# SMOKING BEHAVIOR AND THE IMPACT ON SLEEP QUALITY AND HEALTH-RELATED QUALITY OF LIFE AMONG OPERATING ENGINEERS

**by**

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## DEDICATION

***To my family***

## ACKNOWLEDGEMENTS

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## ABSTRACT

**Smoking Behavior and the Impact on Sleep Quality and Health-Related Quality of Life Among Operating Engineers**

**By**

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The objective of this secondary data analysis of cross-sectional data was to explore smoking behavior among blue collar workers, especially Operating Engineers (heavy equipment operators). With the guidance of the Health Promotion Model, the specific aims were (1) to determine variables associated with smoking behavior among Operating Engineers, (2) to examine smoking as one of the variables related to sleep quality among Operating Engineers, and (3) to examine smoking as one of the variables related to health-related quality of life among Operating Engineers. Working with Michigan Operating Engineers Local 324, data were collected until a quota of 500 participants was reached in 2008. Two surveys were incomplete, leading to the final sample of 498. Data contained demographic information, health conditions (depressive symptoms and medical comorbidities), health behaviors (smoking, alcohol use, diet, physical activity, and sleep), and health-related quality of life. Linear and logistic regression analyses were used to analyze the data. About 29% of the participants smoked cigarettes and smoking behavior was significantly associated with engaging in other high risk health behaviors (problem drinking, physical inactivity, and a lower BMI). This supported findings from a 2009 NIH meeting on the Science of Behavior Change that risky health behaviors often bundle together. In addition, smokers with nicotine dependence had poorer sleep quality and poor health-related quality of life among Operating Engineers. Considering the bundled health behaviors among smokers, multiple health behavior interventions would be more beneficial for Operating Engineers than single health behavior interventions. When designing multiple health behavior interventions, researchers should consider the pivotal role of smoking behavior in bundled health behaviors and view smoking cessation as a gateway to changing other risky health behaviors. Furthermore, multiple health behavior interventions combined with smoking and other risky health behaviors could improve health-related quality of life among Operating Engineers.

# CHAPTER I

## Introduction

### Statement of Purpose

While the prevalence of smoking in the USA has declined from 42.4% since the first Surgeon General Report in 1964 to 20.4% reported in 2009 (Centers for Disease Control and Prevention, 2010), there remain disparities in smoking prevalence among occupational groups. Smoking rates are reported to be 35.4 % among blue collar workers and 20.3 % among white collar workers (Bang & Kim, 2001; Lee et al., 2004; Smith, 2008). Moreover, the decline in smoking prevalence is also lower among blue collar workers compared to white collar workers (Giovino, 2002; Lee et al., 2007). One reason for the disparities in smoking prevalence is the lack of studies examining smoking behavior focusing on blue collar workers. Lee et al. (2004) argued that smoking related variables in blue collar workers might differ from those in white collar workers. Based on these differing variables, different strategies for smoking cessation should be developed and employed to reduce the disparities in smoking prevalence among blue collar workers.

One group of blue collar workers, Operating Engineers (those responsible for the operation and maintenance of heavy earthmoving equipment used in the construction of buildings, bridges, roads, and other facilities; Stern & Haring-Sweeney, 1997) in Michigan, showed a high prevalence of smoking (28.5%) (Duffy et al., 2011). Thus, studies are needed to explore smoking behavior among Operating Engineers and develop strategies tailored to the population. Even though a number of studies have focused on smoking behavior, few studies have focused on blue collar workers and even fewer studies have used theoretical frameworks. In order to design effective smoking cessation interventions, especially for blue collar workers, a theory-guided understanding of smoking behavior in this population is essential. The main purpose of this dissertation was to explore smoking behavior among Operating Engineers in Michigan. Specific aims of this study were: 1) to determine variables associated with smoking behavior among Operating Engineers; 2) to examine smoking as one of the explanatory variables of sleep quality among Operating Engineers; and 3) to examine smoking as one of the explanatory variables of health-related quality of life among Operating Engineers. These specific aims are interrelated since smokers have been shown to engage in other risky health behaviors simultaneously, which in turn leads to poor sleep quality and health-related quality of life, particularly when integrated into a healthy lifestyle (Pender, Murdaugh & Parsons, 2006).

## Structure of the Dissertation

The three specific aims were explored in detail in the following three chapters. Each chapter will serve as a manuscript. Using the Health Promotion Model as a guide, Chapter II determined personal and related behavioral variables associated with smoking among Operating Engineers. Chapter III examined smoking as one of the variables associated with sleep quality. Chapter IV explored smoking as one of the variables associated with health-related quality of life. Chapter V summarized the findings from Chapter II through Chapter IV and discussed overall health behaviors and health promoting interventions for Operating Engineers.

## Background and Significance

### Significance of the Problem

#### Smoking among blue collar workers

The gap in smoking prevalence between white collar workers and blue collar workers is significant and remains even when controlling for age, sex, race, ethnicity, education, as well as income (Barbeau et al., 2004). The smoking rate among construction trades was reported to be 40.8 % during the period 1987-1994, which is fairly stable when compared to 38.8 % during the period 1997-2004 (Lee et al., 2007). In addition to the slow decrease in smoking prevalence, when compared to the smoking rate of 27.8% among the general population during the period 1987-1994 and 24.5% during the period 1997-2004, the smoking rates among construction trades were significantly high. Contrarily, a more rapid drop and lower smoking rates among white collar workers have been noted (Okechukwu, Krieger, Sorensen, Li & Barbeau, 2009). Furthermore, blue collar smokers are more likely to be heavy smokers and are more likely to start smoking at an earlier age, which makes smoking cessation more difficult; therefore, they are less likely to quit smoking when compared to white collar smokers (Adler & Newman, 2002; Lawrence, Fagan, Backinger, Gibson & Hartman, 2006; Moolchan et al., 2007; Okechukwu et al., 2009). Moreover, Operating Engineers, in general, had seasonal downtime during winter when they are unemployed and might have financial difficulties. Individuals with financial stress have a hard time quitting smoking and easily relapse after a period of smoking cessation (Siahpush & Carlin, 2006).

### Possible reasons for high rates of smoking among blue collar workers

Unequal distribution of health promoting interventions and application of anti-smoking policies are the possible reasons for the gap of smoking rates between blue collar workers and white collar workers. First, the high smoking prevalence among blue collar workers indicates their high need for smoking cessation interventions. Despite the high need for smoking cessation interventions, blue collar workers have had relatively limited accesses to health promoting interventions (Okechukwu et al., 2009). On the other hand, white collar workers with higher educational levels, are more likely to have accesses to and benefit from smoking cessation interventions (Adler & Newman, 2002). The unequal distribution of smoking cessation interventions has widened smoking disparities between blue collar workers and white collar workers.

Another possible reason for the disparity is that blue collar workers do not benefit as much from anti-smoking policies as do white collar workers. Since they are outdoor workers, they do not benefit from worksite smoking restrictions that have been found to be among the most effective smoking cessation interventions in the general population (Farrelly, Evans & Sfekas, 1999; Rachiotis, Karydis, Drivas & Hadjichristodoulo, 2009). Therefore, public health efforts have led to a reduction in smoking prevalence among white collar workers, but have had less considerable impact among blue collar workers.

### Risks associated with smoking

The adverse effects of smoking on health have been well established in the literature; smokers are more likely to have smoking-related diseases, such as cardiovascular disease and pulmonary diseases (Rothenbacher et al., 1998). Moreover, smoking has causal relationships with the development of various malignant tumors of the oral cavity, esophagus, larynx, lung, pharynx, and urogenital bladder (Gandini et al., 2007; U.S. Department of Health and Human Services, 2004). Among Operating Engineers, the risks of smoking are even more severe as they are exposed to occupational hazards, such as asbestos, arsenic, cadmium, and radon, on a daily basis (Oliver, Mirecle-McMahill, Littman, Oakes & Gaita, 2001). The occupational exposures to these contaminants have shown a dose-response synergic effect with smoking on lung cancer (Chen et al., 2004). The high smoking rates in Operating Engineers and the synergic effects with occupational contaminants on pulmonary diseases may be the reason for greater risks and elevated mortality ratios related to bronchitis, emphysema, pneumoconiosis, and lung cancer in that population (Dement et al., 2003; Mastrangelo, Tartari, Fedeli, Fadda & Saia, 2003; Stern & Haring-Sweeney, 1997; Wang, Dement & Lipscomb, 1999). Thus, Operating Engineers who smoke are at risk for increased mobility and mortality.

### Costs associated with smoking

As a result of these harmful effects of smoking, workers who smoke are linked to higher employee turnover, absenteeism, lower productivity, higher medical costs, and early retirement (Alavinia, Berg, van Duivenbooden, Elders & Burforf, 2009; Lee et al., 2004; Rothenbacher et al., 1998; Smith, 2008). The Centers for Disease Control and Prevention (CDC) estimated the combined direct and indirect economic costs of smoking exceeded $167 billion per year, which includes $75 billion in direct healthcare costs and $92 billion in lost productivity (CDC, 2010). The portion of these costs, however, decreases once employees quit smoking (Nelson et al., 1994; Okechukwe et al., 2009).

## Theoretical Framework: Health Promotion Model

According to Parkerson et al. (1993), health behavior refers to "the actions of individuals, groups, and organization, as well as the determinants, correlates, and consequences of these actions—which include social change, policy development and implementation, improved coping skills and enhanced quality of life… related to health." Health behaviors described in the literature include smoking, drinking alcohol, diet, physical activity, sleep, substance use, and sexual practices; these risky health behaviors contribute 50% of total mortality in the US (Mokdad, Marks, Stroup & Gerberding, 2004) and have been associated with quality of life (Redding, Rossi, Rossi, Velicer & Prochaska, 2000). Given that health behaviors are modifiable, many theories, such as the Health Belief Model, the Health Promotion Model, the Theory of Reasoned Action and Planned Behavior, and the Transtheoretical Model, have tried to explain as well as predict health behaviors. Among the theories, the Health Promotion Model (Pender, Murdaugh, & Parsons, 2006) was chosen as a theoretical framework to guide this study on smoking behavior among Operating Engineers.

The first rationale for the choice of the model is that the Health Promotion Model does not include "fear" or "threat" as a source of motivation for health behavior changes as does the Health Belief Model (Pender et al., 2006). Given that the sample of this study is a healthy working population and relatively young, "threats" in the distant future may not play a significant role in motivation for healthy behaviors. The second rationale is that while most other health behavior theories (the Health Belief Model, the Theory of Reasoned Action and Planned Behavior, and Transtheoretical Model) emphasize psychological and cognitive constructs that can be applied only to a specific behavior, the

Health Promotion Model includes not only behavior specific psychological and cognitive variables, but also the “related behavior” factor. Related behaviors include prior experience, knowledge, and skills of the same or related behaviors and have been shown to influence subsequent behaviors. Even though psychological and cognitive variables can explain the most proximal aspects of health behaviors, at the same time they limit their territory to a single health behavior (e.g., self-efficacy for smoking cessation, self-efficacy for physical activity…) rather than extending to multiple health behaviors (e.g. cumulative self-efficacy). For example, Murnaghan et al. (2010) tested predictive values of the Theory of Planned Behavior across three health behaviors (physical activity, healthy diet, and smoking cessation) and concluded that the model had inconsistent predictive values across these behaviors. Similarly, a meta-analysis documented inconsistencies in processes of change in the Transtheoretical Model across four health behaviors (smoking cessation, recovery from substance abuse, exercise adoption, and diet change); while, for smoking cessation, cognitive processes were more often used in earlier stages, for exercise adoption and a diet change, both cognitive and behavioral processes increased as individuals advanced through the stages of change (Rosen, 2000).

As opposed to behavior-specific psychological and cognitive constructs, the “related behavior” could be suitable to explain bundled risky health behaviors among smokers. Pronk et al. (2004) stated that about 92% of smokers engaged in at least one additional health risky behavior. The bundled risky health behaviors in which smokers were more likely to engage included problem drinking, physical inactivity, unhealthy diet, and less sleep (Foster, 1992; National Institutes of Health, 2009; Oleckno & Blacconiere, 1990; Pronk et al., 2004). Moreover, the number of cigarettes smoked was negatively associated with performance of health promoting behaviors (Prochaska, Nigg, Spring, Velicer, & Prochaska, 2010). Given the findings of previous studies and the high rates of risky behaviors (smoking, problem drinking, low fruit and vegetable intake, low physical activity, and high obesity rates) among Operating Engineers (Duffy et al., 2011), the Health Promotion Model seemed best suited to understand smoking behavior as it relates to other risky behaviors and health-related quality of life among Operating Engineers (Figure 1).

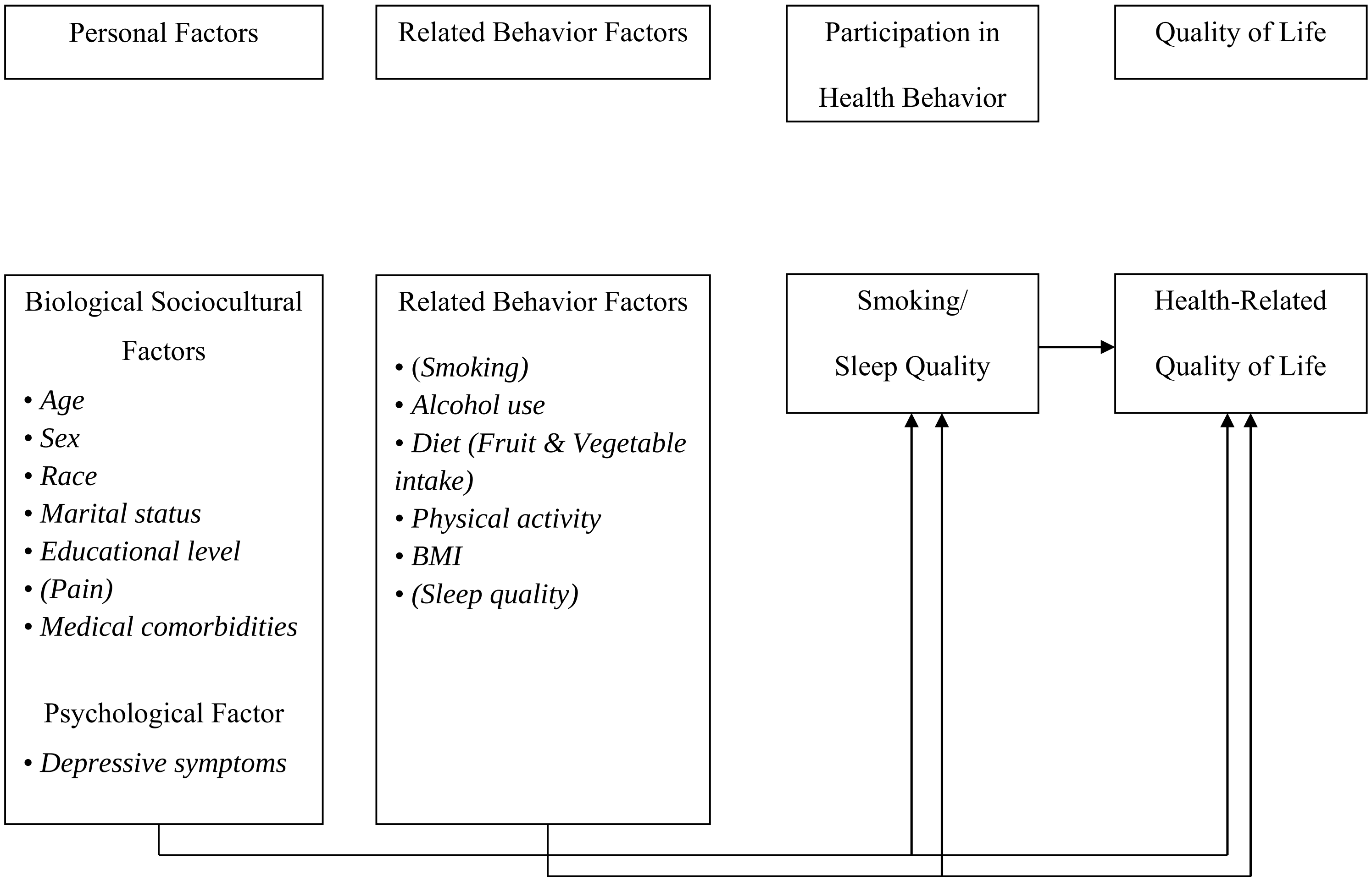


Figure 1. Theoretical Framework

## Review of the Literature

The Health Promotion Model is a framework for exploring why some people perform health promoting behaviors, including smoking cessation, exercise, a healthy diet, and stress management, whereas others do not (Pender et al., 2006). In the model, health behaviors are determined by individual characteristics (personal factors), experiences of the same or related behaviors (related behaviors), and behavior specific cognitions and affects. The constructs of the Health Promotion Model are described below.

### Individual Characteristics and Experiences

Individual characteristics and experiences involve personal factors and related behaviors.

Personal factors include biological, psychological, and socio-cultural factors (Pender et al., 2006). Biological and socio-cultural factors embrace demographic variables, those who were younger, male, non-White, not married, and at a lower educational level have been associated with high smoking rates (Barbeau et al., 2004; Chung et al., 2009; Dallongeville et al., 1998; Fagan et al., 2007; Garrett et al., 2004; Laaksonen et al., 2001; Siahpush, Singh, Jones, & Timsina, 2009). Psychological factors include self-esteem, self-motivation, and perceived health status (Pender et al., 2006). When individuals perceived higher locus of control over smoking cessation, they were more likely to make quit attempts and succeeded at maintaining abstinence (Stuart, Borland & McMurry, 1994).

Related Behaviors, one of the components unique to the Health Promotion Model, refers to prior experience, knowledge, and skills of the same or related behaviors. Related behaviors have been shown to influence subsequent behaviors (Pender, 2006). For example, quit attempts in the past predicted quit attempts in the future, and the length of the longest previous quit attempt, in turn, predicted the success of subsequent quit attempts (Godin et al., 1992; Norman, Conner, & Bell, 1999). Moreover, other risky health behaviors, such as problem drinking, unhealthy diet, physical inactivity, and less sleep, have been related to smoking behavior in the literature (Chiolero, Wietlisbach, Ruffieux, Paccaud, & Cornuz, 2006; Emmons et al., 1994; Garrett et al., 2004; Kvaavik, Meyer, & Tverdal, 2004; Laaksonen et al., 2001; Ma, Betts, & Hampl, 2000; Poortinga, 2007; Pronk et al., 2004; Schuit, van Loon, Tijhuis , & Ocke, 2002).

**Behavior Specific Cognitions and Affect**

Behavior specific cognitions and affects include perceived benefits, perceived barriers, perceived self-efficacy, activity-related affect, and interpersonal and situational influences.

Perceived benefits refer to positive aspects of health behavior that influence individuals to make plans of participating in health promoting behaviors (e. g. smoking cessation) and to encourage continued behavior changes.

Perceived barriers, on the other hand, refer to negative aspects of changing health behavior and discourage individuals to change behaviors. While perceived benefits (e. g., health improvements or prior positive experience of smoking cessation) were associated with increases in motivation to quit smoking, perceived barriers (e. g., nicotine dependence, inconvenience or expense of smoking cessation programs) were associated with decreases in motivation and relapses (McKee, O'Malley, Salovey, Krishnan-Sarin, & Mazure, 2005; Stegbauer, 1995).

Perceived self-efficacy refers to confidence in an individual's ability to abstain. Self-efficacy in the Health Promotion Model is interrelated to other constructs in the model functioning as four resources of self-efficacy—mastery experiences, vicarious experience, verbal persuasion, and physiological and affective states—noted by Bandura (Bandura, 1977): (1) prior related behaviors—past experiences of successful behavior change—indicate mastery experiences, (2) situational influences represent vicarious experience, (3) interpersonal influences may promote verbal persuasion to quit smoking, and (4) activity related affect enhances physiological and affective status promoting behavior change. In addition, self-efficacy in the Health Promotion Model is considered a mediator supporting the association of related behaviors and personal factors with health behaviors (Pender et al., 2006). Consistent with this proposition, experience of successful quit attempts in the past led to increases in self-efficacy, which, in turn, motivated individuals to make another quit attempt or maintain abstinence (Martinelli, 1999; Stuart et al., 1994).

Activity-related affect refers to feelings before, during, and after behavior change, which in turn influence individuals to repeat the behavior in the future or maintain the behavior (Pender et al., 2006). Prior negative experience of smoking cessation (e. g., unpleasant experience of withdrawal symptoms) resulted in individual's relapses and avoidances of making subsequent quit attempts. Positive smoking cessation related affect led individuals to make quit attempts directly and indirectly through increases in self-efficacy (Pender et al., 2006).

Interpersonal influences refer to perceptions regarding social norms and supports from significant others, such as family, peers, co-workers, and health care providers (Kelley, Sherrod & Smyth, 2009), and they influence health behaviors both directly and indirectly through increases in social pressures or encouragements to commit to a plan (Pender et al., 2006). Encouragement and incentives from an individual's physician have been shown to result in high smoking cessation rates (Kelley et al., 2009).

Situational influences refer to perceptions of external environments influencing health behaviors (Pender et al., 2006). External environments include accesses of smoking cessation interventions and anti-smoking legislations. For example, anti-smoking regulations in public areas and worksites created a demand to quit smoking, which in turn promoted smoking cessation (Ho, Berggren & Dahlborg-Lyckhage, 2010; Macy, Seo, Chassin, Presson & Sherman, 2007).

## Conclusion

The literature has documented the phenomenon of bundled health behaviors (National Institutes of Health, 2009) and acknowledged that health promoting interventions targeting multiple risky health behaviors simultaneously could be more effective than interventions targeting single behavior (Prochaska, 2008); thus, multiple health risk interventions should lead public health interventions. However, few studies have investigated bundled risky health behaviors among blue collar workers guided by health behavior theories.

Guided by the Health Promotion Model, the specific aims of this study were: (1) to determine personal and related behavioral factors associated with smoking behavior among Operating Engineers; (2) to examine smoking as one of the variables related to sleep quality among Operating Engineers; and (3) to examine smoking as one of the variables related to health-related quality of life among Operating Engineers. Since the focus of this dissertation was smoking behavior in relation to other related behaviors, bundled risky health behaviors among smokers, “related behavior” associated with smoking behavior was used as a key construct, and behavior-specific psychological and cognitive constructs were not examined.

## Methods

### Design

This study is a secondary analysis of cross-sectional data collected by Dr. Duffy in 2008 with an aim of exploring health conditions and health behaviors among Operating Engineers. The goal of this study was to examine smoking behavior, especially in relation to other health behaviors, sleep quality, and health-related quality of life among Operating Engineers in Michigan. Chapter II is a cross-sectional correlational design to determine personal and related behavioral factors associated with smoking behavior. Chapter III is a cross-sectional correlational design to examine smoking in relation to sleep quality. Chapter IV is a cross-sectional correlational design to examine smoking in relation to health-related quality of life. Institutional Review Board (IRB) at University of Michigan (HUM00015849) was obtained.

### Sample and Setting

A convenience sample of Operating Engineers was recruited from a training center in Howell where every Operating Engineer in Michigan was gathered for either a three-year apprentice certification course or the 8-hour Hazardous Materials (Hazmat) refresher course. Ninety percent of the Operating Engineers who were asked to participate agreed and returned the survey. Two of the returned surveys were incomplete and dropped from the analysis, resulting in a final sample size of 498.

### Procedures and Measures

After the instructor of the training center explained the study, anonymous surveys (including study information sheet, survey, and a return envelope) were distributed until a quota of 500 was reached. Those who completed the survey received a $10 gasoline gift card. The data included demographic information, health conditions (medical comorbidities, depressive symptoms), health behaviors (smoking, alcohol use, diet, physical activity, BMI, and sleep quality), and health-related quality of life.

## Summary

A number of studies have documented the disparities of smoking prevalence between white collar workers and blue collar workers. However, few studies have examined smoking behavior focusing on blue collar workers and even fewer studies have used theoretical frameworks. Therefore, the main purpose of this study was to explore smoking behavior among one group of blue collar workers, namely Operating Engineers.

In Chapter II, by using the construct of "related behavior," smoking behavior was examined in relation to other risky health behaviors, with a dependent variable of smoking status, and independent variables of personal factors (demographic data, medical comorbidity, and depressive symptoms) and related-health behaviors (alcohol use, diet, physical activity, BMI, and sleep quality). In Chapter III, smoking behavior was examined as one of the variables related to sleep quality with a dependent variable of sleep quality, and independent variables of personal factors (demographic data, medical comorbidity, and depressive symptoms) and related-health behaviors (smoking, alcohol use, diet, physical activity, and BMI). In Chapter IV, smoking behavior was examined as one of the variables related to health-related quality of life with a dependent variable of health-related quality of life, and independent variables of personal factors (demographic data, medical comorbidity, and depressive symptoms) and related-health behaviors (smoking, alcohol use, diet, physical activity, BMI, and sleep quality). The findings from this study will be foundations to develop health promoting programs including smoking cessation tailored to Operating Engineers who have particularly high smoking prevalence.

# CHAPTER II: Variables Associated with Smoking Behavior Among Operating Engineers


## Abstract

**Purpose**: Disparities in smoking prevalence between white collar workers and blue collar workers have been documented. Reasons for these disparities have not been well studied. Using the Health Promotion Model as a guide, the objective was to determine variables associated with smoking among Operating Engineers.

