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Effects of Obesity On United States Farmers: A Pilot Study

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EFFECTS OF OBESITY ON UNITED STATES FARMERS: A PILOT STUDY

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Nursing
at the University of Kentucky

By

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ABSTRACT OF DISSERTATION

EFFECTS OF OBESITY ON WORK ABILITY IN U.S. FARMERS: A PILOT STUDY

Previous research described the value farmers place on their ability to work. The impact of obesity on workers is an increasing concern in occupational health research; yet, knowledge regarding the impact of obesity on the performance of farm work is limited. Identifying the impact of obesity on farmer's work ability can guide healthcare workers in promoting and motivating farmers to implement lifestyle changes to improve health and sustain longevity in their ability to work.

The purpose of this dissertation was to examine the impact of obesity on the work ability of U.S. farmers. Specific aims were to 1) examine the current state of the science regarding obesity in farmers; 2) to evaluate the psychometric properties of the Work Ability Index; 3) identify the relationship between obesity and work ability; and 4) compare central versus general obesity as predictors of decreased work ability in U.S. farmers.

Key findings of this research support obesity as an increasing concern among U.S. farmers which can result in a decline in work ability. Psychometric evaluation of the Work Ability Index also supports the use of this tool for research and clinical assessment in this population. Implications for clinical practice and nursing research are also discussed.

KEYWORDS: Farmers, Obesity, Work ability, Work Ability Index, Body Mass Index, Waist Circumference

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This work is dedicated to my husband, Joe. Your tolerance, patience, love, and support have been invaluable throughout my life and my career. I will always love you; what else is there to say?

and

To Dr. Jeanne Flannery Stewart, my role model, mentor and source of inspiration. Thank you so much for your pride and belief in me, which gave me the confidence to set my goals higher and strive to achieve them.

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CHAPTER 1. INTRODUCTION

The current focus of occupational health has changed from ensuring a safe physical work environment to maintaining a healthy, sustainable workforce. In 1984, the National Institute of Occupational Safety and Health (NIOSH) recommended a synergistic approach combining occupational safety and health and worksite health promotion to improve the health of workers (National Institute of Occupational Safety Health (NIOSH), 2012). This idea evolved into a focus on total worker health, defined by NIOSH as the "policies, programs, and practices that integrate protection from work-related safety and health hazards with the promotion of injury and illness prevention efforts to advance worker well-being." (NIOSH, 2015, paragraph 1). The American College of Occupation and Environmental Medicine (ACOEM) and the World Health Organization also embrace this model as essential to ensuring a healthy, productive workforce and sustaining productive enterprises, organizations, and national and global economies (ACOEM Committee on Health, 2009; Burton, 2010).

Smith (2013) identified obesity as one of the three deadliest threats facing American workers, and an increasing risk for both personal and economic health. Obesity is also an increasing problem among U.S. farmers (Myers, Layne, & Marsh, 2007, Schenker & Kirkhorn, 2001). This dissertation explored the role of obesity in work ability among U.S farmers. Findings from this study expand the current knowledge of the role of obesity in occupations requiring substantial physical labor. This research also addressed the mandate of the National Occupational Research Agenda (NORA) strategic goal 5, "To improve the health and well-being of agricultural workers by reducing occupational causes and contributing factors to acute and chronic illness and disease (NORA AgFF Sector Council, 2008)." Furthermore, this study provided data to support improved clinical evaluation, education and counseling regarding the impact of obesity on farmers' continued ability to perform work.

Conceptualization of this study was based on the *Multidimensional Model of Work Ability* (Illmarinen, Gould, Jarvikoski, & Jarvisalo, 2008). Workability is the balance of worker resources to work demands (Ilmarinen, 1999; Ilmarinen, Tuomi, & Klockars, 1997, van den Berg, Elders, de Zwart, & Burdorf, 2009). Worker resources include health and functional capacity along with knowledge, skills, values, and attitudes; word demands includes work content, organization, work environment and management (Ilmarinen, Tuomi, & Seitsamo, 2005). Declines in work ability are associated with increased disability (Alvania, DeBoer, Van Duivenbooden, & Frings-Dresen, 2009), early retirement (Sell, 2009; van den Berg, Elders, & Burdorf, 2010), overall decreased workforce participation (Klarenbach, Padwal, Chuck, and Jacobs, 2006) and increased lost productivity (Vänni, Virtanen, Luukkaala, & Nygård, 2012.)

From 1980 to 2000 obesity rates in the U.S. doubled (Wilborn et al., 2005). Slower but persistent increases have continued over the last decade. Based on analysis of the 2010-2011 National Health and Nutrition Examination Survey (NHANES), the obesity rate among U.S. workers was estimated at 27.7 % or more than 134 million workers (Gu et al., 2014; Luckhaupt et al., 2014).

This increase raises concerns about the impact of obesity on ensuring a sustainable workforce. Extensive research supports the role of obesity in the development of chronic diseases including Type 2 Diabetes, coronary artery disease, and arthritis (Brown, Fujioka, Wilson, & Woodworth, 2009; Jensen, 2008; Korner, Woods & Woodworth, 2009). Independent of obesity-related disease, research also links obesity to altered body mechanics and posture, increased mechanical overload on the spine and joints, decreased muscle strength, and adverse effects on the cardiopulmonary systems (Capodaglio et al., 2010; Hergenroeder et al., 2011; Ling et al., 2012; Pataky, Armand, Muller-Pinget, Golay, & Allet, 2014; Salome, King, & Berend, 2010; Wearing, Hennig, Byrne, Steele & Hills, 2006; Zutler et al., 2012) which lead to declines in physical functioning. Obese workers also report increased psychological distress due to perceived workplace discrimination, decreased work advancement and decreased career success (Geil et al., 2010). The physiological and psychological impact of obesity can lead to decreased ability to perform work (Laitinen, Nayha, & Kujala,2005).

Studies on the impact of obesity most commonly use the body mass index (BMI) as the indicator of obesity. However, recent literature questions if this is the best method. Central obesity, measured by waist circumference (WC), waist to hip or waist to height ratio, has been shown to be a better prognostic indicator of mortality (Petursson, Sigurdsson, Bengtsson, Nilsen, & Getz, 2011; Kahn, Bullard, Barker & Imperatore, 2012), chronic illness (Conoy, 2008; Evans, McIntyre, Fluck, McIntyre & Taal, 2012; Peppa et al., 2012) and physical disability in women (Wong et al., 2012). Abdominal fat, or central obesity, has also been shown to be an independent predictor of decreased functional capacity and disability in the elderly population (Houston, Stevens, & Cai, 2005; Sternfeld, Ngo, Satarino, & Tager, 2002). However, research is absent on the impact distribution of fat exhibits in work ability.

Farmers offer a unique population for the study of obesity’s impact on work. Farm and farm-related industries contributed substantially to the U.S. economy contributing $835 billion (4.8%) to the gross domestic product and employment of 17 million (9.3%) full and part-time workers to U.S. employment (U.S. Department of Agriculture, 2016). In the U.S., 91% of all farms are small, family-owned businesses. The U.S. Department of Agriculture (February 2013) estimated that there are 1, 282, 100 hired farm workers in the U.S, constituting approximately one-third of the farm labor population. Self-employed farmers and non-paid family members perform the remainder of farm labor. Maintaining health to ensure maximum productivity is essential for both personal and economic health.

Farmers in the U.S. also have substantially high rates of obesity. Andreotti et al. (2010) reported increased obesity rates for the Agricultural Health Study Cohort (n=67, 947), including 43% overweight, 16.75% class 1 obesity, and 4.7 % highly obese. More recently, Gu et al. (2014) reported an obesity rate among farmers in the National Health Interview Survey of 29.1%. However, research on the occupational impact of obesity on farmers is almost nonexistent.

Research on work ability in farmers is limited, and the available research was conducted on Finnish farmers. In this population, work ability among farmers was rated lower than other occupational groups, with older farmers and females rating their work ability as poorer. Other risk factors for poor work ability included small herd size, lack of mental breaks from work, inadequate leisure time, and non-use of alcohol (Karttunen & Rautiainen, 2011). Finnish farmers differ significantly from U.S. farmers in mean age, 44 and 58 years respectively (Karttunen & Rautiainen, 2009; U.S. Department of Agriculture, 2016). In addition, research on self-rated health revealed U.S. farmers perceive themselves as healthy and continue to perform work even after they consider themselves retired (Amshoff & Reed, 2005; Winter, Reed & Westneat, 2009). Therefore, generalization of the current research on work ability to U.S. farmers would be questionable. The purpose of this pilot study was to 1) describe the current state of the science regarding obesity in farmers, 2) examine the psychometric properties of the Work Ability Index (WAI) in U.S. farmers; 3) examine the relationship between obesity and work ability in U.S. farmers; and 4) compare the impact of general and central obesity on work ability in farmers.

Chapter two of this dissertation reports the findings of a literature review performed to describe the current knowledge regarding obesity in farmers, determine gaps in the literature, and identify potential confounding variables to consider when exploring obesity and work in farmers. Utilizing the models of the interrelationship between obesity and the occupational environment (Pandalai, Schulte, and Miller, 2013) the following were reviewed: a) prevalence of and contributing factors to obesity in farmers, b) obesity as a contributing factor to farm work-related injuries and illnesses, and c) obesity's impact on work ability and work productivity. Based on the findings of this review, work ability was chosen as the outcome variable for exploring obesities impact on farmers. Confounding variables identified included age, gender, education, race/ethnicity, smoking status and alcohol use.

Chapter three reports the results of a psychometric evaluation of the WAI in a sample of U.S. farmers. The WAI, developed by the Finnish Institute of Occupational Health (FIOH), is based on a holistic model of work ability and evaluates the impact of health, functional capacity and mental resources on work ability. Though widely used internationally, the WAI has limited use in farmers and has not been utilized in U.S. workers. Using a sample of 100 farmers who completed the survey, internal consistency and construct validity of the tool was examined. Cronbach's alpha, exploratory principal component analysis, and hypothesis testing were used to demonstrate adequate reliability and validity of the WAI.

Chapter four describes the study examining the relationship between obesity and work ability. The chapter describes the sample, procedures and the findings of two multivariate linear regression analysis modeling work ability on BMI and identified confounding variables and work ability on WC and identified confounding variables. In addition, a report of a regression commonality analysis comparing the strength of BMI and WC as predictors of work ability is described.

Chapter five provides the conclusion of the dissertation. A synopsis of study findings and conclusions based on these findings are provided. Study limitations and implications for clinical practice are described. Recommendations for future research based on the results of this pilot study are also discussed.

CHAPTER 2. LITERATURE REVIEW

Obesity and Farmers' Work, Health, and Safety: The State of the Science

Abstract

Objective: To review the current literature related to the prevalence, contributing factors and impact of obesity in the U. S. farming sector.

Background: Obesity is a recognized threat to the health and well-being of individuals, the sustainability of a productive workforce, and the economic well-being of organizations and nations. Current information regarding the impact of obesity on physically demanding occupations such as farming is limited.
Method: We conducted a literature search of PubMed, Medline, CINAHL, and Agricola for the dates 2000 to 2015. Criteria for inclusion in the review included farmer-related articles with measures of obesity as a study demographic or study variable. Data from the search was utilized to describe the prevalence, factors contributing to, and impact of obesity on work.

Results**:** The search returned forty-six relevant articles including 12 prospective studies and one meta-analysis; the remaining studies were cross-sectional design. Results support that obesity prevalence is increasing among farmers. Factors identified as contributing to obesity in farmers included decreased occupational workload, limited leisure physical activity and exposure to obesogenic chemicals. Current research regarding obesity's impact on work-related illnesses and injuries, work ability, and work productivity is too limited to draw conclusions at this time.

Conclusion: Obesity is increasing in prevalence among farmers. Both behavioral and work factors are contributing to this increase. Further research is needed to evaluate the impact of obesity on the ability to perform farm work safely and efficiently.

Introduction

Obesity is a complex disease that affects 13% of adults globally and over 1 in 3 adults in the U.S. (Ng et al., 2014). The role of obesity is well-documented as a risk factor for non-communicable illnesses, decreased quality of life, and as a contributor to premature morbidity and mortality. Obesity is also a recognized threat to a sustainable, productive workforce and a growing economic burden on organizations and national economies (Lehnert et al., 2013; Long, Reed, & Lehman, 2006; Withrow & Atler, 2010). Occupational health organizations recommend addressing the interaction of occupational and personal risk factors, such as obesity, with a focus on total worker health to ensure a safe, healthy and productive workforce (Burton, 2010; American College of Occupational and Environmental Medicine [ACOEM], 2009; National Institute for Occupational Safety and Health [NIOSH, 2012].

The traditional portrayal of farming is a healthy, wholesome, bucolic lifestyle. In reality, farming is strenuous, stressful, and dangerous work. Though past research supported an association between farming and decreased mortality and chronic illness (Fleming, Gomez-Marin, Zheng, Ma, & Lee, 2003; Rautainen & Reynolds, 2002), more recent research revealed increased rates of obesity and associated co-morbidities as a health threat for farmers (Brumby, Chandrasekara, McCoombe, Kremer, & Lewandowski, 2011; Gu, et al., 2014; Luckhaupt, Cohen, Li, & Calvert, 2014). Brumby, Chandrasekara, McCoombe, Kremer, And Lewandowski (2011), in their work with Australian farmers, described social and environmental factors in farming that result in a "defeat cycle" and lead to negative outcomes including psychological distress, obesity, and poor mental and physical health outcomes.

Independent of disease, obesity induces physiological changes which alter body mechanics, decrease cardiopulmonary function and impact worker performance and safety (Arndt, Rothenbacher, Zschenderlein, Schuberth, & Brenner, 2007; Capodaglio et al., 2010; Hergenroeder, Brach, Otto, Sparto, & Jakicic, 2011; Ling, Kelechi, Mueller, Brotherton, & Smith, 2012; Pataky, Armand, Muller-Pinget, Golay, & Allet, 2014; Salome, King, & Berend, 2010; Zutler et al., 2012). Though associated with sedentary lifestyles, research is increasingly identifying obesity, and associated poor work outcomes, in workers from occupations with high physically demanding workloads. Findings supported an association between obesity and increased work-related injuries in construction workers and firefighters (Dong, Wang, & Largay, 2015; Jahnke, Poston, Haddock & Jitnarin, 2013). Obesity is also associated with disability in construction workers (Claessen, Brenner, Druth, & Arndt, 2013); and increased risk of musculoskeletal disorders, disability and work productivity in obese workers in other physically demanding occupations (Summers, Jinnett, & Bevans, 2015). As an industry, farming is a leading contributor to work-related illnesses and injuries in the U.S (Bureau of Labor Statistics [BLS], 2015; BLS, 2014). Currently, farming faces threats of an aging worker population and declining numbers of young people entering the field (Hoppe, 2014), making additional lifestyle risks to farmers' health and productivity especially concerning.

Farming is vital to the health and wellbeing of society. Farmers' contributions in the U.S., include a safe, adequate food supply, a 60% lower percentage of income for food cost relative to global markets, production of 10% of the nation's exports; and major contributions to rural and national economies (Joint Economic Committee, 2013). Ensuring the health and wellbeing of farmers has implications for individuals, communities, nations, and global societies.

Ensuring a healthy, productive agricultural workforce requires knowledge of the current status and impact of obesity on the performance of farm work. The potential to blame the worker for occupationally related disease and injuries has been identified as an ethical concern in research regarding lifestyle behaviors' impact on occupational health and safety (Schulte et al., 2008). Understanding the impact and interaction of combined personal and workplace risk is imperative to ensure safety in the workplace, and a clear analysis of obesity in farmers is lacking. Therefore, the purpose of this review is to analyze the current knowledge regarding obesity in farmers, including (a) the prevalence of obesity; (b) work related factors contributing to obesity; and (c) obesity's impact on farmers' health and safety, work ability, and work productivity.

Methodology

The heuristic models of the interrelationship between obesity and occupational risk (Pandalai, Schulte, & Miller, 2013) served as a conceptual model for evaluating the science of obesity's impact on the occupational health and safety of farmers. Within these models, occupational risk factors and personal risk factors combine to produce the outcome of obesity, the personal risk factor of obesity combines with occupational risk factors to alter occupational illness and injury outcomes, and obesity and the demands of the work environment interact to alter the worker's performance. The review consisted of a series of searches of the databases Medline (Ovid), PubMed, Agricola, and CIHNAL. Each search utilized the Boolean phrase obesity AND farmers OR agricultural workers in combination with the one of the following keywords: contributing factors, work-related injuries, work-related illnesses, work ability, disability, productivity, and health AND safety. Additionally, a search using the Boolean phrase of obesity prevalence AND farmers OR agricultural workers was also performed. Peer-reviewed articles published between 2000-2015 in the English language and human adult subjects 19 years of age and older were included. Following removal of duplicates, reviews and editorials, text and abstracts were reviewed. Studies retained for the review included those that incorporated farmers or agricultural workers and a measure of obesity.

