12.3% in 2006. Hunger was estimated at 5.7% and 4.3%, respectively for the same time frame. These estimates correspond well to state specific estimates reported by Nord for the United States Department of Agriculture, which were 12.4% and 5.5%, respectively for food insecurity and hunger in Oregon from 2005 through to2007 (Nord et al. 2008).

The prevalence of disability in Oregon in 2005 and 2006, as estimated by this study, was 24.7%. This is fairly consistent with other estimates of BRFSS-identified disability in Oregon in recent years (Horner-Johnson, 2009; OODH 2009). The present study provided additional insight into characteristics of Oregon's disability population. Among individuals with a single

disability, physical only was the predominant type (18.6% of the total adult population), followed by cognitive only (1.9%), psychiatric or emotional health-related (1.3%) and lastly, sensory only (0.6%). Furthermore, an estimated 1.6% of Oregonians were living with multiple disabilities compared to 22% with a single disability type.

The estimate of food insecurity among people with disabilities in this study (21.8%) is consistent with that observed by Adams et al. (2007), which was 22.9% (2005 only). Nord (2007), for USDA-ERS , estimated a national prevalence of 29% among households with members with work-limiting disabilities (2005 only). Estimates established by this study are comparatively higher than food insecurity and hunger experienced by individuals without disabilities (11.2% and 2.9%, respectively).

Correlates of Food Insecurity

The results of this analysis were consistent with existing literature in regards to correlates of food insecurity. In the 2005-2006 Oregon BRFSS sample, household income, employment, education, race/ethnicity, gender, age, and household composition (marital status and number of adults in household) were all significant correlates of food insecurity. Disability, health status, and obesity demonstrated strong correlative relationships to food insecurity as well. All correlates appear to function as potential risk factors for food insecurity; however, age demonstrated an inverse relationship with the outcome. It was expected that older people would experience more food insecurity, based on the theory that higher health care costs may contribute to increased risk of food insecurity. According to Schneider and Guralnik (1990), "average annual Medicare costs per person increase substantially with age, from $2017 for individuals aged 65 to 74 years to $3215 for those aged 85 and above." Although findings that less food

insecurity is reported among older people (aged 55 years and older) are consistent with previous research (Nord et al. 2006 & 2008; Nord 2007), it seems somewhat counterintuitive if higher medical costs are assumed to contribute to food insecurity. Klesges et al. have demonstrated that the greater the number of medical conditions, the higher the odds of experiencing financial difficulties in acquiring food among elderly minority women (2001). More research is needed to examine the relationship between food insecurity and other household expenses, particularly around the elderly.

Multivariate analysis did not include variables for education, marital status, and number of adults in the household (refer to Appendix A for model building processes). The correlate group consisting of marital status and number of adults in household was dropped because it did not meet the Bonferroni significance thresholds during model building processes. Education was subsequently dropped because the covariate did not have an alpha of 0.05 to continue on to multivariate analysis. The removal of these variables was unexpected. In their assessment of food insecurity among Oregonian residents, Marco and Thornburn (2008) reported that individuals with low educational attainment (i.e. less than or equal to a high school degree) had more than four times the odds of food insecurity than college graduates, after adjusting for other sociodemographic factors and use of food assistance services. Furthermore, Nord et. al. (2006 & 2008) reported that food insecurity and hunger were least prevalent among married couples with children and multi-adult households without children. Thus, based on available literature, these variables were expected to contribute to food insecurity and hungermultivariate models. The relative effects of these variables may have been masked by income and employment. Alternatively, these particular demographics may simply have less influence on food insecurity and hunger in the context of disability.

Correlates of Hunger

The results of this analysis were consistent with much of the available literature in regards to correlates of hunger. Univariately, the same demographic variables attributable to food insecurity were significant for hunger as well, with the addition of area of residence. As was reported by Nord (Nord et al. 2006), this study also demonstrated that metropolitan residents experienced more hunger than non-metropolitan residents.

Multivariate analysis highlighted the importance of gender as a correlate of hunger. While hunger affects both genders, females report a higher prevalence of hunger in the household. This is consistent with findings from other reports (Nord et al. 2008;Edwards et al. 2006) that the prevalence estimates of hunger among women living alone and households with children headed by single women are higher than those for men living alone and households headed by single men. Furthermore, very low food security (i.e. hunger) was found to occur disproportionately in low-income households with members with disabilities. This observation was analogous to those reported in other studies which described the association of food insecurity with the presence of disability in a household (Nord 2007; She & Livermore 2006).

<u>The Association of Food Insecurity and Hunger with Disability</u>

Although prevalence estimates of food insecurity and hunger for overall disability ascertained in this study paralleled estimates reported in other studies (Nord 2007; Adams et al. 2007), a few novel observations were noted that were not available in existing empirical literature. Specifically, this study included the auxiliary exploration of the association of

disability type and number of disabilities with food insecurity and hunger in Oregon. While the odds of both outcomes, food insecurity and hunger, were higher for individuals with disabilities compared to individuals without disabilities, outcomes were also shown to be disproportionately experienced within the disability population by individuals with multiple disabilities, and cognitive or psychiatric disability type compared to those with single disability type, and physical type, respectively.

Disability

Preliminary analysis of main effects revealed that the odds of being food insecure were approximately 1.5 times greater for people with disabilities than people without disabilities. Comparatively, income, employment, race, and health status were stronger correlates of food insecurity than disability. The final multivariate model demonstrated that an interaction existed between employment status and disability. The odds of food insecurity were observed to increase in respondents who self-reported disability. Among respondents who were employed, individuals with disabilities had 83% greater the odds for the outcome than individuals without disabilities. Experience of food insecurity among unemployed individuals did not appear to differ based on the presence of disability ($p=0.931$); however, only 23% unemployed individuals without disabilities reported experience with food insecurity compared to 41% unemployed individuals with disabilities. Sample size restrictions may have resulted in non-significance between the two unemployed subcategories.