**Methods**: This was a cross-sectional correlational design with a dependent variable of smoking and independent variables of personal and related health behavioral factors. A convenience sample of 498 Operating Engineers was recruited from approximately 12,000 Operating Engineers from entire State of Michigan in 2008. Logistic regression was used to determine personal and related health behavioral factors associated with smoking behavior.

**Results**: About 29% of Operating Engineers currently smoked cigarettes. Multivariate analyses showed that personal factors related to smoking were younger age and not being married, and related behavioral factors associated with smoking included problem drinking, physically inactivity, and a lower BMI.

**Conclusion**: Operating Engineers were at high risk of smoking, and smokers were more likely to engage in other poor health behaviors, which supports the idea of bundled health behavior interventions. Worksite interventions addressing smoking as well as other

risky health behaviors simultaneously may have the potential to reduce the high smoking rate and promote other health behaviors among Operating Engineers.

## Introduction

The prevalence of smoking in the USA has declined from 42.4% since the first Surgeon General Report in 1964 to 20.4% reported in 2009 (Centers for Disease Control and Prevention, 2010). Unfortunately, the magnitude of this decline is not equal throughout all occupational groups; the smoking rate has been reported to be 35.4 % among blue collar workers and 20.3% among white collar workers (Bang & Kim, 2001; Lee, LeBlanc, Fleming, Gomez-Marin & Pitman, 2004; Smith, 2008). Moreover, the decline in smoking prevalence is also lower among blue collar workers compared to white collar workers (Giovino, 2002). Given the adverse smoking effects on health (USDHHS, 2004) and standards of living (Siahpush, Spittal & Singh, 2006), the gap of smoking prevalence between white collar and blue collar workers may cause disparities in health status between white collar and blue collar workers.

In one group of blue collar workers, namely Operating Engineers or heavy equipment operators, in particular, the risks of smoking are even more severe as they are exposed to occupational chemicals on a daily basis (Oliver, Mirecle-McMahill, Littman, Oakes & Gaita, 2001), and some of these contaminants have shown a dose-response synergic effect with smoking on lung cancer (Chen et al., 2004). Despite of the synergic effect of the contaminants and smoking, the smoking prevalence in construction workers ranks as the highest among blue collar workers in the USA (Arheart et al., 2008). One possible reason for the high smoking rates among blue collar workers may be the lack of smoking literature and interventions targeting blue collar workers. Another possible reason is that blue collar workers do not benefit as much from anti-smoking policies; since they are outdoor workers, they do not benefit from worksite smoking restrictions that have been found to be among the most effective smoking cessation interventions in the general population (Farrelly, Evans & Sfekas, 1999; Rachiotis, Karydis, Drivas & Hadjichristodoulo, 2009). In general, public health efforts have led to a reduction in smoking prevalence among white collar workers, but have had little considerable impact among blue collar workers.

Lee et al. (2004) argued that smoking related variables in blue collar workers might differ from those in white collar workers, and different strategies for smoking cessation should be developed and employed based on the variables to reduce the disparity of smoking prevalence. Even though a number of studies have investigated smoking related variables among blue collar workers and have identified some unique smoking patterns, for example, earlier initiation of smoking and heavier smoking among blue collar workers, (Lawrence, Fagan, Backinger, Gibson & Hartman, 2006), no studies have focused on Operating Engineers. Using the Health Promotion Model as a framework (Pender, Murdaugh & Parsons, 2006), the purpose of this study is to determine variables that explain smoking behavior in Operating Engineers.

## Conceptual Model and Literature Review

The Health Promotion Model focuses on factors that explain health behaviors including smoking (Pender et al., 2006). In Pender's model (2006), health behaviors are determined by personal factors (biological, sociocultural, and psychological) and related behavioral factors (Figure 2). The personal and related behavioral factors that may influence smoking are reviewed below.

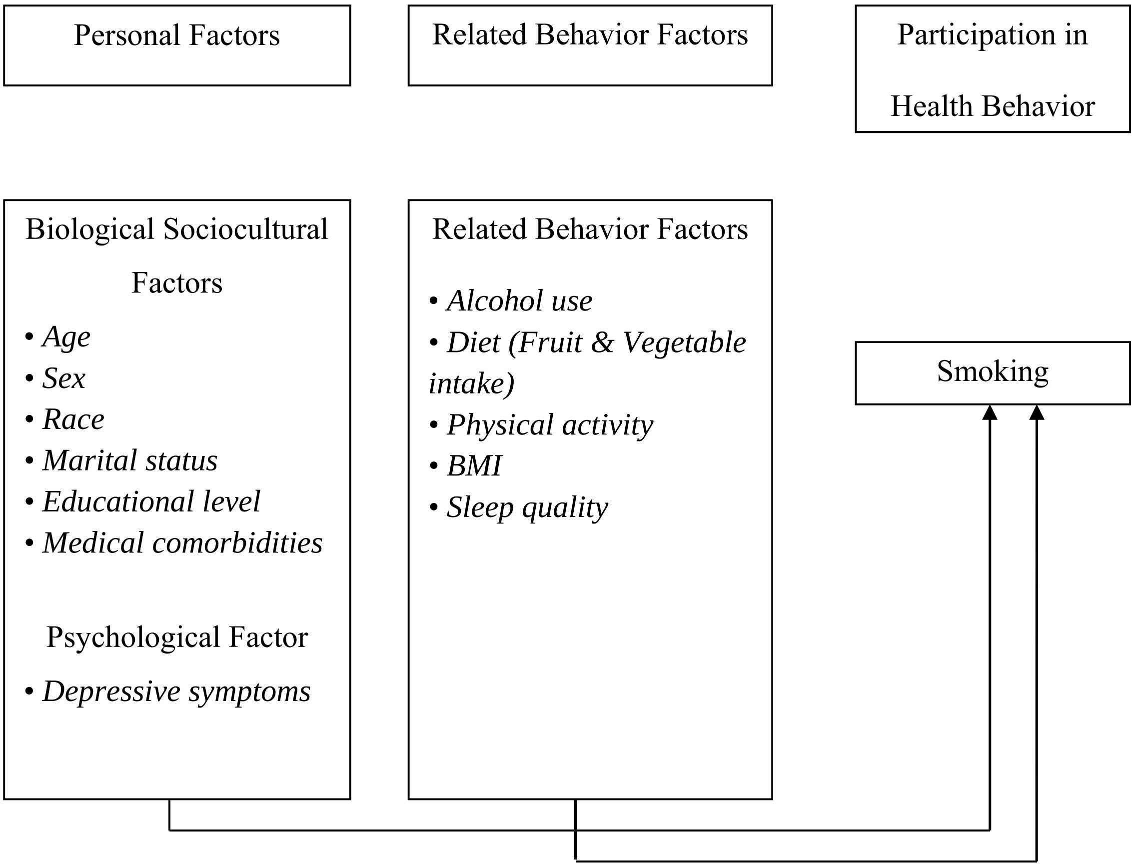


Figure 2. Theoretical Framework of Smoking Behavior

**Personal Factors Related to Smoking**

Biological and Sociocultural Factors: Biological and sociocultural factors that may predict smoking include the individual's unique characteristics such as age, sex, race, marital status, educational level, job experience, and self-reported medical comorbidities. Those who were younger, male, non-White, not married, and lower educational level were more likely to smoke (Barbeau, Krieger & Soobader, 2004; Chung, Kim, Lim, Lee & Cho, 2009; Dallongeville et al., 1998; Fagan, Shavers, Lawrence, Gibson & O'Connell, 2007; Garrett et al., 2004; Laaksonen, Prattala & Karisto, 2001; Siahpush, Singh, Jones & Timsina, 2009). Those who smoke were also likely to have more medical comorbidities, such as lung diseases (Dement et al., 2003; Mastrangelo, Tartari, Fedeli, Fadda & Saia, 2003) including asthma (Oliver et al., 2001) and emphysema (Stern & Haring-Sweeney, 1997; Wang, Dement & Lipscomb, 1999), various cancers (Gao et al., 1994; Nyren, 1996), as well as heart diseases (Jonas, Oates, Ockene, & Hennekens, 1992; USDHHS, 2006).

Psychological Factors**:** Psychological factors, such as depression, have been shown to be associated with smoking in a number of studies: those with depression have been shown to have a more difficult time quitting (Farrell et al., 2001; Glassman, 1993; McClave et al., 2009). A meta-analysis, however, revealed that depression alone was not a predictor of smoking cessation failure, but depression combined with anxiety had predictive value regarding smoking cessation (Hitsman, Borelli, McChargue, Spring & Niaura, 2003).

**Health Behavior Factors Related To Smoking**

Alcohol Use: Smokers are more likely to drink alcohol and to be heavy drinkers (Chiolero, Wietlisbach, Ruffeux, Paccaud & Cornuz, 2006; Chung et al., 2009; Cunradi, Moore & Ames, 2007; Jensen et al., 2003; De Leon et al., 2007; Ma, Betts & Hampl, 2000; Oleckno & Blacconiere, 1990; Schuit, van Loon, Tijhuis & Ocke, 2002). Similarly, heavy drinkers tended to smoke the most cigarettes, to have greater nicotine dependence, and to have a harder time quitting smoking (Hughes, 1993; Ma et al., 2000). The strong relationship may be related to either finding that one habitual behavior could increase tolerance to the effects of the other behavior or that nicotine may cause a stimulating effect depressed by ethanol (Ma et al., 2000).

Diet/ Physical Activity/BMI: Blue collar workers were less likely to eat a healthy diet or to have recommended fruit and vegetable consumption compared with white collar workers (Beydoun & Wang, 2008). Moreover, fruit and vegetable consumption has been shown to be lower among smokers (Emmons et al., 1994; Garrett et al., 2004; Harley et al., 2010; Kvaavik, Meyer & Tverdal, 2004; Larkin, Basiotis, Riddick, Sykes & Pao, 1990; Ma et al., 2000; Palaniappan, Starkey, O'Loughlin & Gray-Donald, 2001; Schuit et al., 2002; Troisi, Heinold, Vokonas & Weiss, 1991). Similarly, blue collar workers ranked among the lowest in leisure time physical activity level (Caban-Martinez et al., 2007). In addition, physical activity has been shown to be negatively associated with smoking (Emmons, Marcus, Kinnan, Rossi & Abrams, 1994; Klesges, Eck, Isbell, Fulliton & Hanson, 1990; Kvaavik et al., 2004; Oleckno & Blacconiere, 1990; Revicki, Sobal & DeForge, 1991). Physically active smokers were more likely to quit smoking (Ward et al., 2003), and interventions for increasing physical activity maintained smoking cessation (Marcus et al., 1995). Even though smokers ate fewer fruits and vegetables and engaged in less physical activity, they tended to be thinner and to have a lower BMI (Dallongeville et al., 1996; Kvaavik et al., 2004; Revicki et al., 1991). The lower BMI was induced by metabolic changes from smoking, including increases in metabolic rate, decreases in metabolic efficiency, or decreases in caloric absorption (Chiolero, Faeh, Paccaud & Cornuz, 2008).

Sleep: While some studies have shown that sleep patterns did not differ by smoking status (Åkerstedt et al., 2002), other studies have shown that smoking has been associated with low sleep quality including a longer initial sleep latency, less total sleep duration, and more stage 1 sleep (Palmer, Harrison & Hiorns, 1980; Revicki et al., 1991; Zhang, Samet, Caffo & Punjabi, 2006). The lower sleep quality among smokers may be the pharmacological effect of nicotine, as a potent stimulant; thus, nicotine inhibits sleep promoting systems (Saint-Mleux et al., 2004). Moreover, nicotine cravings during the night induce arousal and interfere with sleep quality (Wetter, Fiore, Baker & Young, 1994). In addition, poor sleep may increase accidents among Operating Engineers who require a high level of alertness when driving heavy equipment.

### Summary

Based on the review of the literature and the constructs of the Health Promotion Model, smoking behavior in Operating Engineers may be explained by personal factors, including biological, sociocultural, and psychological factors, as well as related behavioral factors. Hence, the specific aims of this study are to determine among Operating Engineers: (1) the personal factors (demographics, self-reported medical comorbidities, and depressive symptoms) associated with smoking behavior; and (2) the related behavioral factors (alcohol use, diet, physical activity, BMI, and sleep) associated with smoking behavior.

## Method

### Design

This cross-sectional study was designed to determine variables related to smoking behavior among Operating Engineers. The dependent variable was smoking. Explanatory variables included personal factors, including biological and sociocultural factors (age, sex, race, marital status, educational level, job experience, and medical comorbidities), a psychological factor (depressive symptoms), and related behavioral factors (alcohol use, diet, physical activity, BMI, and sleep). Institutional Review Board (IRB) approval was received from the University of Michigan.

**Study Population/Setting/Place**

A convenience sample was recruited from approximately 12,000 Operating Engineers in the entire State of Michigan coming to either a three-day apprentice certification course or the 8-hour Hazardous Materials (Hazmat) refresher course provided by the Operating Engineers Local 324 during the Winter of 2008. Operating Engineers were asked to participate until a quota of 500 was reached. Ninety percent of the Operating Engineers who were asked to participate agreed and returned a survey. Two of the returned surveys were incomplete and dropped from the analysis, resulting in a final sample size of 498.

**Procedure**

The instructor for the Hazmat course explained the study to the attendees, passed out the survey packets (which included a study information sheet, health survey, and return envelope), and collected the completed surveys in sealed envelopes. Each participant received a $10 gasoline gift card for completing the survey. The sealed envelopes were then returned to the study team.

## Measures

### Dependent variable

Smoking Status: Smoking status was determined by a self-report based on a 30-day prolonged abstinence measure: “Please circle the answer that best describes your smoking status. (1) I currently smoke cigarettes, (2) I have smoked in the past, but quit within the last month, (3) I have smoked in the past, but quit within the last six months, (4) I have smoked in the past, but quit within the last year, (5) I have smoked in the past, but quit over a year ago, and (6) I have never used tobacco products”. Those who answered (1)-currently smoke cigarettes and (2)-smoked within the last month were categorized to be smokers. A 30-day prolonged abstinence measure has been reported to be more stable than a 24-hour or a 7-day point prevalence abstinence measure and has been shown to have strong validity (Velicer & Prochaska, 2004).

### Independent variables

#### *Personal Factors*

Demographic Factors: Demographic factors included age, sex, race, marital status, educational level, and job experience. For descriptive purposes, the standard Occupational Safety and Health Administration questions on occupational exposures (asbestos, asphalt fumes, benzene, concrete dust/milling, heat stress, lead/lead paint, silica, solvents, welding fumes, and others) were asked. Self-reported medical comorbidities were collected by survey (cancer, lung disease, heart disease, high blood pressure, stroke, psychiatric problems, diabetes, and arthritis) (Mukerji et al., 2007).

These conditions were then totaled and dichotomized into two groups including zero, or more than one comorbid condition.

Depressive Symptoms: Depressive symptoms were measured by the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D is a 20-item self-report scale designed to measure somatic and affective symptoms of depression (Radloff, 1977) and has been frequently used across various ethnicities to monitor depressive symptoms (Crockett, Randall, Shen, Russell & Driscoll, 2005). Possible scores range from zero to 60 with a cut-off score of 16 or higher indicating depression. Alpha ranged from .84 to .87 across ethnicities (Crockett et al., 2005; Radloff, 1977). Validity has been reported to be strong (Halm, Treat-Jacobson, Lindquist & Savik, 2006).

### *Health Behavior Factors*

Alcohol Use: Alcohol use was measured by the Alcohol Use Disorder Identification Test (AUDIT) (Saunders, Ashland, Babor, de la Fuente & Grant, 1993). The AUDIT is a 10-item questionnaire which contains questions about the amount and frequency of alcohol consumption, alcohol dependence, and alcohol-related problems or reactions (Meneses-Gaya, Zuardi, Loureiro & Crippa, 2009). Possible scores range from zero to 40 with a cut-off point of eight or higher indicating problem drinking. A test-retest reliability was .86 (Saunders et al., 1993), and strong validity has been reported across all ethnic and gender groups (Meneses-Gaya et al., 2009).

Diet, Physical Activity, and BMI: Selected questions from the validated Willet food frequency questionnaire were used to assess the average number of servings they ate of fruit, fried foods, and vegetables (Willett, 1985). Physical activity was measured as the score of the Physical Activity Questionnaire (Norman et al., 2001). This is a six-item measure assessing time spent doing different types of activities, including types of occupational activity, and creates a total physical activity score based on the duration and intensity of the activities reported. The test-retest reliability was .65, and validity has been reported to be strong (Norman et al., 2001). BMI (weight in kilograms divided by the square of height in meters) was calculated based on self-reported height (without shoes) and weight.

Sleep: Sleep was measured by the Medical Outcomes Study (MOS) sleep scale. The MOS is a six-item questionnaire designed to measure the quality and quantity of sleep (Hays, Martin, Sesti & Spritzer, 2005). Possible scores range from zero to 100 with higher scores indicating better sleep quality. The internal reliability alpha coefficient ranged from .64 to .87, and strong discriminant and predictive validity has been reported (Hays et al., 2005; Rejas, Ribera, Ruiz & Masrramón, 2007).

**Data Analysis**

Descriptive statistics (means and frequencies) were computed for all variables. To determine the association of independent variables with smoking, bivariate analyses were conducted using t-tests and chi-square tests. Prior to constructing a final multivariate model, Pearson correlation coefficients were examined to determine multicollinearity among independent variables. Since job experience was highly correlated with age ($r$= .64, $p$= .000), only age was included in the final multivariate model. Since there was no difference in depressive symptoms between smokers and non-smokers, and depressive symptoms were highly correlated with sleep ($r$= -.44, $p$= .000), depressive symptoms were not included in the final multivariate model.

Multivariate logistic regression analyses were conducted for the final model. Using the rule of 10 subjects per factor for regression analysis (Harrell, Lee & Mark, 1996), there was sufficient power to include over 20 variables since there were 142 smokers and 270 non-smokers. Values of $p < .05$ were considered to be significant. Analyses were performed with the SPSS for Windows, version 17.0.

## Results

### Descriptions of the Sample

Table 1 shows the characteristics of the sample. The mean age was 43, and the majority of the participants were males (92.3%) and White (92.4%). Sixty-eight percent of the participants were married, and 60.8% had a high school education or less. The majority (80.3%) of the participants worked 10 years or more and self-reported exposure to hazardous materials on a daily basis: asbestos (50.2%), asphalt fumes (61.8%), benzene (38.8%), concrete dust/milling (75.9%), heat stress (73.9%), lead/lead paint (40%), silica (55.4%), and welding fumes (72.1%).

The most common comorbidities were hypertension (25.7%) and arthritis (18.7%). Almost half (46.8%) screened positive for depressive symptoms, and 32.8% scored positive for problem drinking. The mean BMI was 30.3, and the majority were overweight (40%) or obese (45%). Physical activity (Mean = 42.7) and sleep scores (Mean = 70.3) were about average when compared to population norms of 40.8 (Norman, Bellocco, Bergstrm & Wolk, 2001) and 72 (Hays et al., 2005), respectively. Of the 487 participants, 43.6% used tobacco products and were currently tobacco users (n = 206), mostly cigarettes (n = 142), or who had quit within one month (n = 11), and 54.2% were not tobacco users who had quit longer than one month ago (n =107) or who had never used tobacco products (n=163). Fruit and vegetable intake was remarkably low in this population with only 33.6% having fruit (not counting juices) once a day or more, and only 38.8% having vegetable (not counting salad or potatoes) once a day or mire. On the other hand, about three quarters (72.9%) had deep fried foods once per week or more.

Table 1.

*Characteristics of the Sample*

| | Mean (SD) | Range |
|---|---|---|
| Age (n= 476) | 42.95 (9.38) | 18 - 70 |
| Physical activity (n= 472) | 42.65 (5.34) | 29.1 – 61.54 |
| BMI (n= 478) | 30.27 (5.82) | 17.5 – 58.25 |
| Sleep quality (n= 487) | 70.32 (17.36) | 0 - 100 |
| | Frequency | Percent |
| Sex (n= 482) | | |
| Male | 445 | 92.3 |
| Female | 37 | 7.7 |
| Race (n= 472) | | |
| White | 436 | 92.4 |
| Non-white | 36 | 7.6 |
| Marital status (n= 485) | | |
| Married | 329 | 67.8 |
| Non-married | 156 | 32.2 |
| Education (n= 485) | | |
| High school or lower | 295 | 60.8 |
| College or higher | 190 | 39.2 |
| Depressive symptoms (n= 470) | | |
| Yes | 220 | 46.8 |
| No | 250 | 53.2 |
| Medical comorbidities (n= 482) | | |
| None | 239 | 49.6 |
| One or more | 243 | 50.4 |
| Smoking (n= 487) | | |
| Smokers | 142 | 28.5 |
| Non-smokers | 270 | 54.2 |
| Alcohol problems (n= 476) | | |
| Yes | 156 | 32.8 |
| No | 320 | 67.2 |
| Vegetable intake (n= 485) | | |
| Never- 5-6 per week | 297 | 61.2 |
| 1 per day or more | 188 | 38.8 |
| Fruit intake (n= 485) | | |
| Never to 2-4 per week | 322 | 66.4 |
| 5-6 per week or more | 163 | 33.6 |
| Fried food intake (n= 485) | | |
| Never to less than 1 per week | 132 | 27.2 |
| 1 per week or more | 353 | 72.8 |

**Bivariate Analyses**

Table 2 shows the bivariate associations between the independent variables and smoking. Age, marital status, job experience, self-reported medical comorbidities, alcohol use, vegetable intake, physical activity, and BMI were significantly associated with smoking. Compared with non-smokers, smokers were more likely to be younger ($p = .015$), to be separated/widowed/divorced ($p = .015$), to have fewer years of job experience ($p = .020$), to have no medical comorbidities ($p =.023$), to have higher alcohol use ($p = .000$), to be less physically active ($p =.033$), and to have lower BMI ($p =.000$). The relationship between vegetable intake and smoking appeared to be significant, but non-linear; more smokers were distributed in the second lowest (17.3% vs. 15.7%, $p = .039$) as well as the highest (46.6% vs. 33.6%, $p = .039$) category of the four vegetable intake levels compared with non-smokers. There were no differences in sex, race, and educational level between smokers and non-smokers. There were surprisingly no differences in depressive symptoms between smokers and non-smokers (16.80 vs. 16.31, $p = .519$) as both groups screened high for depression (47.4% vs. 46.3%). There were also no differences in fruit intake or sleep quality between the two groups.

Table 2. Bivariate Associations of Independent Variables and Smoking Status

| | Smokers | Non-smokers | P-value |
|---|---|---|---|
| | Mean (SD) | Mean (SD) | |
| Age (n=131/263) | 41.63 (8.91) | 44.05 (9.38) | **.015** |
| CES-D (Depressive symptoms) (N=133/263) | 16.80 (7.85) | 16.31 (5.79) | .519 |
| AUDIT (Alcohol use) (n=133/262) | 7.71 (5.97) | 5.14 (5.07) | **.000** |
| Physical Activity (n=132/261) | 41.94 (5.23) | 43.16 (5.40) | **.033** |
| BMI (n=130/267) | 28.62 (5.35) | 30.96 (6.08) | **.000** |
| Sleep Quality (n=137/267) | 68.22 (17.44) | 71.58 (16.35) | .057 |
| | Smokers | Non-smokers | P-value |
| | Frequency (%) | Frequency (%) | |
| Sex (n=132/266) | | | .737 |
| Male | 119(90.2%) | 244(91.7%) | |
| Female | 13(9.8%) | 22(8.3%) | |
| Race (n=126/265) | | | .098 |
| White | 111 (88.1%) | 248(93.6%) | |
| Non-White | 15 (11.9%) | 17 (6.4%) | |
| Educational level (n=132/268) | | | .315 |
| High school or less | 84(63.6%) | 155(57.8%) | |
| College or more | 48(36.4%) | 113(42.2%) | |
| Marital status (n=133/268) | | | **.015** |
| Married | 82 (61.7%) | 189 (70.5%) | |
| Separated/ Widowed/ Divorced | 32 (24.1%) | 34(12.7%) | |
| Never married | 19 (14.3%) | 45(16.8%) | |
| Job experience (n=133/267) | | | **.020** |
| Up to 9 years | 34 (25.6%) | 41 (15.4%) | |
| 10 or more years | 99 (74.4%) | 226 (84.6%) | |
| Medical comorbidities (n=132/267) | | | **.023** |
| None | 76 (57.6%) | 120 (44.9%) | |
| One or more | 56 (42.4%) | 147 (55.1%) | |
| Fruit intake (n=134/268) | | | .750 |
| None to 2-4 per week | 75(56.0%) | 144(53.7%) | |
| 5-6 per week or more | 59(44.0%) | 124(46.3%) | |
| Vegetable intake (n=133/268) | | | **.039** |
| None to 1 per week | 23(17.3%) | 42(15.7%) | |
| 2-4 per week | 29(21.8%) | 79(29.5%) | |
| 5-6 per week | 19(14.3%) | 57(21.3%) | |
| 1 per day or more | 62(46.6%) | 90(33.6%) | |

**Multivariate Analyses**

Table 3 shows the results of multivariate analyses and revealed that age, marital status, alcohol use, physical activity, and BMI were significantly associated with smoking behavior among Operating Engineers. For each additional year of age, Operating Engineers were 4% less likely to smoke (OR = 0.96, 95% CI .93, .99, p = .007). Those who were separated/widowed/divorced had two times greater odds of smoking (OR = 2.03, 95% CI 1.04, 3.96, p = .037) compared to those who were married. Participants had a 1.1 times greater odds of smoking for every additional score of AUDIT (OR = 1.09, 95% CI 1.04, 1.14, p = .000). For every one point increase in physical activity, Operating Engineers were 7% less likely to smoke (OR = .93, 95% CI .89, .98, p = .003). For every one point increase in BMI, Operating Engineers were 6% less likely to smoke (OR = .94, 95% CI .90, .99, p = .015). While self-reported medical comorbidities and vegetable intake were related to smoking in the bivariate analysis, it was no longer significant on multivariate analysis.