Results

The literature search returned 772 articles with 46 retained for inclusion in the review. **Figure 2-1** outlines the details of the search. Study designs included cross-sectional (n=33), prospective (n=12) and meta-analysis (n=1). Over half the studies (*n*=24) were conducted in North America. Of the remaining studies, six were conducted in Europe, four in Australia, seven in Asia, and two each in South America and Africa. The majority of the studies (57%) utilized BMIs calculated from self-reported heights and

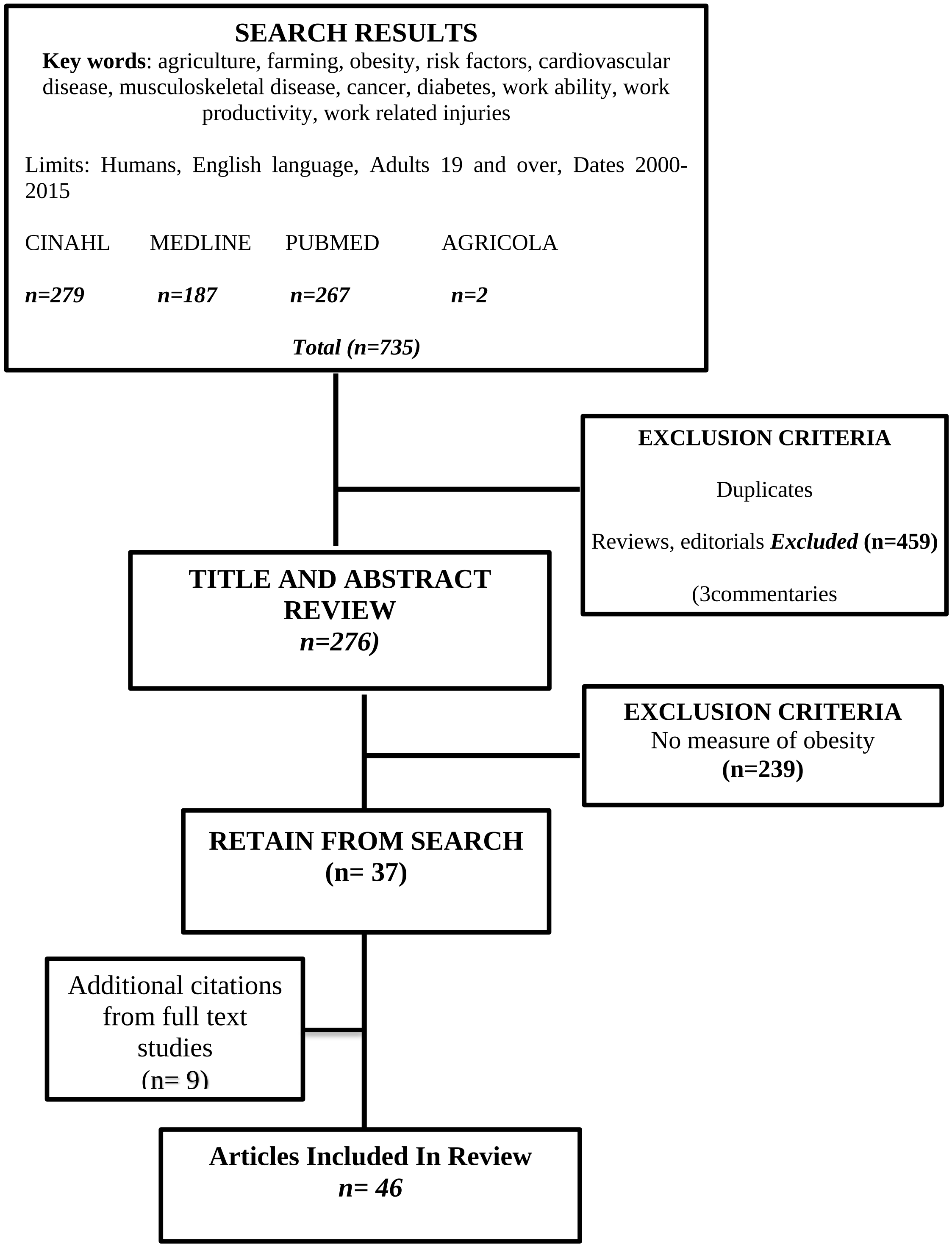

Figure 2-1. Literature Search Methodology and Outcomes

weight. The role of BMI varied in the studies including as a demographic or research variable (32.6 %), outcome (21.7%) and predictor variable (17.4%). The remaining studies used BMI as a confounding variable (28.3%) The study settings and samples were heterogenic and included developed and developing countries, crop and livestock farmers, and both modern high input, high technology, machine based and traditional, low input, labor intensive methods of farming.

Prevalence of Obesity in Farmers

Eight studies evaluated the prevalence of obesity or used obesity as a demographic variable only (**Table 2-1**). Rates of obesity ranged from a low of 9% for agriculture workers in 1999 (Caban et al., 2005) to a high of 44% in black female agriculture workers in 2010 (Gu et al., 2014). However, variations in the definitions of obesity based on the level of BMI impacts the ability to compare findings. One study classified obesity as a BMI greater than or equal to 30 kg/m^2 (Vardavas, Linardakis, Hatzis, Saris, & Kafatos, 2009) while the rest classified BMI as above 30 kg/m^2. Overall, rates of obesity trended higher with the passage of time. Vardavas et al. (2009) reported an increase in mean BMI from 22.9 kg/m^2 kg for the overall population in 1960 to 29.3 kg/m^2 in males and 30.6 kg/m^2 in females in 2005. Based on studies in the U.S., rates of obesity in farmers have doubled over the last three decades, which is consistent with the trend in the nation's general population (Caban et al., 2005; Gu et al., 2014).

Contributing Factors

Factors contributing to farmer obesity were the focus of twelve articles (**Table 2-2**). The majority of the studies supported level of physical activity as a factor impacting weight in farmers. Among farmers using traditional farming methods, the level of occupational physical activity (PALs) remained in the moderate (1.90) range and mean BMIs remained within normal levels (Dufour & Piperata, 2008; Sarkar, Aronson, Patil, Hugar, & van Loon, 2012). Mechanization and the introduction of modern agricultural practices, however, were associated with decreased physical labor and increased BMIs among farmers (Sarkar et al., 2012; Picket et al., 2015). Modernization of farming techniques included the use of mechanical instead of manual labor, monoculture farming or growing only one crop, and increased use of chemicals. In addition to altering physical activity, modern techniques also altered dietary patterns. Diets became higher in fat and processed food rather than the traditional diet of the area, and BMI and non-communicable diseases increased (Sarkar et al., 2012).

Seasonal variations in physical activity between peak and off seasons in farming also affected weight changes. Offseason associated sedentary periods contributed to significant ($p < 0.001$) increases in weight in both males and females (Kim, Yeon, Lee, & Choe, 2015; Sabbag, 2012; Simondon et al., 2008). Sabbag also reports that weight did not return to baseline during the next peak season which resulted in a trend of weight gain (> 1 kilogram/ year) over time. During the offseason, levels of physical activity, energy expenditure, and energy requirements all declined (Kim et al., 2015). Failure to adjust dietary intake or increase non-occupational physical activity during the off season further

Table 2-1 Obesity Prevalence in Farmers

Citation	Setting/ Design	Sample	Obesity measurement/source/ definition	Obesity variable type	Findings	Limitations
Ascherio et al., 2006	United States Prospective case control	Cancer Prevention Study (CPS) II Nutrition Cohort participants, data collected 1992, 1997, 1999, 2001. *n*=7864 pesticide exposures, 135,461 non-exposed. 15% of pesticide exposures farmers	Mean BMI	Demographic variable only	Pesticide-exposed: BMI = 26.4 Non-exposed =25.9	Sample bias: Permission to access medical records higher in pesticide-exposed group.
Bonauto et al., 2014	United States/ Cross-sectional	Washington State workers, BRFSS 2003- 2009, *n*=37,626.	BMI/ self-reported/ BMI > 30 classified obese	Research	Obesity prevalence Farming, forestry and fishing sector =22.3%; general working population=24.6%	Self-report, Cross-sectional data
Caban et al., 2005	United States/Cross-sectional	NHIS workers, 1986-1995 and 1997-2002, *n*=pooled sample of 600,000	Self- reported, BMI > 30 classified obese	Research	Obesity prevalence 1986-1995 (1997-2001) Farm operators and managers Male=14.2% (21.62%) Female= 11.69% (18.72%) Agricultural workers Male = 9.0% (18.35%) Females =12.79% (22.76%)	Self- report; Cross-sectional pooled data

Table 2-1 (continued)

Author	Setting/ Design	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Gu et al., 2014	United States Cross sectional	NHIS workers, Data collection 2004-2011; *n*= 125,992	Height & weight; Self- reported BMI > 30 classified obese	Research	Obesity prevalence rates: Agricultural workers: Non-Hispanic white Males = 29.1% Females = 38.9% Non-Hispanic blacks Males = 9.6% Females = 44% Hispanics Males = 20.9 % Females = 31.3 % Farmers Overall = 29.1 Supervisors = 31.8%	Small sample size for minorities Self-reported, cross-sectional data
Mairger et al., 2007	United States Cross-sectional	Virginia farmers on farm greater than 28 hectares, Data collection 2006, *n* = 308	Heights & weights; Self- reported; Underweight: BMI < 18.5 Healthy: BMI =18.6 - 25 Overweight = BMI 25.6-30 Obese = BMI > 30.1	Research	Mean BMI = 28.5 Obesity rate in farmers = 30.9 % Obesity in general population = 25.3%	Small response, Self-reported, cross sectional

Table 2-1 (continued)

Citation	Setting/ Design	Sample	Obesity measurement/ source/ definition	Obesity variable type	Findings	Limitations
Nonnenmann et al., 2008	United States Cross-sectional cohort	Dairy farmers in Northeast Iowa, *n* = 341.	Self- reported heights/weights. BMI mean reported.	Demographic	Mean BMI = 27.8	41.9% return rate on survey, Self-reported, Cross-sectional data
Rosecrance et al. 2006	United States Cross-sectional cohort	Kansas farmers *n* = 499.	Self-reported heights/weights Mean BMI reported.	Demographic	Mean BMI = 28.1	Cross-sectional, Self- reported
Vardavas et al., 2009	Crete Cross-sectional	Greek farmers, 2005, *n* = 502	Measured heights/weights and waist circumference; Overweight = BMI 25-29.9 Obese = BMI ≥ 30 Central obesity: Waist circumference males > 102 cm females >88 cm	Research variable; rates compared to 1960	Overweight = 49.9% Obese = 43.2% Mean BMI Males =29.3 Females =30.6 Waist circumference > recommended: Males = 40.3% Females=39.3%.	

Note. BMI=Body mass index, reported in kilograms/meter^2

Table 2-2. Contributing Factors to Farmer Obesity

Citation	Setting/ Design	Sample	Obesity measurement/source/definition	Obesity variable type	Outcome	Limitations
Brumby et al., 2013a	Australia Cross sectional descriptive	Adults farming > 5 years, Data collection 2003-2009, *n*=1792	Measured heights/weights. Underweight = BMI < 18; Normal = BMI > 18 ≤ 25; Overweight = BMI >25 ≤ 30, Obese = BMI > 30	Outcome variable; Predictors: High alcohol consumption, psychological distress	BMI Males 16.66-59.87; mean 27.64 Females 14.82-51.11, mean 29.98. Prevalence Women: 24% Men: 20.3 % High alcohol consumption associate with obesity and psychological distress (p=.01)	Non-random sample, self-reporting.
Brumby et al., 2013b	Australia Quasi-experimental prospective	Overweight or obese Australian farmers, n = 43 males, 29 females	Measured; Reported as means.	Outcome variable Predictor: Physical activity	Total group BMI: Baseline 31.31 Follow-up 31.19 Significant difference in BMI between the intervention and control group difference = -0.097 (p-0.001)	Control and intervention not randomized; Study was underpowered.
Dufour & Piperata, 2008	Meta- analysis,	Adult farmers in developing countries, n = 26 studies	Mean BMI	Outcome variable: Predictors PAL	BMI was not related to level physical activity, PAL was of moderate level throughout (minimum 1.70) but varied with seasons	Variations in measurements of PAL

Table 2-2 (continued)

Citation	Setting/ Design	Sample	Obesity measure/ source/definition	Obesity variable type	Findings	Limitations
Kim et al., 2015	Korea Longitudinal, comparative	Farmers, *n*=72	Measured; Underweight = BMI < 18.5, Normal = BMI 18.5-24.9; Overweight = BMI 25-29.9; Obese = BMI > 30	Research variables BMI, PAL, TEE, EER	Significant difference off versus on season: Body weight: Males (50.4 to 52.4 kg, $p < 0.001$), BMI: Males (22.5 to 25.1 $p < 0.001$) Females (34.1 to 35.7, $p < 0.001$), Body fat free mass females (40.0 – 39.3 $p < 0.001$). PAL declines: Males: 1.77-1.53 Females: 1.69 - 1.52 in females Significant increase ($p <$ .05) were also seen in off season blood pressure.	Potential measure bias of total energy expenditures; Small sample size.
Oliva et al., 2001	Argentina Cross-sectional, descriptive	Adult males seeking infertility consultation in a farming region, Dates between 1995 and 1998, *n*=225.	Measured heights/weights. Reported as mean BMI.	Covariate	BMIs were significantly higher among solvent exposures compared to non-exposures (28.9 vs. 25.8 %, p=.003).	Possible selection bias due to high rates of exposure (only 80 of 189 negative for exposure).

Table 2-2 (continued)

Citation	Setting/ Design analysis	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Raafat et al., 2012	Al-Sharkia Cross-sectional comparative;	Non-diabetic, farmers who were pesticide-exposed for≥ ten years; Data collected 2010, *n*=98 farmers and 90 controls	Measured heights and weights, and waist circumference. Reported as means.	Covariate Predicator Pesticide use Outcome: insulin resistance	BMI and WC were both greater in farmers than controls (32.49 to 28.70 and 102.75 cm to 90.30 cm respectively). Pearson's correlation was significant (p= .021 and .002 respectively) for BMI and WC correlation to pesticide blood levels. Multivariate regressions were significant for waist circumference at (p= .023) as an independent factor contributing to insulin resistance, as was the pesticide malathion	Small sample size
Sarkar, 2012	Karnataka, India Cross-sectional	40 households in 6 villages	Measured heights and weights; BMI's considered low if < 20; high > 25	Outcome measure: BMI for nutritional status Predictor: Modern versus traditional farm practices	Males and females had an increased relative risk of high BMIs at 2.38 and 2.50 respectively in high input (modernized) regions,	Mixing of anecdotal and statistical information.

Table 2-2 (continued)

Citation	Setting/ Design/	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Shaikh et al., 2015	United States, Cross-sectional, descriptive	Employed adults National Health Interview Survey, 2010 *n* = 14, 754	Self- reported heights and weights Obese: BMI ≥ 30 morbid obese: ≥ 40	Research variable	Obesity in farming, fishing and forestry section, Obese: 28.18 %; Morbidly obese: 4.48%. The highest prevalence of non- adherence to physical activity recommendations were in farming, fishing, forestry section (87.9%).	Cross-sectional data and self-reported. Does not include those who do not identify farming as their primary occupation.
Simondon et al., 2008	Senegal Longitudinal, observational	Postpartum women in a farming community who came to the immunization clinic	Measured height/weight. Underweight = BMI < 18.5; Overweight = BMI >25; Obese = BMI > 30	Outcome variable Predictor: seasonal changes	6.8 % were overweight or obese; weight variations of 2.5 to 3.9 kilograms with agricultural seasons; trend of increasing weight over time	Sample bias
Zick et al., 2013	United States Cross-sectional	Community gardening participants in Salt Lake City, Utah; *n*=198	Self- reported height/weight. Classified as overweight/obese yes or no based on BMI >25.	Outcome variable Predictor variable: participation in community gardening	BMI was -1.84 and -2.52 in female and male gardeners respectively compared with their neighbors. Female gardeners were 34% and males 36 % less likely to be overweight or obese.	Potential sample bias, Lacks control for other factors.

Note: BMI-body mass index reported in kilograms/meter² (kg/m²); PAL-physical activity level reported activity factor; TEE-total energy expenditures; EER-estimated energy requirement; WC-waist circumference reported in centimeters; body weight reported in kilograms contributes to the energy imbalance. Farmers in the U.S. reported the highest rates (87.9%) of non-adherence to recommendations for physical activity, compared to 76.12% among workers overall (Shaikh, Sikora, Siahpush & Singh, 2015). Though interventions to increase leisure time physical activity have been associated with declines in weight among farmers (Brumby et al., 2013a), failure to maintain these activities over an extended period resulted in failure to sustain weight changes over time (Perkio-Makela, 1999).

Farm work may also expose farmers to products that include chemicals classified as persistent environmental pollutants (PEP) and endocrine disruptors (ED). Endocrine disruptors are a potential etiology of obesity and related diseases (Grun & Blumberg, 2006), and some PEPs are lipophilic, increasing the duration of toxic exposure and leading to increased risk of illness (LaMerrill et al., 2013). Two articles compared measures of weight between farmers exposed to chemicals and controls. Findings included significantly increased BMI (p=.003) associated with solvent use (Oliva, Spira, & Multiger, 2001), and increased BMI and WC in pesticide-exposed farmers versus controls (Raafat, Abass & Salem, 2012). Raafat and colleagues also reported significant positive correlations between BMI (p=.021) and WC (p=.002) and increased pesticide blood levels.

The connection between stress and obesity is well established (Mouchacca, Abbott & Ball, 2013). Despite the high levels of reported stress and suicide in farmers (Bin, 2010; Behere & Bhise, 2009), only one article was identified addressing the relationship between obesity and stress. Brumby et al. (2013b) conducted a study on Australian farmers and found significant correlations between high-risk alcohol intake, psychological distress and obesity (p<.01). However, limited inferential analysis was performed that could clarify the specific relationship.

Obesity and Work Related Illness and Injuries

Though the impact of aging on illness and injury in farmers has generated a substantial body of literature, obesity, despite its growing prevalence, has had only limited attention. The search identified twenty-six articles focusing on farm-related injuries and illnesses that included obesity as a variable in the study. Topics addressed included musculoskeletal disorders (MSD) (**Table 2-3**), cancer (**Table 2-4**), cardiovascular disease (CVD) (**Table 2-5**), metabolic disease (**Table 2-6**), pulmonary disease (**Table 2-7**), and work related injuries (**Table 2-8**).