The composition of the final model for hunger revealed an interaction between disability and area of residence. The disability effect was much stronger in this model compared to the

derivative variable in the main effects model. Initially, the main effects model demonstrated that the odds of hunger for people with disabilities was twice that for people without disabilities. Additionally, the main effects model showed that the odds of hunger in metropolitan residence was more than twice that for non-metropolitan residents. Cross classification in the final model allowed analysis to focus solely on the combined effects of disability and area of residence (in four mutually exclusive categories). Final estimates indicated that non-metropolitan residents with disabilities had three times the odds of hunger than non-metropolitan residents without disabilities; metropolitan residents with disabilities had nearly 6 times the odds compared to metropolitan residents without disabilities; metropolitan residents without disabilities had over three times the odds compared to non-metropolitan residents without disabilities. Within the disability sample, the odds of hunger for metropolitan residents were 85% greater than non-metropolitan residents. This may be predominantly explained by the relatively higher cost of living in metropolitan areas where housing is generally more expensive. Final model estimates suggest that the association of hunger among Oregonians with or without disabilities is influenced by county-level factors. The slight discrepancies in odds ratio estimates in the main effects model compared to the final model may be the result of aggregated cell counts in the final model, such a combination may have served to overcome the strong effect o f the income correlate.

Overall, individuals with disabilities in both metropolitan and non-metropolitan counties had greater odds of food insecurity than individuals without disabilities in corresponding county categories. Interestingly, however, non-metropolitan residents with disabilities had over three times the odds of experiencing hunger as their counterparts without disabilities (compared to an two-fold odds ratio increase between metropolitan residents with and without a disability). This

may be indicative of general rural issues and the potential effect these issues have on people with disabilities. Relatively less economic development or federal funding available to rural communities lead to: 1) limited accessibility of adequate and affordable food supplies (i.e. number of food markets, in-store availability and cost of food items) ; 2) lack of variety of food assistance programs/services available (e.g. food pantries, food drives, meal services); 3) instability in employment or income (e.g seasonal employment); and/or 4) poor availability of transportation, public or otherwise. The limited amount of services available to the public may not necessarily be accessible to people with disabilities. For example, a county may not be able to provide food services that specifically target people with disabilities or an accessible transportation system that would help support an individual with a disability go to a well-stocked grocery store.

Food insecurity was found to be experienced at younger ages among people without disabilities. The median age of people without disabilities reporting food insecurity was 31 years, while the median age of individuals with disabilities who experienced food insecurity was 44 years. The age distribution for the experience of hunger in the household was similarly disparate; the median age was 35 years for individuals without disabilities and 44 for individuals with disabilities. Attempts were made to control for such disparities in order to create a model that provided good fit to the data. However, as a result of some unknown confounder, age could not be assessed as a correlate of either outcome at this stage of analysis. The estimated odds of food insecurity and hunger among Oregonians with disabilities were likely underestimated by final composition models (see Tables 8 and 9) because of the exclusion of the age variable. Subsequent models were restricted to the disability sample only. This allowed the re-

examination of age as a correlate of food insecurity and hunger; its presence in disability-only models served to improve goodness of fit.…

This study's observation that greater odds for food insecurity and hunger exist among people with disabilities may be due to the fact that people with disabilities experience a comparatively higher burden of health expenses and subsequent material hardship than the general population (Mitra et al., 2008; She & Livermore 2006). This study provides additional reinforcement for the results of previous work conducted by Nord for USDA-ERS (Nord 2007). However, assessments of people with disabilities as a homogenous group may preclude important contextualized risk factors for food insecurity and hunger. The exploration of these outcomes across more explicit categorizations of disability (i.e. disability type and number of disabilities) was an attempt to understand the complexities of the experienced reality of individuals with disabilities.

Disability Type

Most categories of disability type were affected by food insecurity and hunger. However, relative to physical type, individuals with either cognitive or psychiatric disabilities were impacted to a larger extent. With regard to food insecurity, only psychiatric type demonstrated a difference in odds compared to physical type. Income persisted as the strongest correlate for the outcome. The composition of the final model revealed that the disparity between physical and psychiatric type remained despite adjustment for age groups. Among the age groups of 35-54 years and 55 years and older, psychiatric type had 3.00 and 3.27 times the odds of food insecurity, respectively, compared to physical disability type. Shaner and colleagues (1995)

reported that many patients with serious mental illness have co-morbid substance abuse problems. The results of their study indicated that cocaine-abusing schizophrenic patients spent nearly half of their total income on acquiring drugs thus depleting funds needed for housing and food and increasing the potential for hospitalization. Elbogen and colleagues (2003) also reported that persons with psychiatric disabilities were likely to have substance abuse problems. However, they found that persons with psychiatric disabilities that have their finances, including benefits from Social Security Disability Insurance (SSDI) and Supplemental Security Income(SSI), managed by third parties were more likely to have enough money to cover necessities, including housing and food. These findings suggest that aspects of living with a psychiatric disability may increase risk of food insecurity. Alternatively, food insecurity may contribute to psychiatric disability. Heflin and colleagues (2005) suggested that household food insufficiency could affect the onset and recurrence of major depression through nutritional deprivation. Additionally, food insecurity may function as a stressful life event contributing to major depression, particularly among low-income women (Helfin et al. 2005).