Table 3. Multivariate Analysis of Independent Variables Related to Smoking Status (n=366)

| | Odds Ratio | 95% CI | P-value |
|---|---|---|---|
| Age | .96 | .93 – .99 | **.007** |
| Marital status | | | **.016** |
| Separated/Widowed/Divorced | 2.03 | 1.04 – 3.96 | **.037** |
| Never married | .542 | .26– 1.12 | .100 |
| Married (Reference) | 1 | 1 | |
| Medical comorbidities | .75 | .46 – 1.24 | .268 |
| AUDIT (Alcohol use) | 1.09 | 1.04 – 1.14 | **.000** |
| Vegetable intake | | | .056 |
| None to 1 per week | .67 | .34 – 1.35 | .267 |
| 2-4 per week | .52 | .28 – .95 | **.034** |
| 5-6 per week | .43 | .21 – .87 | **.019** |
| 1 per day or more (Reference) | 1 | 1 | |
| Physical activity | .93 | .89 – .98 | **.003** |
| BMI | .94 | .90 – .99 | **.015** |

## Discussion

### Personal Factors Related To Smoking Behavior

Similar to other studies, the Operating Engineers who were smokers were more likely to be younger (Dallongeville et al., 1996; Garrett et al., 2004; Poortinga, 2007a) and to be separated/widowed/divorced (Garrett et al., 2004). However, different than expected, depression did not vary significantly between smokers and non-smokers as this population of both smokers and non-smokers have approximately two times higher depression rates than the population norm of 21% (Radloff, 1977). Considering the high prevalence of depression among the Operating Engineers and the decreased chances of quitting among those with depression (Glassman, 1993), smokers with depressive symptoms should be offered smoking cessation interventions as well as validated medical treatments for depression. Some medications, such as Bupropion, have been shown to be effective for smoking cessation and may also provide relief for comorbid depressive symptoms (Brown et al., 2007).

### Behavioral Factors Related To Smoking Behavior

The high prevalence of depression may also account for the additional poor health habits found among Operating Engineers as depression, problem drinking, and smoking are highly interrelated (Duffy et al., 2006). The rate of problem drinking in this population (33%) was approximately three times greater than population norms of 7-13% (Hasin, Stinson, Ogburn & Grant, 2007; Substance Abuse and Mental Health Services Administration, 2009). Drinkers are more likely to smoke and have a more difficult time quitting (Dawson, 2000; Hughes, 1993; Leeman, McKee, Toll, Krishnan-Sarin, Cooney & O'Malley, 2008). For individuals who are problem drinkers and smokers, interventions, such as referrals to Alcoholics Anonymous, may be needed at the same time when smoking interventions are implemented.

Vegetable intake was not significantly associated with smoking perhaps because this study included other health behaviors, which were related to vegetable intake, in the model simultaneously. Albeit multicollinearity was examined using VIF and tolerance, there might be correlations between vegetable intake and other health behaviors, such as physical activity and BMI, which possibly influence the relationship between vegetable intake and smoking. Despite the fact that the smokers in this study were less physically active than nonsmokers, they still had a lower BMI than non-smokers. This is consistent with the literature in that smoking induces increasing metabolic rate, decreasing metabolic efficiency, or decreasing caloric absorption (Chiolero et al., 2008). Operating Engineers may have even less on-the-job physical activity than other blue collar workers as they are driving and thus sitting for most of the day. Improving physical activity may also help reduce the high depression rates in this population as physical activity is known to increase the release of endorphins and reduce depression (Willes, Haase, Gallacher, Lawlor & Lewis, 2007). While sleep problems have been noted to be correlated with smoking in other studies (Palmer et al., 1980; Revicki et al., 1991; Zhang et al., 2006), sleep quality was not associated with smoking among Operating Engineers perhaps because this study assessed self-reported sleep whereas other studies assessed objective sleep architecture or sleep quantity by the use of polysomnography or hours of sleep. More studies are needed to identify the association of smoking with sleep using more diverse measures.

## Practice Implications

The present study confirmed the findings of other studies that have shown the clustering or bundling of risky health behaviors among smokers (Chioero et al., 2006; Emmons, Marcus, Linnan, Rossi & Abrams, 1994; Garrett et al., 2004; Kvaavik et al., 2004; Laaksonen et al., 2001; Ma et al., 2000; Poortinga, 2007b; Pronk et al., 2004; Schuit et al., 2002). Two or more combined risky health behaviors have been shown to result in much higher risks for developing chronic diseases, such as cardiovascular diseases or various cancers, than can be expected by the sum each of the separate effects of the risky behaviors (Ma et al., 2000; Schuit et al., 2002). Moreover, occupational exposures to hazardous inhalants on a daily basis have a dose-response synergic effect with smoking on pulmonary diseases (Chen et al., 2004). Given the high prevalence of smoking (28.5%), daily exposure to occupational hazards, and the clustering of other risky health behaviors, such as drinking, unhealthy diet, as well as physical inactivity, smoking cessation interventions that also target other risky health behaviors might be beneficial to Operating Engineers.

As the 2009 NIH meeting on the Science of Behavior Change emphasized the importance of focusing on clusters of health behaviors that may have common underlying processes (National Institutes of Health, 2009), several studies have designed health promoting interventions for multiple health behaviors. For example, Duffy et al. (2006) found that the tailored smoking, alcohol, and depression intervention produced higher smoking cessation rates compared with the usual care group. Marcus et al. (1995) reported higher smoking cessation rates when the smoking cessation intervention was combined with physical activity as opposed to the only smoking cessation intervention. In a study of construction workers, Sorensen et al. (2007) noted that a smoking cessation intervention combined with a healthy diet improved both smoking cessation rates and fruit and vegetable consumption. When designing interventions targeting multiple risky health behaviors, smoking should be viewed as a central behavior among multiple risky health behaviors as smoking remains the strongest risk factors for morbidity and mortality (Laaksonen et al., 2001).

There are several reasons that worksite interventions may be the ideal environment for health behavior interventions. Union halls where workers congregate are places where a higher number of people with compromised health behaviors may be reached. Co-workers sharing similar risky health behaviors could motivate and support each other as social support from co-workers produce more favorable outcomes (Campbell et al., 2002). Many blue collar workers such as Operating Engineers, who are traditionally less likely to have access to interventions before (Okechukwu, Krieger, Sorensen, Li & Barbeau, 2009), have seasonal downtime which provides a window of opportunity for participation in interventions.

Moreover, since many unions (such as Operating Engineers Local 324) pay directly for health care, there is motivation on the part of management to provide interventions that reduce health care costs. Worksite interventions may also decrease absenteeism and other employment-related costs (Warner, Smith, Smith & Fries, 1996). Worksite interventions for multiple risky health behaviors including smoking have been shown to be effective in health promoting behavior change in the general population (Emmons, Linnan, Shadel, Marcus & Abrams, 1999) as well as in construction workers (Campbell et al., 2002; Harley et al., 2010; Sorensen et al., 2007). Consequently, these preliminary data have resulted in a web-based smoking cessation module, which is currently being tested among Operating Engineers.

## Limitations

Since this was a cross-sectional design, the findings from this study cannot determine causation as might a prospective study. The results were also based on the data from Operating Engineers solely in Michigan, therefore the results may not be generalizable to Operating Engineers in other geographic areas. There were no differences in sex, race and educational level between smokers and non-smokers most likely because the socioeconomic status of Operating Engineers is fairly homogeneous; most are Caucasian males of similar educational level. Even though self-report smoking status has been found to be reliable (Gorber, Schofield-Hurwitz, Hardt, Levasseur & Tremblay, 2009), a self-report smoking status without biochemical verification might introduce misclassification of smokers into non-smokers.

## Conclusion

Compared to non-smokers, Operating Engineers who smoke are more likely to be younger, not married, problem drinkers, less physically active, and of lower BMI. Smoking cessation interventions combined with interventions for multiple risky health behaviors have the potential to promote health behavior changes among Operating Engineers. Worksite interventions may have the potential to improve health behaviors and wellness of blue collar workers such as Operating Engineers.

# CHAPTER III: Variables Associated with Sleep Quality Among Operating Engineers


## Abstract

**Purpose**: The negative impacts of sleep disturbances, including increases in absenteeism, fatal work accidents, the use of sick leave, work disability, medical comorbidities, as well as subsequent mortality, have been well-documented in the literature. However, sleep quality of blue collar workers has not been studied extensively, and no studies have focused Operating Engineers among whom daytime fatigue would place them at high risk for accidents. Therefore, the purpose of this study was to determine variables associated with sleep quality among Operating Engineers.

**Methods**: This was a cross-sectional correlational design with a dependent variable of sleep quality and independent variables of personal and related health behavioral factors. A convenience sample of 498 Operating Engineers was recruited from approximately 12,000 Operating Engineers from entire State of Michigan in 2008. Linear regression was used to determine personal and related health behavior factors associated with sleep quality.

**Results**: Approximately 34% (n=143) showed interest in health service for sleep problems. Multivariate analyses showed that personal factors related to poor sleep quality were younger age, female sex, higher pain, more medical comorbidities and depressive symptoms and behavioral factors related to poor sleep quality were nicotine dependence.

**Conclusion**: While many personal factors (i.e., age, sex, and comorbidities) associated with poor sleep quality are not changeable, treatment of pain, depression and smoking may improve sleep quality.

## Introduction

The prevalence of sleep complaints varies according to populations, and it has been estimated to be 16-30% among working populations in the United States (Metlaine, Leger & Choudat, 2005). Sleep problems include difficulty in falling asleep, difficulty in staying asleep, and poor quality sleep (Walsh, 2004). These sleep problems are associated with daytime fatigue, sleepiness, and impaired daytime function (Edell-Gustafsson, 2002; Voinescu, Coogan, Orasan & Thome, 2010).

The socioeconomic losses induced by sleep problems include increases in absenteeism, fatal work accidents, the use of sick leave, work disability, medical comorbidities, as well as subsequent mortality (Ãkerstedt, Fredlund, Gillberg & Jansson, 2002; Ãkerstedt, Kecklund, Alfredsson & Selen, 2007; Deatherage, Roden & Zouhary, 2009; Doi, Minowa & Tango, 2003; Kripke, Garfinkel, Wingard, Klauber & Marler, 2002; Lamberg, 2004; Léger, et al., 2006; Leigh, 1991; Linton & Bryngelsson, 2000; Mallon, Broman & Hetta, 2002; Melamed & Oksenberg, 2002; Naughton, Ashworth & Skevington, 2007). Although no study has estimated the cost of sleep problems, direct and indirect costs caused by sleep problems among working populations may be substantial not only at the individual, but also at societal levels (Metlaine et al., 2005). On the other hand, good sleep quality has been associated with better physical health, greater psychological well-being, greater job satisfaction, and better quality of life (Katz &

McHorney, 2002; Léger, Scheuermaier, Philip, Paillard & Guilleminault, 2001; Metlaine et al., 2005; Viala-Danten, Martin, Guillemin & Hays, 2008).

The sleep quality of blue collar workers has not been studied extensively and may be different from that of the general population as blue collar workers are generally exposed to high job stress and loud noises at work, all of which are associated with poor sleep quality (Deatherage et al., 2009). In addition, many of the predictors of poor sleep quality, such as smoking and problem drinking, are more prevalent in blue collar workers (Kaarne, Aalto, Kuokkanen & Seppa, 2009; Smith, 2008). In fact, our prior work has shown that Operating Engineers have been shown to have many of the predictors of poor sleep (Duffy et al., 2011). As a result, blue collar workers may be more at risk for accidents due to poor sleep quality as many of their occupations are physically riskier than white collar workers. Yet sleep quality is not well studied among blue collar workers, and no studies were found on sleep quality of Operating Engineers among whom daytime fatigue would place them at risk for accidents. Therefore, the purpose of this study is to determine explanatory factors associated with sleep quality among Operating Engineers in Michigan.

## Conceptual Model and Literature review

The Health Promotion Model focuses on factors that explain health behaviors including smoking, hearing protection, exercise, healthy diet, as well as sleep (Pender, Murdaugh, & Parsons, 2006). In Pender’s model (2006), health behaviors are determined by personal factors (biological, sociocultural, and psychological) and related behavioral factors (Figure 3). The personal and behavioral factors that may influence sleep quality are reviewed below.

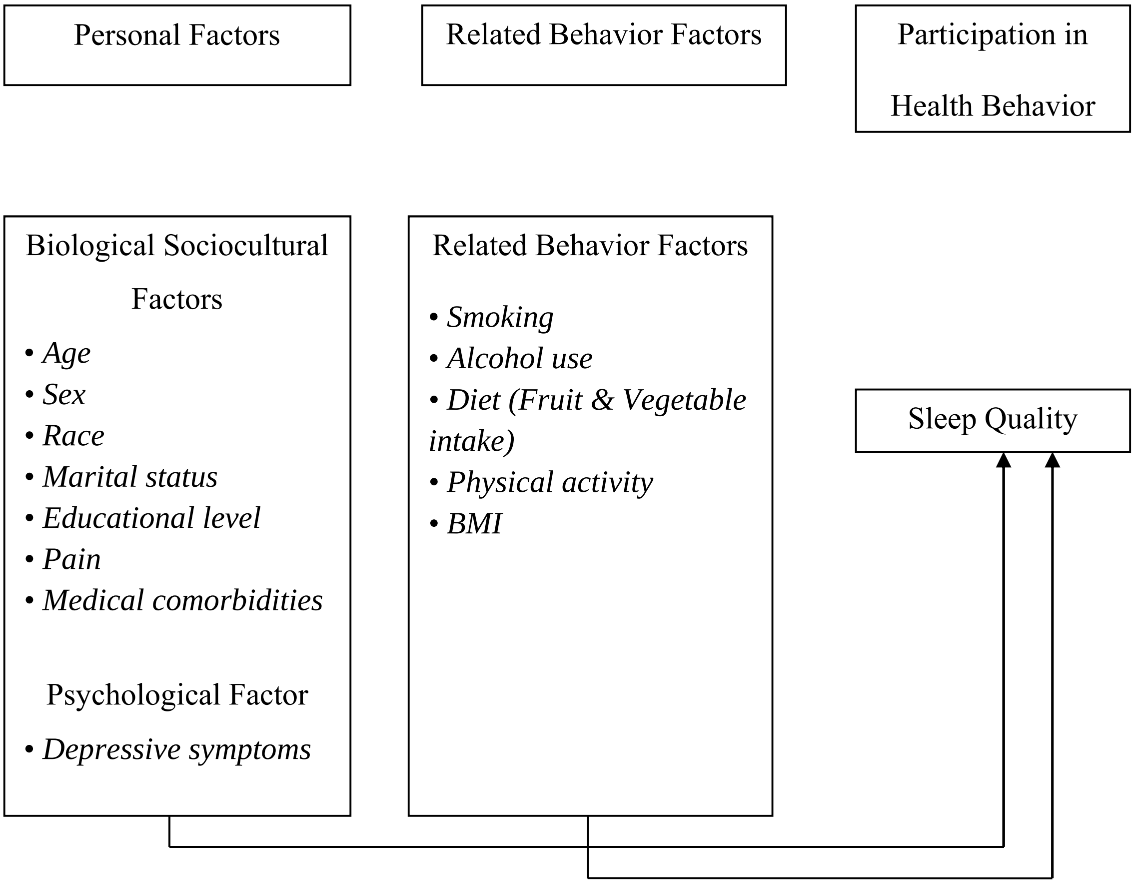


Figure 3. Theoretical Framework of Sleep Quality

## Personal Factors Related to Sleep Quality

### Biological and sociocultural factors

Demographic Factors: Age, sex, marital status, and educational level have been linked to quality of sleep. Aging has been related to poor sleep quality because of age-related changes in sleep architecture and patterns, such as reduced electroencephalogram slow-wave activity and a reduced slow-wave response to sleep deprivation (Deatherage et al., 2009; Lallukka, Rahkonen, Lahelma & Arber, 2010; McCrae, Nau, Taylor &

Lichstein, 2006; Riemann, Berger & Voderholzer, 2001; Schoenborn, Adams, & Division of Health Interview Statistics, 2008; Walsh, 2004). However, conflicted results were found among working populations with younger people being at greater risk for poor sleep quality because of their high work stress, yet low ability to cope with that stress (Doi et al., 2003; Knudsen, Ducharme, & Roman, 2007). Moreover, being female (Doi et al., 2003; Lallukka et al., 2010, McCrae et al., 2006; Metlaine et al., 2005; Nasermoaddeli et al., 2005; Riemann et al., 2001; Walsh, 2004), not married (Baker, Wolfson, & Lee, 2009; Doi et al., 2003), and less educated (Baker et al., 2009; Doi et al., 2003) increased the risk of poor sleep quality. Racial differences in sleep quality have not been well studied, yet more sleep disturbances have been reported in African Americans compared to Caucasians (Lichstein, Durrence, Riedel, Taylor & Bush, 2004).

<u>Pain</u>: Prior studies found that pain worsened sleep quality and caused sleep problems (i.e., difficulty in falling asleep and staying asleep) due to the arousal enhancing function of pain (Foley, 2004; Lautenbacher, Kundermann & Krieg, 2006; Smith & Haythornthwaite, 2004). Moreover, disturbed sleep predicted increased pain sensitivity, and restorative sleep has been found to be effective for pain management (Chung & Tsoa, 2010; Edwards, Almeida, Klick, Haythornthwaite & Smith, 2008; Hamilton, Catley & Karlson, 2007; Raymond, Nielson, Lavigne, Manzini & Choinière, 2001).

<u>Medical Comorbidities</u>: Medical comorbidities, such as arthritis, gastroesophageal reflux disorder (GERD), coronary artery disease (CAD), congestive heart failure (CHD), hyperthyroidism, end-stage renal disease (ESRD), obstructive airway disease (OAD), diabetes, and various cancers had a dose-response relationship to poor quality of sleep, and poorer sleep quality was related to a higher number of comorbidities (Ancoli-Israel,

2006; Hayashino et al., 2010; Janson, Lindberg, Gislason, Elmasry & Boman, 2001; McCrae et al., 2006; Wolk, Gami, Garcia-Touchard & Somers, 2005). This association may be related to the finding that chronic sleep disturbance impaired the functions of the inflammatory system and immune system (Cizza et al., 2010; Nishitani & Sakakibara, 2007; Spiegel, Leproult & van Cauter, 1999; van Cauter & Knutson, 2008).

### Psychological factors

Depressive Symptoms: Bidirectional inverse relationships between depression and sleep quality has been reported in a number of studies (Ehlers, Gilder, Criado & Caetano, 2010; Hayashino et al., 2010; Knudsen et al., 2007; Riemann et al., 2001). Sleep disturbance occurred in 40-90% of depressed patients (Chueh, Yang, Chen & Chiou, 2009; McCrae et al., 2006; Walsh, 2004). Conversely, individuals with disturbed sleep had four times an increased chance of developing depressive symptoms, and this predictive effect remained even after controlling for the influence of the previous depressive symptoms (Ancoli-Israel, 2006; Breslau, Roth, Rosenthal & Andreski, 1996; Cho et al., 2008; Walsh, 2004). Furthermore, cognitive behavioral therapies for insomnia improved depressive symptoms (Manber et al., 2008), and manipulations of sleep, including a sleep-wake cycle or a phase advance of the sleep period, have been found to improve depressive symptoms (Riemann et al., 2001).

## Health Behavior Factors Related to Sleep Quality

Smoking: Smoking has been associated with low sleep quality including a longer initial sleep latency, less total sleep duration, and more stage 1 sleep (Deatherage et al., 2009; Janson et al., 2001; Palmer, Harrison & Hiorns, 1980; Revicki, Sobal, & DeForge, 1991; Zhang, Samet, Caffo & Punjabi, 2006). The poorer sleep quality among smokers may be caused by the pharmacological effect of nicotine, a potent stimulant which inhibits sleep promoting systems (Saint-Mleux et al., 2004). Moreover, nicotine cravings during the night may induce arousal and interfere with sleep quality (Wetter, Fiore, Baker & Young, 1994).

Alcohol Problems: Alcohol has been commonly used as a self-treatment for insomnia among the general population (Roehrs, Papineau, Rosenthal & Roth, 1999). However, alcohol consumption is one of the common causes of insomnia since it increases fragmentation and decreases quality of sleep (Deatherage et al., 2009; McCrae et al., 2006). Indeed, a number of studies confirmed the negative relationship between alcohol consumption and sleep quality (Chueh et al., 2009; Ehlers et al., 2010; Voinescu et al., 2010), and problem drinkers frequently reported poor sleep quality and sleep difficulties (Brower, 2001; Brower et al., 2001; Janson et al., 2001).

Physical Activity: Physical activity has been found to improve sleep quality, including shorter actual wake time and less movement (Payne, Held, Thorpe, & Shaw, 2008), and regular physical activities have been recommended for individuals with sleep problems (Atkinson & Davenne, 2007; Janson et al., 2001; Youngstedt, 2005). This beneficial effects of physical activity on sleep may be because of anxiety reduction, antidepressant effects, thermogenic effect, and circadian phase-shifting effect induced by physical activity (Youngstedt, 2005).

Obesity: Obesity has been associated with obstructive sleep apnea (OSA), awakenings, choking, and loud snoring, which are linked to poor sleep quality and daytime sleepiness (Janson et al., 2001; Kohatsu et al., 2006; Resta et al., 2003; Stranges et al., 2007; Vgontzas et al., 2008; Vorona et al., 2005). OSA has increasingly been recognized as an important public health issue resulting in driving and industrial accidents among drivers (Philip et al., 2010). Although there is no study to estimate the prevalence of OSA in this population, the prevalence of OSA among commercial truck drivers has been estimated to be 28% (Pack, Dinges, & Maislin, 2002). Conversely, sleep deprivation has been linked to hormonal changes, including decreased glucose tolerance, insulin sensitivity, and leptin levels, and increased ghrelin levels and evening concentrations of cortisol (Lumeng et al., 2007), which in turn lead to weight gain and obesity (Lumeng et al., 2007; Patel & Hu, 2008; Vorona et al., 2005).

**Summary**

Based on the review of the literature and the constructs of the Health Promotion Model, sleep quality may be associated with personal factors, including biological, sociocultural, and psychological factors, as well as related behavioral factors. Many of the predictors of poor sleep quality have been shown to be prevalent in Operating Engineers, yet sleep quality among these heavy equipment operators has not been studied. Hence the specific aim of this study was to determine the personal factors (demographics, pain, self-reported numbers of medical comorbidities and depressive symptoms) and related behavioral factors (smoking, alcohol problems, physical activity, and obesity) associated with sleep quality among Operating Engineers.

## Methods

### Design

This cross-sectional study was designed to determine variables explaining sleep quality among Operating Engineers. The dependent variable was sleep quality. Explanatory variables included personal factors, including biological and sociocultural factors (age, sex, marital status, educational level, pain, and self-reported number of medical comorbidities), a psychological factor (depressive symptoms), and behavioral factors (smoking, alcohol problems, physical activity, and obesity). Institutional Review Board (IRB) approval was received from the University of Michigan.

### Study Population/Setting/Place

A convenience sample was recruited from approximately 12,000 Operating Engineers in the entire State of Michigan coming to either a three-day apprentice certification course or the 8-hour Hazardous Materials (Hazmat) refresher course provided by the Operating Engineers Local 324 during the Winter of 2008. Operating Engineers were asked to participate until a quota of 500 was reached. Ninety percent of the Operating Engineers who were asked to participate agreed and returned a survey. Two of the returned surveys were incomplete and dropped from the analysis, resulting in a final sample size of 498.

### Procedure

The instructor for the Hazmat course explained the study to the attendees, passed out the survey packets (which included a study information sheet, health survey, and return envelope), and collected the completed surveys in sealed envelopes. Each participant received a $10 gasoline gift card for completing the survey. The sealed envelopes were then returned to the study team.

## Measures

### Dependent Variable

Sleep Quality: Sleep quality was measured by the Medical Outcomes Study (MOS) sleep quality scale. The MOS is a six-item questionnaire designed to measure the quality and quantity of sleep (Hays et al., 2005). Possible scores range from zero to 100 with higher scores indicating better sleep quality. The internal reliability alpha coefficient ranged from .64 to .87, and strong discriminant and predictive validity has been reported (Hays et al., 2005; Rejas, Ribera, Ruiz & Masrramón, 2007).

### Independent Variables

#### *Personal Factors*

Demographic Factors: Demographic factors included age, sex, race, marital status, and educational level.

Pain: Pain was measured using the bodily pain scale from the Medical Outcomes Survey Short Form-36 (Ware, Snow, Kosinski, & Gandek, 1993). Bodily pain scale contains two items assessing the intensity of bodily pain and the extent of interference with normal activities due to pain. Lower scores indicate worse pain, and content validity and scale reliability of .90 have been documented (Ware, Kosinski & Keller, 1994).

Number of Medical Comorbidities: Self-reported medical comorbidities were collected by survey (cancer, lung disease, heart disease, high blood pressure, stroke, psychiatric problems, diabetes, and arthritis) (Mukerji et al., 2007). These conditions were then totaled to calculate the number of medical comorbidities.