Musculoskeletal disease. MSD was the most commonly studied farm work-related illness that included the impact of obesity. Although the methodology and area of body studied varied, findings supported an increased rates of MSD in farmers in the presence of obesity (Bihari, Kesavachandran, Pangtey, Srivastava, & Mathur, 2011; Hartmen, Vrielink, Huime, & Metz, 2006; Birabi & Ndukwu, 2012). The strongest support existed for the impact of obesity on the development of MSD in the lower limbs (Bihari et al., 2011; Thelin et al., 2004). Findings on the association of obesity in farmers with back pain (Birabi & Ndukwu, 2012; Hartman et al., 2006; Holmberg,Thelin,

Table 2-3 Obesity, Illness, and Injury in Farmers: Musculoskeletal Disorders

Citation	Setting/ Design	Sample	Obesity measurement/ source/ definition	Obesity variable type	Outcome	Limitations
Bihari et al., 2011	National Capital Region of India Cross-sectional;	Workers in National Capital Region of India, n=2086	Measured heights/weights. Normal = BMI 18.5-24.9 Overweight = BMI 25-29.9 Obese = BMI ≥ 30	Predictor variable Outcome Muscular-skeletal pain	Odds ratio for musculoskeletal symptoms: Overweight = *OR* 1.7; obese = *OR* 1.28 Backache =*ns* Joints, limbs and knees=1.90 Lower limbs = 4.89 (p=.0049) Other MSD problems = *OR* 2.09 (p=.00144) Highest prevalence of symptoms in agriculture and dairy workers, males =31.4% and females = 44.7%.	Cross- sectional data
Birabi et al., 2012	Nigeria Cross sectional	Full time adult farmers, *n* =310	Measured heights/weights. Desirable = BMI < 25, Overweight = BMI 25-30, Obese = BMI > 30	Predictor Dependent variable: Low back pain	12% overweight, 18 % obese; Significant associations identified between severe low back pain and high BMI (χ^2 = 13.9, *p* =.001).	Information bias due to ergonomics education program; No controls, cross-sectional data
Hartman et al., 2006	Netherlands Cross-sectional case control	Self-employed farmers, Data collection,2001; *n*= 198 LBP, 89 upper extremity pain; controls*:* *n* = 816	Measured heights and weights. High BMI > 25 for upper extremity and > 27 for low back pain	Predictor Outcome: Low back pain, upper extremity pain	High BMI associated with increased LBP (*OR*: 1.93; CI=1.18-3.15) BMI not associated with upper extremity pain	Selection bias due to low response to survey

Table 2-3 (continued)

Citation	Setting/ Design	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Holmberg et al., 2003	Sweden Cross-sectional cohort	Matched pairs of 657 male farmers and non- farmers	Measured analysis based on an increase of 5 kg/m²	Predictor Outcome Pain Primary care symptoms and hospital admissions	The odds ratio for hand/forearm symptoms increased by 1.32 per BMI increase of 5 kg/m². Neck/shoulder, low back, hip and knee pain not correlated with BMI. No significant difference in mean BMI: farmers = 26.3 referents = 26.6.	Recall bias, cross-sectional design
Thelin et al., 2004	Matched case-control	Swedish male farmers with hip joint symptoms n=369 and controls	Measured heights/weights. Reported as means.	Covariate Predictor: Type of farm work Outcome: osteoarthritis of hip	BMIs were significantly higher in cases than in controls; BMIs were elevated at age 30 (24.15 vs. 23.4, p.0002). Large dairy and swine confinement had a higher risk of OA hip.	Possible underestimates due to lack of contrast in exposures; recall bias

Note. BMI=Body mass index, reported in kilograms/meter²

Table 2-4 Obesity, Illness, and Injury in Farmers: Cancer

Citation	Setting/ Design	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Andreotti et al., 2010	United States Cohort	Licensed pesticide applicators and spouses, Iowa and North Carolina Agricultural Health Study Data collected, 2005; *n*=39, 628 males and 28, 319 females; cancer-free at enrollment	Self- reported heights and weights. Underweight = BMI <18 underweight, Normal = BMI 18- ≤ 25, Overweight = BMI 25 ≤ 30, Class I obesity = BMI > 30 ≤ 35; Class II and III obesity > 35	Predictor and co-predictor Outcome: Cancer incidence	Underweight = 0.8% Normal = 34.8 % Overweight = 43%; Class 1 obese = 16.7%; Class 2 and 3 obese = 4.7. Interaction between BMI and pesticides carbofuran (HR 1.10, p=.04) and metochalor (1.09) and colon cancer in males (p=.02) and breast cancer in women (HR 1.03, 95% CI 1.01–1.06).	Self-reporting; inability to evaluate BMI changes over time (only collected at enrollment).
Dennis et al., 2008	Cohort study	Licensed pesticide applicators' spouses in Iowa and North Carolina participating in the Agricultural Health Stud; 1993-1994 enrollment, Data collection, 2005. *n*=22101 applicators and 21,985 spouses	Self-reported heights/weights. BMI classified at enrollment as < 25, 25-26.99, 27 and classified at age 20 as < 20, 20-24.99 and 25+.	Predictor Outcome: melanoma	BMI of greater than 25 at age 20 increased the risk of melanoma (OR 2.5). A U-shaped response was seen with hours per day in the sun and risk of cutaneous melanoma.	Self -reporting

Note. BMI=Body mass index, reported in kilograms/meter²

Table 2-5 Obesity, Illness, and Injury in Farmers: Cardiovascular Disease

Citation	Setting/ Design	Sample	Obesity measurement/ Source/Definition	Obesity variable type	Finding	Limitations
Brumby et al., 2012	Australia Cross-sectional descriptive,	Adult farmers, farming > 5 years. Data collected 2003-2009, *n*=1792	Measured heights/ weights and waist circumference. Underweight = BMI < 18 Normal weight = BMI >18 ≤ 25 Overweight = BMI > 25 ≤ 30, Obese = BMI > 30 obese.	Research variable Other variables: Cardiovascular disease; psychological distress	Mean BMI: < age 50 = 27 > age 50 = 27.6 Obesity rates (%) Farmers (national): Overweight = 42.5 (39) Obesity = 21.8 (20.5) Central obesity = 54 (28.8) Hypertension: 54% vs. % 28.8% Diabetes: 25.3. % vs. 23.8 BMI, abdominal obesity, metabolic syndrome was significantly increased in psychologically distressed farmers over 50.	Cross-sectional study

Table 2-5 (continued)

Citation	Sample/ Design	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Cormier et al., 2004	Quebec Cross-sectional Matched cohort	Non- smoking male pig farmers, n=36, and 35 unexposed male referents	Measured heights/weights and WC. BMI and WC reported as means.	Covariate Predictor Organic dust Outcome: Metabolic disease cardiovascular risk	BMI: Farmers =25.7 Controls=24.8 WC: Farmers =85.8 centimeters Controls=84.3 centimeters Farmers had markers for chronic inflammation. Correlations were found between CRP levels, BMI, WC and total Cholesterol to HDL levels, and insulin levels.	Cross-sectional data Small sample size
Davis-Lameloise et al., 2013	Cross-sectional case-control, regressions	Rural Australian adults, 2004-2006, n= 214 male and 79 females agricultural workers, 123 male technicians, 148 male and 272 female managers	Calculated from measured heights and weights. Reported as means.	Outcome associated variables: cardiovascular risks and lifestyle habits	No significant differences in BMI or cardiovascular risk, hypertension, obesity, fasting glucose, self- reported diabetes, metabolic syndrome, hypertension or hypercholesterolemia. Agriculture workers had healthier diets, fewer smokers, and higher occupational physical activity, but lower leisure time activity	Cross-sectional data, small female sample size, did not consider mortality or morbidity rates

Table 2-5 (continued)

Citation	Setting/ Design	Sample	Obesity measurement/ source/definition	Associated Variables	Outcome	Limitations
Davis-Lameloise et al., 2013	Cross-sectional case-control, regressions	Rural Australian adults, 2004-2006, n= 214 male and 79 females agricultural workers, 123 male technicians, 148 male and 272 female managers	Calculated from measured heights and weights. Reported as means.	Outcome associated variables: cardiovascular risks and lifestyle habits	No significant differences in BMI or cardiovascular risk, hypertension, obesity, fasting glucose, self- reported diabetes, metabolic syndrome, hypertension or hypercholesterolemia. Agriculture workers had healthier diets, fewer smokers, and higher occupational physical activity, but lower leisure time activity.	Cross-sectional data, small female sample size, did not consider mortality or morbidity rates
Dayton et al., 2010	Prospective study, Logistic regression	Women participants from the Agriculture Health Study, Iowa and North Carolina, n=22,425	Self- reported; 15-25 kg/m^2, 25.1-30 kg/m^2; > 30kg/m^2	Covariate Predictor: Pesticide use Outcome Myocardial infarction	Myocardial infarction was associated with specific pesticides, not pesticides in general. BMI was controlled for, but the risk for MI based on BMI was not reported. No interaction between pesticide and BMI conducted	Self-reported data on MI and BMI

Table 2-5 (continued)

Citation	Setting/ Design	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Gregory et al., 2007	Guatemala Longitudinal, cohort	Rural-born adults *n*= 527 women, and 360 men	Measured heights/weights, waist circumference BMI Overweight = ≥ 25kg/m²; Obese = ≥30 kg/m²; WC=>108 cm in men, > 88 cm in women	Outcome Predictors were Occupation and Residents	BMI, WC and % body fat lowest in agricultural men, highest urban men. No significant difference found in metabolic profile.	Sample bias due to exclusion and drop out
Liu et al., 2011	Prospective cohort study, Generalized Estimating Equation (GEE)	Farmers and workers from the Collaborative Study of Cardiovascular and Cardiopulmonary Epidemiology, data collected 1983-84 and 1993-94	Calculated from measured heights and weights. Classified as overweight ≥ 25 mg/k², obese ≥ 30 mg/k²	Outcome variable. Cardiovascular risk in low-risk populations	Significant increases in overweight or obesity in farmers, 6.1 % increase in males and 4.8 % in females; significant changes also occurred for increases in hypertension and hyperlipidemia	Potential for sample bias, health worker effect, dated data
Variyam & Mishra, 2005	Cross-sectional case-control	A pooled sample of the U.S. civilian, non-institutionalized population who participated in the 1997-2002 NHIS, n= 2,026 farmers, 900 construction laborers, and 115,050 other workers	Self-reported Classified as < 25 normal weight, ≥ 25 overweight/obese	Description of health indicators	Obesity rates Farm workers = 19.3 % Construction workers =22.14% General workers = 21.21 % (*ns).* No significant differences were found – between groups for cardiovascular disease.	Self-reported data, access to care and the level of health needed for physical labor not addressed.

Table 2-5 (continued)

Citation	Setting/ Design	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Villarejo et al, 2010	Cross sectional; survey; descriptive	Hired farmworkers; California Agricultural Workers Survey, 1999, n=654	Measured. Overweight > 25 BMI, obesity > 30 BMI.	Research variable for health status	Overweight Males = 74% Females = 79% Obesity Males = 29% Females = 38%Health CVD Status (obese vs. non-obese) Males: Hypertension rates 1.5x greater Higher diabetes risk (3.09) Higher diagnosed diabetes (5.68) Females: Limited sample of high blood pressure and diabetes risk	Possible sample bias.

Table 2-5 (continued)

Citation	Setting/ Design	Sample	Obesity measurement/ definition/source	Obesity variable type	Findings	Limitations
Wang et al., 2012	Cross-sectional comparative study of dyslipidemia between Yi farmers and urban migrants	Chinese adults native to the rural Yi province, 2007-2008. *n* = 1538 farmers and 1310 migrants	Calculated from measured heights and weights. Reported as means.	Outcome variable	Migrants had significantly higher BMIs, total cholesterol, and lower high-density cholesterol. Low-density cholesterol was not significantly different. They also had lower rates of light and moderate physical activity and higher rates of hypertension and diabetes. Mean BMI for farmers was 21.13 males and 21.76 females compared to 23.85 in males and 23.08 in females among migrants	Limited number of women, no dietary consideration

Note. BMI=Body mass index, reported in kilograms/meter^2; WC = waist circumference

Table 2-6 Obesity, Illness & Injury in Farmers: Metabolic Disorder

Citation	Setting/ Design	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Davila et al., 2010	United States Descriptive, cross- sectional	Workers in the NHANES, date collected 1999-2004	Measured-under-weight/normal; overweight and obese specific ranges not given	Covariate Research variable: Prevalence of metabolic syndrome	Prevalence among farm operators, managers, and supervisors of metabolic syndrome was 27.4 %, 18.7 percent among farm and nursery workers. Farm operators, managers, and supervisors had the second highest prevalence. BMI increased odds among general workers to 5.63 for overweight and 25.94 for obese.	Cross-sectional design, lack of fasting glucose to establish metabolic syndrome, inability to evaluate impact of work factors due to lack of information
Dyck et al., 2013	Saskatchewan Cross-sectional, cohort study; Generalized estimation equation	Caucasian participants, Saskatchewan Rural Health Study. *n* = 3, 445 farm residents and 4, 763 non-farm residents	Self-reported heights/weights; Overweight = BMI 25-29.9 Obese = BMI > 30	Covariate Predictor: Farm vs. non-farm Outcome: Diabetes	Increased risk of diabetes =odds ratio (*OR*) for overweight =1.73 and obese = 16.1. Farmers had lower rates of diabetes (6.9%, p < 0.001) than non-farmers (10.7%). Pesticide exposure increased odds of diabetes risk among males (*OR* = 1.83).	Self- reported, cross-sectional analysis, moderate response rate (42%), lack of inclusion of diverse ethnic groups, no distinction between Type 1 and Type 2 diabetes

Table 2-6 (continued)

Citation	Setting/ Design	Sample	Obesity measurement/ source/definition	Obesity variable type	Outcome	Limitations
Montgomery et al., 2008	United States Cross-sectional Descriptive	Licensed pesticide applicators and spouses, Agricultural Health Study. Data collection 1999-2003. *n*=13,637.	Self-reported heights/weights. Normal weight = BMI < 25. Overweight =BMI 25 -29; Obese = BMI 30 – 32, Morbid obese = BMI > 32.	Covariate Predictor Pesticide exposure Outcome Diabetes	Odds adjusted ratio for diabetes based on BMI in pesticide applicators was 3.01 for BMI 25-29; 6.65 for BMI 30 – 32; and 9.77 for BMI > 32.	Self-reported data
Starling et al., 2013	United States Prospective cohort study	Farmer's wives from the AHS study who personally mixed or applied pesticides, Data collection 1993-97. *n*=13,637.	Self-reported heights/weights. Normal weight = BMI < 25, Overweight = BMI 25-29.99, Obese = Class 1 BMI 30-34.99, and Class 2 & 3 BMI ≥ 35.	Covariate Predictor Pesticide application Outcome Diabetes	35% of the diabetic cases were obese compared to 33 % non-diabetics. Rates for diabetes in exposed versus not exposed for class 1 and 2 obesity were 32 and 12, and 16 and 4 respectively. With adjusting for BMI, three specific pesticides increased odds for diabetes.	Self - reporting, potential bias due to potential pesticide effect as an obesogenic

Note. BMI=Body mass index, reported in kilograms/meter²

Table 2-7 Obesity, Illness & Injury in Farmers: Pulmonary Disorders

Citation	Setting/ Design	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Hoppin et al., 2007	United States Prospective cohort study	Licensed pesticide applicators spouses in Iowa and North Carolina participating in the Agricultural Health Study, 2000 date collection n=89,000	Self- reported heights/weights. Dichotomized as BMI <25 and BMI > 25	Covariate Predictor Pesticide use Outcome Respiratory disease or symptoms	64 % of farmers exceeded a BMI of 25 and 18 exceeded a BMI of 31. No reported results of impact on respiratory outcome by BMI.	Self -reported data
Hoppin et al., 2014	United States Case-control	Licensed pesticide applicators spouses in the Agricultural Health Study; Data collection 2005, *n* =43,548; controls from NHANE, Data collection 2010, n=17, 132.	Self-reported; less than 25 mg/k² or greater than 25 kg/m²	Covariate Farmers versus general population Outcome respiratory health	Farmers had less obesity (24 % vs. 30 %), but greater rates of overweight (49 vs. 38%). Farmers had a higher prevalence of respiratory symptoms, but lower rates of self-reported diagnosed disease.	Agricultural Health Survey is self-reported, and NHANES is measured for BMI
Johnson et al., 2009	United States Cross-sectional cohort	Male farmers age 55 and older from Family health and Hazard Surveillance Project, Data collected 1993-1995, *n*=134	Self- reported heights/weights, Underweight = BMI <18.5, Normal = 18.5 - 24.99, Overweight = BMI 25.0-29.99, and obese = BMI ≥ 30.	Demographic variable only Research variable: reported respiratory symptoms	Self- reported respiratory system may not accurately reflect disease state. Reported symptoms prevalence 0.24, spirometry respiratory impairment 0.35	Misclassifica-tion due to self- reports

Table 2-7 (continued)

Citation	Setting/ Design	Sample	Obesity measurement/ source/ definition	Obesity variable type	Findings	Limitations
Pahwa et al., 2012	Prospective cohort; descriptive	Rural Saskatchewan residents, n= 8153, 42% farm, 58% non- farm.	Self- reported. Normal < 25, overweight, 25-30, obese> 30.	Covariate Predictor: farm versus rural resident Outcome: Bronchitis	An obese classification increased the odds of chronic bronchitis, OR=1.73 in the univariate analysis and 1.52 in the multivariate analysis. Chronic bronchitis was reported in 5.5% of farm residents and 7.1 percent of non-farm residents.	No clear comparison between farm and non-farm residents. Self-reported symptoms.

Note. BMI=Body mass index, reported in kilograms/meter^2; National Health and Nutrition Examination Survey

Table 2-8 Obesity, Illness, and Injuries in Farmers: Work-related Injuries

Citation	Setting/ Design	Sample	Obesity measurement/ source/definition	Obesity variables type	Findings	Limitations
Marcum et al., 2011	United States Fixed cohort	Farmers over 50, Kentucky and South Carolina, Collection date: 1994-96 and 2002-2005. *n* = 1,394	Self-reported heights/weights. Underweight = BMI < 18.5; Normal = BMI 18.5-24.99; Overweight = BMI 25-29.99; and Obese ≥ 30	Predictor Others: health conditions, work practices	1.43 increase in farm-related injuries per 10 units increase in BMI	Self-report; no specific definition of injury, large report of “other” injuries
Park, et al, 2001	Prospective; Regression	Iowa male farmers, n=290, Data collected: 1991-1992	Self-reported; < 30- not obese ≥ 30= obese	Predictor Outcome Work related injury	Farmers < 30 (*n*=237) reported injuries= 27; > 30 (*n*=53) reported injuries= 3; *OR*. 0.38	Self- reporting; Small survey response rate; Males only sample

Note. BMI=Body mass index, reported in kilograms/meter²

Table 2-9 Obesity in Farmers: Work Ability and Productivity

Citation	Setting/ Design	Sample	Obesity measurement/ source/definition	Obesity variable type	Findings	Limitations
Periko-Makela, 1999	Finland 3-year prospective quasi-experimental study evaluating physical activity on workability	Female farmers, *n*=62 intervention, 64 control	Body mass was defined as weight in kilograms	BMI= Outcome Independent= Physical activity intervention Outcomes: Workability Musculoskeletal capacity symptom improvement	BMI: No significant changes Musculoskeletal capacity and symptoms were improved at 1 (p=.001) and 3 years (p=.028). Workability improved at 1 year (p=.039) but not at 3 years.	Small sample size, inconsistent participation, high dropout rate

Note. BMI=Body mass index, reported in kilograms/meter²

Stiernstram & Svardsudd, 2005; Thelin, Vingard & Holmsberg, 2004) and upper extremity symptoms (Hartman et al., 2006; Holmberg, Thelin, Stiernstram & Svardsudd, 2003; Thelin et al., 2004) have shown mixed results. The duration of obesity and the nature of the farming tasks were factors identified as impacting the development of MSDs in farmers (Holmberg et al., 2003; Holmberg et al., 2005; and Thelin et al., 2004).