This study found that cognitive and psychiatric disabilities both had greater odds of hunger than physical type. These results may be explained by several possibilities. Perhaps individuals with cognitive or psychiatric disability type rely on third-party financial assistance more so than individuals with physical disability type. Finances aside, individuals with cognitive or psychiatric disability type may also experience relatively greater difficulties in self-care management. For example, these individuals may have to rely on others to obtain and prepare food for them; thus, these individuals are relegated to depend on the availability and inclination of others. Another possibility, proposed by Klesges and colleagues (2001), is that better physical functioning and health reduce the difficulties in acquiring food. In this sample, 55% of

respondents with cognitive disabilities cited poor or fair health compared to 36% of respondents with physical disabilities. Although individuals with physical disabilities have some limitations in physical functioning, the relatively better health status reported by this group may help explain their lower risk of hunger in comparison to the overall less healthy respondents with cognitive disabilities. Lastly, as the study by Shaner et al. (1995) has indicated, individuals with psychiatric disabilities frequently experience co-morbidities of drug addiction. Drug addiction not only depletes finances but takes a devastating toll on health, which may further impact ability to obtain food.

Comparisons of sensory to physical type almost always demonstrated non-significance. Prevalence estimates also depicted food insecurity and hunger as less common among individuals with sensory disabilities than individuals without disabilities. This is likely a result of limited sample size. Overall, there were few BRFSS respondents with sensory disabilities – a total of 60 individuals for both the 2005 and 2006 survey years (representing less than 1% of the adult population of Oregon). Small cell sizes prohibited adequate assessments of food insecurity or hunger in this subpopulation. The telephone interviewing strategy BRFSS employs likely excludes a sizable portion of people with sensory disabilities, particularly individuals who are deaf or hard of hearing.

Number of Disabilities

An estimated 1.6% of Oregonians live with multiple disability types whereas 22% live with a single disability type. Number of disabilities was imputed from the number of responses given during the interview regarding the type of disability-related health condition. Thus number of disabilities refers to single disability type or multiple disability types rather than the

interpretation of multiple impairments of a single nature (e.g. deaf and blind) which was not assessed by this study. A total of 142 respondents identified living with multiple disability types. It is likely that further demographic stratification of these subjects led to the non-significant contribution to the model. The presence of other strong correlates such as income and employment likely masked the effect of the number of disabilities. In order to force this correlate of interest into the model, number of disabilities was cross-classified with a significant variable such as health status or age. Thus, the odds of food insecurity or hunger were modeled as a function of number of disabilities and some other demographic variable.

With regard to food insecurity, this study uncovered a significant interaction involving imputed number of disabilities and self-reported health status. Overall, individuals with either single or multiple disabilities reporting fair or poor health status had higher chances of experiencing food insecurity than those reporting excellent, very good, or good health. Number of disabilities did not exclusively show a relationship with food insecurity. However, the cross classification of number of disabilities with health status revealed that despite number of disabilities, respondents reporting fair or poor health have greater odds of food insecurity. The estimated odds of food insecurity were not statistically different between individuals with a single disability reporting poor health (OR 2.08) and those with multiple disabilities reporting poor health (OR 2.80). This non-significance may be explained by the manner in which the single and multiple disability categories were defined by this study. Individuals were only considered to have multiple disabilities if they reported more than one type of disability. It is possible that individuals classified as having a single disability type experience multiple impairments of that type (i.e. blindness and deafness for sensory disability type).). While this explanation may also explain why ‘multiple disability with good health’ did not differ from

'single disability in good health,' restrictive cell size was also evidently problematic (among respondents reporting food insecurity and good health, eight had multiple disabilities and 135 had a single disability).

When assessing hunger in a household in the context of single and multiple disabilities, females in younger age categories (18-34 years and 35-54 years) were at higher odds for hunger than the referent age group, 55 years and older. However, this study also observed that females 55 years and older with multiple disabilities experienced greater odds than females with single disability type in the same age group. This finding complements the study by Klesges and colleagues which found that a greater likelihood of financial difficulty in acquiring food was associated with elderly women with more medical conditions (2001). While household income is an inadequate measure of household finances, income distribution was assessed to provide more insight into age-related reports of hunger among women with single or multiple disability types. Low-income earnings were reported by a disproportionate amount of women with multiple disability types aged 35-54 years compared to women with single disability type of the same age. However, differences in income distribution were not statistically significant in either oldest or youngest women with single or multiple disabilities. More research is needed to bring to light factors that influence reports of hunger in similar age categories.

Number of disabilities remained non-significant for hunger in males. Income and employment alone remained significant correlates. Again, this is likely an issue of cell size: only 6 respondents that had multiple disability types identified themselves as male and described hunger in their households.

Strengths and Limitations

This study has several strengths. The source of its greatest strength comes from its use of population-based data made available through the Behavioral Risk Factor Surveillance System. The CDC-generated weighting scheme allows results from the analysis of a representative sample of the population to be generalizable throughout Oregon. BRFSS data are important for identifying various public health issues because of the variety of measures obtained from participants, including demographics, health behaviors, and health conditions. Use of 2005 and 2006 data allowed for the examination of a multitude of factors that influence household food insecurity and hunger. Perhaps most significantly, this study was able to provide greater insight into the experience of food insecurity and hunger within the disability population by distinguishing between various disabilities (physical, sensory, cognitive, and psychiatric) and living with single versus multiple disabilities.