Depressive Symptoms: Depressive symptoms were measured by the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D is a 20-item self-report scale designed to measure somatic and affective symptoms of depression (Radloff, 1977) and has been frequently used across various ethnicities to monitor depressive symptoms (Crockett, Randall, Shen, Russell & Driscoll, 2005). Possible scores range from zero to 60 with higher scores indicating more depressive symptoms. Alpha ranged from .84 to .87 across ethnicities (Crockett et al., 2005; Radloff, 1977). Validity has been reported to be strong (Halm, Treat-Jacobson, Lindquist & Savik, 2006).

***Health Behavior Factors***

Smoking: Every participant was categorized into one of three groups: (1) non-smokers, defined as those who had never smoked or had quit smoking more than one month; (2) smokers with non-nicotine dependence, defined as those who had smoked or had quit smoking within one month and had no nicotine dependence; and (3) smokers with nicotine dependence, defined as those who had smoked or had quit smoking within one month as well as had nicotine dependence. Nicotine dependence was measured and dichotomized by the Fagerstrom Test for Nicotine Dependence (FTND) (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). The FTND is a six -item scale assessing nicotine dependence. Possible scores range from 0 to 10 with a cut-off point of six or higher indicating nicotine dependence. Decent internal consistency and strong validity has been documented (Meneses-Gaya, Zuardi, Loureiro & Crippa, 2009; Heatherton et al., 1991).

Alcohol Problems: Alcohol problems were measured and dichotomized by the Alcohol Use Disorder Identification Test (AUDIT) (Saunders, Ashland, Babor, de la Fuente & Grant, 1993). The AUDIT is a 10-item questionnaire which contains questions about the amount and frequency of alcohol consumption, alcohol dependence, and alcohol-related problems or reactions (Meneses-Gaya et al., 2009). Possible scores range from zero to 40 with a cut-off point of eight or higher indicating alcohol problems. A test-retest reliability was .86 (Saunders et al., 1993), and strong validity has been reported across all ethnic and gender groups (Meneses-Gaya et al., 2009).

Physical Activity/ Obesity: Physical activity was measured as the score of the Physical Activity Questionnaire (Norman, Bellocco, Bergstrm & Wolk, 2001). This is a six-item measure assessing time spent doing different types of activities, including types of occupational activity, and creates a total physical activity score based on the duration and intensity of the activities reported. The test-retest reliability was .65, and validity has been reported to be strong (Norman et al., 2001). Obesity was defined as 30 or higher BMI (weight in kilograms divided by the square of height in meters), which was calculated based on self-reported height (without shoes) and weight.

**Data Analysis**

Descriptive statistics (means and frequencies) were computed for all variables. To determine the association of independent variables with sleep quality, bivariate analyses were conducted using Pearson correlations, t-tests, and one-way ANOVA tests. Multicollinearity was assessed using tolerance values and the variance inflation factor (VIF); multicollinearity is a concern when either the tolerance values equal 0.1 or less or the VIF values exceed 10 (Stevens, 1996). The tolerance values ranged from .79 to .95, and VIF values ranged from 1.05 to 1.29 in this study.

Results from bivariate and multicollinearity analyses and clinical judgment were used to select variables for the final, multivariate linear regression model. Using the rule of 10 subjects per factor for regression analysis (Harrell, Lee & Mark, 1996), there was sufficient power to include 13 variables since there were over 400 participants. Values of $p < .05$ were considered to be significant. Analyses were performed with the SPSS for Windows, version 17.0.

## Results

### Descriptions of the Sample

The mean age of the sample (N=498) was 43, and the majority of the participants were males (92.3%) and White (92.4%). Sixty-eight percent of the participants were married, and 60.8% had a high school education or less. The most common comorbidities were hypertension (25.7%) and arthritis (18.7%). Sleep quality (Mean = 70.32) did not differ from the population norms of 72 (Hays et al., 2005). Almost half (46.8%) screened positive for depressive symptoms, and 32.8% scored positive for alcohol problems. Among the participants, 28.5% were smokers and 54.2% were non-smokers. Among the smokers, 40.1% (n = 57) were nicotine dependent. The majority were overweight (40%) or obese (45%), and physical activity (Mean = 42.65) was about average when compared to population norms of 40.8 (Norman et al., 2001). About 34% (n=143) showed interest in health service for better sleep quality.

**Bivariate Analyses**

Table 4 shows the bivariate associations between the independent variables and sleep quality. Sex, marital status, pain, self-reported number of medical comorbidities, depressive symptoms, alcohol problems, and smoking were significantly associated with sleep quality. While being married ($p$ = .014) was associated with better sleep quality, being a female ($p$ = .006), reported pain ($p$ = .000), increased number of medical comorbidities ($p$ = .000), depressive symptoms ($p$ = .000), and problem drinking ($p$ = .002) were associated with poor sleep quality. The association of smoking and sleep quality was significant ($p$ = .002), and a bonferroni post hoc analysis revealed that sleep quality in smokers with nicotine dependence was significantly lower than that in either non-smokers ($p$ = .001) or smokers with no nicotine dependence ($p$ = .012). Age, race, educational level, physical activity, and obesity did not vary by sleep quality.

Table 4. Bivariate Analyses of Sleep Quality

| | Pearson Correlation Coefficients | P-values |
|---|---|---|
| Age | .090 | .052 |
| Sex (Female) | -.126 | **.006** |
| Race (White) | .049 | .294 |
| Marital status (Married) | .112 | **.014** |
| Education (High school or less) | -.046 | .315 |
| Pain | .376 | **.000** |
| Number of Medical Comorbidities | -.242 | **.000** |
| Depressive symptoms | -.444 | **.000** |
| Alcohol Problems | -.142 | **.002** |
| Smoking | 6.43* | **.002** |
| Physical Activity | .002 | .972 |
| Obesity | -.010 | .826 |

*indicates F-value

**Multivariate Analyses**

Multivariate analysis revealed that age, sex, pain, self-reported number of medical comorbidities, depressive symptoms, and nicotine dependence were significantly associated with sleep quality among Operating Engineers (Table 5). While older age (β = .134; p = .005) was significantly related to better sleep quality, being a female (β = -.100; p = .041), reported pain (β = .239; p = .000), increased number of medical comorbidities (β = -.151; p = .003), and depressive symptoms (β = -.310; p = .000) were associated with poor sleep quality. As expected, sleep quality in smokers with nicotine dependence was significantly lower than that of non-smokers (β = -.129; p = .008). This model explained 33% of variance in sleep quality. Marital status and alcohol problems were significant in bivariate analysis but no longer significant in multivariate analysis. Race, educational level, physical activity, and obesity were significant neither in bivariate nor in multivariate analysis.

Table 5. Multivariate Analysis of Independent Variables Related to Sleep Quality

| | Beta | P-value |
|---|---|---|
| Age | .134 | **.005** |
| Sex (Female) | -.100 | **.041** |
| Race (White) | -.055 | .235 |
| Marital status (Married) | .067 | .159 |
| Education (High school or less) | -.065 | .156 |
| Pain | .239 | **.000** |
| Number of Medical Comorbidities | -.151 | **.003** |
| Depressive symptoms | -.310 | **.000** |
| Alcohol Problems | -.063 | .185 |
| Smoking | | |
| Non-Smokers | 1 | |
| Smokers with Non-Nicotine Dependence | .036 | .451 |
| Smokers with Nicotine Dependence | -.129 | **.008** |
| Physical Activity | -.055 | .243 |
| Obesity | .024 | .614 |
| $R^2$ | .327 | |

## Discussion

### Personal Factors Related To Sleep Quality

Consistent with the findings from working populations (Doi et al., 2003; Knudsen et al., 2007), older age has a positive relationship with sleep quality among Operating Engineers. This indicates that younger Operating Engineers may experience more job stress, yet fewer resources to deal with the stress (Metlaine et al., 2005; Vgontzas et al., 2008). Similar to previous studies (Doi et al., 2003; Lallukka et al., 2010, McCrae et al., 2006; Metlaine et al., 2005; Nasermoaddeli et al., 2005; Riemann et al., 2001; Walsh, 2004), females are more likely to report poor sleep quality possibly related to reproductive hormone changes and higher prevalence of depression among females (Baker et al., 2009).

As expected, pain, medical comorbidities, and depressive symptoms were related to poor sleep quality. The associations between these factors and sleep quality may be related to a vicious cycle where pain, underlying medical comorbidities, and depressive symptoms disrupt sleep quality, and disturbed sleep, in turn, augments pain intensity, underlying medical comorbidities, and depressive symptoms (Lautenbacher et al., 2006). Given the reciprocal relationships among them, interventions improving either sleep quality or pain, underlying diseases, or depressive symptoms may produce favorable outcomes. Better sleep quality improved pain management (Chung & Tsoa, 2010; Edwards et al., 2008; Hamilton et al., 2007; Raymond et al., 2001), and most antidepressants, cognitive-behavioral therapies, and social activities for depression have been shown to improve sleep quality (Nasermoaddeli et al., 2005).

## Behavioral Factors Related To Sleep Quality

The National Center for Sleep Disorders Research reviewed the associations between sleep practice and other health risky behaviors and concluded that smoking, alcohol problems, physical inactivity, and obesity were clustered among either individuals who slept less than six hours or those who sleep nine hours or more (Schoenborn et al., 2008). Furthermore, risky health behaviors have a dose-response relationship to poor sleep quality with a higher number of risky health behaviors associated with poorer sleep quality (Janson et al., 2001). Contrary to expectations, the associations of sleep quality with alcohol problems, physical activity, and obesity were not statistically significant perhaps because the population was relatively young and had not fully experienced the detrimental consequences associated with these negative health behaviors. Among the health behavior factors, only nicotine dependence was significantly associated with poorer sleep quality. This association could be used to educate smokers with sleep problems about the benefits of smoking cessation. Moreover, health care providers should carefully examine and manage sleep quality among smokers with nicotine dependence.

## Practice Implications

Given the clustering of poor sleep quality, depression and nicotine dependence, health care providers need to consider the interrelatedness in treating these disorders. For example, widely used non-nicotine pharmacotherapies—Bupropion (an antidepressant) and Varenicline (a partial nicotine receptor agonist)—have been proven to be effective in helping smokers quit smoking. However, these drug therapies also caused sleep problems (Coe, Busch, & Singer, 2010; Franzen & Buysse, 2008), which eventually led patients to stop using these drugs. Therefore, for smokers with sleep problems, nicotine replacement therapies (patch, gum, inhalator, spray, sublingual tablet, and lozenge), which cause fewer sleep disturbances (Chaplin & Hajek, 2010), should be offered as the first smoking cessation treatment rather than non-nicotine pharmacotherapies. In addition, given the reciprocal relationship of sleep quality to pain and medical comorbidities, interventions to improve sleep quality may conversely improve pain and other underlying diseases and vice versa.

Although the mean sleep scores did not differ from population norms, one third of Operating Engineers were interested in worksite interventions to improve sleep quality, which indicates that a subgroup of Operating Engineers are at high risk for the personal and behavioral factors associated with poor sleep quality. Thus, health care providers could improve their sleep quality by addressing their personal (e.g., managing underlying diseases, depression) and behavioral factors (e.g., interventions to modify health risky behavior). To this end, pharmaceutical and worksite behavioral therapies have been shown to be effective.

### Pharmaceutical interventions

Pharmaceutical interventions have been the most common treatment offered. Those with sleep problems spent two to five times more money on prescriptions for sleep treatments as well as for depression and anxiety (Daley, Morin, LeBlanc, Grégoire, & Savard, 2009). However, their long-term use often leads to side effects, such as cognitive and psychosocial impairment, anterograde amnesia, rebound insomnia, development of drug tolerance and dependence, as well as a high risk of mortality by overuse (Cao, 2011). Therefore, health care providers should consider behavioral interventions first in treating sleep problems.

### Behavioral Interventions

Evidence indicates that cognitive behavioral therapy is also effective for treating sleep problems. Considering that younger workers reported higher job stress in this group, stress management skills such as cognitive behavioral or relaxation therapies, both of which have been shown to be effective among working populations, may be a good intervention for improving their sleep quality (Richardson & Rothstein, 2008). Klatt et al. (2009) determined the efficacy of a six-week worksite intervention consisting of meditation and yoga using a randomized controlled trial design. Forty-eight university faculty and staff participated in the study, and those in the intervention group reduced perceived stress and improved sleep quality.

Moreover, given the impact of health behaviors on sleep quality (Janson et al., 2001), modifying health behaviors may promote sleep quality, such as enhancing physical activity and treating tobacco use and problem drinking. Atlantis et al. (2006) conducted a randomized controlled trial to examine the efficacy of a worksite intervention with 73 casino workers. The intervention included exercise (aerobic and weight-training) and sleep hygiene education (e.g., avoiding large meals and caffeine toward the end of shift; reducing noise and light at home in preparation for sleep…) for 24 weeks, and the intervention group improved sleep quality as well as health-related quality of life. Similarly, with 47 poor sleeping workers, Adachi et al. (2008) developed a self-help program including regular exercise for a month. The authors reported that the self-help material increased total sleep time, reduced sleep onset latency, and improved sleep efficiency. However, this study lacked a control group; thus, further well-designed worksite interventions are needed. Even though sleep hygiene interventions alone have been shown to be less effective, sleep hygiene interventions combined with other cognitive behavioral therapies and customized sleep hygiene interventions produced favorable outcomes (Hauri, 1993). Although sleep hygiene rules documented in the literature vary, core factors include regular bedtime/waketime; avoiding use of caffeine and nicotine; and appropriate temperature, comfortable bed, and noise.

About 40% were overweight and 45% were obese, which may put Operating Engineers at risk for OSA, yet unfortunately OSA was not assessed in this study. While more complicated, treatment of OSA may also be used to treat sleeplessness (Epstein et al., 2009). Education to increase awareness of the symptoms of OSA, often related to obesity, may help identify high risk workers and create motivation for polysomnographic assessment. Diagnosis of OSA may allow treatment with Continuous Positive Airway Pressure (CPAP) for a minimum of four hours within a 24-hour period, or surgery as recommended. When properly identified, sleep disturbances are often amenable to treatment which may increase work productivity, improve quality of life, and reduce morbidity and mortality.

## Limitations

Since this was a cross-sectional design, the findings from this study cannot determine causal relationships as might a prospective study. The results were also based on the data from Operating Engineers in Michigan; therefore, the results may not be generalizable to Operating Engineers in other geographic areas. There were no differences in sleep quality according to race and educational level, and this is most likely due to few variations of these variables in this sample as most are White having similar educational levels. The non-significant association between obesity and sleep quality may be because some obese Operating Engineers were already under the treatments of OSA, which we did not examine and were unable to control for the effects of sleep apnea treatments. Moreover, obesity was determined based on self-report, thus the participants may not have reported the most accurate height and weight. In fact, all of the survey data was based on self-report without clinical verification, which may bias the results.

## Conclusion

Younger age, being a female, higher degree of pain, higher number of medical comorbidities, higher depressive symptoms, and nicotine dependence were associated with poor sleep quality among Operating Engineers. Given the high prevalence of depressive symptoms, medical comorbidities, smoking, and alcohol problems in this population, health care providers should offer routine screening tests examining sleep quality and, if needed, interventions to promote sleep quality. Worksite interventions to improve sleep quality among Operating Engineers that include the clustering of personal and behavioral factors may be beneficial to increasing work productivity and quality of life among Operating Engineers.

## CHAPTER IV: Variables Associated with Health-Related Quality of Life Among Operating Engineers


### Abstract

**Purpose**: Health-related quality of life has been acknowledged for its impact on clinical outcomes. However, health-related quality of life among blue collar workers has not been well studied; thus, the purpose of this study was to determine explanatory variables associated with health-related quality of life among Operating Engineers.

**Methods**: This was a cross-sectional correlational design with a dependent variable of SF-36 and independent variables of personal and related health behavioral factors. A convenience sample of 498 Operating Engineers was recruited from approximately 12,000 Operating Engineers from entire State of Michigan in 2008. Linear regression was used to determine personal and related health behavior factors associated with smoking behavior.

**Results**: Personal factors related to poor health-related quality of life were older age, had higher medical comorbidities and had more depressive symptoms. Behavioral factors associated with poor health-related quality of life included smoking, low fruit and vegetable intake, low physical activity, high BMI, and low sleep quality.

**Conclusion**: Operating Engineers are at risk for poor health-related quality of life. Underlying medical comorbidities and depressive symptoms should be well-managed.

Moreover, worksite wellness programs targeting health behaviors that negatively influence health-related quality of life may be beneficial.

## Introduction

Quality of life has been shown to be associated with current and future health status, functioning, and even mortality (Kaplan et al., 1996; Karvonen-Gutierrez et al., 2008). However, the meaning of quality of life in the literature has been confusing, referring to health status, physical functioning, well-being, life satisfaction, and happiness (Ferrans, Zerwic, Wilbur & Larson, 2005). Therefore, the term of health-related quality of life has been created, referring to broad aspects of an individual's life that are heavily influenced by changes in health status and that are significant to the individual (Kane & Radosevich, 2011). Because research on health-related quality of life, particularly in working populations, has been emphasized for its predictive values of absenteeism (employees are absent from the job) and presenteeism (employees are at the job but impaired due to a health problem), work ability and productivity, morbidity, and subsequent mortality (Hanebuth, Meinel & Fischer, 2006; Kaplan et al., 1996; Sorensen et al, 2008), it has been widely used as an outcome of health care (Kane & Radosevich, 2011; Wilson & Cleary, 1995). While predictors of health-related quality of life vary depending on occupational groups (Blane, Netuveli & Bartley, 2007; Soares, Wiitasara & Macassa, 2007), predictors of health-related quality of life among blue collar workers have not been well studied. Hence, the purpose of this study is to determine the predictors of health-related quality of life among one group of blue collar workers, namely Operating Engineers.

## Conceptual Model and Literature review

The Health Promotion Model asserts that health behaviors, particularly when integrated into a healthy lifestyle, result in improved health, enhanced functional ability, and better quality of life (Pender et al., 2006). The Health Promotion Model has not been acknowledged as a health-related quality of life model in the literature. However, Pender's model was chosen as a theoretical framework to guide this work since the intention in this paper was to focus on the relationship between health promoting behaviors and health-related quality of life.

In this model (2006), quality of life is determined by personal factors, including biological, sociocultural, and psychological factors, and health behaviors (Figure 4). Biological and sociocultural factors included demographic factors (age, sex, race, marital status, and educational level) and medical comorbidities. Psychological factors included depressive symptoms. Health behavior factors included smoking, problem drinking, diet (fruit, vegetable, and fried food intake), physical activity, BMI, and sleep quality. The personal and behavioral factors that may influence health-related quality of life among Operating Engineers are reviewed below.

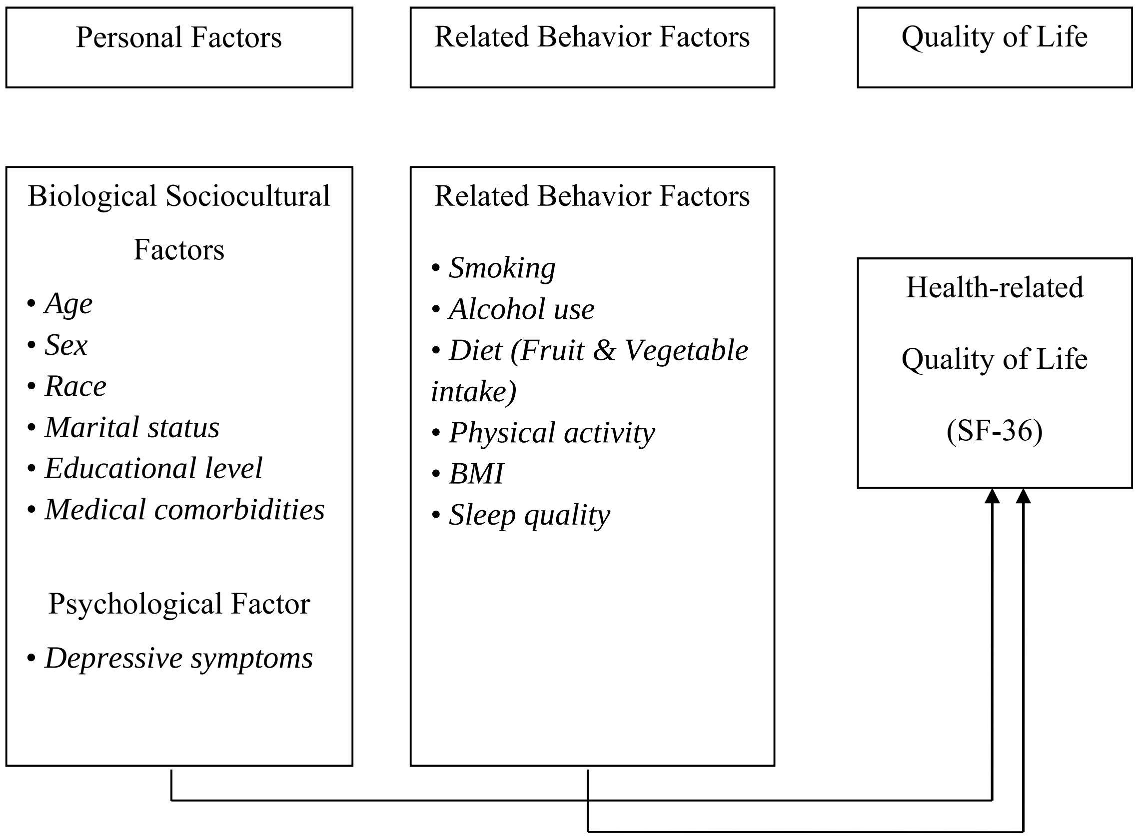


Figure 4. Theoretical Framework of Health-Related Quality of Life

**Personal factors Related To Health-Related Quality Of Life**

**Biological and sociocultural factors**

Biological and sociocultural factors associated with health-related quality of life contain individuals' demographic characteristics, such as age, sex, race, marital status, and educational level. Those who are young, male, non-Hispanic, married, and of higher educational levels have been shown to have better quality of life (Baker, Haffer & Denniston, 2003; Sorensen et al., 2008). Medical comorbidities, including various cancers and cardiovascular diseases, have been found to have detrimental effects on subjective health (Baker et al., 2003; Boini, Brianon, Guillemin, Galan & Hercberg, 2004) and health-related quality of life (Balfour et al., 2006; Garster, Palta, Sweitzer, Kaplan & Fryback, 2009; Goldney, Fisher, Phillips & Wilson, 2004; Jenkinson, Coulter & Wright, 1993). Furthermore, diagnosed cancers had a dose-response relationship with poor subjective health (Clauser, 2008).

### Psychological factor

Depression has been shown to increase mortality rates (Ng et al., 2007) and decreased health-related quality of life (Balfour et al., 2006; Cully et al., 2006; Duffy et al., 2002; Goldney et al., 2004; Soares et al., 2007). The significant association between depression and poor health-related quality of life still exists even when controlling for demographic variables and health behaviors, such as smoking and drinking alcohol (Balfour et al., 2006). Furthermore, the negative impact of depression was not limited to mental health scales, but extended to physical health scales.

## Health Behavior Factors Related To Health-Related Quality Of Life

### Smoking/ Alcohol problems

Prior studies have shown that smoking was correlated with lower subjective health (Kennedy, Kawachi, Glass & Prothrow-Stith, 1998) and poor health-related quality of life (Balfour et al., 2006; Duffy et al., 2002; Hays et al., 2008; Laaksonen, Rahkonen, Martikainen, Karvonen & Lahelma, 2006; Michael, Colditz, Coakley & Kawachi 1999; Sarna, Bialous, Cooley, Jun & Feskanich, 2008; Strandberg et al., 2008). In addition, smoking cessation led to improvements in health-related quality of life

(Mulder, Tijhuis, Smith & Kromhout, 2001) and subjective life satisfaction (McClave, Dube, Strine & Mokdad, 2009).

Studies have shown that the association between drinking alcohol and health-related quality of life was not linear but inversed U-shaped: while light to moderate alcohol consumptions was linked with better quality of life (Byles, Young, Furuya & Parkinson, 2006; Chan, Mühlen, Kritz-Silverstein & Barrett-Connor, 2009; Stranges et al., 2006; Van Dijk, Toet & Verdurmen, 2004) and better subjective health compared to non-drinkers (Guallar-Castillon et al., 2001), heavy drinking was linked to deteriorated health-related quality of life (Grucza, Przybeck & Cloninger, 2008; Poikolainen, Vartiainen & Korhonen, 1996). On the other hand, another study reported that the greatest health-related quality of life—role physical, general health perception, vitality, role emotional, and mental health index—existed among current drinkers, regardless of consumption and frequency of alcohol use, followed by non-drinkers and ex-drinkers (Saito et al., 2005). However, this relationship may be due to the health condition of the participants, who were healthy and young (mean age of 39.4 years) workers.

**Diet/ Physical activity/ BMI/ Sleep quality**

A number of studies found that a healthy diet, which included a high intake of fruit and vegetables and a low intake of fried food, was related to better perceived health (Manderbacka et al., 1999) and health-related quality of life (Myint et al., 2006). Moreover, interventions to increase fruit and vegetable consumption led to improvements in quality of life (Steptoe, Perkins-Porras, Hilton, Rink & Cappuccio, 2004). Despite the benefits of healthy diet, blue collar workers were less likely to eat healthy diet or have the recommended fruit and vegetable consumption compared with white collar workers (Harley et al., 2010).