Cancer. Despite growing literature supporting the role of obesity in the development of some cancerous tumors (Basen-Erguqist & Chang, 2011; Blaskaran et al., 2014; Hursting & Dunlap, 2012), the inclusion of obesity in studies of cancer in farmers is very limited. Though the Agricultural Health Study (AHS) has resulted in extensive research related to pesticide exposure and increased cancer, only two studies incorporating measures of obesity were identified. Andreotti et al. (2012), studied BMI as both a confounding and interaction variable in their evaluation of the association between pesticide exposure and cancers. In those exposed to pesticides, correlations between BMI and colon cancer in men and post-menopausal breast cancer in women were identified. Men also showed an increased risk of colon cancer associated with BMI and pesticide interaction for two specific pesticides, carbofuran and metolachlor. The second study, evaluated the impact of obesity on cutaneous melanoma in farmers (Dennis, Lowe, Lynch, & Alavanja, 2008). Excess weight, if present at age 20, increased the risk of melanoma by an odds ratio (*OR*) of 2.5 compared to farmers of normal weight. Further research is needed to clarify the underlying etiology of this relationship.

Cardiovascular disease. Unlike the decades, long research on cancer risk for farmers, CVD in farmers is a recent concern. Of the nine articles identified, two studies evaluated the risk for cardiovascular disease related to obesity and occupational exposures in farming. Occupational exposure to pesticides (Dayton et al., 2010) and organic dust (Cormier et al., 2004) resulted in increased rates of obesity compared to non-exposed controls. The higher rates of obesity among pesticide-exposed women also correlated with increased rates of myocardial infarction (Dayton et al., 2010). Male swine farmers exposed to organic dust had increased levels of C-reactive protein, a biomarker for inflammation and coronary artery disease, total cholesterol, high-density lipoprotein (HDL) cholesterol and insulin levels (Cormier et al., 2004).

Six articles reported on the increasing obesity in farmers and the impact on cardiovascular health. Despite a decreased risk profile, including lower rates of smoking, healthier diets, and higher levels of occupational physical activity levels than the general populations (Davis-Lameloise et al, 2013; Variyam & Mishara, 2005; Gregory, Dai, Remirez-Zea, & Stein, 2007; Wang et al., 2012), farmers exhibited an increased risk for cardiovascular diseases. These risk included (a) increasing levels of obesity with associated cardiovascular disease or risk factors and hypertension (Brumby et al., 2012; Davis-Lameloise et al., 2013; Liu et al., 2011; Villaejo, 2010; Wang et al., 2012); (b) increased total cholesterol (Liu et al., 2011; Wang et al., 2012); (c) low levels of high-density lipoprotein (HDL) cholesterol (Gregory et al., 2007; Wang et al., 2012); and (d) high triglycerides (Gregory et al., 2007).

Metabolic disorders. Four articles, each treating obesity as a confounding factor, addressed metabolic syndrome and diabetes in farmers. Overall farmers displayed lower rates of diabetes compared to non-farmers, 6.9% and 10.7%, respectively (Dyck et al., 2013). Among farmers with continued moderate to heavy physical activity, farming provided a protective effect for both obesity and metabolic disease (Davila et al., 2013; Wang et al., 2012). However, pesticide exposure among farmers was associated with an increased odds of developing diabetes, which was most prevalent among obese farmers (Dyck et al., 2013; Montgomery, Kamel, Saldana, & Sandler, 2008; Starling et al., 2014). However, all of the studies failed to address the potential interactions between obesity and the farming environment in the development of metabolic disorders.

Respiratory disease. Farming results in exposure to a variety of inhaled substances (pesticides, organic and inorganic dust, and endotoxins) with the potential for causing disease. Past research has reported an increased risk for a broad range of respiratory illnesses (Rautiainen & Reynolds, 2002). Despite obesity's impact on both inflammation and structural limitations affecting breathing, only four articles including BMI in the study of respiratory issues were identified. One article reported the impact of BMI on the study outcome. Pahwa et al.'s (2012) study of Saskatchewan farm residents compared to non-farm residents reported obesity increased the odds of having chronic bronchitis (*OR*=1.52); however, rates of chronic bronchitis were higher in the non-farming residents.

Farm work related injuries. Though safety issues and injuries in farming are a focus of extensive research, research on the impact of obesity on farming injuries is lacking. Only two studies addressed the role of obesity in agriculture injuries. Park et al. (2001) reported a decreased incident of injuries in obese farmers (*OR*= 0.38) compared to healthy weight farmers. However, in a more recent study, Marcum, Browning, Reed, and Charnigo (2011) reported a 43% increase in risk for injury in farmers per 10 unit increase in BMI. Given the high rate of both fatal and non-fatal injuries in farming, further research is needed to clarify the role of obesity may play in farm related work injuries and promote farmer safety.

Work ability and productivity. Despite evidence supporting obesity's impact on agriculture workers' health, research on the impact obesity has on work is essentially nonexistent. Research conducted on work ability has shown over a third of farmers (39%-44%) reported a decline in work ability (Karttunen & Rautiainen, 2011; Perkio-Makela, 2000), and 44% reported a decrease in functional ability (Perkio-Makela, 2000) compared to lifetime best. Factors affecting work ability included age (Karttunen & Rautiainen, 2011; Perkio-Makela, 2000), gender (Karttunen & Rautiainen) musculoskeletal disease, and depression (Perkio-Makela). However, Perkio-Makela (2000) and Karttunen & Rautiainen (2011) did not include obesity as a variable in these studies, which were conducted in Finland where all farmers with 5 hectares (12.355 acres) or more have mandatory workman's compensation. Access to worker compensation may limit the ability to generalize these findings in farmers who lack access to workman's compensation and disability insurance. Studies in Sweden (Thelin & Holberg, 2010) and the U.S. (Amshoff & Reed, 2005; Reed, Rayens, Conley, Westneat,

& Adkins, 2012) reported 64% of Swedish farmers and 42% of U.S. farmers continued to work beyond the standard retirement age of 65. Neither health status nor psychosocial factors were identified as significantly impacting work limitations or retirement (Reed et al., 2012; Thelin & Holmberg, 2010). Cole and Donovan (2008) reported high rates of continued work among aging U.S. farmers, but credit experience and compensatory and adaptive mechanisms for allowing farmers to continue to work safely and productively. Whether obese farmers have the ability to alter their work to compensate for changes due to obesity is not known.

Only one prospective, interventional study was identified that evaluated the impact of a program to increase physical activity on BMI and work ability in female farmers; however, the study was limited by a small sample size and high drop-out rates (Perkio-Makela 2015). No significant changes were identified in BMI, and though workability initially improved, it was not maintained over the three-year period of the study. No studies identifying the impact of obesity on work productivity in farmers was found.

Discussion

Obesity in workers has become an increasing concern over the last decade. Obesity rates are increasing in both developed and developing countries, with extremely high rates in primarily agrarian nations such as Tonga, Samoa and Kuwait (Ng et al., 2014). This review summarizes the current knowledge regarding the prevalence, contributing factors, and the impact of obesity on health and safety and work performance in farmers. Findings from these studies supported obesity in farmers, especially in developed nations, as an area of concern (Brumby et al., 2013a; Gu et al., 2014; Pickett et al., 2015; Vardavas et al., 2009), and identified a potential contributor to this as inadequate physical activity due to both seasonal variations in occupational activity (Kim, et al., 2015; Sabbag, 2012) and declining occupational activity without corresponding increases in leisure physical activity (Pickett et al., 2015; Sarkar, 2012; Shairkh, et al, 2015). Prevalence rates and patterns of farmer's obesity are consistent with the rates and patterns of obesity in the general worker population (Ng et al., 2014; Organization for Economic Cooperation & Development (OCED), 2014). However, given the recognition of the multifactorial nature of the etiology of obesity, more research is needed regarding other occupational-related exposures associated with both farming and obesity, including job-related stress (Luckhaupt et al., 2014; Rayens & Reed, 2014; Stevens, 2013) and pesticide exposure (Wei, Zhu & Nguyen, 2014).

Research on the impact of obesity on farmer's health, safety and work performance is essentially non-existent. Despite growing recognition of the need to consider both lifestyle and occupational risk in evaluating occupational health issues, the majority of the studies addressed obesity either as an outcome or confounding variable. Andreotti et al. (2010) reported the only study that examined the interaction between obesity and occupational exposure. Seven additional studies utilized BMI as a predictor variable, including four articles related to MSD, two articles on work-related injuries, and one additional article on cancer. Though MSDs and elevated BMIs are both major contributors to the disability-adjusted life years in the U.S., none of the studies on obesity as a risk for MSD were conducted in the United States. This limited research supported links between occupational exposure, obesity, and the development of cancer, however, the remaining studies showed mixed results. Research has also failed to explore the impact of obesity on farmer's work ability and work productivity. Farmers report few work limitations due to health (Reed et al., 2012), yet research has failed to examine work limitations related specifically to obesity and how these limitations affect workability and productivity. These gaps in knowledge limit the ability to understand and address the impact of obesity on farmers.

In addition to these gaps, the literature also contains major limitations which could lead to bias including a) weak to moderate study designs; b) non-representative samples; c) recall and self-report; and d) misclassification. The majority of the literature reviewed was cross-sectional, descriptive, or cohort studies from diverse populations which restricts the ability to generalize or compare the findings. The heterogeneity of farming, livestock versus crop, modern versus traditional farm methods, and farm size presents different demands and risk factors and limits the ability to generalize findings. Furthermore, over half the studies were secondary analysis of data from large national or regional surveys in which the primary focus was not obesity, and farmers were only a sub-cohort of the population. This further limits the ability to control for or incorporate into the studies the heterogenic factors that could affect the study outcomes.

The reviewed literature also contained several sources of potential selection bias which could contribute to non-representative samples. Forty-two percent of the U.S. farmer-related studies utilized the AHS database, which is limited to licensed pesticide applicators. Other sources of potential selection bias are also present. Inclusion criteria for the studies often focused on actively working farmers. As a result, this introduces the healthy worker effect that can impact study outcomes and excludes those who may have exited from farming due to obesity-related health effects. Additionally, samples pulled from large national surveys where people self-identify as farmers may not capture all farmers. For many farmers, farming is not their primary or sole occupation. These farmers participate in work both on and off farm and may list their off- farm employment as their primary occupation. This may result in their omission from the study entirely or being used as a control when they share the exposure.

Another limitation of the studies is the potential for self-reporting and recall bias. The heights and weights for BMI calculations were self-reported in the majority of the studies. Self-reported BMIs have a high incidence of underestimation of body weight and overestimation of height, resulting in underestimation of both the prevalence and impact of obesity (Shiely, Hayes, Perry, & Kelleher, 2013). Additionally, survey based self-reports regarding injuries and exposures are also subject to recall bias.

Misclassification of weight category due to varying definitions may also have occurred. Despite clearly defined cut points for the BMI categories (WHO, 1995), cut points used in the literature are inconsistent and sometimes unclear. For example, BMI dichotomized as less than 30 kg/m^2 or greater than 30 kg/m^2 fails to define which group includes 30 kg/m^2. Also, the impact of BMI on health is curvilinear (Zajacova, 2008), therefore including people with a BMI of less than 18.5 with those of the normal BMI category may diminish the difference in findings between normal and obese categories. Farmers' high level of physical activity and the failure of BMI to distinguish between adipose and muscle tissue may contribute to misclassification of farmers with high BMI due to muscle mass as obese. Overall, consideration of these issues is essential when utilizing the findings reported in the literature.

Conclusion

The health and well-being of farmers are vital to an adequate food supply and the economic well-being of communities, nations, and the world. Though obesity rates in farmers have been rising, limited research has been conducted to identify the effects obesity has on farmers' work ability, work productivity or work safety. The nature of farm work results in work demands that are often of high physical intensity and time sensitive, limiting the ability to schedule, slow down or delay work based on physical ability to perform. Further research is needed to fill the gap in knowledge of the impact of obesity on the efficiency and safety in performing farm work. Knowledge of obesity's impact could serve as a motivator for improved health habits to decrease or control weight, lead to the development of total worker health programs for the farming sector, and identify methods for adjusting work methods to promote safety and efficiency for obese farmers.

CHAPTER 3. VALIDITY AND RELIABILITY TESTING OF THE WORK ABILITY INDEX IN U.S. FARMERS

Abstract

Objective: The purpose of this study was to examine the psychometric properties of the Work Ability Index in a sample of U.S. farmers.
Methods: Internal consistency was evaluated by Cronbach's alpha (a = 0.744) and item-total correlations. Construct validity was conducted using principal component analysis and hypothesis testing for convergent and divergent validity.
Results: Results revealed a two component factor with one item, absence from work due to illness, failing to load. Internal consistency was modest (a = 0.744) but acceptable, but also supported removing the absence due to illness item. Convergent validity was supported by positive correlation with a one item self- reported health question. Divergent validity was supported through inverse correlation with all four sub-scales, the total score and the estimation of lost productivity from the Work Limitations Questionnaire.
Conclusion: Overall, the findings of this study support the use of the Work Ability Index in research in the U.S. farming population.

Introduction

Farming in the United States (U.S.) is a unique occupation. Despite mechanization and modern farming techniques, farming continues to require a moderate to high level of physical workload (Church et al., 2011; Gorborz & Juliszewski, 2013). In addition, 73% of farmers are self-employed (Bureau of Labor Statistics, 2014a) and must also cope with the mental demands of operating a financially successful business enterprise in the face of high risk and uncertainty (Blank, 2008; Reganold et al., 2011). Farming is also a high-risk occupation related to health and safety (Bureau of Labor Statistics, 2014b; Bureau of Labor Statistics, 2014c, Leigh, Du & McCurdy, 2014). Yet, in contrast to other high-risk occupations, farming in the U.S. requires no pre-employment assessment or health monitoring, has limited occupational health and safety oversight, and generally requires no mandatory worker's compensation or disability insurance. As a result, focus on assessing, promoting or maintaining the work ability of farmers is limited.

The loss of the ability to work, however, has significant consequences for the farmer, the farmer's family, and society overall. Farmers highly value their ability to work, relating it to their identity, health, well- being, and quality of life (Amshoff &Reed, 2005; Nolan & Peel, 2014; Reed, 2004; Reed et al., 2012). The majority of farms in the U.S. (97%) are family owned (Hoppe, 2014). Family members, along with the farmers, provide two-thirds of farm labor in the U.S. (U.S. Department of Agriculture, 2014), so the loss of work ability for the farmer may result in additional workload for family members. Additionally, loss of work ability may not only lead to a decline in productivity and income but may lead to the loss of the farm. Decreases in work ability can also impact the community and nation due to declines in work participation, loss of expertise, and loss of revenue (Brumby, 2009). Maintaining and promoting work ability in U.S. farmers is essential to ensuring sustainability of the agricultural sector, and ensuring national and global food security.

Work ability is a multidimensional, diverse, and dynamic concept (Gould, Ilmarinen, Jarvisalo & Koskinen, 2008). The concept of work ability, developed by the Finnish Institute of Occupational Health (FIOH), describes the current and short-term balance between worker's capacity and resources and the demands of the job (Toumi et al., 1991). An aging workforce, changing work demands, and a growing dependency role supports the need to focus on preserving the ability to work to lengthen work careers, promote worker health and wellbeing, sustain quality of life, and improve work productivity (Tuomi, Huuhtanen, Nykyri, & Ilmarinen, 2001). A continued program of research by the FIOH has supported the original assumptions of the work ability concept and broadened its dimensions. A more holistic view of work ability, as described in the *Multidimensional Model of Work Ability* (**Figure 3-1**), has developed that includes work related coping skill, worker control, and participation in the work community, as well as work organization and the work environment as important factors determining work ability (Ilmarinen, Gould, Jarvikoski, Y Jarvisalo, 2008; Tuomi, Huuhtanen, Nykyri, & Ilmarinen, 2001). The foundation of work ability, however, remains the individual

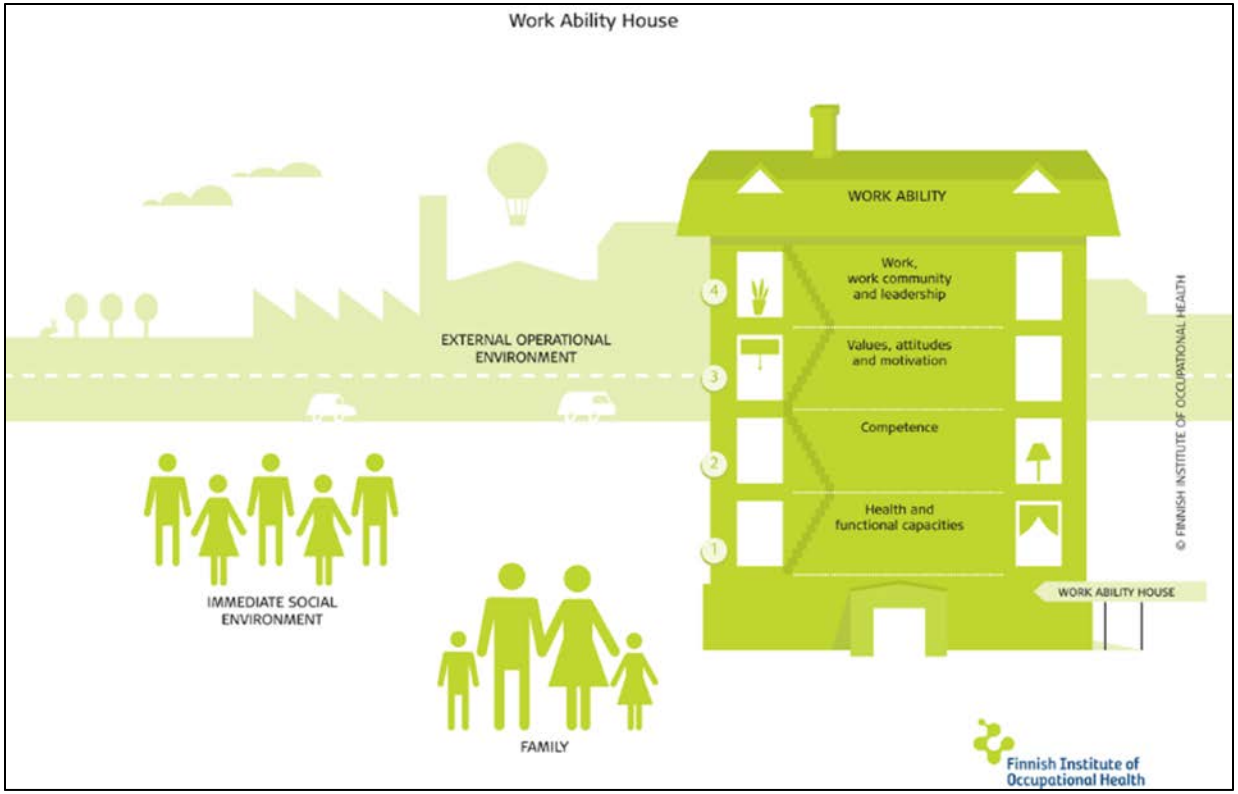

Figure 3-1 Multidimensional Work Ability Model
Describes the components that determines a worker's ability to meet job demand.
Reprinted with permission Finnish Institute of Occupational Health. (2014). *Multidimensional Work Ability Model*. Retrieved from http://www.ttl.fi/en/health/wai/multidimensional_work_ability_model/pages/default.aspx.

worker's resources including health, functional capacity, knowledge and skill, values, attitudes and motivation (Ilmarinen, 2006).