This study also has several limitations. The study used cross-sectional data to assess the association of food insecurity and hunger with disability. Module design limits measurement of food insecurity and hunger to acute events; data are not available on food insecurity and hunger as chronic circumstances of a household over the course of multiple years. Furthermore, data on duration of disability were not available. Therefore, as no temporality can be imputed, this study does not definitively distinguish disability as a causal factor of these outcomes but does stress that the co-occurrence of disability with food insecurity and hunger is noteworthy in and of itself. Odds ratios do explicate on the likeliness of food insecurity and hunger experienced by individuals with disabilities as compared to the general population and the likeliness with which these outcomes occur within the disability subpopulation itself. Thus, results from this study carry public health implications.

Since its inception, a major concern for this study has revolved around the adequacy of subpopulation sample sizes. Prior to DHS approval and data analyses, power calculations were conducted based on 2005 and 2006 disability type estimates reported by the Oregon Department of Human Services for public viewing at http://www.dhs.state.or.us/dhs/ph/chs/brfs/brfss.shtml. However, this strategy included several short-comings: 1) BRFSS estimates were a compendium of all available data from survey years 2005 and 2006 (i.e. these estimates included respondents from survey versions that were not usable for this study); 2) DHS-reported nature of disability categories overlapped; and 3) sample sizes for multiple versus single disabilities were hypothetical (and, after analyses of actual data, recognized as inflated).

Numerical instability from small cell counts was observed during the model building process. To avoid small cell counts, all variables were dichotomized, with the exception of disability type (which had four subcategories) and age (which was assessed both as a continuous variable and as a three level ordinal variable). Although variable dichotomization was necessary, the collapse of several categories resulted in unavoidable heterogeneity within cells. Cell heterogeneity among some demographic variables is likely to have contributed to the presence of wide confidence intervals, which was particularly prevalent for estimates involving the annual household income demographic.

Sample size may also have been a contributing factor to observations of threshold-like events, such as in the interaction between age group and psychiatric disability in relation to food insecurity. There were 29 respondents with psychiatric type of disability aged 55years and older, 47 respondents aged 35-54 years, and 17 respondents aged 18-34 years. The youngest age group showed a non-significant relationship with food insecurity, perhaps due to the small cell size.

The highest odds of food insecurity were observed for individuals with psychiatric disability type in the middle aged category (OR 10.14), which had the largest cell size.

To properly interpret odds ratios, unweighted cell counts were inspected; cell counts of 20 or less were identified to potentially explain imprecise endpoints. For example, when assessing food insecurity in a multivariate model, individuals with sensory disabilities with households income less than $25,000 annually were found to have significantly greater odds of food insecurity that than referent group members with physical disabilities and household income of $25,000 or more (OR 7.97; 95%CI:1.31-49.63; p=0.024). While the association itself may be present in the Oregon population, the estimates are characteristic of numerical instability and cannot be used with confidence. Out of a total of 57 individuals reporting sensory disability type, five out of 17 reporting annual household incomes of less than $25,000 also reported experience with food insecurity; none of the individuals earning $25,000 or more reported food isencurity. Comparatively, the physical referent category consisted of 1,243 observations, 202 of whom reported food insecurity. Small cell sizes were also a concern for males reporting disabilities. BRFSS respondents included considerably fewer respondents who were males with disabilities than respondents who were females with disabilities. The limited male sample size limited exploration of the number of disability as a correlate of hunger, and may have contributed to the non-significance of gender in other multivariate analyses.

Another limitation regards BRFSS study design which was alluded to in previous sections. BRFSS obtains survey data through telephone interviews. As such, persons without landlines (that is, households with no telephone or members using only cell phones) are not represented. Specific populations, such as males, minorities, and low-income adults, are more likely to live in cell-phone-only households, and wireless substitution is increasingly common

among young adults (aged 18-24 years) (Blumberg & Luke 2007; 2009). In their analysis of national BRFSS data regarding the use of alcohol and tobacco among young adults, Delnevo et al. (2008) suspected that the observed decrease in prevalence of drinking and smoking was an artifact of under-coverage via traditional phone sampling and the increasing trend for wireless substitution. Although Kinne and Topolski (2005) reported that population telephone surveys do not appear to under-represent adults with disabilities, the characteristic low income levels of individuals reporting food insecurity suggests that the potential for under-coverage bias exists in this study. Furthermore, hundreds of interviews in 2005 and 2006 were impeded due to physical or mental impairments of the respondent (CDC-Data Quality 2005 & 2006. Because the BRFSS interviewing strategy does not include the use of proxies to identify other members in the household who may have a disability, the prevalence of individuals with disabilities in Oregon may be underestimated. Likewise, the prevalence of food insecurity and hunger among individuals with disabilities may have also been underestimated. The overall response rate (ORR) in Oregon was 36.9% in 2005 and 35.4% in 2006 (CDC-Data Quality 2005 & 2006). The ORR is a conservative response rate that includes a higher percentage of all households in the denominator. Quality control guidelines by CDC suggest a minimum acceptable value of 30% (CDC-Data Quality 2005 & 2006) . The response rate based on guidelines from the Council of American Survey Research Organizations (CASRO) was 59.2% in 2005 and 51.7% in 2006 (CDC-Data Quality 2005 & 2006). The minimum acceptable value for CASRO rates is 40% (CDC-Data Quality 2005 & 2006). This estimate reflects telephone sampling efficiency, the degree of cooperation among eligible persons who were contacted, and the assumption that numbers never contacted contain the same percentage of eligible households as records whose eligibility status is known. Although 2005 and 2006 survey years appear to have garnered

acceptable response rates, a substantial number of potentially eligible households and eligible households were excluded from BRFSS because of physical or mental impairments that impeded interviews. Additional households were excluded as a result of language barriers, which likely reduced participation of people with disabilities from racial/ethnic backgrounds other than non-Hispanic White, and may also have excluded persons with communication disabilities. These exclusions likely contributed to an underestimation in the prevalence of certain disability types.