Being physically active was associated with better health-related quality of life (Dugan et al., 2009; Rejeski & Mihalko, 2001) and interventions for increasing physical activity enhanced health-related quality of life in both physical and mental health domains (Elley, Kerse, Arroll & Robinson, 2003; Kallings, Leijon, Hellenius & Stahle, 2008). The benefits of increased physical activity on health-related quality of life were even evident among obese people (Jia & Lubetkin, 2005). Despite these benefits, blue collar workers ranked among the lowest in leisure time physical activity level (Caban-Martinez et al., 2007). Having a higher BMI was associated with poor health-related quality of life (Fontaine, Barofsky & Cheskin, 1996; Ford, Moriarty, Zack, Mokdad & Chapman, 2001; Hassan, Joshi, Madhavan & Amonkar., 2003; Jia & Lubetkin, 2005; Katz et al., 2000; Kozak et al., 2010; Larsson, Karlsson & Sullivan, 2002; Lean, 1998; Michael et al., 1999; Stafford et al., 1998) and this relationship was still persistent even controlling for obesity-related comorbidities (Jia & Lubetkin, 2005).

Sleep problems have been found to be associated with impaired daytime performance (Léger, Guillemenault, Bader, Levy & Paillard, 2002), increased absenteeism (Godet-Cayre et al., 2006; Léger et al., 2002; Philips et al., 2008), increased work accidents (Ãkerstedt, Fredlung, Gillberg & Jansson, 2002; Léger et al., 2002; Metlaine et al., 2004), as well as decreased productivity (Chilcott & Shapiro, 1996; Manocchia, Keller & Ware, 2001). In addition, sleep problems were found to predict poor health-related quality of life (Chevalier, Los, Boichut, Bianchi, Nutt, Hajak, Hetta, Hoffman & Crowe, 1999; Idzikowski, 1996; Katz & McHorney, 2002; Krystal, 2007;

Léger, Scheuermaier, Philip, Paillard & Guilleminault, 2001; Metlaine et al., 2004; Philips et al., 2008; Viala-Danten, Martin, Guillemin & Hays, 2008). Treatment for insomnia has been shown to improve health-related quality of life (Krystal, 2007).

### Summary

The literature suggests that there is an association between personal and behavior factors and health-related quality of life. However, few studies have comprehensively evaluated effects of the explanatory variables on health-related quality of life among blue collar workers, namely Operating Engineers. Therefore, the specific aims of this study are to determine the personal and behavior factors associated with health-related quality of life among Operating Engineers.

## Methods

### Design

This study is a cross-sectional correlational design to determine variables related to health-related quality of life among Operating Engineers. The dependent variable was health-related quality of life. Explanatory variables included personal factors, including biological, sociocultural, and psychological factors, and behavioral factors. Institutional Review of Board approval was received from the University of Michigan.

### Sample and Setting

A convenience sample was recruited from estimated 1,200 workers from the entire State of Michigan coming to either a three-year apprentice certification course or an eight-hour Hazardous Materials (HAZMAT) refresher course provided by the

Operating Engineers Local 324 during the winter of 2008. Operating Engineers were asked to participate in this study, and 90 % of the Operating Engineers agreed and returned a survey. Total number of the participants who completed the survey was 500, but two of them were dropped from the analysis due to incomplete data leaving a final sample size of 498.

## Procedure

The study was explained to the Hazmar course attendees by the course instructor. The anonymous survey packets including a study information sheet, health survey, and return envelope was distributed. Once the attendees completed the survey, the instructor collected it in sealed envelopes. Each participant who completed the survey received a $10 gasoline gift card. The sealed envelopes were then returned to the study team.

## Measures

### Dependent variables

Health-Related Quality of Life: Health-related quality of life was measured by the Medical Outcomes Survey Short Form-36 (Ware, 1993). The SF-36 with 36 questions is a generic measure assessing health concepts of basic human values that are relevant to everyone’s functional status and well-being (Ware, 1993). The 36-item questionnaire contains eight subscales of health status: physical functioning, role physical, bodily pain, general health perception, vitality, social functioning, role emotional, and mental health index. These eight scales are aggregated to a physical component scale and a mental component score. Physical component scale is composed of four physical health scales (physical functioning, role physical, bodily pain, general health perception), while mental component scale is composed of four mental health scales (vitality, social functioning, role emotional, mental health index). Physical component scale and mental component scale scores are standardized and range from zero to 100 with higher scores indicating better health-related quality of life. Median reliability coefficients equaled or exceeded .80, and strong validity has been reported across various populations (Ware, 2000).

### Independent variables

#### ***Personal Factors Related to Health-Related Quality of Life***

<u>Demographic Factors</u>: Demographic factors included age, sex, race, marital status, and educational level. Self-reported medical comorbidities were collected by survey (cancer, lung disease, heart disease, high blood pressure, stroke, psychiatric problems, diabetes, and arthritis) (Mukerji et al., 2007). These conditions were then totaled to calculate the number of medical comorbidities.

<u>Depressive Symptoms</u>: Depressive symptoms were measured and dichotomized by using the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D is a 20-item self-report scale designed to measure somatic and affective symptoms of depression (Radloff, 1977) and has been frequently used across various ethnicities to monitor depressive symptoms (Crockett, Randall, Shen, Russell & Driscoll, 2005). Possible scores range from zero to 60 with a cut-off score of 16 or higher indicating depression. Alpha ranged from .84 to .87 across ethnicities (Crockett et al., 2005; Radloff, 1977). Validity has been reported to be strong (Halm, Treat-Jacobson, Lindquist & Savik, 2006).

***Health Behaviors Related to Health-Related Quality of Life***

Smoking: Smoking status was determined by a self-report based on a 30-day prolonged abstinence measure. If participants currently smoked cigarettes or had quit within the last month, they were categorized into smokers. If participants had quit more than one month ago or never used tobacco products, they were categorized into non-smokers.

Alcohol Problems: Alcohol problems were assessed and dichotomized by the use of the Alcohol Use Disorder Identification Test (AUDIT) (Saunders, Ashland, Babor, de la Fuente & Grant, 1993). The AUDIT is a 10-item questionnaire which contains questions about the amount and frequency of alcohol consumptions, alcohol dependence, and alcohol-related problems or reactions (Meneses-Gaya, Zuardi, Loureiro & Crippa, 2009). Possible scores range from zero to 40 with a cut-off score of eight; scores equal to or greater than eight indicate alcohol problem. A test-retest reliability was .86 (Saunders et al., 1993), and strong validity has been reported across all ethnic and gender groups (Meneses-Gaya et al., 2009).

Diet/ Physical Activity/ BMI: Selected questions from the validated Willet food frequency questionnaire were used to assess the average number of servings they ate of fruit, vegetables, and fried foods (Willett et al., 1985). Physical activity was measured as the score of the Physical Activity Questionnaire (Norman, Bellocco, Bergstrm & Wolk, 2001). This is a six-item measure assessing time spent doing different types of activities, including types of occupational activity, and creates a total physical activity score based on the duration and intensity of the activities reported. The test-retest reliability was .65, and validity has been reported to be strong (Norman et al., 2001). BMI (weight in kilograms divided by the square of height in meters) was calculated based on self-reported height (without shoes) and weight.

Sleep Quality: Sleep quality was measured by the Medical Outcomes Study (MOS) sleep scale. The MOS is a six-item questionnaire designed to measure the quality and quantity of sleep (Hays, Martin, Sesti & Spritzer, 2005). Possible scores range from zero to 100 with higher scores indicating better sleep quality. The internal reliability alpha coefficient ranged from .64 to .87, and strong discriminant and predictive validity has been reported (Hays et al., 2005; Rejas, Ribera, Ruiz & Masrramón, 2007).

**Analyses**

Descriptive statistics (means and frequencies) were computed for all variables. To determine the association of independent variables with the SF-36 among Operating Engineers, bivariate analyses were conducted using Pearson correlations and Spearman's rho correlations according to the level of variables and distributions. In multivariate analyses, all the variables that showed significant relationships to the SF-36 in bivariate analyses were entered into 10 multiple linear regression models. Since depressive symptoms and mental health represented almost the same concept, depressive symptoms were eliminated from the five mental health regression models (vitality, social functioning, role emotional, mental health index, and mental component scale). The regression assumptions were examined for all 10 models: independence of residual errors, normally distributed errors, homoscedasticity, and linearity. When constructing regression models, multicollinearity among independent variables was examined by using tolerance and variance inflation factor (VIF). Having either tolerance less than .01 or VIF exceeding 10 was considered multicollinearity (Stevens, 1996). Values of $p < .05$ were considered to be significant. Analyses were performed with the SPSS for Windows, version 17.0.

## Results

### Descriptions of the Sample

The sample (N=498) has been described in detail in a prior paper (Duffy et al., 2011). In summary, the mean age was 43, and the majority of the participants were male (92.3%), White (92.4%), married (67.8%), and of high school or less degree (60.8%). Almost half (46.8%) screened positive for depressive symptoms, and 32.8% scored positive for problem drinking. Almost 29% smoked cigarettes or quit within one month at the time of the survey. The majority were overweight with BMI between 25 and 29.99 (40%) or obese with BMI equal to 30 or higher (45%). Physical activity (Mean = 42.65) and sleep quality (Mean = 70.32) were about average when compared to population norms of 40.8 (Norman et al., 2001) and 72 (Hays et al., 2005), respectively.

### Bivariate analyses

In bivariate analyses, increased age, depressive symptoms, smoking, alcohol problems, and higher BMI were related to poorer health-related quality of life, while being White, having higher vegetables and fruit intake, higher physical activity, and higher sleep quality were related to better health-related quality of life among Operating Engineers (Table 6). Age was negatively correlated with physical functioning ($p$=.000), role physical ($p$=.000), bodily pain ($p$=.002), role emotional ($p$=.009), and physical component score ($p$=.000). Being White was correlated to better role emotional ($p$=.044). Depressive symptoms were examined only in five physical health scales and were significant with all the scales (physical functioning, *p*=.006; role emotional, *p*=.000; bodily pain, *p*=.000; general health perception, *p*=.000; physical component scale, *p*=.005). The number of self-reported medical comorbidities was negatively associated with all ten scales of the SF-36. Sex, marital status, and educational level were not statistically significant to health-related quality of life.

Regarding behavioral factors, smoking was negatively associated with general health perception (*p*=.000), and physical component score (*p*=.027), and alcohol problems were negatively related only to bodily pain (*p*=.033). Vegetable intake was positively related with physical functioning (*p*=.012), vitality (*p*=.000), social functioning (*p*=.000), role emotional (*p*=.027), mental health index (*p*=.001), and mental component score (*p*=.000). Fruit intake was significant with all mental health scales (vitality, *p*=.001; social functioning, *p*=.006; mental health index, *p*=.009; and mental component score, *p*=.004) and general health perception (*p*=.015). As expected, physical activity was positively related to physical health scales (physical functioning, *p*=.001; role physical, *p*=.002; general health perception, *p*=.023; and physical component score, *p*=.001). BMI was negatively associated with all physical health scales (physical functioning, *p*=.000; role physical, *p*=.019; bodily pain, *p*=.026; general health perception, *p*=.001; and physical component score, *p*=.000). Health-related quality of life did not significantly vary by fried food consumptions.

Table 6.

*Bivariate Relationship Between Personal Factors and Health Behaviors and SF-36 Quality of Life Scales*

| | PF | RP | BP | GH | VT | SF | RE | MH | PCS | MCS |
|---|---|---|---|---|---|---|---|---|---|---|
| Age[a] | -.22** | -.17** | -.14* | -.03 | -.01 | -.00 | -.12* | -.03 | -.20** | .02 |
| Sex (Female)[a] | -.01 | .03 | .02 | -.04 | -.07 | -.01 | -.06 | -.06 | .02 | -.07 |
| Race (White)[a] | .03 | .02 | .04 | .02 | -.03 | .02 | .09* | .07 | .00 | .05 |
| Marital status (Married)[a] | -.08 | -.04 | -.06 | -.03 | -.02 | .00 | .-.02 | -.01 | -.08 | .01 |
| Education (High school or less)[a] | -.04 | -.06 | -.02 | -.08 | -.01 | -.04 | -.07 | -.01 | -.06 | -.02 |
| Number of medical Comorbidity[a] | -.23* | -.22* | -.33** | -.37** | -.33** | -.21** | -.18** | -.31** | -.32** | -.25** |
| Depressed[a] | -.13** | -.24** | -.24** | -.25** | | | | | -.13** | |
| Smoking[a] | -.09 | -.03 | -.07 | -.15** | -.01 | -.01 | -.04 | -.05 | -.11* | -.01 |
| Alcohol problems[a] | -.03 | -.03 | -.10* | -.07 | -.07 | -.05 | .00 | -.08 | -.07 | -.05 |
| Vegetable intake[b] | .11* | .07 | .06 | .06 | .16** | .16** | .10* | .16** | .05 | .18* |
| Fruit intake[a] | .05 | .07 | .08 | .11* | .16** | .12** | .07 | .12** | .06 | .13** |
| Physical activity[a] | .15** | .14* | .05 | .10* | .03 | .02 | .08 | .03 | .15** | .00 |
| BMI[a] | -.21** | -.11* | -.10* | -.15** | -.06 | -.02 | -.03 | -.02 | -.22** | .03 |
| Sleep quality[a] | .20** | .29** | .38** | .44** | .53** | .42** | .38** | .58** | .24** | .56** |

*: p <.05; **: p <.001; PF: physical functioning; RP: role physical; BP: bodily pain; GH: general health perception; VT: vitality; SF: social functioning; RE: role emotional; MH: mental health index; PCS: physical component score: MCS: mental health score; [a]: Pearson correlation coefficients; [b]: Spearman correlation coefficients

**Multivariate analyses**

Ten regression models were constructed by using the eight scales and two component scales of the SF-36 as dependent variables. All ten regression models were significant at the level of .05, and explained 20 to 44% of variance in health-related quality of life among Operating Engineers.

Age, marital status, number of medical comorbidities, depressive symptoms, smoking, vegetable and fruit consumptions, physical activity, BMI, and sleep quality were significantly associated with the SF-36 scales (Table 7). Older Operating Engineers had lower scores in the physical functioning ($p$=.000), role physical ($p$=.003), bodily pain ($p$=.011), role emotional ($p$=.017), and physical component scale ($p$=.003). Those who were married had lower scores on bodily pain ($p$=.012), general health perception ($p$=.029), vitality ($p$=.046), mental health index ($p$=.028), and physical component scale ($p$=.034) compared with those who were not married. Depressive symptoms were tested with only five physical health scales and were related to poorer health-related quality of life in physical functioning ($p$=.012), role physical ($p$=.002), and bodily pain ($p$=.035). As expected, number of medical comorbidities was negatively associated with all health scales except for social functioning and role emotional (physical functioning, $p$=.003; role physical, $p$=.014; bodily pain, $p$=.000; general health perception, $p$=.000; vitality, $p$=.000; mental health index, $p$=.000; physical component scale, $p$=.000; and mental component scale, $p$=.003).

As expected, smokers had lower scores in the physical functioning ($p$=.038), general health ($p$=.001), and physical component scale ($p$=.008) as compared to non-smokers. Surprisingly, alcohol problems were not associated with any of the SF-36 scales in this study. Those who had fruit intake from two to four per week had lower scores on general health perception ($p$=.022), vitality ($p$=.008), role emotional ($p$=.021), mental health index ($p$=.005), mental component scale ($p$=.007) compared to those who had one per day or more. As expected, higher physical activity was related to higher scores on the physical functioning ($p$=.040). BMI, unexpectedly, had ambi-directional relationships with health-related quality of life. BMI had negative relationships with two physical health scales (physical functioning, $p$=.001; and physical component scores, $p$=.001), and a positive relationship with mental component scores ($p$=.019). Sleep quality was the strongest variable and positively associated with health-related quality of life among Operating Engineers with significant relationships in all 10 multiple regression models: as sleep quality improved, all scores of the SF-36 increased.

Table 7.

*Multivariate Linear Regression Analyses Showing Predictive Values of Personal Factors and Health Behaviors and SF-36 Quality of Life Scales*

| | PF | RP | BP | GH | VT | SF | RE | MH | PCS | MCS |
|---|---|---|---|---|---|---|---|---|---|---|
| Age | -.183** | -.155* | -.126* | | | | -.120* | | -.152* | |
| Marital status (Married) | | | -.122* | -.098* | -.086* | | | -.091* | -.105* | |
| Depressed | -.131* | -.165* | -.107* | | | | | | | |
| Number of medical comorbidities | -.157* | -.132* | -.238** | -.286** | -.215** | | | -.196** | -.242** | -.133* |
| Smoking | -.109* | | | -.151** | | | | | -.138* | |
| Alcohol problem | | | | | | | | | | |
| Vegetable intake | | | | | | | | | | |
| None to 1/wk | | | | | | | | | | |
| 2-4/wk | | | | | | | | | | -.103* |
| 5-6/wk | | | | | | | | | | |
| 1/day or more (Ref) | | | | | | | | | | 0 |
| Fruit intake | | | | | | | | | | |
| None to 2-4/wk | | | | -.108* | -.119* | | -.119* | -.122* | | -.119* |
| 1/day or more (Ref) | | | | 0 | 0 | | 0 | 0 | | 0 |
| Physical activity | .104* | | | | | | | | | |
| BMI | -.165* | | | | | | | | -.166* | .103* |
| Sleep quality | .140* | .233** | .264** | .357** | .499** | .442** | .397** | .552** | .151* | .566** |
| $R^2$ | .209 | .195 | .251 | .359 | .386 | .242 | .212 | .435 | .228 | .416 |

*: p <.05; **: p <.00; PF: physical functioning; RP: role physical; BP: bodily pain; GH: general health perception; VT: vitality; SF: social functioning; RE: role emotional; MH: mental health index; PCS: physical component score: MCS: mental health score;

# Discussion

Older age, non-White race, medical comorbidities, depressive symptoms, smoking, and high BMI were related to poorer health-related quality of life, whereas high fruit intake, physical activity, and sleep quality were related to greater health-related quality of life. In general, health-related quality of life in physical functioning, vitality, and emotional role were higher among Operating Engineers than the general population, whereas bodily pain, general health perception, and social functioning were lower (Appendix A). High levels of depression, smoking, and problem drinking found in this group might play a significant role in poor health-related quality of life among Operating Engineers.

## Personal factors related to health-related quality of life

Among the demographic factors, older age and being married was associated with decreased health-related quality of life. Since marriage is a marker for social support (Williams, Sassler & Nicholson, 2008), which has been shown to improve health-related quality of life, the inverse relationship between marriage and health-related quality of life in this study is perplexing. The unexpected finding may be related to other confounders (e.g., financial stress may be more severe among those who are married with dependents than those who are not married) associated with quality of life, but not examined in this study. Thus, more research is needed to identify clear relationships between marital status and health-related quality of life among Operating Engineers.

Consistent with previous studies, the number of medical comorbidities was related to all of the physical health scales (physical functioning, role physical, bodily pain, general health perception), two mental health scales (vitality, mental health index), as well as two component scales (physical component scale and mental component scale) in the regression analyses. Similarly, depressive symptoms, examined in only five physical health scales, showed negative associations with three physical health scales (physical functioning, role physical, bodily pain). Given the high rates of depression and the negative impact on health-related quality of life, depression interventions may be beneficial in this population.

**Health behavioral factors related to health-related quality of life**

As has been shown in other studies, smoking was associated with deteriorating physical health scales (Duffy et al., 2002; Hassan et al., 2003; Sarna et al., 2008). Worksite smoking cessation interventions may be useful in improving health-related quality of life among Operating Engineers who smoke. Surprisingly, problem drinking was not associated with any of the health-related quality of life scales. Nonetheless, problem drinking rates were about three times higher in this population compared to population norms (Hasin, Stinson, Ogburn & Grant, 2007; Substance Abuse and Mental Health Services Administration, 2009). Given the fact that treatment costs of problem drinking make up more than 1% of gross national product in both high income and middle income countries (Rehm et al., 2009), interventions for problem drinking may not only improve the long-term health-related quality of life, but also save the money at the national level. Alcohol screening and brief interventions (Blow et al., 2009; Saitz, 2010) and community programs such as Alcoholics Anonymous (Kelly, Stout, Magill, Tonigan & Pagano, 2010) have been shown to be effective in improving alcohol outcomes.

This study confirms the previous findings that higher fruit intake was associated with better health-related quality of life (Hassan et al., 2003). Given the very low percentage of Operating Engineers eating more than one serving of fruit per day (14%), interventions to address nutritional intake, specifically increasing fruit and vegetable intake are indicated. Physical activity was positively related to a physical health scale (physical functioning), but not to the mental health scales, which complements findings of previous studies (Dugan et al., 2009; Elley et al., 2003; Savela et al., 2010; Strandberg et al., 2009). Different than expected, BMI had ambi-directional relationship with the SF-36 scales: higher BMI was related to poor physical health scales (physical functioning and physical component scale), but also related to better mental health, perhaps because some obese individuals adapted to mental health conditions despite limited physical health (Kozak et al., 2011).

Poor sleep quality was the strongest predictor of deteriorating health-related quality of life among Operating Engineers, with a stronger relationship with the mental health scales compared to physical health scales. This is in line with prior studies showing that poor sleep quality was associated with declining mental functioning (Katz & McHorney, 2002; Léger et al., 2001). Given the negative impacts of smoking (Saint-Mleux et al., 2004; Wetter et al., 1994), problem drinking (Palmer, Harrison & Hiorns, 1980; Roehrs & Roth, 2008; Vitiello, 1997), and depression (Philips et al., 2008; Shuman et al., 2010; Viala-Danten et al., 2008) on sleep quality, high prevalence of all three of these in this population may influence sleep quality. Considering the negative effects of poor sleep quality on health-related quality of life as well as on society, such as high absenteeism (Godet-Cayre et al., 2006; Léger et al., 2002), work accidents (Ãkerstedt et al., 2002; Léger et al., 2002; Metlaine et al., 2004), and decreased productivity (Chilcott & Shapiro, 1996), interventions and treatments to improve sleep quality are indicated.

**Practice Implications**

While most of the personal factors (e.g., age and medical comorbidities) associated with health-related quality of life are unchangeable, interventions—wellness programs at worksites—are available to improve the health behavior factors associated with health-related quality of life. For example, Kelly (2009) found that self-testing workplace stations, in which employees were able to self-test blood pressure and body weight, were useful in 13 workplaces with various sizes. Employees determined to be high risk after the initial visit were more likely to revisit and reduce the health risks, while the health risks of other employees who did not visit were not changed or increased. The self-testing workplace stations may encourage employees to modify their unhealthy behaviors; thus, if combined with other wellness programs (smoking cessation, physical activity, or diet interventions), the wellness programs may produce even better outcomes. Milani and Lavie (2009) found that the worksite intervention, consisting of smoking cessation, fitness counseling, nutritional education, weight control, and treatment for drug and alcohol addiction, produced better health outcomes, resulting in more than half of high risk workers being converted to a low risk status, as well as enhanced health-related quality of life.

In addition to the health effects, changes in risky health behaviors directly led to increases in productivity (reduction in absenteeism and presenteeism) (Carnethon et al., 2009). As a result, interventions promoting worksite health are cost-effective by reducing total medical claim costs and improving productivity. A meta-analysis documented cost effectiveness of worksite wellness programs addressing weight loss, smoking cessation, and multiple risky health behaviors (Baicker, Cutler, & Song, 2010); worksite wellness programs reduced medical costs by about $3.27 for every dollar spent on wellness programs and absenteeism costs by about $2.73 for every dollar spent. Thus, wellness programs produce health benefits as well as costs benefits.

Given the negative effects of engaging in any health risky behavior, such as high medical expenditures (Goetzel et al., 2009), high absenteeism and presenteeism (Goetzel et al., 2009), and productivity loss (Burton et al., 2005), worksite interventions to modify the risky health behaviors are necessary. Among health care providers, nurses may be in the best position to conduct worksite health behavior interventions, given their counseling skills and broad knowledge of health practice. Indeed, prior studies have proven the significance of the nurse's role in changing health behaviors (Rice & Stead, 2009; Lyons, 2005).

## Limitations

Since this study was designed to be cross-sectional, the findings cannot determine causal relationships as would a prospective study. Rather than causal relationships, the significant factors should be interpreted as being tied to health-related quality of life among Operating Engineers. The results were also based on the data from Operating Engineers in Michigan, USA; therefore, the findings may not be generalizable to Operating Engineers in other geographic areas. Health-related quality of life did not differ according to sex and educational levels since the sample was fairly homogeneous with most being white males of similar socioeconomic level.

## Conclusion

Operating Engineers are at risk for poor health-related quality of life related to personal factors (older age, higher medical comorbidities and depressive symptoms) and health behaviors (smoking, diet low in fruit intake, low physical activity, higher BMI, and low sleep quality). Efficacious worksite interventions available to treat related health behaviors that negatively impact health-related quality of life have the potential to enhance health-related quality of life among Operating Engineers.

# CHAPTER V: Discussion and Conclusion

Using cross-sectional correlational design, the three studies in this dissertation examined variables associated with smoking and the variables related to sleep quality and health-related quality of life (particularly smoking) among Operating Engineers. The Health Promotion Model was used as a theoretical framework. Personal factors and related behavioral factors, the Health Promotion Model explained 33% of variance in sleep quality and 20-44% of variance in health-related quality of life. Given that this study did not include behavior-specific psychological and cognitive variables, which have been proven to be the most proximal variables explaining health behaviors and produced the largest amount of variance, $R^2$ in this range would be sufficient. The findings of this study support evidence of bundled health behavior interventions.