Another significant development of the FIOH program of research was the development of the Work Ability Index (WAI), a questionnaire to assess work ability [Finnish Institute of Occupational Health (FIOH), 20l5; Ilamarinen, Tuomi, & Klockars, 1997]. The WAI has been used extensively in Europe and other culturally diverse countries and is available in 26 languages. The WAI was designed and has been utilized in diverse worker populations, including professional white collar workers (van den Berg, et al., 2008), farmers (Karttunen & Rautiainen, 2011; Perkio-Makela, 2000), textile workers (Safari, Akbari, Kazemi, Mououdi, & Mahaki, 2013), construction workers (Alvinia, van den Berg, Duivenbooden, Elders, & Burdorf, 2006), and shipyard workers (Alexopoulous, Merekoulias, Gnardellis, & Jelastopulu, 2013) for work related research and clinical assessment. However, no evidence of the use of the tool or associated psychometric properties in a U.S. population was identified.

The purpose of this paper is to evaluate the psychometric properties of the WAI in a sample of U.S. farmers. The specific aims of this study are to 1) evaluate the internal consistency of the WAI, 2) to assess the construct validity of the WAI by examining the dimensionality of the tool and 3) to evaluate convergent and divergent validity through hypothesis testing in a sample of U.S. farmers. Based on the theoretical assumption of work ability the following hypothesis were formulated a priori to evaluate convergent and divergent validity of the WAI among U.S. farmers: 1) WAI scores will positively correlate with levels of self-rated health, 2) WAI scores will inversely correlate with the subscales and total scores of the Work Limitations Questionnaire (WLQ), and 3) decreased scores on the WAI will be predictive of higher levels of lost productivity.

Methods

This psychometric evaluation was conducted as part of a pilot study exploring the impact of obesity on the performance of farm work. Data collection was conducted from February through November 2014 at farm shows, farming association conferences, and through local extension agencies. Eligible subjects were 18 years of age or older, able to read or speak English, and actively engaged in farm work. Eligible individuals who consented to participate (n=100) were asked to complete a questionnaire and underwent anthropometric measurements. A $20 incentive was offered to maximize enrollment. Institutional Review Board approval was obtained from the University of Kentucky, Lexington, Kentucky.

Measurements

Data collection was conducted utilizing a self-reported, 64 item questionnaire. In addition to the WAI and demographic information, two addition tools were utilized: the Work Limitation Questionnaire (WLQ) with absentee report and a measure of self-reported health. The questionnaire required approximately 30 minutes to complete.

The WAI, developed by the FIOH, is a self-administered questionnaire reflecting a person's perception of their ability to perform their work (Ilmarinen, 2007). The tool consists of ten items through which seven dimensions are scored individually and summed for a total index score (**Table 3-1**). Total index scores range from 7-49, with a score of 7-27 indicating poor work ability, 28-36 moderate work ability, 37-43 good work ability and 44-49 excellent work ability (Gould, Ilmarinen, Jarvisalo, & Koskinen, 2008). The index has established reliability ($\alpha = 0.72$, range .54-.80), in diverse populations including Iranian healthcare workers (Abdolalizadeh et al., 2012); Thai workers with varying occupations (Kaewboonchoo & Ratanasiripong, 2015); Brazilian electrical workers (Martinez, Latorre, & Fisher, 2009); and Brazilian nurses (Silva, 2013). Construct validity and predictive ability have been established for health status (Peralta et al., 2012; Silva et al., 2013), work absenteeism (Martinez, Latorre & Fisher, 2009; Meyer et al., 2013); and work disability (Bethge, Radoschewski, & Gutenbrunner, 2012; Radkiewicz & Widerszal-Bazyl, 2005). Acceptable test-retest reliability of the WAI over four weeks has been established in nursing workers (Silva et al., 2013), metal mechanic workers (Renosto, Hennington, & Pattussi, 2009), and construction workers (de Zwart, Frings-Dresen, & van Duivenbooden, 2002).

The WLQ and a measure of self-rated health were utilized to examine divergent and convergent validity. Divergent validity was measured by comparison of the WAI scores to scores on the WLQ. The WLQ, developed by Tufts Medical Center, is a 25-item self-administered questionnaire that evaluates the impact of chronic health conditions on worker's health-related productivity loss (Learner et al., 2001). In contrast to the WAI, the WLQ measures diminished resources and capacity to complete work task. The questionnaire rates the percentage of time a person has overall impaired task performance and difficulty meeting work demands in four areas or sub-scales: time management (5 items), physical demands (6 items), mental-interpersonal demands (9 items), and output quantity and quality (5 items). Each item is rated on a 6 point Likert Scale of 0, impacted none of the time, to 5, impacted all of the time. Scores range from 0% (health limits job none of the time) to 100% (health limits job all of the time). The tool also allows for an algorithm calculation of a Productivity Loss Score, which reflects the percentage of lost productivity due to health problems compared to benchmarks of healthy workers (Learner, Rogers, & Chang, 2009). As worker resources include health and functional capacity, higher WAI should predict lower levels of work impairment and lower levels of lost productivity. WLQ has documented construct and criterion validity, as well as reliability ($\alpha \geq 0.90$), and test-retest reliability (Lerner et al., 2001; Walker et al., 2005).

Self-rated health was measured by the widely used single item question from the National Health Interview Survey "In general, how would you describe you general health status?" Responses were on a five-point Likert scale of poor, fair, good, very good, and excellent (National Health Inventory Survey, 2012). The single item measure of self-rated health has been shown to be a valid reflection of health status (Haddock et al., 2006; Idler, Russel & Davis, 2000). The WAI includes physical and mental health as components of work ability. Therefore, self-rated health scores and WAI scores should converge with higher levels of self-rated health correlating with higher levels of work ability.

Table 3-1 Work Ability Dimensions, Items, and Scoring Ranges

Dimensions	Items	Score range (points)	Evaluation scoring
Current Work Ability	Current work ability compared to lifetime best	0-10	0 = worse 10 = best
Work ability related to job demands		2-10	Total score of summed item score
	Work ability related to physical demands	1-5	
	Work ability related to mental demands	1-5	
Diagnosed diseases	Number of physician diagnosed diseases	1-7	No disease =7 1 disease = 5 2 diseases = 4 3 diseases = 3 4 diseases = 2 5 or more = 1
Impact on work performance	Estimated work impairment due to disease	1-6	No impact = 6 Some symptoms = 5 Sometimes slow down = 4 Often slow down = 3 Only work part time =2 Unable to work= 1
Absence due to illness	Whole days off due to illness in last year (12 months)	1-5	None = 5 1-9 days = 4 10-24 days = 3 25-99 days = 2 >100 days = 1
Estimation of future work ability	Ability to do job in 2 years from now	1-7	Certain = 7 Not certain = 4 Unlikely = 1

Table 3-1 (continued)

Dimensions	Items	Score range (points)	Evaluation scoring
Mental health resources	In the last 3 months, have you: enjoyed your daily activities? been active and alert? felt full of hope for the future?	1-4	Scored on scale of 0 (never) to 4 always; summed and scored as Sum 0-3 = 1 Sum 4-6 = 2 Sum 7-9 = 3 Sum 9-12 = 4
WAI	Total Score	7-49	Excellent = 44-49 Good = 37-43 Moderate = 28-38 Poor = 7-27

Adapted from Celedova, L., Babkova, K., Rogalewicz, V., & Cevela, R. (2014). The work ability index for persons aged 50+ as an instrument for implementing the concept of age management. *Kontakt*, *16*: e242-e248; Kujala, V., Remes J., Ek, E., Tammelin, T., & Laitinen, J. (2005) Classification of Work Ability Index among young employees. *Occupational Medicine*, *55*:399–401

Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics Package version 22. Descriptive statistics means and frequencies were used to describe the sample. Cronbach's alpha and item-total correlations were used to determine the internal consistency of the overall scale and discriminant power for each scale item respectively. Minimal acceptable correlations were identified as 0.40. To evaluate construct validity, exploratory factor analysis, and hypothesis testing was performed. Principle components analysis (PCA) and Varimax orthogonal rotation method were conducted with 0.4 or higher constituting a significant contribution. Bartlett's test of sphericity and the Kaiser Meyer-Olkin (KMO) statistic was used to assess suitability for factor analysis. Factors with eigenvalues greater than one and above the inflection point of the scree plot were retained. Hypothesis testing was conducted for convergent validity between the WAI and self-rated health and for divergent validity between the four subscales of the WLQ, the total WLQ score, and the lost productivity score. Correlation was conducted using the non-parametric Spearman's rho test as WAI scores were not normally distributed (Shapiro-Wilk, $p < .001$).

Results

The study sample was predominately male (69%), white non-Hispanic (83%), with a mean age of 48.8 years. The mean WAI score was 42.35, and the majority (82%) reported their work ability as good or excellent. Additional demographics describing the sample are in **Table 3-2**.

Reliability

Modest, but adequate, internal consistency of the seven-item WAI scale was supported by a Cronbach's alpha of 0.744. Inter-item correlations ranged from 0.086 to 0.531 supporting a lack of multicollinearity among items. Discriminant power of each of the seven items was evaluated through analysis of item-total correlations **(Table 3-3**). Analysis of the corrected item-total correlations revealed two values that failed to meet the 0.4 correlation including "whole days off work due to illness" (0.273) and "available mental resources" (0.307). However, increases in the overall Cronbach's alpha with deletion of the items, 0.747 and 0.748 respectively, did not substantially improve the internal consistency of the index. Based on the standardized scoring and interpretation of the WAI, these items were retained.

Validity

Factor validity. A PCA with Varimax orthogonal rotation was conducted on the eight items scored on the WAI. The Kaiser-Meyer-Olkin (KMO) result (0.710) supported sampling adequacy and the Bartlett's test of sphericity (X^2 (28) = 208.573, $\rho < .001$) supported sufficiently large correlations for PCA. Both the rotated and non-rotated analysis, based on eigenvalues >1 and the scree plot (**Figure 3-2**), produced two primary components that explained 54.65 % of the variance in work ability. On the rotated

Table 3-2 Selected Demographics of Sample Participants (n=100)

Variable		Mean	S.D.	Number	Frequency (%)
Gender	Male			69	69
	Female			31	31
Age (year)		42.8	17.9		
Education (years)		14.48	3.76		
Ethnicity	White, non-Hispanic			83	83
	Black, non-Hispanic			16	16
	Other			1	1
Total income	< $10,000			7	7.1
	10,001-25,000			6	6.1
	25,001-40,000			18	18.4
	40,001-80,000			24	24.5
	80,001-100,000			12	12.2
	>100,000			31	31.6
	(2 missing)				
Farm type	Crops			35	35
	Livestock			65	65
# acres farmed		386.96	564.92		
Hours Farm work (per week)		26.77	20.77		
WAI		42.35	5.61		
	Poor			3	3
	Moderate			15	15
	Good			30	30
	Excellent			52	52

N=participants in sample (SD)= stand deviation; (%)= percent; ($)= dollars; WAI= work ability index

Table 3-3. Work Ability Index Cronbach's Alpha, Item and Item-Total Statistics

Item	Mean	S.D.	Corrected item-total correlation	Cronbach's alpha if item deleted
Current work ability compared to lifetime best	8.24	1.564	.594	.678
Current work ability to job demands	8.78	1.168	.498	.705
Number of current physician-diagnosed diseases	5.30	1.839	.587	.687
Estimated work impairment due to disease	5.04	1.332	.599	.678
Absence due to illness in last year	4.57	.742	.273	.747
Self-estimation of work ability in 2 years	6.56	1.122	.425	.720
Mental health resources	3.83	.428	.307	.748
Work Ability Index (all questions)				.744

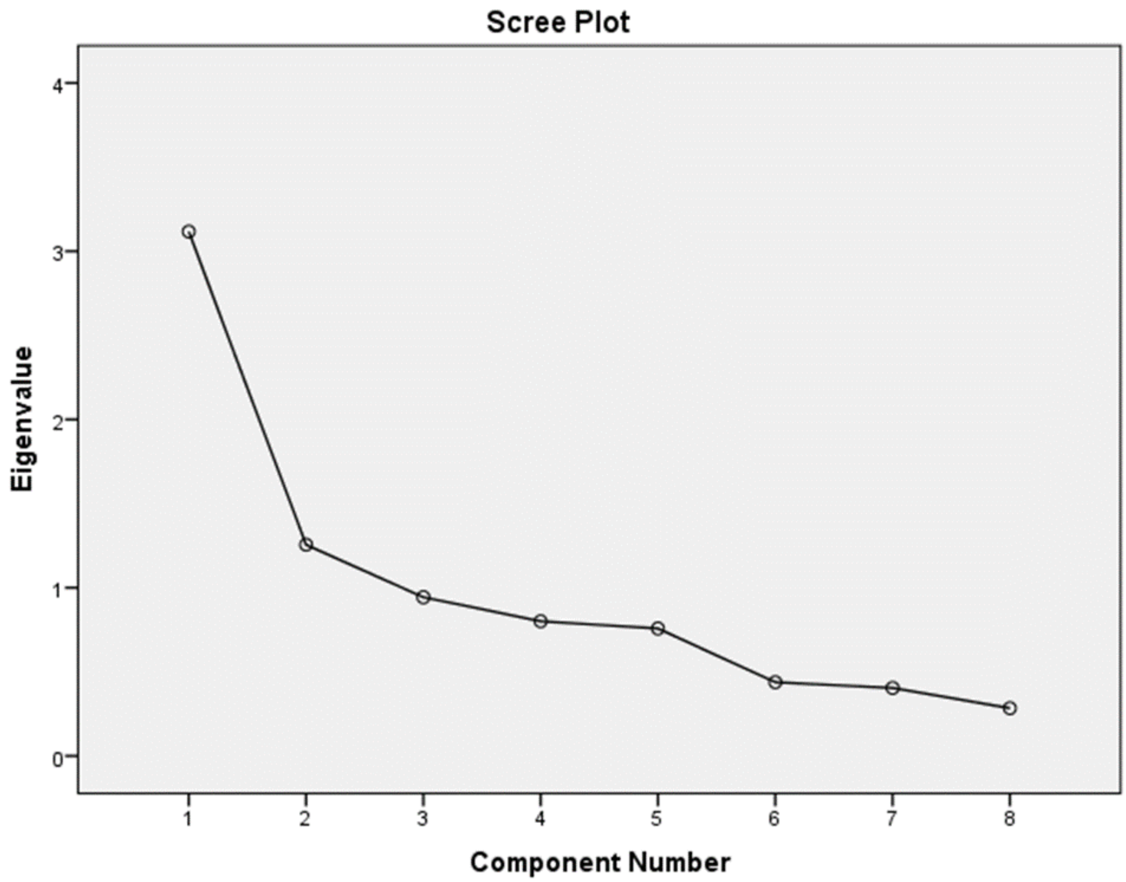

Figure 3-2 Scree plot of the principal component analysis of the Work Ability Index.

analysis, component one was comprised of five items including “work impairment due to disease”, “current work ability compared to lifetime best”, “self-estimated work ability in two years”, “number of current diseases diagnosed by physician”, and “work ability in relation to physical demands of work”. Component two consisted of two items, “current work ability compared to mental demands of work” and “mental health resources. One item, “whole days off work last year due to illness” failed to obtain recommended levels of correlation to other items in the scale (all correlations < 0.3), meet the recommended level for commonalities (0.261) and failed to load on the non-rotated and rotated extraction. **Table 3-4** contains the principle component analysis components, loadings, and variances.

The holistic model of work ability identifies a multidimensional view of work ability based on the individual worker’s resources, factors related to work, and the environment outside of work (Ilmarinen, 2006). The strength and durability of work ability are highly dependent on the individual worker’s resources. Based on this model, component one is most representative of the individual worker’s resources of health and functional capacity determined by the presence or absence of illness and disease. This promotes worker endurance and ability to meet the physical demand of the job. Component two is representative of the individual worker’s mental resources of expertise, values, and attitudes to meet the mental demands of work.

Hypothesis testing. Construct validity of the WAI was further supported by convergent and divergent validity (**Table 3-5**). The WAI showed a modest, but significant, positive correlation with self- rated health. In addition, the WAI demonstrated a significant ($\rho < 0.001$) inverse relationship between all subscales and the total score of the work limitations questionnaire. Hypothesis testing also supported a strong, significant inverse correlation between the WAI and lost productivity ($r = -0.612$, $\rho < .001$), supporting the hypothesis that promoting high levels of WAI correlate with improved worker productivity and work quality (Ilmarinen, 2006).

Discussion

The purpose of this study was to evaluate the psychometric properties of the WAI in a sample of U.S. farmers. The analysis identified a two-dimensional instrument with overall acceptable internal consistency and construct validity. Findings of the analysis, however, fail to support the inclusion of the item “whole days off due to illness in the last year” in the instrument.