Another issue in regards to study design and analysis arises from the merging of group and individual level measures. Disability and disability type are individual level measures. Food security is a household measure. Individual level food security measures do not yet exist. A USDA guide on measuring food insecurity suggests that when a household's food security level is severe enough to affect any household member then others, if not all, are also affected (Bickel et al. 2000). A separate review on food security suggests that there may not be a difference in mean food intake between preschoolers from food insecure and food secure households (Rose 1999). However, the review identified a significant lower mean consumption rate in adult members of a food insecure household. Because the present study was limited to adults only, differences between household level and individual respondent experiences of food insecurity were likely mitigated.

Lastly, certain limitations arise as a result of the categorization of disability types in the BRFSS and the manner in which analysis was conducted in this study. Although the five categories (Physical, Sensory, Cognitive, Psychiatric, Something Else) are fairly broad, certain disabilities may not have been captured within the categories analyzed. For example, individuals with multiple chemical sensitivities may have chosen "something else" as a disability type instead of the relatively specific categories of physical, sensory, cognitive, or psychiatric type.

Because “something else” was excluded from analysis, a portion of the disability population was lost. Reasons behind excluding “something else” were primarily concerned with eliminating unknowns. “Something else” may have been chosen by individuals with chronic conditions, autoimmune diseases, viral infections, or disabilities that were too multifaceted to pinpoint with BRFSS categories. A total of 70 respondents described their disability condition as “something else;” 7 and 2 of these respondents reported experience with food insecurity and hunger, respectively. Another issue suspected in the low prevalence of people with multiple disability types is the way in which the supplemental disability question is asked. For example, if the question was asked in the following manner “What is the nature this health condition – physical, sensory, cognitive, psychiatric, or something else,” it may not have been clear to respondents that they had the option of selecting multiple categories. Interviewers entered more than one description of disability type only if the respondent volunteered that information.

Public Health Implications and Future Studies

Despite decreases in the overall prevalence of food insecurity and hunger in the state, many Oregonians still struggle with these circumstances in their households. As this study has shown, Oregonians with disabilities are particularly affected by food insecurity and hunger. Although Oregon continues to invest a considerable amount of resources into food assistance programs, this study’s findings suggest that alternative strategies may be needed to expand food assistant services and target the disability population. In their population-based study, Klesges et al. (2001) reported that only a small portion of elderly disabled women with food insecurity received food stamps (19.3%) and fewer participated in food assistance programs (7%). It is conceivable that many Oregonians with disabilities are unaware of the Supplemental Nutrition

Assistance Program (SNAP, formerly the food stamp program) and of the availability of local food pantries and other emergency food services. Furthermore, issues with the SNAP enrollment process or the accessibility of various food pantry facilities may pose barriers to utilization of such programs. Although SNAP generally requires face to face interviews, exceptions are made for households with members with disabilities in that a representative may be appointed to go to the SNAP office or the interview may be conducted over the phone or through a home visit. However, SNAP staff must be aware of the household first. It may be beneficial to target the disability population and case managers to increase awareness of food assistance programs. Additionally, when households with disabilities are in receipt of the SNAP stipend, the stipend could be supplemented with food-wise educational materials, such as brochures that promote fruit and vegetable consumption.

To further enhance outreach, focus groups, at a city or county level, could be conducted to discuss unique issues individuals with disabilities face in obtaining appropriate quantities and quality of food, including obstacles such as transportation, lack of knowledge, and income limitations. In fact, the Oregon Food Bank annually conducts a series of focus groups throughout the state that allow emergency food pantry clients to discuss their experiences with hunger and share opinions on how similar experiences might be reduced in Oregon. In 2008, many participants discussed having to trade-off getting food in order to get other necessities such as medicine (OFB 2008). Others discussed the stress associated with stretching every penny and how despite their efforts to save money, healthy foods such as fruit and vegetables were difficult to purchase on a budget and spoiled easily (OFB 2008). Perhaps, as an initial step, the use of focus groups could be used to design interventions to reduce food insecurity and hunger among people with disabilities and provide education on nutrition, managing finances, developing a

support system, etc. Eventually, perhaps there could be a "FoodWise" program analogous to Trimet's RideWise Program[11]. Regardless of the specific programs available, awareness of food assistance programs needs to be expanded, particularly to certain groups more vulnerable to food insecurity than others, such as people with disabilities. To facilitate participation these programs need to be accessible; language used should be easy to understand, the enrollment process should be uncomplicated and easy to execute, and the built environment should accommodate all disability types.

Future studies may involve assessment of food stamp benefits received by individuals with disabilities as well as their utilization of food pantries. This may be possible with other datasets such as the National Health and Nutrition Examination Survey (NHANES) that assess food insecurity and disability in a household along with receipt of food stamp benefits; disability type may be roughly imputed from descriptions of activity limitations given by respondents.