## Health Behaviors Among Operating Engineers

Unhealthy behaviors, including smoking, drinking alcohol, low fruit and vegetable intake, physical inactivity, and poor sleep quality, negatively contribute to health outcomes; health behaviors contribute to 50% of total mortality in the United States (Mokdad et al., 2004) and are associated with quality of life (Redding et al., 2000). A better understanding of health behaviors among Operating Engineers is essential to develop tailored health promoting interventions.

## Smoking

This group of Operating Engineers showed a particularly high smoking prevalence (28.5%). Smoking behavior in this population should be considered in the context of the work environment; Operating Engineers are exposed to occupational contaminants on a daily basis, which has a dose-response relationship with smoking on pulmonary diseases (Chen et al., 2004). In addition, smokers in this group showed the clustering of health risky behaviors: smokers were more likely to engage in problem drinking and physical inactivity. Consistent with previous studies, smokers with nicotine dependence had poor sleep quality and poorer health-related quality of life in physical health domains (physical functioning, general health perception, and physical component scale) compared to non-smokers. Given the clustering of health behaviors among smokers, Operating Engineers could benefit from multiple health behavior interventions addressing smoking and other behaviors as well to change bundled health behaviors simultaneously.

## Alcohol Use

In this population of Operating Engineers, the problem drinking rate was about three times higher than the general population rates (Substance Abuse and Mental Health Services Administration, 2009), yet only about one fifth of the sample showed interests in receiving services for alcohol problems. The literature on alcohol problem interventions combined with smoking cessation is contradictory. Some researchers argue that alcoholics with nicotine dependence should be treated for alcohol problems first, and then smoking cessation interventions should be implemented later (Joseph, Willenbring, Nugent & Nelson, 2004), others report that combined smoking and alcohol cessation interventions would produce favorable outcomes (Bowman & Walsh, 2003; Duffy et al., 2006). Thus, further studies are needed to determine the efficacy of alcohol problem interventions combined with smoking cessation.

Consistent with the literature, alcohol use was related to smoking behavior. Contrary to expectations, problem drinking in this group did not show a significant relationship with either sleep quality or health-related quality of life. This may be due to the characteristics of the sample, which are young and healthy; thus, they did not have alcohol-related health problems yet. However, considering the high costs induced by alcohol problems worldwide (more than 1% of GNP worldwide; Rehm et al., 2009), and the strong relationship with smoking, interventions for problem drinking would be beneficial for this population.

**Diet/ Physical Activity/ BMI**

This group of Operating Engineers showed a diet remarkably low in fruit and vegetable intake with only 38.8% eating vegetable once a day or more and 33.6% eating fruit once a day or more. In addition, unlike other blue collar workers, Operating Engineers have a fairly sedentary job that involves sitting on heavy machinery, albeit the median physical activity was not different from the general population’s median (Norman et al., 2001). As a result of a diet low in fruit and vegetable intake and physical inactivity, 45% screened positive for obesity and another 40% were overweight.

Diet, physical activity, and BMI in this study were significantly related to smoking and health-related quality of life, but not to sleep quality. However, considering the beneficial effects of physical activity on obesity (Anderson et al., 2009) and sleep quality (Adachi et al., 2008; Atlantis et al., 2006) found in other studies, physical activity interventions may be beneficial for this population. In fact, combined interventions of diet and physical activity increased fruit and vegetable consumption and levels of physical activity (Babazono, Kame, Ishihara, Yamamoto, & Hillman, 2007; Elliot, Goldberg, Kuehl, Moe, Breger, & Pickering, 2007), which improved chronic disease profiles, such as BMI, blood pressure, and low density lipoprotein cholesterol (Aldana et al., 2005; Arao et al., 2007; Hardcastle, Taylor, Bailey, & Castle, 2008). Moreover, given that smoking cessation was associated with increased habitual exercise (Nagaya, Yoshida, Takahashi & Kawai, 2007), smoking cessation interventions combined with physical activity may change both behaviors simultaneously in Operating Engineers.

**Sleep Quality**

The mean sleep score in this study was lower than the population mean (Hays et al., 2005). Younger age, female sex, higher pain levels, medical comorbidities, depressive symptoms, and smoking with nicotine dependence were significantly related to poor sleep quality. Sleep quality was the strongest factor associated with health-related quality of life with significant relationships with all ten domains of SF-36. Given the high prevalence of smoking, medical comorbidities, and depressive symptoms in this group, Operating Engineers are at risk for poor sleep quality. Therefore, sleep quality should be evaluated on a regular basis, and interventions for better sleep quality, if needed, should be provided.

Pharmaceutical and behavioral therapies for better sleep quality are available. Although pharmaceutical therapies have been most commonly used, their long-term use has been shown to cause side effects (Cao, 2011). Thus, behavioral therapies should be offered first. Examples of effective behavioral therapies include stress management skills

(Richardson & Rothstein, 2008), meditation and yoga (Klatt et al., 2009), enhancing physical activity (Adachi et al., 2008; Atlantis et al., 2006), and treatments of OSA (Epstein et al., 2009). Moreover, sleep hygiene interventions combined with cognitive behavioral therapies and customized sleep hygiene interventions promoted sleep quality (Hauri, 1993). In addition, given the reciprocal relationship of sleep quality to pain and medical comorbidities, underlying diseases and depressive symptoms should be appropriately treated since well-managed underlying diseases and depressive symptoms may conversely improve sleep quality and vice versa.

In addition to risky health behaviors, this group of Operating Engineers showed particularly high depressive symptoms: about half of the sample screened positive for depressive symptoms. Moreover, depressive symptoms were significantly associated with sleep quality and health-related quality of life. Therefore, interventions for depressive symptoms would be beneficial for this population.

### Bundled Health Behaviors

Bundled health behaviors have been documented in the literature (National Institutes of Health, 2009) and have been shown to cause much higher risks for chronic diseases (Ma et al., 2000; Schuit et al., 2002). In the general population, only three percent of adults meet criteria for a healthy lifestyle including non-smoking, physical activity, a healthy diet, and BMI (Reeves & Rafferty, 2005). Surprisingly, none of this group of Operating Engineers met the criteria; 54.2% met the criterion of non-smoking; 40.2% met the criterion of physical activity; 1.2% met the criteria of fruit intake; 2.1% met the criteria of vegetable intake; 14.9% met the criterion of normal BMI. Considering the high smoking rates, bundled risky health behaviors among smokers, and their contribution to morbidity, mortality, as well as quality of life, Operating Engineers are good candidates for wellness programs.

There are four reasons that wellness interventions at worksites may be the ideal environment for health behavior interventions. First, union halls where workers congregate are places where a higher number of people with compromised health behaviors may be reached. Second, co-workers sharing similar health risk behaviors could motivate and support each other as social support from co-workers produce more favorable outcomes (Campbell et al., 2002). Third, many blue collar workers such as Operating Engineers, who are traditionally less likely to have access to interventions (Okechukwu, Krieger, Sorensen, Li & Barbeau, 2009), have seasonal downtime which provides a window of opportunity for participation in interventions. Lastly, the literature has shown the cost-effectiveness of worksite wellness programs (Baicker et al., 2010; Warner et al., 1996). Since many unions (such as Operating Engineers Local 324) are now paying directly for health care, there is motivation on the part of management to provide interventions that reduce health care costs.

The number of target behaviors of wellness programs range from one to multiple health behaviors. However, as suggested by Prochaska (2008), health promoting interventions targeting multiple health behaviors simultaneously are more beneficial for promoting public health than those targeting one health behavior at a time. When designing multiple health behavior programs, researchers should remember that smoking has the most consistent relationship to other risky health behaviors (problem drinking, physical inactivity, unhealthy diet, and less sleep) (Schoenborn et al., 2008), thus, smoking should be considered as a pivotal point in the bundled behaviors. Furthermore, smoking cessation interventions could be viewed as a gateway to modifying other risky health behaviors (Nagaya et al., 2007; Schoenborn & Adams, 2008; Spring et al., 2004).

Exploring health behaviors among Operating Engineers will provide the groundwork to design theory-driven health promoting interventions tailored to this population. Given the overall health behaviors in this group, they will receive more benefits from wellness programs addressing multiple risky health behaviors than those addressing one behavior. As mentioned above, considering the consistent relationships of smoking with other health behaviors, smoking cessation should be a main target behavior in wellness programs. Besides smoking, diets low in fruit and vegetable intake, physical inactivity, higher BMI, and low sleep quality were related to poor health-related quality of life. Thus, wellness programs targeting these health behaviors will modify unhealthy behaviors and improve health-related quality of life. Furthermore, wellness programs are cost-effective (increasing productivity and decreasing absenteeism and presenteeism) (Carnethon et al., 2009). Therefore, the findings in this dissertation are important as it supports theory-driven significant relationships between smoking and other health risky behaviors, which can guide further studies to design health promoting programs incorporated with smoking cessation tailored to the factors that characterize Operating Engineers.

## Suggestions for Future Studies

The successes of wellness programs targeting two or more risky health behaviors simultaneously imply that there exist common mechanisms of behavior changes across various health behaviors. However, little is known about the common mechanisms; thus, future studies need to investigate more on the common mechanisms across changes in multiple health behaviors. One possible mechanism is “co-variation” meaning that one behavioral change can lead to another behavioral change (Prochaska, 2008). Contrary to co-occurrence of health behaviors (some risky health behaviors occur together, bundled health behaviors), co-variation emphasizes changes in health behavior simultaneously. Co-variation of smoking cessation would be a key for designing smoking cessation interventions targeting other risky health behaviors simultaneously. For example, if smoking cessation co-occurs with diet changes among Operating Engineers, health promoting programs targeting smoking cessation and healthy diet would be the best strategy to change the behaviors. However, very little research has been studied co-variation of smoking cessation (e.g., which health risky behavior would occur when smokers quit smoking?). Therefore, future studies need to further explore the co-variation of smoking cessation.

## Limitations

There are several limitations to the studies in this dissertation. First, the studies were based on a cross-sectional design in which findings are limited to determining association, but not causation as might a prospective study. Thus, in order to determine causal relationships, future studies with longitudinal data will be needed. Moreover, randomized controlled trials are needed to determine the efficacy of health behavior interventions with this population.

Second, the characteristics of the sample may limit the generalizability of the findings; there were few females, non-White, and those with high educational levels. Future studies with heterogeneous samples would draw different findings and would be important to verify the findings of this study. Nonetheless, the demographics of this sample were similar to other studies of Michigan Operating Engineers (Hong, 2005).

Third, all of the survey data were based on self-report without clinical verification, which may bias the results. For example, even though self-report on smoking status has been found to be reliable (Gorber et al., 2009), self-reported smoking status without biochemical verification might introduce misclassification of smokers into non-smokers. Moreover, self-report on the participant's height and weight may not represent the most accurate measures, which may lead to a non-significant relationship between obesity and sleep quality.

Fourth, the data were collected during winter when Operating Engineers were not employed, so they might have had more financial stress, which possibly influenced depressive symptoms, smoking behavior, and problem drinking. If data were collected at a time other than winter, or if the survey collected data on financial stress and social support as covariates, the findings of smoking behavior in relation to other health behaviors and other health characteristics may be different. Therefore, more studies with data collected at a time other than winter or with data on financial stress and social support should be conducted to verify the findings of this study.

## Conclusion

This study provides a secondary data analysis with aims of exploring smoking behavior and the impact of smoking and other covariates on sleep quality and health-related quality of life among Operating Engineers. Personal factors (biological, sociocultural, and psychological) and related behavioral factors associated with smoking behavior were examined. Compared to non-smokers, Operating Engineers who smoke were more likely to be younger and separated/widowed/divorced. In addition, problem drinking, physical inactivity, and a lower BMI were associated with smoking.

Moreover, although smoking behavior itself did not impact sleep quality, smoking with nicotine dependence was associated with poor sleep quality. In addition, smoking behavior was significantly associated with poor health-related quality of life. The significant relationships of smoking with other related health behaviors, sleep quality, and health-related quality of life support the theoretical framework. As hypothesized, smoking behavior was associated with other health risky behaviors, poor sleep quality and poor health-related quality of life.

Given the overall health behaviors and the clustering of unhealthy behaviors, Operating Engineers will benefit from multiple health behavior programs. Considering the most consistent relationship of smoking with other behaviors, worksite wellness programs addressing smoking combined with other risky behaviors have the potential to promote health behavior changes. Furthermore, the programs will improve sleep quality and health-related quality of life among Operating Engineers.

## APPENDIX

A. SF-36 Scores Among Operating Engineers Compared With U. S. Population Norms

| Scales | Operating Engineers | Population Norm | t | p-value |
|---|---|---|---|---|
| PF | 83.3 | 84.2 | -.939 | .348 |
| RP | 83.6 | 80.9 | 2.914 | **.004** |
| BP | 71.1 | 75.2 | -4.198 | **.000** |
| GH | 67.2 | 71.9 | -5.738 | **.000** |
| VT | 62.8 | 60.9 | 2.248 | **.025** |
| SF | 81.3 | 83.3 | -2.020 | **.044** |
| RE | 86.1 | 81.3 | 5.401 | **.000** |
| MH | 73.3 | 74.7 | -1.680 | .094 |
| PCS | 50.6 | 50.0 | 1.791 | .074 |
| MCS | 50.0 | 50.0 | .071 | .944 |

Note: For comparison, the 1998 general US population mean values were used (Ware et al., 1994); PF: physical functioning; RP: role physical; BP: bodily pain; GH: general health perception; VT: vitality; SF: social functioning; RE: role emotional; MH: mental health index; PCS: physical component score: MCS: mental health score

## REFERENCES

Adachi, Y., Sato, C., Kunitsuka, K., Hayama, J., & Doi, Y. (2008). A brief behavior therapy administered by correspondence improves sleep and sleep-related behavior in poor sleepers. *Sleep and Biological Rhythms, 6*, 16-21. doi:10.1111/j.1479-8425.2007.00329.x

Adler, N. E., & Newman, K. (2202). Socioeconomic disparities in health: Pathways and policies. *Health Affairs, 21*(2), 60-76.

Ãkerstedt, T., Fredlund, M., Gillberg, M., & Jansson, B. (2002). A prospective study of fatal occupational accidents—relationship to sleeping difficulties and occupational factors. *Journal of Sleep Research, 11*(1), 69-71.

Åkerstedt, T., Fredlund, P., Gillberg, M., & Jansson, B. (2002). Work load and work hours in relation to disturbed sleep and fatigue in a large representative sample. *Journal of Psychosomatic Research, 53*(1), 585-588.

Ãkerstedt, T., Kecklund, G., Alfredsson, L., & Selen, J. (2007). Predicting long-term sickness absence from sleep and fatigue. *Journal of Sleep Research, 16*(4), 341-345.

Alavinia, S. M., Berg, T. I., Duivenbooden, C., Elders, L. A., & Burdorf, A. (2009). Impact of work-related factors, lifestyle, and work ability on sickness absence among Dutch construction workers. *Scandinavian Journal of Work, Environment Health, 35*(5), 325.

Ancoli-Israel, S. (2006). The impact and prevalence of chronic insomnia and other sleep disturbances associated with chronic illness. *The American Journal of Managed Care, 12*(8), S221-S229.

Anderson, L. M., Quinn, T. A., Glanz, K., Ramirez, G., Kahwati, L. C., Johnson, D. B., . . . Katz, D. L. (2009). The effectiveness of worksite nutrition and physical activity interventions for controlling employee overweight and obesity: A systematic review. *American Journal of Preventive Medicine, 37*(4), 340-357. doi:10.1016/j.amepre.2009.07.003

Arheart, K. L., Lee, D. J., Dietz, N. A., Wilkinson, J. D., Clark, J. D., LeBlanc, W. G.,... Fleming, L. E. (2008). Declining trends in serum cotinine levels in US worker groups: The power of policy. *Journal of Occupational and Environmental Medicine, 50*(1), 57-63.

Atkinson, G., & Davenne, D. (2007). Relationships between sleep, physical activity and human health. *Physiology Behavior, 90*(2-3), 229-235.

Atlantis, E., Chow, C. M., Singh, M. A. F., & Kirby, A. (2006). Worksite intervention effects on sleep quality: A randomized controlled trial. *Journal of Occupational Health Psychology, 11*(4), 291-304. doi:10.1037/1076-8998.11.4.291

Baker, F. C., Wolfson, A. R., & Lee, K. A. (2009). Association of sociodemographic, lifestyle, and health factors with sleep quality and daytime sleepiness in women: Findings from the 2007 national sleep foundation ‘‘Sleep in america poll’’. *The Journals of Women's Health, 18*(6), 841-849. doi:10.1089=jwh.2008.098

Baker, F., Haffer, S. C., & Denniston, M. (2003). Health-related quality of life of cancer and noncancer patients in medicare managed care. *Cancer, 97*(3), 674-681.

Balfour, L., Cooper, C., Kowal, J., Tasca, G. A., Silverman, A., Kane, M., … Garber, G. (2006). Depression and cigarette smoking independently relate to reduced health-related quality of life among canadians living with hepatitis C. *The Canadian Journal of Gastroenterology, 20*(2), 81-86.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215.

Bang, K. M., & Kim, J. H. (2001). Prevalence of cigarette smoking by occupation and industry in the United States. *American Journal of Industrial Medicine, 40*(3), 233-239. doi: 10.1002/ajim.1094

Barbeau, E. M., Krieger, N. & Soobader, M. (2004). Working class matters: Socioeconomic disadvantage, race/ethnicity, gender, and smoking in NHIS 2000. *American Journal of Public Health, 94*(2), 269-278.

Berrigan, D. (2003). Patterns of health behavior in US adults. *Preventive Medicine, 36*(5), 615-623. doi: 10.1016/S0091-7435(02)00067-1

Beydoun, M. A., Powell, L. M., & Wang, Y. (2008). The association of fast food, fruit and vegetable prices with dietary intakes among US adults: Is there modification by family income? *Social Science Medicine, 66*(11), 2218-2229. doi: 10.1016/j.socscimed.2008.01.018

Blane, D., Netuveli, G., & Bartley, M. (2007). Does quality of life at older ages vary with socio-economic position? *Sociology, 41*(4), 717-726. doi: 10.1177/0038038507078927

Blow, F. C., Ilgen, M. A., Walton, M. A., Czyz, E. K., McCammon, R., Chermack, S. T., et al. (2009). Severity of baseline alcohol use as a moderator of brief interventions in the emergency department. *Alcohol and Alcoholism, 44*(5), 486-490.

Boini, S., Brianon, S., Guillemin, F., Galan, P., & Hercberg, S. (2004). Impact of cancer occurrence on health-related quality of life: A longitudinal pre-post assessment. *Health and Quality of Life Outcomes, 2*, 4-4.

Bowman, J. A. & Walsh, R. A. (2003). Smoking intervention within alcohol and other drug treatment services: a selective review with suggestions for practical management. *Drug and Alcohol Review, 22*(1), 73-82. doi: 10.1080/0959523021000059857

Breslau, N., Roth, T., Rosenthal, L., & Andreski, P. (1996). Sleep disturbance and psychiatric disorders: A longitudinal epidemiological study of young adults. *Biological Psychiatry, 39*(6), 411-418.

Brower, K. J. (2001). Alcohol's effects on sleep in alcoholics. *Alcohol Research and Health, 25*(2), 110-125.

Brower, K. J., Aldrich, M. S., Robinson, E. A. R., Zucker, R. A., & Greden, J. F. (2001). Insomnia, self-medication, and relapse to alcoholism. *The American Journal of Psychiatry, 158*(3), 399-404.

Brown, R. A., Niaura, R., Lloyd-Richardson, E. E., Strong, D. R., Kahler, C. W., Abrantes, A. M., … Miller, I. W. (2007). Bupropion and cognitive-behavioral treatment for depression in smoking cessation. *Nicotine and Tobacco Research, 9*(7), 721-730. doi: 10.1080/14622200701416955

Byles, J., Young, A., Furuya, H., & Parkinson, L. (2006). A drink to healthy aging: The association between older women's use of alcohol and their health-related quality of life. *Journal of the American Geriatrics Society, 54*(9), 13411347. doi: 10.1111/j.1532-5415.2006.00837.x

Caban-Martinez, A., Lee, D., Fleming, L., Leblanc, W., Arheart, K., Chung-Bridges, K., … Pitman, T. (2007). Leisure-time physical activity levels of the US workforce. *Preventive Medicine, 44*(5), 432-436. doi: 10.1016/j.ypmed.2006.12.017

Campbell, M. K., Tessaro. I., DeVellis, B., Benedict, S., Kelsey, K., Belton, L., & Sanhueza, A. (2002). Effects of a tailored health promotion program for female blue-collar workers: Health works for women* 1. *Preventive Medicine, 34*(3), 313-323. doi:10.1006/pmed.2001.0988

Cao, M. (2011). Editorial. *Current Pharmaceutical Design, 17*(15), 1416-1417.

CDC. (2010). Annual smoking-attributable mortality, years of potential life lost, and productivity losses---united states, 1997-2001. Retrieved 4/14, 2010, from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5425a1.htm

Chan, A. M., von Mühlen, D., Kritz-Silverstein, D., & Barrett-Connor, E. (2009). Regular alcohol consumption is associated with increasing quality of life and mood in older men and women: The Rancho Bernardo Study. *Maturitas, 62*(3), 294-300. doi:10.1016/j.maturitas.2009.01.005

Chaplin, S., & Hajek, P. (2010). Nicotine replacement therapy options for smoking cessation. *Prescriber, 21*(19), 61-65. doi:10.1002/psb.679

Chau, N., Mur, J., Benamghar, L., Siegfried, C., Dangelzer, J., Franais, M., … Sourdot, A. (2004). Relationships between certain individual characteristics and occupational injuries for various jobs in the construction industry: A case-control study. *American Journal of Industrial Medicine, 45*(1), 84-92.

Chen, C., Hsu, L., Chiou, H., Hsueh, Y., Chen, S., Wu, M., & Chen, C. (2004). Ingested arsenic, cigarette smoking, and lung cancer risk: A follow-up study in arseniasis-endemic areas in Taiwan. *JAMA, 292*(24), 2984-2990. doi:10.1001/jama.292.24.2984

Chevalier, H., Los, F., Boichut, D., Bianchi, M., Nutt, D. J., Hajak, G., et al. (1999). Evaluation of severe insomnia in the general population: Results of a european multinational survey. *Journal of Psychopharmacology, 13*(4 Suppl 1), S21-S24.

Chilcott, L. A., & Shapiro, C. M. (1996). The socioeconomic impact of insomnia: An overview. *Parmacoeconomics, 10*(sup1), 1-14.

Chiolero, A., Faeh, D., Paccaud, F., & Cornuz, J. (2008). Consequences of smoking for body weight, body fat distribution, and insulin resistance. *The American Journal of Clinical Nutrition, 87*(4), 801-809.

Chiolero, A., Wietlisbach, V., Ruffieux, C., Paccaud, F., & Cornuz, J. (2006). Clustering of risk behaviors with cigarette consumption: A population-based survey. *Preventive Medicine, 42*(5), 348-353. doi:10.1016/j.ypmed.2006.01.011

Cho, H. J., Lavretsky, H., Olmstead, R., Levin, M. J., Oxman, M. N., & Irwin, M. R. (2008). Sleep disturbance and depression recurrence in community-dwelling older adults: A prospective study. *The American Journal of Psychiatry, 165*(12), 1543-1550.

Chueh, K., Yang, M., Chen, C., & Chiou, S. (2009). Poor sleep quality and alcohol use problems among elderly taiwanese aboriginal women. *International Psychogeriatrics, 21*(3), 593-599. doi:10.1017/S1041610209008850

Chung, K. F., & Tsoa, K. C. (2010). Relationship between insomnia and pain in major depressive disorder: A sleep diary and actigraphy study. *Sleep Medicine, 11*(8), 752-758. doi:10.1016/j.sleep.2009.09.005

Chung, W., Kim, H., Lim, S., Lee, S., & Cho, K. (2009). Factors influencing cigarette smoking and quantified implications for anti-smoking policy: Evidence from South Korea. *International Journal of Public Health, 54*(6), 409-419. doi: 10.1007/s00038-009-0087-x

Cizza, G., Marincola, P., Mattingly, M., Williams, L., Mitler, M., Skarulis, M., & Csako, G. (2010). Treatment of obesity with extension of sleep duration: A randomized, prospective, controlled trial. *Clinical Trials, 7*(3), 274-285.

Clauser, S. B. (2008). Disparities in HRQOL of cancer survivors and non-cancer managed care enrollees. *Health Care Financing Review, 29*(4), 23-40.

Coe, J. W., Busch, F. R., & Singer, R. A. (2010). Chapter 16. Varenicline (Chantix): An α4β2 nicotinic receptor partial agonist for smoking cessation. In J. J. Li, & D. S. Johnson (Eds.), *Modern drug synthesis* (pp. 227-247) John Wiley & Sons, Inc. doi:10.1002/9780470768594.ch16

Crockett, L. J., Randall, B. A., Shen, Y., Russell, S. T., & Driscoll, A. K. (2005). Measurement equivalence of the center for epidemiological studies depression scale for Latino and Anglo adolescents: A national study. *Journal of Consulting and Clinical Psychology, 73*(1), 47-58. doi: 10.1037/0022-006X.73.1.47

Crosby, R., & Noar, S. M. (2010). Theory development in health promotion: Are we there yet? *Journal of Behavioral Medicine, 33*(4), 259-263.