“Whole days off due to illness in the last year,” did not contribute substantively to the measurement of work ability in this sample and exclusion from the instrument resulted in a marginal increase in the tool’s internal consistency and validity. Radkiewicz & Widerszal-Bazyl (2005) also found this item to have poor discriminant power in a large sample of nurses and recommend removal of the item. Further support for removal of this item was found in its failure to load on either component of the principle factor analysis. Theoretically, work absence could be conceptualized as an outcome of decreased work ability and not a defining trait of the concept of work ability. Prior

Table 3-4 Principal Component Analysis of the Work Ability Index in U.S. Farmers

Item	Without Rotation		With Rotation*	
	Component 1	Component 2	Component 1	Component 2
Work impairment due to disease	0.800		0.687	
Current work ability compared to lifetime best	0.736		0.735	
Self-estimated work ability in 2 years	0.696		0.566	
Number of current diseases diagnosed by physician	0.672		0.733	
Work ability in relations to physical demands of work	0.561	0.551	0.768	
Whole days off work last year	-	-	-	-
Current work ability compared to mental demands of work		0.893	0.545	0.712
Mental health resources		0.729		0.574
Variance explained by component (%)	32.65	22.28	38.96	15.69
Total cumulative variance (%)	54.65		54.65	

*Varimax rotation converged in 3 iterations

Table 3-5 Spearman's Correlation Coefficients for the Work Ability Index in U.S. Farmers: Convergent and Divergent Validity

Validity	Item	*r*	p
Convergent	Self- rated health	0.333	0.001
Divergent	Time management (WLQ)*	-0.615	<0.001
	Physical demands(WLQ)	-0.671	<0.001
	Mental demands (WLQ)	-0.431	<0.001
	Output (WLQ)	-0.560	<0.001
	Total Score (WLQ)	-0.498	<0.001
	Lost productivity (WLQ)	- 0.0612	<0.001

Note. WLQ is the Work Limitations Questionnaire studies (Abdolalizadeh et al., 2012; Martinez, Latorre & Fisher, 2005; Kaewboonchoo & Ratanasiripong, 2015) have used the WAI's ability to predict work absenteeism to evaluate the discriminant validity of the WAI. However, this finding was not present in studies with more occupationally heterogeneous samples (Kaewboonchoo & Ratanasiripong, 2015; Martinez, Latorre & Fisher, 2009). As both of these studies focused on homogeneous occupational groups, this finding may be unique to these occupations. In farming, the demands and nature of the work result in farmers, despite the presence of health problems, missing little work due to illness (Sauter, 2013). Further research with larger samples and diverse populations of U.S. workers is needed to clarify this finding.

The principle component analysis identified the WAI as having two components. The dimensionality of the WAI has been inconsistent; with studies finding between one (Bethge, Radoschewski, & Gutenbrunner, 2012) and three components (Martus et al., 2010; Peralta et al., 2012). In addition, the two identified components only explain a little over half of the variance in work ability in U.S. farmers. This is also consistent with findings in other studies where the total explained variance ranged from 53.49 (Kaewboonchoo & Ratanasiripong, 2015) to 57.9 (Martinez, Latorre & Fisher, 2009). With increasing literature supporting the multiple factors impacting work ability (Ilmarinen, Gould, Jarikoski, & Jarvisalo, 2008), this may reflect a lack of the tool in its current state to assess all aspects related to work ability fully.

As the theory of work ability has evolved from a balance theory model to a holistic model, the work ability has expanded to incorporate worker resources, work factors and the outside environmental and societal influences (Ilmarinen, Gould, Jarvikoski, & Jarisalo, 2008). Prior studies have generally identified factors associated with subjective and objective assessments of work ability (Martus et al., 2010; Radkiewicz & Widerszal, 2005). The dimensions identified in this analysis seem to reflect more closely the physical and psychosocial resources of the worker. As such, with these resources explaining approximately half of the perceived work ability, this adds support to the work ability model's conceptualization of the worker's resources being the foundation of work ability. These finding also support the use of the WAI in identifying and developing worker resources to meet the demands of work. Additional research and measures to address work factors and the cultural, societal, and political environments impact on work ability are also be needed to capture the ever increasing complexity of work and the worker's perception of their ability to perform.

Hypothesis testing strongly supported the WAI as a measure of work ability. Given the impact of health status on the ability to work, the correlation with self-reported health status supports work ability as the construct being measured. In addition, the inverse relationship between measures of work limitations and productivity supports that the WAI has discriminatory power as a measure of work ability. Ilmarinen (2006) identifies increased work quality and productivity as being an outcome of assessment and promotion of work ability. Our finding supports the WAI as a measure to identify decreased work ability and to intervene to support and promote improved work ability and work productivity for U.S. farmers. However, limitation of this study including the homogeneity of the sample and the small sample size limits the ability to generalize these finding to other populations.

Additional limitations also impact the generalizability of this study. Only persons physically engaged in farm work were eligible to participate in this study. As such, the healthy worker effect may have impacted the findings. In addition, the farmer's in this study were younger and more affluent than the average U.S. farmer. Use of farm shows and farm association meeting may have introduced selection bias. Recall bias may also be present due to the design of the WAI. Participants were required to recall and self-report work absences over the last year. Farmers usually live where they work so even though they may not have been able to perform as they expected on any given day, they may have simply changed tasks, thereby not missing work. This may have led to inaccuracies in the data related to absenteeism. Despite these limitations, overall, the psychometric findings in this study are reflective of the findings in psychometric evaluations of the tool in other populations.

Conclusions

This report on the psychometric properties supports the use of the WAI in U.S. farmers. Findings of this study support the WAI as a modestly reliable and valid measure of worker resources to meet job demands. However, additional assessment of work and environmental factors are also needed. The homogeneity and small size of the sample, healthy worker effect, and selection and recall bias may have suppressed the range of scores and affected the findings. Further studies to compare findings in larger, more diverse populations of workers in the U.S. are needed.

CHAPTER 4. OBESITY AND WORK ABILITY IN UNITED STATES FARMERS: A PILOT STUDY

Abstract

Background: Farming consists of both physically and mentally demanding work. The aims of this study were to assess the impact of obesity on farmers' work ability and to determine which measurement of obesity, body mass index or waist circumference, was a more accurate predictor of decreased work ability.
Methods: A cross-sectional pilot study was conducted using anthropometric measurements and a pen and pencil questionnaire that included the Work Ability Index. Descriptive and bivariate analysis was first performed to identify factors for further investigation. Multivariate Analysis consisted of two linear regression models to assess body mass index and waist circumference as predictors of decreased work ability controlling for covariates. Regression with commonality analysis was performed to compare the unique contribution of body mass index and waist circumference as predictors of work ability.
Results: The findings support obesity as a risk for decreased work ability in U.S farmers. Age was the predominate variable in explaining the variance in Work Ability Index scores. Body mass index and waist circumference, controlling for age and ethnicity, explained 4 and 5% of the variances in work ability, respectively. Body mass index, however, contributed minimally to explaining the variance beyond that uniquely explained by age or waist circumference.
Conclusion: Findings of this study support the need for education of farmers, health care providers, and farm organizations to promote interventions to reduce obesity-related declines in work ability. Waist circumference should be included in physical assessment to identify risk for decreased work ability. Further research with larger samples and longitudinal study designs is needed to clarify these findings and support evidence-based interventions to address this issue.

Introduction

Obesity is a global epidemic. Worldwide, an estimated 1.9 billion adults are overweight, and over 600 million are obese [World Health Organization (WHO), 2015], resulting in 2.8 million obesity-related deaths per year (WHO, 2012). Obesity affects an estimated 27.7% of the United States (U.S.) workforce (Gu et al., 2014; Luckhaupt et al., 2014) and has been identified as a major threat to the health and well-being of American workers (Smith, 2013). Obesity is well established as a major contributor to premature mortality and non-communicable disease (Jia & Lubetkin, 2010; Ng et al., 2014). Obesity is also gaining recognition as a contributor to increased functional limitations (Hergenroeder, Brach, Otto, Sparto, & Jakicic, 2011; Ling, Kelechi, Mueller, Brotherton, & Smith, 2012), decreased work ability (Snih et al., 2007; Robroek et al., 2013), and decreased workforce participation (Klarenbach, Padwal, Chuck, & Jacobs, 2006; Soteriades, Hauser, Kawachi, Christiani, & Kales, 2008). Obesity, therefore, has major implications not only for the health, well-being and quality of life for individuals, but the economic well-being of individuals, organizations, and society.

In an aging workforce, the effects of obesity on work ability may be even more profound. Work ability is the balance between workers' resources and job demands (Toumi et al., 1991). Factors impacting work ability include physical and mental health, occupational knowledge and skills, coping and social skills, motivation and attitude, and the organizational and community environment where work takes place (Ilmarienen, Gould, Jarvikoski, & Jarvisalo, 2008). Decreased functional capacity, even in the absence of illness, can alter the physical and psychological responses of older workers to work demands (Bridger, Brasher, & Bennett, 2012). Farmers are an aging population with 32% of principal operators over the age of 65 (Hoppe, 2014). In addition, based on self-reported heights and weights from the National Health Interview Survey, 29.1% of farmers are obese (Gu et al., 2014). Past research identifies aging and obesity as threats to work ability in moderately demanding work environments (Bridger and Bennett, 2011; Kiss, Walgrave, & Vanhoorne, 2002). In the U.S., farms remain predominately small, family owned businesses where the farm family supplies most of the physical labor. Farmers also face an array of mental demands related to the uncertainty of operating a business in an unpredictable physical environment and a changing economic and political climate (Fraser et al., 2005). Farmers must be proactive in addressing issues that can affect both their health and the financial well-being of the farm enterprise.

Obesity is a personal risk factor with the potential to alter the work ability of farmers. Exploration of obesity's impact on work ability of farmers will provide evidence to assist in addressing the total worker health of farmers and farm workers. This study addressed a large gap in the knowledge regarding obesity's effects on vulnerable farm workers who experience a work environment with high physical demands. The project focused on the relational concepts of health and functional capacity and ability to work as described in the Multidimensional Work Ability Model (Ilmarinen, Gould, Jarvikoski, & Jarvisalo, 2008). Specifically, the purpose of the study was to examine the direct effects of obesity on self-perceived ability of U.S. farmers to meet the jobs demands of farm work. The study addressed the following specific aims and related hypothesis:

Specific Aim 1: To identify the relationship between obesity and work ability in farmers/farmworkers**:**

H1a**:** Participants' risk for decreased work ability will increase with a body mass index (BMI) consistent with obesity.

H1b: Participants' risk for decreased work ability will increase with a waist circumference (WC) consistent with central obesity.

Specific Aim 2: To identify which pattern of obesity, general versus central, is the stronger predictor or decreases work ability in U.S. farmers

H2: Farmers with central obesity based on WC will have a higher risk of decreased work ability than farmers with general obesity based on BMI.

Methods

A cross-sectional pilot study was conducted to evaluate the impact of general and central obesity on the work ability of farmers. Data collection occurred from February through November 2014, in Kentucky, West Virginia, and Tennessee. Multiple points of contact including farm shows, farming association conferences, and county cooperative extension agencies were used to recruit participants. Exhibit hall booths provided an area for screening and data collection at farm shows and association events. County extension agencies identified additional potential participants who were invited to participate through postal and/or email contact and announcements in agency newsletters. **Figure 4-1** outlines the data collection activities and participation results.

Calculations using the G-Power 3.1 calculator (Faul, Erdfelder, Buchner, & Lang, 2009) identified minimal sample size of 394 for performing linear regression with one predictor variable and assuming a significance level of 0.05, a power of .80 and an expected small effect size of 0.02. Under these assumptions, but including six potential covariates, a minimal sample size of 688 was required. Based on the recommendations for a sample size for pilot studies of 10-20% of the total sample required, a sample size of 100 was identified. Inclusion criteria included all adults (≥ 18 years of age) who reported currently doing farm work, spoke and read English, and had no obvious cognitive impairment. Recruitment strategies were designed to encourage participation of female and minority farmers.

Description of Measures

The outcome variable for this study, work ability, was measured by the *Work Ability Index (WAI)* total index score. The predictor variables included the continuous variables BMI and WC. Personal characteristics associated with decreased work ability in prior research, including age, gender, education, income, ethnicity, smoking and alcohol use (Gould, Ilmarinen, Jarvisalo & Koskinen, 2008; van den Berg, Elders, de Zwart, & Burdorf, 2008) were also collected (**Table 4-1**).

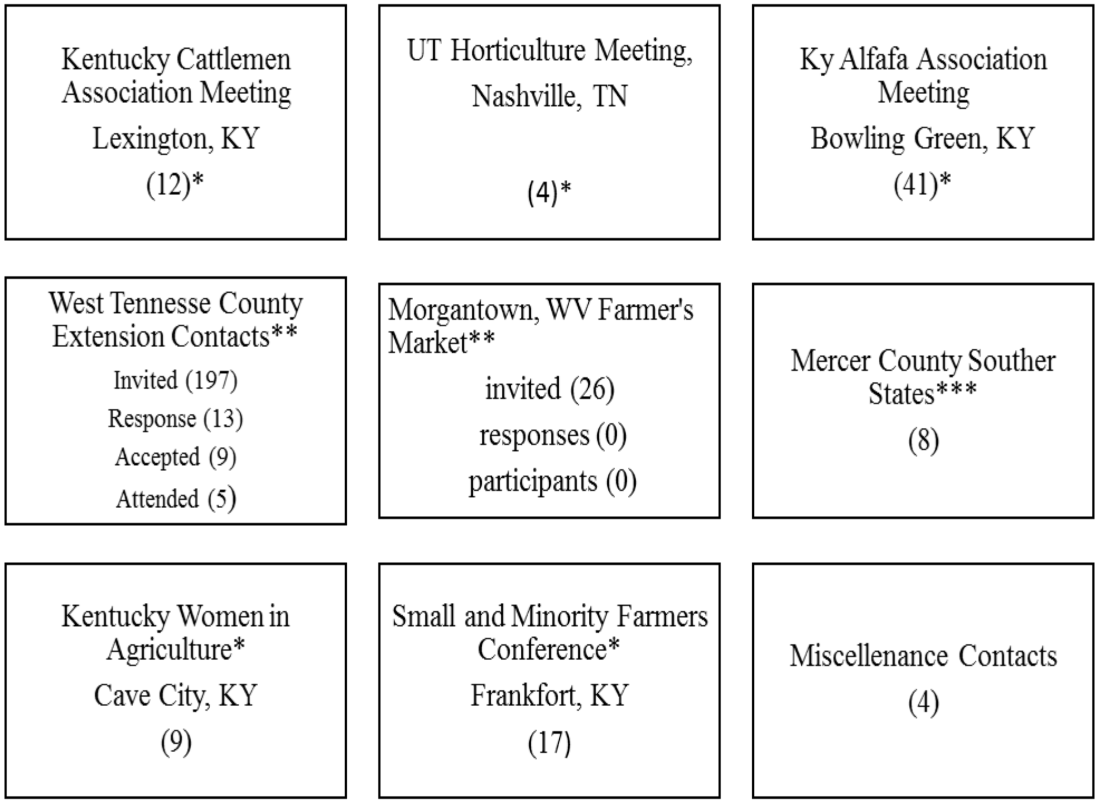

Figure 4-1 Data Collection Map. Diagram outlining recruitment of participants
* = exhibition booth with banner, ** = postal and email invitations with RSVP, *** = contact through announcements with contact information to notify if plans to attend.

Table 4-1. Covariant Variables for Work Ability and Obesity

Variable	Measurement	Question	Source	Options
Age	In years	What is your current age?		
Gender	Self-identification as male or female	What is your gender?		Male Female
Education	Years completed	How many years of school did you complete?		
Race/ethnicity		Please indicate which of the following you most closely identify with?		Caucasian African-American Hispanic Other (specify)
Smoking status	Never, former, current	Have you smoked at least 100 cigarettes in your life? Do you NOW smoke cigarettes every day, some days or not at all? IF you smoked in the past and have quit, how long has it been since you quit smoking?	National Health Interview Survey, 2013	Yes No Every day/Some days/ Not at all Years since quit______
Alcohol use	Non-drinker Moderate- Women 3 or less drinks per day and less than 7 per week. Men 4 or less per day and 14 or less per week Heavy- greater than 5 drinks on 5 or more 5 days per month	In the past year, how often did you drink any type of alcoholic beverage? In the past year, on the days you drank alcoholic beverages, on average, how many drinks did you have?	National Health Interview Survey, 2013. Definition based on the National Institute of Alcohol, Abuse, and Alcoholism (No date)	Never________ Number of days______ Number of drinks per day

Work Ability Index (WAI)

The WAI, developed by the Finnish Institute of Occupational Health, is a self-administered questionnaire reflecting a person's perception of his/her ability to perform work (Ilmarinen, 2007). The tool consists of seven items that are scored individually and summed for a total index score. The index score ranges from 7-49; a range of 7-27 is considered poor work ability, 28-36 is moderate work ability, 37-43 is good work ability, and 44-49 is excellent work ability. The WAI has been used extensively in research and clinical assessment in Europe, Asia and South America, including in farming populations in Finland, and is available in 26 languages. The index has established reliability (α = 0.72, range .54-.79), content validity and predictive power (Radkiewicz & Widerszal-Bazyl, 2005), as well as test-retest reliability (de Zwart, Frings-Dresen, & van Duivenbooden, 2002). Cronbach's alpha for this study was 0.744.

Body Mass Index (BMI)

Body mass index (BMI) was calculated based on U.S. guidelines (National Heart, Lung & Blood Institute (NHLBI, 1998). Equipment used to obtain measurements included a portable, professional grade stadiometer for height and a portable, high capacity professional grade scale for weights. Calibration and measurement of the equipment followed the recommended procedures of the equipment manufacturers. Participants removed outerwear, such as coats, sweaters, or vests and removed shoes for measurement of heights and weights. BMI was calculated using the pound inches formula of weight (pounds) x 703/(height in inches)^2.

Waist Circumference (WC)

Waist Circumference (WC) is a measure of central obesity or excess abdominal fat. WC was measured using an anthropometric tape measure and rounded to the nearest inch. Measurements, based on U.S. government guidelines (NHLBI, 1998) were performed standing, with the tape measure placed in a horizontal plane around the abdomen at the level of the iliac crest. The tape measure was placed to be snug but without compression of the skin and the reading was taken at the end of normal expiration with the waist free of clothing.

Procedures

The University of Kentucky Institutional Review Board granted approval for this study. The investigators screened farmers who indicated a willingness to participate for their eligibility based on the inclusion criteria. If eligible, participants received an explanation of the study that included the study purpose, risks, benefits, and answers to any questions. After signing the informed consent, participants completed the pen/pencil questionnaires, followed by measurement of heights, weights, and waist. After completion, the anthropometric measurement and information on how to access information on BMI were supplied to the participants on preprinted cards. To ensure consistency throughout data collection, the primary investigator (PI) and a PI trained assistant collected all data. Participants who completed the study received a $20.00 gift card in recognition of the time spent.

Data Analysis

Statistical analysis was conducted in four steps using IBM SPSS Statistic 22 (IBM Corp, 2013). First, univariate analysis of all potential variables was performed using frequency distribution, means, and standard deviations. Next bivariate analysis was conducted to evaluate the relationship between the dependent variable work ability, the independent variables BMI and WC, and the covariates age, gender, ethnicity, education, total gross income, smoking status, and alcohol use. To ensure a parsimonious model, predictor variables and covariates associated with work ability scores at a statistically significant level ($p < 0.05$) were retained for the multivariate analysis.