As a last point, this study lends further support to previous findings that, comparatively, people with disabilities make less money, are less likely to perceive health as good, very good, or excellent, and are more likely to be obese than people without disabilities (She & Livermore 2006; Drum et al. 2009; Adams et al. 2007;). All of the above characteristics are associated with food insecurity and hunger in a household. Because people with disabilities are often less visible, undercounted, underrepresented, and underserved (Hahn 1993), continued public health efforts are needed for the reduction and prevention of such disparities. Chilton and Rose (2009) recommend a human rights approach to addressing the problem of food insecurity in the United States. A human rights framework would reposition the approach to solving food insecurity by acknowledging and actively addressing its social and economic determinants, such as the

[11] RideWise is a collaborative effort by TriMet and Ride Connection to provide transportation services to elderly and people with disabilities. RideWise representatives provide one-on-one training with interested individuals. Website: http://rideconnection.org/services/RideWise.htm

sociodemographic circumstances of people with disabilities. Chilton and Rose discount the needs-based approach employed thus far; claiming "the idea of good nutrition is not something based solely on benevolence or charity, but is, rather, the duty and obligation of a country to its people" (2009). To support the authors' argument and to reiterate a point made elsewhere, income alone cannot adequately describe the circumstances associated with food insecurity and hunger. Thus, providing income-specific interventions alone will not entirely eliminate food insecurity and hunger. For example, people with psychiatric disabilities may reduce their odds of experiencing food insecurity with benefits from SSI, SNAP and Medicaid, access to substance abuse treatment, increased employment opportunities, housing security, and improved communication with family, case managers, and health providers. Chilton and Rose emphasize a shift to a rights-based approach to create enabling environments for people to procure their own food but without the forced trade-offs among basic needs of housing, food, and medical care (2009). A rights-based approach to preventing food insecurity would involve the evaluation of whether programs, policies, and built environments create or maintain vulnerability in people with disabilities.

Conclusion

This study has described a range of demographic factors associated with food insecurity and hunger, including the high prevalence of these outcomes among people with disabilities in Oregon. Furthermore, this study found that within Oregon's disability subpopulation, food insecurity and hunger were disproportionately experienced by people with certain types of disability. Individuals with either cognitive or psychiatric disability type as well as individuals with multiple disabilities had high odds of experiencing food insecurity and hunger in their

households. Programs focused on addressing food insecurity may benefit from including strategies that alert individuals with disabilities and their caregivers to such services. However, to increase program effectiveness it is prudent that disability as a "lived experience" be better understood. Disability is a complex issue involving many factors; additional studies are needed to investigate social and environmental elements to enhance accessibility of paths to health and well-being. Initial steps involve recognizing the diversity within the disability population, and understanding the reasons behind varying levels of food insecurity.

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Appendix A

Correlate Variable Grouping for model building process

Rank	Correlate Grouping	Bonferroni Significance level
1	Disability Variable[§] Annual Household Income Employment	0.0166
2	Education Race Age Gender	0.0125
3	Health Status Obesity	0.025
4	Marital Status Number Adults	0.025
5[¥]	Metropolitan County Residence Western County Residence	0.025

§Due to high degree of correlation, disability variables (overall disability, disability type, and number of disabilities) assessed separately.

¥ Last Grouping only for model assessing correlates for HUNGER in Oregon.

Model Building Processes:

Table A1. Manual Model Selection Process – Multivariable Logistic Regression Model, Adjusted Wald F-Statistic p-values for food insecurity with disability as covariate of interest. Refer to Table 8 in the thesis.

Characteristic	Stage 1: Grouped Correlate Testing, Wald F p-value	Characteristic	Stage 2: Individual Correlate Testing* Wald F P-value
Disability Income Employment	<0.0001	Disability	0.0002
		Income	<0.0001
		Employment	0.0022
Age Race Gender Education	<0.0001	Age	<0.0001
		Race	<0.0001
		Gender	0.0043
		Education	0.0911
Health Status Obesity	0.0034	Health Status	0.0233
		Obesity	0.0397
Marital Status Number of Adults	0.5594		

(Date Source: 2005 & 2006 Oregon BRFSS)

*** Individual correlate testing is a manual backwards stepwise regression model building technique.**

Table A2. Manual Model Building Process – Multivariable Logistic Regression Model, Odds ratios and p-values for food insecurity with disability as covariate of interest. Refer to Table 8 in the thesis.

Characteristic	Stage 1: Grouped Correlate Testing, OR (p-value)[§]	Stage 2: Individual Correlate Testing, OR (p-value)[∞]	Stage 3: Removal of Age Variable[φ]
Disability	2.02 (<0.001)	2.03 (<0.001)	1.55 (0.016)
Income	3.54 (<0.001)	3.72 (<0.001)	4.57 (<0.001)
Employment	1.92 (0.003)	1.95 (0.002)	1.87 (0.006)
Age	0.97 (<0.001)	0.97 (<0.001)	
Race	2.27 (<0.001)	2.24 (<0.001)	2.59 (<0.001)
Gender	1.54 (0.005)	1.55 (0.004)	1.45 (0.011)
Education	1.32 (0.078)	1.31(0.091	
Health Status	1.68 (0.020)	1.67 (0.023)	1.57 (0.027)
Obesity	1.39 (0.034)	1.38 (0.040)	1.27 (0.121)
Marital Status	1.11 (0.293)		
Number of Adults	1.00 (0.987)		

(Date Source: 2005 & 2006 Oregon BRFSS)
§ Grouped correlates that did not meet Bonferroni significance levels were eliminated from model.
∞ Correlates that did not meet alpha of 0.05 were eliminated from model.
φ Age variable removed to improve model fit. Obesity variable subsequently dropped after elimination of Age variable.

Table B1. Manual Model Selection Process – Multivariable Logistic Regression Model, Adjusted Wald F-Statistic p-values for hunger with disability as covariate of interest. Refer to Table 9 in the thesis.