Cully, J. A., Graham, D. P., Stanley, M. A., Ferguson, C. J., Sharafkhaneh, A., Souchek, J., … Kunik, M. E**.** (2006). Quality of life in patients with chronic obstructive pulmonary disease and comorbid anxiety or depression. *Psychosomatics, 47*(4), 312-319. doi: 10.1176/appi.psy.47.4.312

Cunradi, C., Moore, R., & Ames, G. (2007). Contribution of occupational factors to current smoking among active-duty US navy careerists. *Nicotine and Tobacco Research, 10*(3), 429-437. doi: 10.1080/14622200801889002

Daley, M., Morin, C. M., LeBlanc, M., Grégoire, J. P., & Savard, J. (2009). The economic burden of insomnia: Direct and indirect costs for individuals with insomnia syndrome, insomnia symptoms, and good sleepers. *Sleep, 32*(1), 55-64.

Dallongeville, J. Marecaux, N., Fruchart, J., & Amouyel, P. (1998). Cigarette smoking is associated with unhealthy patterns of nutrient intake: A meta-analysis. *The Journal of Nutrition, 128*(9), 1450-1457.

Dawson, D. (2000). Drinking as a risk factor for sustained smoking. *Drug and Alcohol Dependence, 59*(3), 235-249.

De Leon, J., Rendon, D. M., Baca-Garcia, E., Aizpuru, F., Gonzalez-Pinto, A., Anitua, C., & Diaz, F. J. (2007). Association between smoking and alcohol use in the general population: Stable and unstable odds ratios across two years in two different countries. *Alcohol and Alcoholism : International Journal of the Medical Council on Alcoholism, 42*(3), 252-257. doi:10.1093/alcalc/agm029

Deatherage, J. R., Roden, R. D., & Zouhary, K. (2009). Normal sleep architecture. *Seminars in Orthodontics, 15*(2), 86-87.

Dement, J. M., Welch, L., Bingham, E., Cameron, B., Rice, C., Quinn, P., & Ringen, K. (2003). Surveillance of respiratory disease among construction and trade workers at department of energy nuclear sites. *American Journal of Industrial Medicine, 43*(6), 559-573. doi: 10.1002/ajim.10226

Doi, Y., Minowa, M., & Tango, T. (2003). Impact and correlates of poor sleep quality in Japanese white-collar employees. *Sleep, 26*(4), 467-471.

Duffy, S. A., Missel, A. L., Waltje, A. H., Ronis, D. L., Fowler, K. E., & Hong, O. (2011). Health behaviors of operating engineers. *American Association of Occupational Health Nurses Journal, 59*(7), 293-301. doi:10.3928/08910162-20110616-01

Duffy, S. A., Ronis, D. L., Valenstein, M., Lambert, M. T., Fowler, K. E., Gregory, L., … Terrell, J. E. (2006). A tailored smoking, alcohol, and depression intervention for head and neck cancer patients. *Cancer Epidemiology Biomarkers Prevention, 15*(11), 2203-2208. doi:10.1158/1055-9965.EPI-05-0880

Duffy, S. A., Terrell, J. E., Valenstein, M., Ronis, D. L., Copeland, L. A., & Connors, M. (2002). Effect of smoking, alcohol, and depression on the quality of life of head and neck cancer patients. *General Hospital Psychiatry, 24*(3), 140-147. doi: 10.1016/S0163-8343(02)00180-9

Edell-Gustafsson, U. M. (2002). Sleep quality and responses to insufficient sleep in women on different work shifts. *Journal of Clinical Nursing, 11*(2), 280-288. doi:10.1046/j.1365-2702.2002.00574.x

Edwards, R., Almeida, D., Klick, B., Haythornthwaite, J., & Smith, M. (2008). Duration of sleep contributes to next-day pain report in the general population. *Pain, 137*(1), 202-207.

Ehlers, C., Gilder, D., Criado, J., & Caetano, R. (2010). Sleep quality and alcohol-use disorders in a select population of young-adult mexican americans. *Journal of Studies on Alcohol and Drugs, 71*(6), 879-884.

Elley, C. R. (2003). Effectiveness of counselling patients on physical activity in general practice: Cluster randomised controlled trial. *British Medical Journal (Clinical Research Ed.),326*, 793. doi: 10.1136/bmj.326.7393.793

Emmons, K. (2001). Behavioral and social science contributions to the health of adults in the United States. In: Smedley BD, Syme SL (3rd Ed.), *Promoting health: Intervention strategies from social and behavioral research.* (pp. 254-321). Washington, DC: Institute of Medicine.

Emmons, K. M., Marcus, B. H., Linnan, L., Rossi, J. S. & Abrams, D. B. (1994). Mechanisms in multiple risk factor interventions: Smoking, physical-activity, and dietary-fat intake among manufacturing workers. *Preventive Medicine, 23*(4), 481-489.

Emmons, K., Linnan, L. A., Shadel, W. G., Marcus, B. & Abrams, D. B. (1999). The working healthy project: A worksite health-promotion trial targeting physical activity, diet, and smoking. *Journal of Occupational & Environmental Medicine, 41*(7), 545-555.

Epstein, L. J., Kristo, D., Strollo, P. J., Friedman, N., Malhotra, A., Patil, S. P., . . . Weaver, M. D. (2009). Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. *Journal of Clinical Sleep Medicine, 5*(3), 263-276.

Fagan, P., Shavers, V. L., Lawrence, D., Gibson, J. T., & O'Connell, M. E. (2007). Employment characteristics and socioeconomic factors associated with disparities in smoking abstinence and former smoking among US workers. *Journal of Health Care for the Poor and Underserved, 18*(4), 52-72. doi: 10.1353/hpu.2007.0119

Farrell, M., Howes, S., Bebbington, P., Brugha, T., Jenkins, R., Lewis, G., … Meltzer, H. (2001). Nicotine, alcohol and drug dependence and psychiatric comorbidity: Results of a national household survey. *The British Journal of Psychiatry, 179*(5), 432-437.

Farrelly, M. C., Evans, W. N., & Sfekas, A. E. S. (1999). The impact of workplace smoking bans: Results from a national survey. *Tobacco Control, 8*(3), 272-277. doi: 10.1136/tc.8.3.272

Ferrans, C. E., Zerwic, J. J., Wilbur, J. E., & Larson, J. L. (2005). Conceptual model of health-related quality of life. *Journal of Nursing Scholarship, 37*(4), 336-342. doi: 10.1111/j.1547-5069.2005.00058.x

Foley, D. (2004). Sleep disturbances and chronic disease in older adults: Results of the 2003 national sleep foundation sleep in America survey. *Journal of Psychosomatic Research, 56*(5), 497-502.

Fontaine, K., Barofsky, I., & Cheskin, L. (1996). Predictors of quality of life for obese persons. *Journal of Nervous and Mental Disease, 185*(2), 120-122.

Ford, E. S., Moriarty, D. G., Zack, M. M., Mokdad, A. H., & Chapman, D. P. (2001). Self-reported body mass index and health-related quality of life: Findings from the behavioral risk factor surveillance system. *Obesity, 9*(1), 21-31. doi: 10.1038/oby.2001.4

Foster, M. F., Hess, P., Foxall, M. J., & Roberson, M. H. B. (1992). Health promotion and life satisfaction in elderly black adults. *Western Journal of Nursing Research, 14*(4), 444-463.

Franzen, P. L., & Buysse, D. L. (2008). Sleep disturbances and depression: Risk relationships for subsequent depression and therapeutic implications. *Dialogues in Clinical Neuroscience, 10*, 473-481.

Gandini, S., Botteri, E., Iodice, S., Boniol, M., Lowenfels, A. B., Maisonneuve, P., & Boyle, P. (2007). Tobacco smoking and cancer: A meta-analysis. *International Journal of Cancer, 122*(1), 155-164. doi: 10.1002/ijc.23033

Gao, Y., McLaughlin, J. K., Blot, W. J., Ji, B., Benichou, J., Dai, Q., & Fraumeni, J. F. (1994). Risk factors for esophageal cancer in Shanghai, China. I. Role of cigarette smoking and alcohol drinking. *International Journal of Cancer, 58*(2), 192-196. doi: 10.1002/ijc.2910580208

Garrett, N. A., Alesci, N. L., Schultz, M. M., Foldes, S. S., Magnan, S. J., & Manley, M. W. (2004). The relationship of stage of change for smoking cessation to stage of change for fruit and vegetable consumption and physical activity in a health plan population. *American Journal of Health Promotion, 19*, 118-127.

Garster, N. C., Palta, M., Sweitzer, N. K., Kaplan, R. M., & Fryback, D. G. (2009). Measuring health-related quality of life in population-based studies of coronary heart disease: Comparing six generic indexes and a disease-specific proxy score. *Quality of Life Research, 18*(9), 1239.

Giovino, G. A. (2002). Epidemiology of tobacco use in the United States. *Oncogene, 21*(48), 7326-7340.

Glassman, A. H. (1993). Cigarette smoking: Implications for psychiatric illness. *The American Journal of Psychiatry, 150*(4), 546-553.

Godet-Cayre, V., Pelletier-Fleury, N., Le Vaillant, M., Dinet, J., Massuel, M., & Leger, D. (2006). Insomnia and absenteeism at work. who pays the cost. *Sleep, 29*(2), 179-184.

Godin, G., & Valois, P., Lepage, L. & Desharnais, R. (1992). Predictors of smoking behaviour: An application of Ajzen's Theory of Planned Behaviour. *Addiction, 87*(9), 1335-1343.

Goldney, R. D., Fisher, L. J., Phillips, P. J., & Wilson, D. H. (2004). Diabetes, depression, and quality of life. *Diabetes Care, 27*(5), 1066-1070.

Gorber, S. C., Schofield-Hurwitz, S., Hardt, J., Levasseur, G., & Tremblay, M. (2009). The accuracy of self-reported smoking: A systematic review of the relationship between self-reported and cotinine-assessed smoking status. Nicotine and Tobacco Research, 11(1), 12-24. doi: 10.1093/ntr/ntn010

Grucza, R. A. Przybeck, T. R., & Cloninger, C.R. (2008). Screening for alcohol problems: An epidemiological perspective and implications for primary care. *Missouri Medicine, 105*(1), 67-71.

Guallar-Castillon, P., &Rodriguez-Artalejo, F., Ganan, L. D., Banegas, J. R. B., Urdinguio, P. L., & Cabrera, R. H. (2001). Consumption of alcoholic beverages and subjective health in Spain. *Journal of Epidemiology and Community Health, 55*(9), 648-652.

Halm, M. A., Treat-Jacobson, D., Lindquist, R., & Savik, K. (2006). Correlates of caregiver burden after coronary artery bypass surgery. *Nursing Research, 55*(6), 426-436.

Hamilton, N. A., Catley, D., & Karlson, C. (2007). Sleep and the affective response to stress and pain. *Health Psychology, 26*(3), 288-295.

Hanebuth, D., Meinel, M., & Fischer, J. E. (2006). Health-related quality of life, psychosocial work conditions, and absenteeism in an industrial sample of blue-and white-collar employees: A comparison of potential predictors. *Journal of Occupational and Environmental Medicine, 48*(1), 28-37. doi: 10.1097/01.jom.0000195319.24750.f

Harley, A. E., Devine, C. M., Beard, B., Stoddard, A. M., Hunt, M. K., & Sorensen, G. (2010). Multiple health behavior changes in a cancer prevention intervention for construction workers, 2001-2003. *Preventing Chronic Disease, 7*(3), 1-12.

Harrell, F.E. Jr., Lee, K.L., & Mark, D. B. (1996). Tutorial in biostatistics: Multivariable prognostic models: Issues in developing models, evaluating assumptions and adequacy, and measuring and reducing errors. *Statistics in Medicine, 15*(4), 361-387. doi:10.1002/(SICI)1097-0258(19960229)15:4<361::AID-SIM168>3.0.CO;2-4

Hasin, D., Stinson, F., Ogburn, E., & Grant, B. (2007). Prevalence, correlates, disability, and comorbidity of DSM-IV alcohol abuse and dependence in the United States:

Results from the national epidemiologic survey on alcohol and related conditions. *Archives of General Psychiatry, 64*(7), 830-842.

Hassan, M. K., Joshi, A. V., Madhavan, S. S., & Amonkar, M. M. (2003). Obesity and health-related quality of life: A cross-sectional analysis of the US population. *International Journal of Obesity, 27*(10), 1227.

Hayashino, Y., Yamazaki, S., Takegami, M., Nakayama, T., Sokejima, S., & Fukuhara, S. (2010). Association between number of comorbid conditions, depression, and sleep quality using the pittsburgh sleep quality index: Results from a population-based survey. *Sleep Medicine, 11*(4), 366-371.

Hays, R., Martin, S., Sesti, A., & Spritzer, K. (2005). Psychometric properties of the medical outcomes study sleep measure. *Sleep Medicine, 6*(1), 41-44. doi:10.1016/j.sleep.2004.07.006

Hays, R., Smith, A., Reeve, B., Spritzer, K., Marcus, S., & Clauser, S. (2008). Cigarette smoking and health-related quality of life in medicare beneficiaries. *Health Care Financing Review, 29*(4), 57-67.

Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerstrom, K. O. (1991). The Fagerstrom Test for Nicotine Dependence: A revision of the Fagerstrom Tolerance Questionnaire. *British Journal of Addiction, 86*, 1119-1127.

Hitsman, B., Borelli, B., McChargue, D. E., Spring, B., & Niaura, R. (2003). History of depression and smoking cessation outcome: A meta-analysis. *Journal of Consulting and Clinical Psychology, 71*(4), 657-663.

Ho, A. Y. K., Berggren, I., & Dahlborg-Lyckhage, E. (2010). Diabetes empowerment related to Pender's Health Promotion Model: A meta-synthesis. *Nursing Health Sciences, 12*(2), 259-267.

Hong, O. (2005). Hearing loss among operating engineers in American construction industry. *International Archives of Occupational and Environmental Health*, 78, 565-574. doi: 10.1007/s00420-005-0623-9

Hu, L., Sekine, M., Gaina, A., & Kagamimori, S. (2007). Association between sleep quality and smoking in Japanese civil servants. *Sleep and Biological Rhythms, 5*(3), 196-203. doi:10.1111/j.1479-8425.2007.00277.x

Hughes, J. R. (1993). Treatment of smoking cessation in smokers with past alcohol/drug problems. *Journal of Substance Abuse Treatment, 10*(2), 181-187. doi: 10.1016/0740-5472(93)90043-2

Idzikowski, C. (1996). Impact of insomnia on health-related quality of life. *Pharmacoeconomics, 10*(sup 1), 15-24.

Janson, C., Lindberg, E., Gislason, T., Elmasry, A., & Boman, G. (2001). Insomnia in men: A 10-year prospective population based study. *Sleep, 24*(4), 425-430.

Jenkinson, C., Coulter, A. & Wright, L. (1993). Short form 36 (SF36) health survey questionnaire: Normative data for adults of working age. BMJ, 306, 1437-1440. doi: 10.1136/bmj.306.6890.1437

Jensen, M. K., Sørensen, T. I. A., Andersen, A. T., Thorsen, T., Tolstrup, J. S., Godtfredsen, N. S., & Grønbæk, M. (2003). A prospective study of the association between smoking and later alcohol drinking in the general population. *Addiction, 98*(3), 355-364. doi: 10.1046/j.1360-0443.2003.00304.x

Jia, H., & Lubetkin, E. I. (2005). The impact of obesity on health-related quality-of-life in the general adult US population. *Journal of Public Health, 27*(2), 156.

Jonas, M. A., Oates, J. A., Ockene, J. K., & Hennekens, C. H. (1992). Statement on smoking and cardiovascular disease for health care professionals, American Heart Association. *Circulation, 86(5),* 1664-1669.

Joseph, A. M., Willenbring, M. L., Nugent, S. M., & Nelson, D. B. (2004). A randomized trial of concurrent versus delayed smoking intervention for patients in alcohol dependence treatment. *Journal of Studies on Alcoho, 65*(6):681-691.

Kaarne, T., Aalto, M., Kuokkanen, M., & Seppa, K. (2009). Drinking habits and prevalence of heavy drinking among occupationalhealthcare patients. *Scandinavian Journal of Primary Health Care, 27*, 53-57. doi:10.1080/0281343080258869

Kallings, L. V., Leijon, M., Hellénius, M., & Ståhle, A. (2008). Physical activity on prescription in primary health care: A follow-up of physical activity level and quality of life. *Scandinavian Journal of Medicine Science in Sports, 18*(2), 154.

Kane, R. L., & Radosevich, D. M. (2011). Health-related quality of life. In Lisa Lamenzo (Ed.), *Conducting health outcomes research* (pp. 105-132) Michael Brown.

Kaplan, G. A., Goldberg, D. E., Everson, S. A., Cohen, R. D., Salonen, R., Tuomilehto, J. & Salonen, J. (1996). Perceived health status and morbidity and mortality: Evidence from the Kuopio Ischemic Heart Disease Risk Factor Study. *International Journal of Epidemiology, 25*(2), 259-265. doi: 10.1093/ije/25.2.259

Karvonen-Gutierrez, C. A., Ronis, D. L., Fowler, K. E., Terrell, J. E., Gruber, S. B., & Duffy, S. A. (2008). Quality of life scores predict survival among patients with head and neck cancer. *Journal of Clinical Oncology, 26*(16), 2754-2760. doi: 10.1200/JCO.2007.12.9510

Katz, D. A., & McHorney, C. A. (2002). The relationship between insomnia and health-related quality of life in patients with chronic illness. *The Journal of Family Practice, 51*(3), 229-235.

Katz, D. A., McHorney, C. A., & Atkinson, R. L. (2000). Impact of obesity on health-related quality of life in patients with chronic illness. *Journal of General Internal Medicine, 15*(11), 789-796. doi:10.1046/j.1525-1497.2000.90906.x

Kelley, J. A., Sherrod, P. A., & Smyth, P. (2009). Coronary artery disease and smoking cessation intervention by primary care providers in a rural clinic. *Online Journal of Rural Nursing and Health Care, 9*(2), 82-94.

Kelly, J. F., Stout, R. L., Magill, M., Tonigan, J. S., & Pagano, M. E. (2010). Mechanisms of behavior change in alcoholics anonymous: Does alcoholics anonymous lead to better alcohol use outcomes by reducing depression symptoms? *Addiction, 105*(4), 626-636.

Kennedy, B. P., Kawachi, I., Glass, R., & Prothrow-Stith, D. (1998). Income distribution, socioeconomic status, and self-rated health in the United States: Multilevel analysis. *BMJ, 317*(7163), 917-921.

Klatt, M. D., Buckworth, J., & Malarkey, W. B. (2009). Effects of low-dose mindfulness-based stress reduction (MBSR-ld) on working adults. *Health Education Behavior,* , 601-614. doi:10.1177/1090198108317627

Klesges, R. C., Eck, L. H., Isbell, T. R., Fulliton, W., & Hanson, C. L. (1990). Smoking status: Effects on the dietary intake, physical activity, and body fat of adult men. *The American Journal of Clinical Nutrition, 51*(5), 784-789.

Knudsen, H., Ducharme, L., & Roman, P. (2007). Job stress and poor sleep quality: Data from an American sample of full-time workers. *Social Science Medicine, 64*(10), 1997-2007.

Kohatsu, N. D., Tsai R., Young, T., Vangilder, R., Burmeister, L. F., Stromquist, A. M., & Merchant, J. A. (2006). Sleep duration and body mass index in a rural population. *Archives of Internal Medicine, 166*(16), 1701-1705.

Kok, G., Schaalma, H., Ruiter, R. A. C., Empelen, P. V., & Brug, J. (2004). Intervention mapping: Protocol for applying health psychology theory to prevention programmes. *Journal of Health Psychology, 9*(1), 85-98.

Kozak, A. T., Daviglus, M. L., Chan, C., Kiefe, C. I., Jacobs, D. R., & Liu, K. (2011). Relationship of body mass index in young adulthood and health-related quality of life two decades later: The coronary artery risk development in young adults study. *International Journal of Obesity, 35,* 134-141. doi: 10.1038/ijo.2010.120

Kripke, D. F., Garfinkel, L., Wingard, D. L., Klauber, M. R., & Marler, M. R. (2002). Mortality associated with sleep duration and insomnia. *Archives of General Psychiatry, 59*(2), 131-136.

Krystal, A. D. (2007). Treating the health, quality of life, and functional impairments in insomnia. *Journal of Clinical Sleep Medicine, 3*(1), 63-72.

Kvaavik, E., Meyer, H. E., & Tverdal, A. (2004). Food habits, physical activity and body mass index in relation to smoking status in 40-42 year old Norwegian women and men. *Preventive Medicine, 38*(1), 1-5. doi:10.1016/j.ypmed.2003.09.020

Laaksonen, M., Prattala, R., & Karisto. A. (2001). Patterns of unhealthy behaviour in Finland. European Journal of Public Health, 11(3), 294-300. doi: 10.1093/eurpub/11.3.294

Laaksonen, M., Rahkonen, O., Martikainen, P., Karvonen, S., & Lahelma, E. (2006). Smoking and SF-36 health functioning. *Preventive Medicine, 42*(3), 206-209.

Lallukka, T., Rahkonen, O., Lahelma, E., & Arber, S. (2010). Sleep complaints in middle-aged women and men: The contribution of working conditions and work-family conflicts. *Journal of Sleep Research, 19*(3), 466-477. doi:10.1111/j.1365-2869.2010.00821.x

Lamberg, L. L. (2004). Promoting adequate sleep finds a place on the public health agenda. *JAMA : The Journal of the American Medical Association, 291*(20), 2415-2417. doi:10.1001/jama.291.20.2415

Larkin, F. A., Basiotis, P., Riddick, H. A., Sykes, K. E., & Pao, E. M. (1990). Dietary patterns of women smokers and non-smokers. *Journal of the American Dietetic Association, 90*(2), 230-237.

Larsson, U., Karlsson, J., & Sullivan, M. (2002). Impact of overweight and obesity on health-related quality of life: A swedish population study. *International Journal of Obesity, 26*(3), 417.

Lautenbacher, S., Kundermann, B., & Krieg, J. (2006). Sleep deprivation and pain perception. *Sleep Medicine Reviews, 10*(5), 357-369.

Lawrence, D., Fagan, P., Backinger, C. L., Gibson, J. T., & Hartman, A. (2006). Cigarette smoking patterns among young adults aged 18 - 24 years in the United States. *Nicotine and Tobacco Research, 9*(6), 687-697. doi: 10.1080/14622200701365319

Lean, M. E. J. (1998). Impairment of health and quality of life using new US federal guidelines for the identification of obesity. *Archives of Internal Medicine, 159*(8), 837.

Lee, D. J., Fleming, L. E., Arheart, K. L., LeBlanc, W. G., Caban, A. J., Chung-Bridges, K… Pitman, T. (2007). Smoking rate trends in US occupational groups: The 1987 to 2004 national health interview survey. *Journal of Occupational and Environmental Medicine, 49*(1), 75-81.

Lee, D. J., LeBlanc, W., Fleming, L. E., Gómez-Marín, O., & Pitman, T. (2004). Trends in US smoking rates in occupational groups: The national health interview survey 1987-1994. *Journal of Occupational and Environmental Medicine, 46*(6), 538-548.

Leeman, R., McKee, S., Toll, B., Krishnan-Sarin, S., Cooney, J., Makuch, R., & O'Malley, S. S. (2008). Risk factors for treatment failure in smokers: Relationship to alcohol use and to lifetime history of an alcohol use disorder. *Nicotine and Tobacco Research, 10*(12), 1793-1809. doi: 10.1080/14622200802443742

Léger, D., Guilleminault, C., Bader, G., Lévy, E., & Paillard, M. (2002). Medical and socio-professional impact of insomnia. *Sleep, 25*(6), 621-625.

Léger, D., Massuel, M. A., Metlaine, A., & The SISYPHE Study Group. (2006). Professional correlates of insomnia. *Sleep, 29*(2), 171-178.

Léger, D., Scheuermaier, K., Philip, P., Paillard, M., & Guilleminault, C. (2001). SF-36: Evaluation of quality of life in severe and mild insomniacs compared with good sleepers. *Psychosomatic Medicine, 63*(1), 49-55. doi: 0033-3174/01/6301-004

Leigh, J. P. (1991). Employee and job attributes as predictors of absenteeism in a national sample of workers: The importance of health and dangerous working conditions. *Social Science & Medicine, 33*(2), 127-137. doi:10.1016/0277-9536(91)90173-A

Leigh, J. P., & Jiand, W. Y. (1993). Liver cirrhosis deaths within occupations and industries in the California occupational mortality study. *Addiction, 88*(6), 767-779.

Lichstein, K. L., Durrence, H. H., Riedel, B. W., Taylor, D. J., & Bush, A. J. (2004). An archive of the sleep of african americans. In Lawrence Erlbaum Associates (Ed.), *Epidemiology of sleep: Age, gender, and ethnicity* (pp. 177-201) Mahwah, N.J.

Linton, S. J., & Bryngelsson, I. L. (2000). Insomnia and its relationship to work and health in a working-age population. *Journal of Occupational Rehabilitation, 10*(2), 169-183. doi:10.1023/A:1009408204694

Lumeng, J. C., Somashekar, D., Appugliese, D., Kaciroti, N., Corwyn, R. F., & Bradley, R. H. (2007). Shorter sleep duration is associated with increased risk for being overweight at ages 9 to 12 years. *Pediatrics, 120*(5), 1020-1029.

Lyons, F. (2005). Weight management in primary care: The counterweight project. *Journal of Family Health Care, 15*(3), 77-79.