Two hierarchical linear regressions assessed the individual predictive strength of BMI (specific aim one) and WC (specific aim two) for the work ability total index score. Based on literature support of age as a strong predictor of work ability, age was entered in block one, ethnicity was entered in block two, and BMI was entered in block three of the first model. In model two WC replaced BMI. To evaluate specific aim three, the work ability total index score was regressed on WC and BMI simultaneously adjusting for age and regression commonality analysis was performed using a published syntax for SPSS (Nimon, Lewis, Kane, & Hayes, 2008) to identify the unique contributions of BMI and WC in predicting decreased work ability.

Examination of test assumptions prior to analysis supported the adequacy of the data for testing. Pre-analysis screening revealed missing values on four variables of interest: age (1%), total income (2%), smoking status (1%) and alcohol use (6%). As alcohol items exceeded the recommended 5% for missing data, missing data on this variable was imputed using regression. No statistical differences in correlation were present between test with imputed and missing data. Screening identified one case as both a univariate and multivariate outlier (standardized residual -3.37) on the outcome variable. Review of the data identified this case as the only participant with a BMI less than normal and a corresponding low WAI score. As this study focused on the impact of obesity on work ability, this case was omitted. Mahalanobis distances, Cook's distances, and leverage identified no influential cases on the predictors, and the Durbin-Watson test supported the independence of errors (**Table 4-2**). All tolerance scores for the two regressions were greater than 0.20, and all variance inflation factor (VIF) scores were less than 4, suggesting no significant multicollinearity. Examination of the residual plots revealed a mild to moderate, but acceptable, level of heteroscedasticity and supported a satisfactory degree of normality and linear (**Figures 4-2, 4-3, and 4-4**).

Table 4-2. Residual Statistics for Total Scores on Work Ability (N=100)

	Mean	SD	Minimum	Maximum
Predicted value	42.59	2.406	37.00	47.89
Standardized Predicted value	-0.014	0.996	-2.327	2.181
Standard error predicted value	1.821	0.272	0.507	2.048
Residual	-0.049	4.845	-16.463	7.852
Standardized Residual	-0.010	0.989	-3.362	1.604
Mahalalanobis Distance	1.969	2.424	0.030	15.634
Cook's Distance	.011	.026	.000	.208
Centered Leverage Value	.021	.026	.000	.165

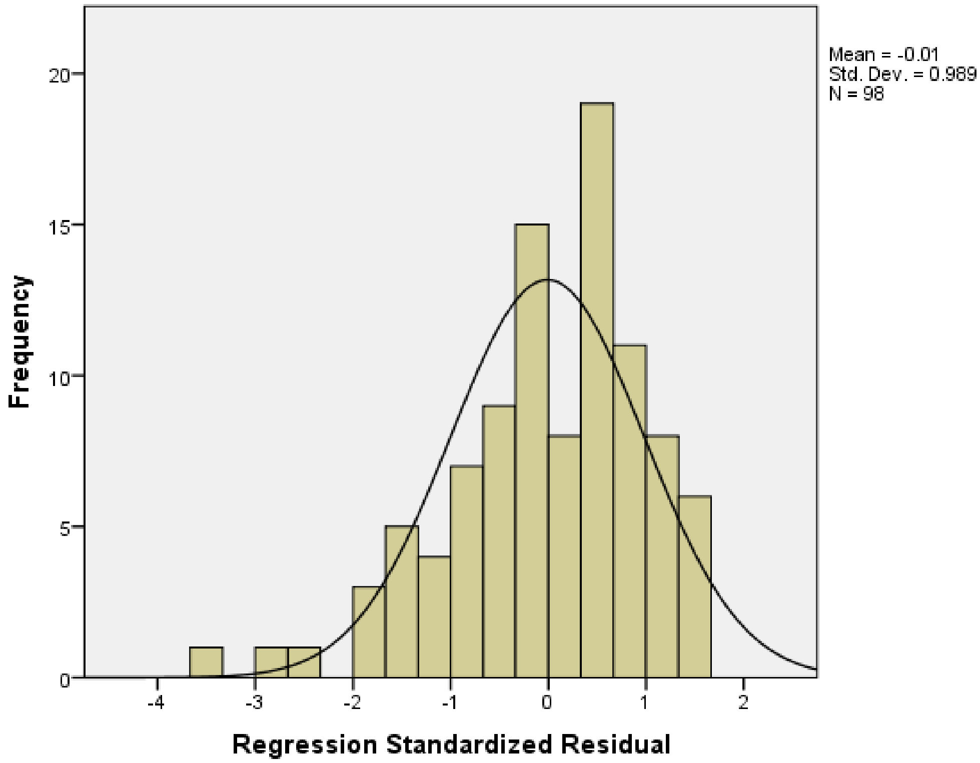

Figure 4-2. Histogram: Dependent Variable *Work Ability Index* Scores Standardized Residuals.
Std. Dev. is the standard deviation and *N* is the sample size.

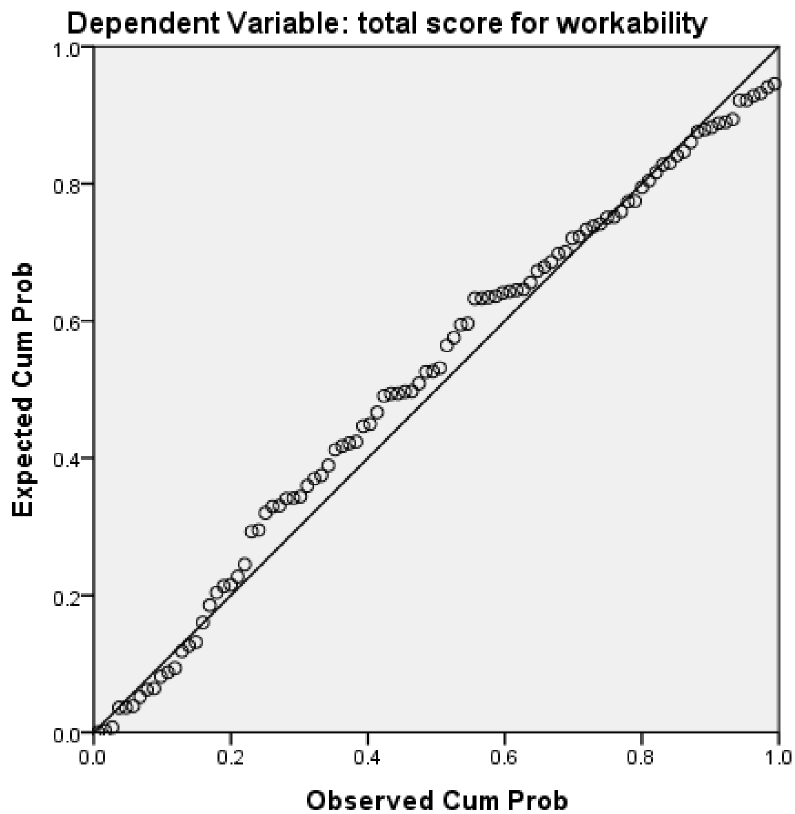

Figure 4-3. Normal P-P Plot of Regression Standardized Residuals for Work Ability.

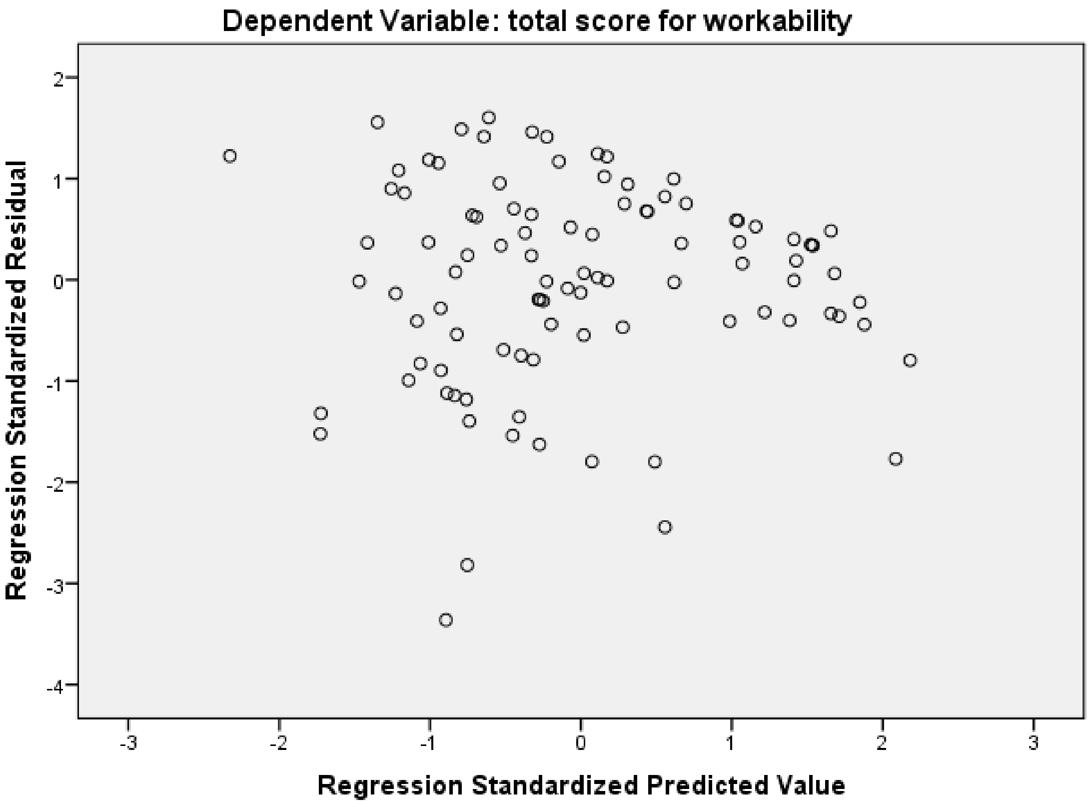

Figure 4-4. Scatterplot Standardized Residual Plots Work Ability Index Scores.

Results

Descriptive analysis

The majority of the farmers in this sample (n=100) were male (69%), white (83%), with a mean age of 48.81 ± 17.22. The mean years of education were 14.48 ± 3.75. Over half the sample (55%) reported income over $40,000. The average BMI was 29 kg/m², and over half (52%) rated their work ability as excellent. **Table 4-3** and **Table 4-4** contain the full descriptions of the categorical and continuous variables, respectively.

Bivariate analysis

Table 4-5 and Table 4-6 present the bivariate analysis of work ability total index scores by the predictor and covariate variables. A one-way analysis of variance indicated a significant difference between white and minority farmers' mean work ability index scores [$F(2,97) = 6.111$, $\rho = 0.015$]. Bivariate correlation revealed significant associations between the work ability score and the predictor variables BMI [r (99) = -.32, $\rho = .021$] and WC [r (99) = -.332, $\rho = .001$. Age was also significantly related to the dependent variable [r (99) = -.232, $\rho = .021$] and included in the multivariate analysis.

Multivariate analysis

To test the hypothesis that an increase in BMI would result in a decreased work ability score a hierarchal multilinear regression with covariates ethnicity and age was conducted (**Table 4-7**). The data identified a significant overall model [F (3, 94) = 8.346, $\rho < .001$] which accounted for 21% of the variance in work ability scores ($R^2 = .210$, adjusted $R^2 = .185$). Among the individual predictors, two predictors, age and BMI, significantly contributed to the model. Age was the most significant contributor to decreased work ability (B= -.104, SE =.029, β= -.393, ρ =.001). BMI was also a significant contributor (B= -.191, SE=.086 β= -.204, ρ = .029). Within the model, BMI explained 4.1 % of the variance of in work ability ($\Delta r^2 = .041$).

A second hierarchal regression was conducted to assess the hypothesis that increased waist circumference would result in a decrease in work ability. **Table 4-8** presents the findings of the regression. The data identified a significant overall model [F (3, 94) = 9.126, $\rho < .001$] which accounted for 22% of the variance in work ability scores (R^2 =.226, adjusted R^2 = .201). Consistent with the regression on BMI, age was the most significant contributor to decreased work ability (B= -.095, SE =.029, β= -.316, ρ = .002). WC was also a significant contributor (B= -.089, SE=.034 β= -.248, ρ = .010), explaining 5.7% of the variance in work ability ($\Delta r^2 = .057$).

To assess which pattern of obesity, general versus central, was a stronger predictor of decreased work ability, a hierarchal regression of work ability on BMI and WC was performed controlling for age (**Table 4-9**). The three predictors together revealed a statistically significant model [F (3, 94) = 8.825, $\rho < .001$] accounting for 22%

Table 4-3. Frequency Distribution of Demographic Characteristic and Study Variables (N =100)

Variable	Frequency	(%)
Gender		
Male	69	69
Female	31	31
Ethnicity		
White	83	83
Minority	17	17
Total gross income		
< $10,000	7	7
10,001- 25,000	6	6
25,001- 40,000	18	18
40,001- 80,000	24	24
80,001– 100,000	12	12
> 100,000	31	31
Missing	2	2
Smoking status		
Never	66	66
Former	24	24
Current	9	9
Missing	1	1
Alcohol use		
Heavy	5	5
Moderate	53	53
None	36	36
Missing	6	6
Work ability (category)		
Excellent	52	52
Good	30	30
Moderate	15	15
Poor	3	3

Table 4-4. Descriptive Demographic Characteristics, Obesity and Work Ability (N = 100)

Variable	Mean	Standard Deviation	Range
Age	48.82	17.9	18-81
Education	14.48	3.76	4-25
Body Mass Index*	29.00	5.86	18.2-51.9
Waist Circumference*	99.74	15.18	71.12-143.51
Work Ability Index	42.35	5.61	24-49

*Body mass index measured in kg/m^2; waist circumference measured in centimeters

Table 4-5. One Way Analysis of Variance on Work Ability Index Scores by Predictor and Covariate Variables (n=99)

Variable	Mean (SD)	*df*	*F*-statistic	ρ-value
Gender		1, 97	1.558	0.215
Male	41.52 (± 5.597)			
Female	42.52 (± 5.392)			
Race		1, 97	6.111	0.015*
White	43.11 (± 4.843)			
Minority	39.65 (± 5.392)			
Total gross income		5, 91	1.430	0.221
< $10,000	39.33 (± 8.847)			
10,001- 25,000	43.17 (± 3.189)			
25,001- 40,000	42.00 (± 5.358)			
40,001- 80,000	42.13 (± 6.096)			
80,001– 100,000	45.83 (± 2.517)			
> 100,000	42.58 (± 4.945)			
Smoking status		2, 95	1.548	0.218
Never	42.77 (± 5.273)			
Former	41.48 (± 5.035)			
Current	45.00 (± 4.444)			
Alcohol use		2, 90	1.139	0.325
Heavy	42.94 (± 5.116)			
Moderate	41.72 (± 5.891)			
None	45.00 (± 2.121)			

* Significant at a priori set value of 0.05

Table 4-6. Bivariate Correlation among Work Ability Index Scores and Age, Education, BMI and WC: (*n*= 99)

Variable	1	2	3	4	5
1. Work Ability Index Score	-	-.394**	-.102	.-232*	-.332**
2. Age (years)		-	.077	.044	.201*
3. Education (years)			-	-.070	.007
4. BMI (kg/m²)				-	.787**
5. WC (centimeters)					-

Note: BMI = body mass index; WC=waist circumference; **Correlation is significant at 0.01; * Correlation is significant at 0.05

Table 4-7. Hierarchical Regression Analysis for Body Mass Index and Covariates Predicting Farmers' Work Ability (n = 99)

	Model 1			Model 2			Model 3		
Variable	B	SE B	β	B	SE B	β	B	SE B	β
Age	-.118	.028	-.393	-105	.030	-.349	-.104	.029	-.324
Ethnicity				-1.838	1.412	-.129	-1.617	1.387	-.114
Body Mass Index							-.191	.086	-.204
Constant (SE)	48.301(1.467)			49.823 (1.872)			55.046 (2.983)		
R^2	.154			.169			.210		
F for change in R^2	17.488**			1.695			4.930*		

Note: BMI = body mass index; **Correlation is significant at 0.01; * Correlation is significant at 0.05

Table 4-8. Hierarchical Regression Analysis for Waist Circumference and Covariates Predicting Farmers' Work Ability (n = 99)

Variable	Model 1			Model 2			Model 3		
	B	SE B	β	B	SE B	β	B	SE B	β
Age	-.118	.024	-.393	-105	.030	-.349	-.0.95	.029	-.3116
Ethnicity				-1.838	1.412	-.129	-1.125	1.397	-.079
Waist Circumference							-.095	.034	-.248
Constant (SE)	48.301(1.467)			49.823 (1.872)			57.354 (3.399)		
R^2	.154			.169			.226		
F for change in R^2	17.488**			1.695			6.874**		

* p value significant at $p \leq .05$; ** p value significant at $p \leq .01$

Table 4-9. Hierarchical Regression Analysis of Waist Circumference, BMI and Age Predicting Farmers' Work Ability (n = 99)

Variable	Model 1			Model 2			Model 3		
	B	SE B	β	B	SE B	β	B	SE B	β
Age	-.118	.028	-.393	-102	.028	-.340	-.103	.029	-.341
Waist Circumference				-.094	.033	-.263	-.090	.050	-.073
Body Mass Index							-.012	.143	-.013
Constant (SE)	48.301(1.467)			56.909 (3.335)			59.903 (3.66)		
R^2	.154			.220			.220		
F for change in R^2	17.488**			8.055**			0.008		

* p value significant at $p \leq .05$; ** p value significant at $p \leq .01$

of the variance in work ability [R^2 = .220; adjusted R^2 =.196]. Age remained a consistent individual predictor of declined work ability (B = -.103, SE= .029, β = .341, ρ = .001), however neither BMI nor WC were significant predictors. Examination of the collinearity diagnostics revealed collinearity between these two predictors biasing the model. Regression commonality analysis was performed to evaluate further the impact of these two variables (**Table 4-10**). Regression commonality analysis revealed the majority (56.5 %) of the variances in work ability was uniquely explained by age. Another 9.8% of the variance was explained solely by waist circumference. However, less than 1% (0.3%) was uniquely explained by BMI, supporting waist circumference as a stronger predictor of work ability.