Characteristic	Stage 1 : Grouped Correlate Testing Wald F p-value	Characteristic	Stage 2 : Individual Correlate Testing* Wald F p-value
Disability Income Employment	<0.0001	Disability	0.0007
		Income	<0.0001
		Employment	0.0053
Age Race Gender Education	0.0105	Age	0.0149
		Race	0.4244
		Gender	0.0661
		Education	0.5562
Health Status Obesity	0.0022	Health Status	0.0159
		Obesity	0.0164
Marital Status Number of Adults	0.6435		
Metropolitan Area Residence County of Residence	0.0006	Metropolitan Area Residence	0.0006
		County of Residence	0.1015

(Date Source: 2005 & 2006 Oregon BRFSS)
*** Individual correlate testing is a manual backwards stepwise regression model building technique.**

Table B2. Manual Model Building Process – Multivariable Logistic Regression Model, Odds ratios and p-values for hunger with disability as covariate of interest. Refer to Table 9 in the thesis.

Characteristic	Stage 1: Grouped Correlate Testing, OR (p-value)[§]	Stage 2: Single Correlate Testing, OR (p-value)[∞]	Stage 3: Removal of Age Variable[φ]
Disability	2.57 (<0.001)	2.55 (<0.001)	2.11 (0.004)
Income	7.53 (<0.001)	7.19 (<0.001)	8.68 (<0.001)
Employment	1.86 (0.007)	1.82 (0.009)	1.70 (0.017)
Age	0.98 (0.014)	0.98 (0.013)	
Race	1.15 (0.599)	1.19 (0.501)	
Gender	1.50 (0.051)	1.48 (0.060)	
Education	1.17 (0.477)	1.19 (0.414)	
Health Status	1.83 (0.017)	1.89 (0.015)	1.91 (0.014)
Obesity	1.74 (0.010)	1.74 (0.011)	1.66 (0.017)
Marital Status	0.89 (0.442)		
Number of Adults	1.11 (0.458)		
Metropolitan Residence	1.86 (0.009)	1.85 (0.010)	2.23 (<0.001)
County of Residence	0.66 (0.092)	0.67 (0.101)	

(Date Source: 2005 & 2006 Oregon BRFSS)
§ Grouped correlates that did not meet Bonferroni significance levels were eliminated from model.
∞ Correlates that did not meet alpha of 0.05 were eliminated from model.
φ Age variable removed to improve model fit.

Table C1. Manual Model Selection Process – Multivariable Logistic Regression Model, Adjusted Wald F-Statistic p-values for food insecurity with disability type as covariate of interest. Refer to Table 10 in the thesis.

Characteristic	Stage 1 : Grouped Correlate Testing Wald F p-value	Characteristic	Stage 2: Individual Correlate Testing* Wald F p-value
Disability Type Income Employment	<0.0001	Disability Type	0.0480
		Income	<0.0001
		Employment	0.5458
Age Race Gender Education	0.0034	Age	0.0089
		Race	0.0020
		Gender	0.0718
		Education	0.5982
Health Status Obesity	0.0244	Health Status	0.0026
		Obesity	0.8803
Marital Status Number of Adults	0.6883		

(Date Source: 2005 & 2006 Oregon BRFSS)
*** Individual correlate testing is a manual backwards stepwise regression model building technique**

Table C2. Manual Model Building Process – Multivariable Logistic Regression Model, Odds ratios and p-values for food insecurity with disability type as covariate of interest. Refer to Table 10 in the thesis.

Characteristic	Stage 1: Grouped Correlate Testing, OR (p-value)[§]	Stage 2: Single Correlate Testing, OR (p-value)[∞]
Disability Type[€]		
Sensory	0.93 (0.921)	0.90 (0.895)
Cognitive	1.50 (0.237)	1.48 (0.257)
Psychiatric	3.42 (<0.001)	3.32 (0.001)
Income	4.84 (<0.001)	4.63 (<0.001)
Employment	1.38 (0.236)	1.33 (0.292)
Age	0.97 (0.005)	0.97 (0.008)
Race	2.89 (0.002)	2.94 (0.002)
Gender	1.54 (0.068)	1.53 (0.081)
Education	1.20 (0.482)	1.23 (0.414)
Health Status	1.96 (0.013)	1.99 (0.010)
Obesity	1.03 (0.889)	1.04 (0.880)
Marital Status	0.87 (0.409)	
Number of Adults	1.07 (0.689)	

(Date Source: 2005 & 2006 Oregon BRFSS)
§ Grouped correlates that did not meet Bonferroni significance levels were eliminated from model.
∞ Correlates that did not meet alpha of 0.05 were eliminated from model.
€ Physical type is referent group for disability type subcategories.

Table D1. Manual Model Selection Process – Multivariable Logistic Regression Model, Adjusted Wald F-Statistic p-values for hunger with disability type as covariate of interest. Refer to Table 11 in the thesis.

Characteristic	Stage 1 : Grouped Correlate Testing, Wald F p-value	Characteristic	Stage 2: Individual Correlate Testing,* Wald F p-value
Disability Type Income Employment	<0.0001	Disability Type	0.0010
		Income	<0.0001
		Employment	0.0012
Age Race Gender Education	0.0203	[redacted]	
Health Status Obesity	0.3623		
Marital Status Number of Adults	0.2304		
Metropolitan Area Residence County of Residence	0.1178		

(Date Source: 2005 & 2006 Oregon BRFSS)
φ Age variable subsequently retained in model.
*** Individual correlate testing is a manual backwards stepwise regression model building technique.**

Table D2. Manual Model Building Process – Multivariable Logistic Regression Model, Odds ratios and p-values for hunger with disability type as covariate of interest. Refer to Table 11 in the thesis.