Discussion and Implications for Nursing

Obesity is an increasing problem in the U.S. workforce, including the farming sector. This study is the first known study to evaluate the impact of obesity on the work ability of U.S. farmers and supports the hypothesis that excess body fat contributes to decreased work ability of the farming population. Consistent with past literature (Bridger & Bennett, 2011; Fassi, et al., Goedhard & Goedhard, 2005; Gould, Polvinen & Seitsamo, 2008; Ilmarinen & Tuomi, 2004; van den Berg, et al., 2008), this study identified age as the predominant factor explaining the majority of decline in work ability. However, Reed, Rayens, Conley, Westneat and Adkins (2012) identified increasing rates of chronic conditions among older farmers that limited their work ability. The added impact of obesity may be an additional threat to the longevity of work traditionally associated with farmers (O'Neill, Komar, Brumfield, & Mickel, 2010). The impact of aging on work ability is offset by health promotion and prevention of chronic illnesses and work environment modifications (Silverstein, 2008; Tuomi et al., 1997). Reducing obesity could aid in not only improving the health and well-being of farmers but maintaining longevity in their farming careers.

The second goal of this study was to identify the measurement of obesity most predictive of declined work ability in farmers. Analysis revealed both WC and BMI as significant, but highly correlated, predictors of work ability. Waist circumference offered significant unique contributions to the prediction of work ability, but the unique contributions of BMI were minimal. The inability of BMI to distinguish between muscle and fat mass and the higher association of visceral obesity to chronic illnesses may contribute to these findings.

Though the study identifies both increased BMI and WC as risk factors for decreased work ability, these increases only explained 4-5% of the variance in work ability. Work ability is a multidimensional construct. Motivation, attitude, and available resources all affect workers' perception of work ability (Gould, Ilmarinen, Jarvisalo, & Koskinen, 2008). Farmers' high levels of work satisfaction (Reed et al., 2012) may serve as a strong motivator for increased perceived work ability and continuation in the labor force. Use of adaptive techniques, including self-pacing of work (Bridger & Bennett, 2011) and use of assistive equipment may also alter farmers' perceptions of the impact of obesity on their work. Farmer's define health as the ability to work (Reed et al., 2012),

Table 4-10. Regression and Commonality Analysis of Age, Body Mass Index, and Waist Circumference Predicting Farmers' Work Ability

Predictor	R	R^2	R^2adj	β	p	Unique	Common	Total	% of R^2
	0.469	0.220	0.195						
Age				-.341	.001	.1030	.0405	.1434	56.5159
WC				-.252	.112	.0179	.0537	.0716	9.8026
BMI				-.013	.931	.0006	.0259	.0265	.3082

BMI=body mass index; WC=waist circumference and this may delay the recognition of obesity-related declines in work ability, as well as identification and intervention for associated health issues until the impact has advanced to a critical point.

Study Limitations

Selection bias and the small sample size limit the ability to generalize the findings. Self-selection into the study may have limited participation of obese and morbidly obese farmers. Despite the provision of privacy during measurements, the requirement to weigh in the presence of others may have been a barrier to participation. The investigator particularly observed obese farmers choosing not to participate. In addition, the mean age and proportion of high-income participants in this study are not consistent with the national population of farmers. Use of farm shows and farm associations for data collection may have also introduced selection bias. However, as low income, increased age, and obesity have all been associated with decreased work ability, these biases would tend to underestimate the risk and impact of obesity on farmers. The small sample size may have limited ability to detect the statistical impact of other factors, including smoking and ethnicity, on work ability. Cross-sectional data restricts the ability to evaluate the change in work ability with changing rates of obesity and reduces the ability to make causal inferences. Additionally, this study focused primarily on working farmers and failed to identify farmers who had left the labor force due to obesity related issues.

Implications for Practice and Research

The lack of occupational health services for farmers in the U.S. may limit access to evaluation of the ability to meet the demands of performing farm work. The Work Ability Index is appropriate for both research and clinical use. Educating health care providers about the utilization of this tool may lead to higher recognition of the impact of obesity and associated health problems on farmers' ability to work and to interventions to promote and improve work ability. Primary care providers for this population also need to be informed regarding the need to consider occupationally-related issues in farming patients. Farming associations, county extension agencies, and other organizations also need to be educated and encouraged to include obesity and its impact on work as a focus of health education and programs for their members.

This pilot study supports the need for large, longitudinal research programs of study to assess further the problem of obesity in farmers and to design and test interventions to address this issue. Challenges to address for future research include identifying methods of accessing farmers from all backgrounds (owners, paid and unpaid laborers, and diverse ethnicity) and increasing research participation of people with higher levels of obesity. Identification and use of more accurate measurements of obesity, such as body fat mass or percentages, may also clarify the role of obesity in farm work.

Summary

This study was the first known study addressing obesity and work ability in U.S. farmers. The findings of this study add to the literature on obesity and work ability in farmers. The findings support obesity as a factor impacting work ability. In addition, the findings indicate the measurement of waist circumference as an inexpensive, convenient method of identifying risk. Increased education of health care providers, farm associations, and farmers regarding the impact of obesity on work is needed to raise awareness of this issue. Further research is also required to clarify the extent and impact of obesity and promote evidence-based interventions.

CHAPTER 5. CONCLUSION

The purpose of this dissertation was to explore the impact of obesity on the performance of farm work in U.S. farmers. Farmers place a high value on their ability to work, equating work with their health and overall well-being (Reed, Rayens, Conley, Westneat & Adkins, 2012; Winter, Reed & Westneat, 2009). Understanding the effects of unhealthy weight on their ability to work may serve as a motivator for lifestyle changes to improve their general health and wellbeing and promote longevity in the performance of farm work.

The conceptual basis of this research was the *Multidimensional Model of Work Ability*. In contrast to work disability, which focuses on monetary compensation for those not able to perform work, work ability focuses on the resources a worker possesses to meet the work demands in their chosen field of work (Ilmarinen, Gould, Jarvikoski, & Jarvisalo, 2008). In addition, evaluation of work ability allows occupational health providers to identify factors negatively affecting ability to work and develop interventions to improve worker's resources and job performance (Ilmarinen, Tuomi, & Klockers, 1997)

Obesity has been identified as a threat to a sustainable workforce (Luckhaupt, Cohen, Li, & Culvert, 2014; Pandalai, Schulte, & Miller, 2013; van den Berg, Elders, & Burdorf, 2010). With declining numbers of young workers entering farming and the aging of the current agricultural population, focusing interventions on controllable risk for decreased work ability in farmers is vital. Chapter two reported the findings of a literature review conducted to identify the current knowledge regarding obesity in farmers. The findings support that obesity is an increasing threat to the health and wellbeing of farmers. Occupational factors contributing to obesity in farmers include mechanization of farm work, seasonal variations in work demands, and limited leisure time activity. Despite the increase in obesity prevalence, research focusing on obesity as a factor contributing to decreased farm work ability was missing. This gap may be the result of the traditional perception of farming as both a healthy occupation and lifestyle (Brumby, Wilder & Martin, 2009). This view may no longer be accurate.

A goal of this pilot study was the evaluation of tools to assess work ability in U.S. farmers. Chapter three reports the findings of a psychometric evaluation of the internal consistency and construct validity of the *Work Ability Index* (WAI) in a sample of 100 farmers. The WAI showed modest but adequate internal consistency (Cronbach's alpha =0.744). In an evaluation of discriminate power through analysis of item-total correlation, two items failed to meet the criteria of 0.4 correlations: "whole days off work due to illness (0.273) and "available mental resources (0.307). However, removal of these items did not substantially improve the internal consistency of the tool. Hypothesis testing supported convergent validity of the tool based on significant positive correlations between the WAI and self-rated health and divergent validity based on significant inverse correlations between the WAI and the scale and subscale scores of the Work Limitations Questionnaire. Factor analysis revealed two components of the WAI consistent with the worker's resources identified in the *Multidimensional Model of Work Ability.* Component one related to health and functional capacity and component two to worker's mental resources.

Chapter four reported the conduction, analysis, and findings of a pilot study exploring and comparing the impact of general and central obesity on work ability in farmers. Finding from this study further support obesity as an area of potential threat to farmers, with 39% of the sample having a body mass index (BMI) consistent with obesity and 58% meeting the criteria for central obesity based on waist circumference (WC). Due to collinearity, two hierarchal regression explorations were performed. Both models identified age as the predominant predictor of work ability. Variance explained by BMI was 4.1%, and WC explained 5.7% of the variance. Comparison of the predictors was conducted through regression commonality analysis. Age remained the primary predictor explaining the majority of the decline in work ability variance (56.5%) in this model. Waist circumference explained an additional 9.8% of the variances. However, the decrease in work ability attributable to BMI was less than 1%. However, findings of this study must be considered in light of the studies limitations.

Limitations and Strengths

Selection bias based on self-selection and undercoverage are of concern in this study. Self-selection may have altered participation in the study of some farmers with obesity. During data collection, the investigators noted farmers with obesity avoiding the data collection booth. However, overall the number of participants with obesity were higher than both the current reported U.S. national rate of 35% (OCED, 2014) and the U.S. farmers' rate of 29.1% (Gu et al., 2014). This finding could reflect either higher rates of obesity based on regional differences, self-selection into the study of farmers concerned about the impact of obesity on their work, or a finding unique to this sample. Regardless, this impacts the ability to generalize these findings to U.S. farmers overall.

In addition to self-selection, selection bias due to undercoverage may have also occurred due to the recruitment methodology. The average age of farmers in this sample was substantially younger than the average age of U.S. farmers, 42.8 years and 58.3 years (U.S. Department of Agriculture, 2014) respectively. In addition, the majority of farms in the U.S. report earning of $50,000 or less per year (U.S. Department of Agriculture, 2014). The majority of farmers in this study (43.8%) reported incomes of more than $80,000. This finding could reflect a higher participation of younger, more affluent farmers in the farming organizations utilized to recruit study participants, resulting in the undercoverage of older, poorer farmers. Identification of efficient methods of recruiting representative samples for research in this population is needed.

An additional limitation of this pilot study is the overall sample size. Given the diversity of factors that can impact work ability, the effect of individual factors on overall work ability may be small. Thus, the small sample size limits the ability of this study to identify and control for other factors which may impact farmer's work ability. Though the findings of this study support the need for further research in this area, these limitations constrain the capacity to draw conclusions based on the findings.

Even with these limitations, the study exhibits two major strengths. One is the use of measured height, weight, and waist circumference. Self-reported anthropometric measurements are prone to bias and can underestimate the actual rate of obesity. The majority of studies reporting obesity status in the U.S. and U.S.farmers utilized self-reported measurements. Acquiring real time measurements of the participants in this study may have contributed to the higher rates of obesity in this sample versus self-reported rates. The second strength was the design of the study to ensure adequate numbers of females and minority farmers. While the number of women in farming has declined in recent years, the number of minority farmers has increased (U.S. Department of Agriculture, 2014). Ensuring adequate representation of these groups in farm research is essential to identifying factors that may be contributing to the exit of females from farming and determining and addressing the unique needs of minority farmers.

Recommendations

Overall, the findings of this inquiry support obesity as a substantial health problem in U.S. farmers that can significantly impact their ability to perform farm work. This pilot study supports the need for full scale, longitudinal studies to explore obesity and other factors that contribute to decreased work ability in farmers. Age is a substantial, but uncontrollable, factor in the decline of work ability. However, this augments the need for research to identify and address additional factors that can contribute to work ability decline. Additionally, research is also required to identify the best method of assessing the impact of obesity on work ability. Findings from this study support waist circumference as the stronger predictor of decreased work ability in farmers. Also needed is the evaluation of waist circumference as a predictor of decreased work ability in other occupations.

Findings from this study also have implications for nursing practice, especially advanced practice nurses in rural areas, and for occupational health coaching and counseling to promote improved health in overweight and obese farmers. First, findings support the inclusion of the measurement of waist circumference as a standard of care in both primary care and occupational health to ensure that central obesity is addressed as a risk factor for both declining health and declining work ability. Second, findings from this study support use of the WAI for assessment of work ability in U.S. farmers. The design of the WAI allows for use in both research and clinical practice. Changing the culture in the U.S. to focus on assessment, promotion and improvement of work ability is needed. Yearly assessments of adult's work ability by primary care and/or occupational health providers are needed to identify factors impacting declining work ability. This change would allow intervention to occur before work ability declines reach the level of work disability and lead to an early exit from the workforce. This approach would support the sustainability of a viable workforce not only in agriculture but all occupations.

In conclusion, the findings of this dissertation add to the body of knowledge and demonstrate the need to address obesity in U.S. farmers. This pilot study supports the need for both additional research and alterations in clinical practice to address this issue. Findings support the implementation of measurements of waist circumference and assessment with the WAI in primary and occupational clinical practice providing care to farmers. On a broader level, shifting the cultural focus in the U.S. from a work disability to a work ability focus may promote increased workforce participation and a sustainable workforce not only in agriculture but other occupations.

APPENDIX 1. INSTITUTIONAL REVIEW BOARD, UNIVERSITY OF KENTUCKY, STUDY APPROVAL LETTER

UK UNIVERSITY OF KENTUCKY

Office of Research Integrity
IRB, IACUC, RDRC
315 Kinkead Hall
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Expedited Initial Review

Approval Ends
October 6, 2014

IRB Number
13-0570-P1H

TO: Sharon Hunsucker, RN
Nursing 5th Floor
c/o Dr. Deborah Reed
553 College of Nursing Bldg 0232
PI phone #: (606) 286-6653

FROM: Chairperson/Vice Chairperson
Medical Institutional Review Board (IRB)

SUBJECT: Approval of Protocol Number 13-0570-P1H

DATE: October 9, 2013

On October 7, 2013, the Medical Institutional Review Board approved your protocol entitled:

Effects of Obesity on Work Ability, productivity and Injuries in Farmers

Approval is effective from October 7, 2013 until October 6, 2014 and extends to any consent/assent form, cover letter, and/or phone script. If applicable, attached is the IRB approved consent/assent document(s) to be used when enrolling subjects. **[Note, subjects can only be enrolled using consent/assent forms which have a valid "IRB Approval" stamp unless special waiver has been obtained from the IRB.]** Prior to the end of this period, you will be sent a Continuation Review Report Form which must be completed and returned to the Office of Research Integrity so that the protocol can be reviewed and approved for the next period.

In implementing the research activities, you are responsible for complying with IRB decisions, conditions and requirements. The research procedures should be implemented as approved in the IRB protocol. It is the principal investigators responsibility to ensure any changes planned for the research are submitted for review and approval by the IRB prior to implementation. Protocol changes made without prior IRB approval to eliminate apparent hazards to the subject(s) should be reported in writing immediately to the IRB. Furthermore, discontinuing a study or completion of a study is considered a change in the protocol's status and therefore the IRB should be promptly notified in writing.

For information describing investigator responsibilities after obtaining IRB approval, download and read the document "PI Guidance to Responsibilities, Qualifications, Records and Documentation of Human Subjects Research" from the Office of Research Integrity's Guidance and Policy Documents web page [http://www.research.uky.edu/ori/human/guidance.htm#PIresp]. Additional information regarding IRB review, federal regulations, and institutional policies may be found through ORI's web site [http://www.research.uky.edu/ori]. If you have questions, need additional information, or would like a paper copy of the above mentioned document, contact the Office of Research Integrity at (859) 257-9428.

Patricia K. Howard, PhD, RN/hs
Chairperson/Vice Chairperson

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Chapter One

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Chapter Three

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VITA

Educational Background

Date	Institution	Degree
1994	Florida State University, Tallahassee, Fl.	Masters of Science in Nursing.
1990	Florida State University, Tallahassee, Fl.	Bachelors of Science in Nursing.
1976	Morehead State University, Morehead, Ky.	Associate of Science: Nursing

Professional Positions Held: Academic

Date	Institution	Position
2009- Present	Frontier Nursing University, Hyden, KY	Course Faculty
2006	University of Kentucky, Lexington, KY	Visiting Faculty
2005	Morehead State University, Morehead, KY	Assistant Professor
1998-2000	Jackson State Community College, Jackson, TN.	Assistant Professor
1994	Florida State University, Tallahassee, FL	Clinical Instructor
1990-1991	Florida State University, Tallahassee, FL	Clinical Instructor

Professional Positions Held: Clinical

2004-2006. 2011-20 13	Clark Family Care, Winchester, KY	Family Nurse Practitioner
2006-2010	Family Care Clinic, Mt. Sterling, KY	Family Nurse Practitioner
2001-2004	Kings Daughter Medical Center, Ashland, KY	Family Nurse Practitioner
2001	ARH Healthcare Center, West Liberty, KY	Family Nurse Practitioner
2000	PSSI, INC., Brownsville, TN.	Wound care Nurse Practitioner

1995-1998	Baptist Health Center, Dyer, TN	Family Nurse Practitioner
1994-1995	Florida Public Health, Wakulla County, FL.	Family Nurse Practitioner
1994	State of Florida, Agency for Healthcare: Medicaid Division, Tallahassee, FL.	Nurse Consultant
1986-1993	Tallahassee Memorial Regional Healthcare Center, Tallahassee, FL	Staff Nurse
1976-1980 & 1982 – 1986	Appalachian Regional Hospital. Whitesburg, KY	Staff-nurse

Scholastic and Professional Honors

1990 to present	Sigma Theta Tau Honors Society
1990 to present	Phi Kappa Phi Honors Society
2012 to present	Delta Epsilon Iota Academic Honor Society-University of Kentucky
2012	Traineeship: NIOSH Education and Research Center-Occupational Health Nursing Scholar
2014	SCHIP Research Scholarship, University of Kentucky

Publications and Presentations

Articles in Refereed Journals

Hunsucker, S.C., Franks, D., & Flannery, J. (1999). "Needs of Families of Critically Ill Patients in Rural Southern Appalachia." Dimensions of Critical Care, May, 1999.

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Hunsucker, S.C. Family Needs and Coping Strategies During Critical Illness in Southern Appalachia. Poster Presentation. Academy of Nurse Practitioners, Los Angeles, California, June, 1995.

Hunsucker, S.C. Off the Beaten Path: Conducting Nursing Research in Rural Setting. Fifth Biennial Clinical Nurse Specialist Conference. National Association of Clinical Nurse Specialist, Philadelphia, Pa. 1998.

Hunsucker, S.C. Rural Health Clinical Nurse Specialist: A Model for Practice. Fifth Biennial Clinical Nurse Specialist Conference. National Association of Clinical Nurse Specialist, Philadelphia, Pa. 1998.

Mannino, D & Hunsucker, S.C. Diagnosis and Progression of Pneumoconiosis. Central Appalachian Regional Worker Safety &
Health Symposium: An Interdisciplinary Update on Mine Health & Safety. exington, KY, 2013.

Hunsucker, S.C. Teleworker Safety. An online employee educational program for Frontier Nursing University employee orientation for online faculty/staff. 2013.