Characteristic	Stage 1: Grouped Correlate Testing, OR (p-value)[§]	Stage 2: Single Correlate Testing, OR (p-value)[∞]
Disability Type[€]		
Sensory	0.14 (0.073)	0.31 (0.128)
Cognitive	2.43 (0.024)	2.45 (0.013)
Psychiatric	3.86 (0.002)	3.45 (0.001)
Income	8.64 (<0.001)	7.68 (<0.001)
Employment	2.74 (0.001)	2.15 (0.006)
Age	0.98 (0.039)	
Race	1.16 (0.702)	
Gender	2.01 (0.012)	
Education	0.75 (335)	
Health Status	1.20 (0.537)	
Obesity	1.45 (0.204)	
Marital Status	0.71 (0.083)	
Number of Adults	1.29 (0.214)	
Metropolitan Residence	1.35 (0.332)	
County of Residence	0.61 (0.181)	

(Date Source: 2005 & 2006 Oregon BRFSS)
§ Grouped correlates that did not meet Bonferroni significance levels were eliminated from model.
∞ Correlates that did not meet alpha of 0.05 were eliminated from model.

Table E1. Manual Model Selection Process – Multivariable Logistic Regression Model, Adjusted Wald F-Statistic p-values for food insecurity with number of disabilities as covariate of interest. Refer to Table 12 in the thesis.

Characteristic	Stage 1 : Grouped Correlate Testing, Wald F p-value	Characteristic	Stage 2: Individual Correlate Testing,* Wald F p-value
Number of Disabilities Income Employment	<0.0001	Number of Disabilities	0.4301**
		Income	<0.0001
		Employment	0.3720
Age Race Gender Education	0.0012	Age	0.0046
		Race	0.0014
		Gender	0.0609
		Education	0.8760
Health Status Obesity	0.0161	Health Status	0.0026
		Obesity	0.5503
Marital Status Number of Adults	0.8941		

(Date Source: 2005 & 2006 Oregon BRFSS)
*** Individual correlate testing is a manual backwards stepwise regression model building technique.**
**** Variable of interest, number of disabilities, retained in model.**

Table E2. Manual Model Building Process – Multivariable Logistic Regression Model, Odds ratios and p-values for food insecurity with number of disabilities as covariate of interest. Refer to Table 12 in the thesis.

Characteristic	Stage 1: Grouped Correlate Testing, OR (p-value)[§]	Stage 2: Single Correlate Testing, OR (p-value)[∞]
Number of Disabilities[φ]	1.37 (0.432)	1.38 (0.418)
Income	4.91 (<0.001)	4.89 (<0.001)
Employment	1.47 (0.140)	1.44 (0.168)
Age	0.97 (0.004)	0.97 (0.004)
Race	2.98 (0.001)	3.02 (0.001)
Gender	1.49 (0.078)	1.49 (0.080)
Education	1.10 (0.691)	1.50 (0.669)
Health Status	1.88 (0.014)	1.90 (0.012)
Obesity	1.15 (0.534)	1.14 (0.550)
Marital Status	0.96 (0.783)	
Number of Adults	1.07 (0.674)	

(Date Source: 2005 & 2006 Oregon BRFSS)
§ Grouped correlates that did not meet Bonferroni significance levels were eliminated from model.
∞ Correlates that did not meet alpha of 0.05 were eliminated from model.
φ Number of disabilities variable retained in model despite lack of significance during model building process.

Table F1. Manual Model Selection Process – Multivariable Logistic Regression Model, Adjusted Wald F-Statistic p-values for hunger with number of disabilities as covariate of interest. Refer to Table 13 in the thesis.

Characteristic	Stage 1 : Grouped Correlate Testing, Wald F p-value	Characteristic	Stage 2: Individual Correlate Testing,* Wald F p-value
Number of Disabilities Income Employment	<0.0001	Number of Disabilities	0.1578**
		Income	<0.0001
		Employment	0.0002
Age Race Gender Education	0.0046	Age	0.0488
		Race	0.6082
		Gender	0.0028
		Education	0.1597
Health Status Obesity	0.1915	[redacted]	
Marital Status Number of Adults	0.4291		
Metropolitan Area Residence County of Residence	0.0497		

(Date Source: 2005 & 2006 Oregon BRFSS)
*** Individual correlate testing is a manual backwards stepwise regression model building technique.**
**** Number of disabilities variable retained in model.**

Table F2. Manual Model Building Process – Multivariable Logistic Regression Model, Odds ratios and p-values for hunger with disability as covariate of interest. Refer to Table 9 in the thesis.

Characteristic	Stage 1: Grouped Correlate Testing, OR (p-value)[§]	Stage 2: Single Correlate Testing, OR (p-value)
Number of Disabilitiesφ	1.59 (0.238)	1.70 (0.167)
Income	9.34 (<0.001)	8.51 (<0.001)
Employment	2.97 (<0.001)	3.02 (<0.001)
Age	0.98 (0.021)	0.98 (0.055)
Race	1.17 (0.651)	1.28 (0.459)
Gender	1.87 (0.018)	2.17 (0.003)
Education	0.75 (0.286)	0.69 (0.160)
Health Status	1.33 (0.308)	
Obesity	1.44 (0.172)	
Marital Status	0.78 (0.182)	
Number of Adults	1.22 (0.296)	
Metropolitan Residence	1.55 (0.154)	
County of Residence	0.64 (0.194)	

(Date Source: 2005 & 2006 Oregon BRFSS)

§ Grouped correlates that did not meet Bonferroni significance levels were eliminated from model.

∞ Correlates that did not meet alpha of 0.05 were eliminated from model.

φ Number of disabilities variable retained in model despite lack of significance during model building process.