Ma, J., Betts, N. M., & Hampl, J. S. (2000). Clustering of lifestyle behaviors: The relationship between cigarette smoking, alcohol consumption, and dietary intake. *American Journal of Health Promotion, 15*(2), 107-117.

Macy, J. T., & Seo, D-C., Chassin, L., Presson, C. C. & Sherman, S. J. (2007). Prospective predictors of long-term abstinence versus relapse among smokers who quit as young adults. *American Journal of Public Health, 97*(8), 1470-1475.

Mallon, L., Broman, J., & Hetta, J. (2002). Sleep complaints predict coronary artery disease mortality in males: A 12-year follow-up study of a middle-aged Swedish population. *Journal of Internal Medicine, 251*(3), 207-216.

Manber, R., Edinger, J. D., Gress, J. L., Pedro-Salcedo, M. G. S., Kuo, T. F., & Kalista, T. (2008). Cognitive behavioral therapy for insomnia enhances depression outcome in patients with comorbid major depressive disorder and insomnia. *Sleep, 31*(4), 489-495.

Manderbacka, K., Lundberg, O., & Martikainen, P. (1999). Do risk factors and health behaviours contribute to self-ratings of health? *Social Science Medicine, 48*(12), 1713-1720. doi: 10.1016/S0277-9536(99)00068-4

Manocchia, M., Keller, S., & Ware, J. E. (2001). Sleep problems, health-related quality of life, work functioning and health care utilization among the chronically ill. *Quality of Life Research, 10*(4), 331.

Marcus, B., Albrecht, A. E., Niaura, R. S., Taylor, E. R., Simkin, L. R., Feder, S. I., … Thompson, P. D. (1995). Exercise enhances the maintenance of smoking cessation in women. *Addictive Behaviors, 20*(1), 87-92. doi:10.1016/0306-4603(94)00048-4

Martinelli, A. M. (1999). An explanatory model of variables influencing health promotion behaviors in smoking and nonsmoking college students. *Public Health Nursing, 16*(4), 263-269.

Mastrangelo, G., Tartari, M., Fedeli, U., Fadda, E., & Saia, B. (2003). Ascertaining the risk of chronic obstructive pulmonary disease in relation to occupation using a case-control design. Occupational Medicine (Oxford, England), 53(3), 165-172. doi: 10.1093/occmed/kqg041

McClave, A. K., Dube, S. R., Strine, T. W., & Mokdad, A. H. (2009). Associations between health-related quality of life and smoking status among a large sample of US adults. *Preventive Medicine, 48*(2), 173-179.

McClave, A. K., Dube, S. R., Strine, T. W., Kroenke, K., Caraballo, R. S., & Mokdad, A. H. (2009). Associations between smoking cessation and anxiety and depression among US adults. *Addictive Behaviors, 34*(6-7), 491-497. doi:10.1016/j.addbeh.2009.01.005

McKee, S. A., O'Malley, S. S., Salovey, P., Krishnan-Sarin, S., & Mazure, C. M. (2005). Perceived risks and benefits of smoking cessation: Gender-specific predictors of motivation and treatment outcome. *Addictive Behaviors, 30*(3), 423-435.

Melamed, S., & Oksenberg, A. (2002). Excessive daytime sleepiness and risk of occupational injuries in non-shift daytime workers. *Sleep, 25*(3), 315-322.

Menesen-Gaya, C., Zuardi, A. W., Loureiro, S. R., & Crippa, J. A. S. (2009). Alcohol use disorders identification test (AUDIT): An updated systematic review of psychometric properties. *Psychol. Neurosci., 2*(1), 83-97. Retrieved from http://scielo.bvs-psi.org.br/scielo.php?pid=S1983-32882009000100012&script=sci_pdf&tlng=en

Meneses-Gaya, I. C. d., Zuardi, A. W., Loureiro, S. R., & Crippa, J. A. d. S. (2009). Psychometric properties of the Fagerström Test for Nicotine Dependence. *Jornal Brasileiro De Pneumologia, 35*, 73-82.

Metlaine, A., Leger, D., & Choudat, D. (2005). Socioeconomic impact of insomnia in working populations. *Industrial Health, 43*(1), 11-19.

Michael, Y. L., Colditz, G. A., Coakley, E., & Kawachi, I. (1999). Health behaviors, social networks, and healthy aging: Cross-sectional evidence from the nurses' health study. *Quality of Life Research, 8*(8), 711-722.

Milani, R., & Lavie, C. (2009). Impact of worksite wellness intervention on cardiac risk factors and one-year health care costs. *The American Journal of Cardiology, 104*(10), 1389-1392.

Mokdad, A. H., Marks, J. S., Stroup, D. F., & Gerberding, J. L. (2004). Actual causes of death in the United States, 2000. *JAMA (Chicago, Ill.), 291*(10), 1238-1245.

Moolchan, E. T., Fagan, P., Fernander, A. F., Velicer, W. F., Hayward, M. D., King, G., & Clayton, R. R. (2007). Addressing tobacco-related health disparities. *Addiction, 102*(S2), 30-42. doi: 10.1111/j.1360-0443.2007.01953.x

Mukerji, S., Duffy, S., Fowler, K., Khan, M., Ronis, D., & Terrell, J. (2007). Comorbidities in head and neck cancer: Agreement between self-report and chart review. *Otolaryngology--Head and Neck Surgery, 136*(4), 536-542. doi:10.1016/j.otohns.2006.10.041

Mulder, I., Tijhuis, M., Smit, H. A., & Kromhout, D. (2001). Smoking cessation and quality of life: The effect of amount of smoking and time since quitting* 1. *Preventive Medicine, 33*(6), 653-660.

Murnaghan, D., Blanchard, C., Rodgers, W., LaRosa, J., MacQuarrie, C., MacLellan, D., & Gray, B. (2010). Predictors of physical activity, healthy eating and being smoke-free in teens: A theory of planned behaviour approach. *Psychology Health, 25*(8), 925-941.

Myint, P. K., Welch, A. A., Luben, R. N., Wainwright, N. W. J., Surtees, P. G., Bingham, S. A., Khaw, K. (2006). Obesity indices and self-reported functional health in men and women in the EPIC-Norfolk ast. *Obesity, 14*(5), 884-893. doi: 10.1038/oby.2006.102

Nagaya, T., Yoshida, H., Takahashi, H., & Kawai, M. (2007). Cigarette smoking weakens exercise habits in healthy men. *Nicotine Tobacco Research, 9*(10), 1027-1032.

Nasermoaddeli, A., Sekine, M., Kumari, M., Chandola, T., Marmot, M., & Kagamimori, S. (2005). Association of sleep quality and free time leisure activities in japanese and british civil servants. *Journal of Occupational Health, 47*(5), 384-390.

National Institutes of Health. (2009). NIH science of behavior change. *Meeting Summary,* Bethesda, Maryland. 1-39.

Naughton, F., Ashworth, P., & Skevington, S. M. (2007). Does sleep quality predict pain-related disability in chronic pain patients? the mediating roles of depression and pain severity. *Pain, 127*(3), 243-252.

Nelson, D. E., Emont, S. L., Brackbill, R. M., Cameron, L. L., Peddicord, J., & Fiore, M. C. (1994). Cigarette smoking prevalence by occupation in the United States: A comparison between 1978 to 1980 and 1987 to 1990. *Journal of Occupational and Environmental Medicine, 36*(5), 516-525.

Ng, T., Niti, M., Tan, W. -., Cao, Z., Ong, K., & Eng, P. (2007). Depressive symptoms and chronic obstructive pulmonary disease: Effect on mortality, hospital readmission, symptom burden, functional status, and quality of life. *Archives of Internal Medicine, 167*(1), 60.

Nishitani, N., & Sakakibara, H. (2007). Subjective poor sleep and white blood cell count in male Japanese workers. *Industrial Health, 45*(2), 296-300.

Noar, S. M. (2008). Behavioral interventions to reduce HIV-related sexual risk behavior: Review and synthesis of meta-analytic evidence. *AIDS and Behavior, 12*(3), 335-353.

Norman, A., Bellocco, R., Bergstrm, A., & Wolk, A. (2001). Validity and reproducibility of self-reported total physical activity--differences by relative weight. *International Journal of Obesity, 25*(5), 682-688.

Norman, P., Conner, M., & Bell, R. (1999). The theory of planned behavior and smoking cessation. *Health Psychology, 18*(1), 89-94.

Nyren, O., Bergstrom, R., Nystrom, L., Engholm, G., Ekbom, A., Adami, H. … Stjernberg, N. (1996). Smoking and colorectal cancer: A 20-year follow-up study of Swedish construction workers. *Journal of the National Cancer Institute, 88*(18), 1302-1307. doi: 10.1093/jnci/88.18.1302

Okechukwu, C. A., Krieger, N., Sorensen, G., Li, Y., & Barbeau, E. M. (2009). MassBuilt: Effectiveness of an apprenticeship site-based smoking cessation intervention for unionized building trades workers. *CCC.Cancer Causes Control, 20*(6), 887-894.

Oleckno, W., & Blacconiere, M. (1990). Risk-taking behaviors and other correlates of seat belt use among university students. *Public Health, 104*(3), 155-164. doi:10.1016/S0033-3506(05)80371-3

Oliver, L. C., Miracle-McMahill, H., Littman, A. B., Oakes, J. M., & Gaita, R. R. (2001). Respiratory symptoms and lung function in workers in heavy and highway construction: A cross-sectional study. *American Journal of Industrial Medicine, 40*(1), 73-86. doi: 10.1002/ajim.1073

Pack, A., Dinges, D., & Maislin, G. (2002). *Study of prevalence of sleep apnea among commercial truck drivers.* Publication No. DOT-RT-02-030. Washington, DC: Federal Motor Carrier Safety Administration.

Palaniappan, U., Starkey, L. J., O'Loughlin, J., & Gray-Donald, K. (2001). Fruit and vegetable consumption is lower and saturated fat intake is higher among Canadians reporting smoking. *The Journal of Nutrition, 131*(7), 1952-1958.

Palmer, C. D., Harrison, G. A., & Hiorns, R. W. (1980). Association between smoking and drinking and sleep duration. *Annals of Human Biology, 7*(2), 103-108. doi:10.1080/03014468000004111

Parkerson, G. R., Connis, R. T., Broadhead, W. E., Patrick, D. L., Taylor, T. R., & Tse, C. J. (1993). Disease-specific versus generic measurement of health-related quality of life in insulin-dependent diabetic patients. *Medical Care, 31*(7), 629-639.

Patel, S. R., & Hu, F. B. (2008). Short sleep duration and weight gain: A systematic review. *Obesity, 16*(3), 643-653.

Payne, J. K., Held, J., Thorpe, J., & Shaw, H. (2008). Effect of exercise on biomarkers, fatigue, sleep disturbances, and depressive symptoms in older women with breast cancer receiving hormonal therapy. *Oncology Nursing Forum, 35*(4), 635-642. doi:10.1188/08.ONF.635-642

Pender, N. J., Murdaugh, C. L., & Parsons, M. A. (2006). A prevention model. *Health promotion in nursing practice* (Fifth Edition ed., pp. 38-57). NJ: Pearson.

Philip, P., Sagaspe, P., Lagarde, E., Leger, D., Ohayon, M. M., Bioulac, B., . . . Taillard, J. (2010). Sleep disorders and accidental risk in a large group of regular registered highway drivers. *Sleep Medicine, 11*(10), 973-979. doi:10.1016/j.sleep.2010.07.010

Phillips, B. A., Collop, N. A., Drake, C., Consens, F., Vgontzas, A. N., & Weaver, T. E. (2008). Sleep disorders and medical conditions in women. *Journal of Women's Health, 17*(7), 1191-1199. doi:10.1089/jwh.2007.0561

Poikotainen, K., Vartiainen, E., & Korhonen, H. J. (1996). Alcohol intake and subjective health. *American Journal of Epidemiology, 144*(4), 346-350.

Poortinga, W. (2007). Associations of physical activity with smoking and alcohol consumption: A sport or occupation effect? *Preventive Medicine, 45*(1), 66-70. doi:10.1016/j.ypmed.2007.04.013

Poortinga, W. (2007a). The prevalence and clustering of four major lifestyle risk factors in an English adult population. *Preventive Medicine, 44*(2), 124-128. doi:10.1016/j.ypmed.2006.10.006

Poortinga, W. (2007b). Associations of physical activity with smoking and alcohol consumption: A sport or occupation effect? *Preventive Medicine, 45*(1), 66-70. doi:10.1016/j.ypmed.2007.04.013

Prochaska, J. J., Nigg, C. R., Spring, B., Velicer, W. F., & Prochaska, J. O. (2010). The benefits and challenges of multiple health behavior change in research and in practice. *Preventive Medicine, 50*(1-2), 26-29.

Prochaska, J. O. (2008). Multiple health behavior research represents the future of preventive medicine. Preventive Medicine, 46(3), 281-285. doi: 10.1016/j.ypmed.2008.01.015

Pronk, N., Anderson, L. H., Crain, L., Martinson, B. C., O'Connor, P., Sherwood, N. E., & Whitebird, R. R. (2004). Meeting recommendations for multiple healthy lifestyle factors: Prevalence, clustering, and predictors among adolescent, adult, and senior health plan members. *American Journal of Preventive Medicine, 27*(2), 25-33. doi: 10.1016/j.amepre.2004.04.022

Rachiotis, G., Karydis, I., Drivas, S., & Hadjichristodoulo, C. (2009). Pattern of smoking habit among Greek blue and white collar workers. *International Journal of Environmental Research and Public Health, 6*(6), 1812-1817.

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*(3), 385-401. doi: 10.1177/014662167700100306

Raymond, I., Nielsen, T. A., Lavigne, G., Manzini, C., & Choinière, M. (2001). Quality of sleep and its daily relationship to pain intensity in hospitalized adult burn patients. *Pain, 92*(3), 381-388. doi:10.1016/S0304-3959(01)00282-2

Redding, C. A., Rossi, J. S., Rossi, S. R., Velicer, W. F., & Prochaska, J. O. (2000). Health behavior models. *The International Electronic Journal of Health Education, 3*, 180-193.

Rejas, J., Ribera, M. V., Ruiz, M., & Masrramón, X. (2007). Psychometric properties of the MOS (medical outcomes study) sleep scale in patients with neuropathic pain. *European Journal of Pain, 11*(3), 329-340. doi:10.1016/j.ejpain.2006.05.002

Rejeski, W. J., & Mihalko, S. L.(2001). Physical activity and quality of life in older adults. *The Journals of Gerontology Series A Biological Sciences and Medical Sciences, 56*(suppl 2), 23-35.

Resta, O., Barbaro, F., Bonfitto, P., Giliberti, T., Depalo, A., Pannacciulli, N., & Pergola, G. D. (2003). Low sleep quality and daytime sleepiness in obese patients without obstructive sleep apnoea syndrome. *Journal of Internal Medicine, 253*(5), 536-543. doi:10.1046/j.1365-2796.2003.01133.x

Revicki, D., Sobal, J., & DeForge, B. (1991). Smoking status and the practice of other unhealthy behaviors. *Family Medicine, 23*(5), 361-364.

Rice, V. H., & Stead, L. F. (2009). Nursing interventions for smoking cessation (Review). *Cochrane Database Systematic Review*. doi: 10.1002/14651858.CD001188.pub3

Richardson, K. M., & Rothstein, H. R. (2008). Effects of occupational stress management intervention programs: A meta-analysis. *Journal of Occupational Health Psychology, 13*(1), 69-93. doi:10.1037/1076-8998.13.1.69

Riemann, D., Berger, M., & Voderholzer, U. (2001). Sleep and depression--results from psychobiological studies: An overview. *Biological Psychology, 57*(1-3), 67-103. doi:10.1016/S0301-0511(01)00090-4

Roehrs, T., & Roth, T. (2008). Sleep, alcohol, and quality of life. *Sleep and Quality of Life in Clinical Medicine*, 333-339. doi: 10.1007/978-1-60327-343-5_34

Roehrs, T., Papineau, L., Rosenthal, L., & Roth, T. (1999). Ethanol as a hypnotic in insomniacs:: Self administration and effects on sleep and mood. *Neuropsychopharmacology, 20*(3), 279-286.

Rosen, C. S. (2000). Is the sequencing of change processes by stage consistent across health problems? A meta-analysis. *Health Psychology, 19*(6), 593-604.

Rothenbacher, D., Arndt, V., Fraisse, E., Zschenderlein, B., Fliedner, T. M., & Brenner, H. (1998). Early retirement due to permanent disability in relation to smoking in workers of the construction industry. *Journal of Occupational and Environmental Medicine, 40*(1), 63-68.

Saint-Mleux, B., Eggermann, E., Bisetti, A., Bayer, L., Machard, D., Jones, B. E., … Serafin, M. (2004). Nicotinic enhancement of the noradrenergic inhibition of sleep-promoting neurons in the ventrolateral preoptic area. *The Journal of Neuroscience, 24*(1), 63-67. doi:10.1523/JNEUROSCI.0232-03.2004

Saito, I., Okamura, T., Fukuhara, S., Tanaka, T., Suzukamo, Y., Okayama, A., et al. (2005). A cross-sectional study of alcohol drinking and health-related quality of life among male workers in japan. *Journal of Occupational Health, 47*(6), 496.

Saitz, R. (2010). Alcohol screening and brief intervention in primary care: Absence of evidence for efficacy in people with dependence or very heavy drinking. *Drug and Alcohol Review, 29*(6), 631-640.

Sarna, L., Bialous, S. A., Cooley, M. E., Jun, H., & Feskanich, D. (2008). Impact of smoking and smoking cessation on health-related quality of life in women in the nurses' ™ health study. *Quality of Life Research, 17*(10), 1217-1227.

Saunders, J. B., Aasland, O. G., Babor, T. F., Fuente, J. R., & Grant, M. (1993). Development of the alcohol use disorders identification test (AUDIT): World health organization collaborative project on early detection of persons with harmful alcohol Consumption—II. *Addiction, 88*(6), 791-804. doi: 10.1111/j.1360-0443.1993.tb02093.x

Saunders, J. B., Aasland, O. G., Babor, T. F., Fuente, J. R., & Grant, M. (1993). Development of the alcohol use disorders identification test (AUDIT): World health organization collaborative project on early detection of persons with harmful alcohol Consumption—II. *Addiction, 88*(6), 791-804. doi: 10.1111/j.1360-0443.1993.tb02093.x

Savela, S. L., Koistinen, P., Tilvis, R. S., Strandberg, A. Y., Pitkala, K. H., Salomaa, V. V., … Strandberg. (2010). Physical activity at midlife and health-related quality of life in older men. *Archives of Internal Medicine, 170*(13), 1171.

Schoenborn, C. A., Adams, P. F. & Division of Health Interview Statistics. (2008). *Sleep duration as a correlate of smoking, alcohol use, leisure-time physical inactivity, and obesity among adults: United states, 2004-2006.* Retrieved 08/11, 2011, from www.cdc.gov/nchs/data/hestat/sleep04-06/sleep04-06.pdf

Schuit, A. J., van Loon, A. J. M., Tijhuis, M., & Ocke, M. C. (2002). Clustering of lifestyle risk factors in a general adult population. *Preventive Medicine, 35*(3), 219-224. doi: 10.1006/pmed.2002.1064

Shuman, A. G., Duffy, S. A., Ronis, D. L., Garetz, S. L., McLean, S. A., Fowler, K. E., et al. (2010). Predictors of poor sleep quality among head and neck cancer patients. *The Laryngoscope, 120*(6), 1166-1172. doi: 10.1002/lary.20924

Siahpush, M., & Carlin, J. B. (2006). Financial stress, smoking cessation and relapse: Results from a prospective study of an Australian national sample. *Addiction, 101*(1), 121-127.

Siahpush, M., Singh, G. K., Jones, P. R., & Timsina, L. R. (2009). Racial/ethnic and socioeconomic variations in duration of smoking: results from 2003, 2006 and 2007 tobacco use supplement of the current population survey. *Journal of Public Health, 32*(2), 210-218.

Siahpush, M., Spittal, M., & Singh, G. K. (2007). Association of smoking cessation with financial stress and material well-being: Results from a prospective study of a population-based national survey. *American Journal of Public Health, 97*(12), 2281-2287. doi: 10.2105/AJPH.2006.103580

Smith, D. R. (2008). Tobacco smoking by occupation in Australia and the United States: A review of national surveys conducted between 1970 and 2005. *Industrial Health, 46*(1), 77-89. doi:10.2486/indhealth.46.77

Smith, M. T., & Haythornthwaite, J. A. (2004). How do sleep disturbance and chronic pain inter-relate? insights from the longitudinal and cognitive-behavioral clinical trials literature. *Sleep Medicine Reviews, 8*(2), 119-132. doi:10.1016/S1087-0792(03)00044-3

Soares, J. J. F., Viitasara, E., & Macassa, G. (2007). Quality of life among lifetime victimized men. *Violence and Victims, 22*(2), 189-204.

Sorensen, G., Barbeau, E. M., Stoddard, A. M., Hunt, M. K., Goldman, R., Smith, A., … Wallace, L. (2007). Tools for health: The efficacy of a tailored intervention targeted for construction laborers. *Cancer Causes Control, 18*(1), 51-59. doi: 10.1007/s10552-006-0076-9

Sorensen, L., Pekkonen, M., Mannikko, K., Louhevaara, V., Smolander, J., & Alen, M. (2008). Associations between work ability, health-related quality of life, physical activity and fitness among middle-aged men. *Applied Ergonomics, 39*(6), 786-791. doi: 10.1016/j.apergo.2007.11.001

Spiegel, K., Leproult, R., & Cauter, D. V. (1999). Impact of sleep debt on metabolic and endocrine function. *The Lancet, 354*(9188), 1435-1439. doi:10.1016/S0140-6736(99)01376-8

Spring, B., Doran, N., Pagoto, S., Schneider, K., Pingitore, R., & Hedeker, D. (2004). Randomized controlled trial for behavioral smoking and weight control treatment: Effect of concurrent versus sequential intervention. *Journal of Consulting and Clinical Psychology, 72*(5), 785-796.

Stafford, M., Hemingway, H., & Marmot, M. (1998). Current obesity, steady weight change and weight fluctuation as predictors of physical functioning in middle aged office workers: The whitehall II study. *International Journal of Obesity, 22*(1), 23.

Stegbauer, C. C. (1995). Smoking cessation in women: Findings from qualitative research. *The Nurse Practitioner, 20*(11 part 1), 80-85.

Stepanski, E. J., & Wyatt, J. K. (2003). Use of sleep hygiene in the treatment of insomnia. *Sleep Medicine Reviews, 7*(3), 215-225. doi:10.1053/smrv.2001.0246

Steptoe, A., Perkins-Porras, L., Hilton, S., Rink, E., & Cappuccio, F. P. (2004). Quality of life and self-rated health in relation to changes in fruit and vegetable intake and in plasma vitamins C and E in a randomised trial of behavioural and nutritional education counselling. *The British Journal of Nutrition, 92*(1), 177.

Stern, F., & Haring-Sweeney, M. (1997). Proportionate mortality among unionized construction operating engineers. *American Journal of Industrial Medicine, 32*(1), 51-65.

Stevens, J. (1996). *Applied multivariate statistics for the social sciences* (3rd ed.). NJ: Mahwah.

Strandberg, A. Y., Strandberg, T. E., Pitkala, K., Salomaa, V. V., Tilvis, R. S., & Miettinen, T. A. (2009). The effect of smoking in midlife on health-related quality of life in old age: A 26-year prospective study. *Archives of Internal Medicine, 168*(18), 1968-1974.

Strandberg, T. E., Strandberg, A. Y., Salomaa, V. V., Pitkala, K. H., Tilvis, R. S., Sirola, J., & Miettinen, T. A. (2009). Explaining the obesity paradox: Cardiovascular risk, weight change, and mortality during long-term follow-up in men. *European Heart Journal, 30*(14), 1720-1727. doi: 10.1093/eurheartj/ehp162

Stranges, S., Cappuccio, F. P., Kandala, N. -., Miller, M. A., Taggart, F. M., Kumari, M., . . . Marmot, M. G. (2007). Cross-sectional versus prospective associations of sleep duration with changes in relative weight and body fat distribution. *American Journal of Epidemiology, 167*(3), 321-329.

Stranges, S., Notaro, J., Freudenheim, J. L., Calogero, R. M., Muti, P., Farinaro, E., et al. (2006). Alcohol drinking pattern and subjective health in a population-based study. *Addiction, 101*(9), 1265.

Stuart, K., Borland, R., & McMurry, N. (1994). Self-efficacy, health locus of control, and smoking cessation. *Addictive Behaviors, 19*(1), 1-12.

Substance Abuse and Mental Health Services Administration (2009). Results from the 2008 National Survey on Drug Use and Health: National Findings (Office of Applied Studies, NSDUH Series H-36, HHS Publication No. SMA 09-4434). Rockville, MD.

U. S. Department of Health and Human Services. (USDHHS). (2004). The health consequences of smoking: A report of the Surgeon General. Washington, DC. : U.S. Government Printing Office Number 0-16-051576-2. Atlanta: Centers for Disease Control and Prevention, Office of Smoking and Health.

Van Cauter, E., & Knutson, K. L. (2008). Sleep and the epidemic of obesity in children and adults. *European Journal of Endocrinology, 159*(suppl_1), S59-S66.

Van Dijk, A. P., Toet., & Verdurmen, J. E. E. (2004). The relationship between health-related quality of life and two measures of alcohol consumption. *Journal of Studies on Alcohol, 65*(2), 241-249.

Velicer, W. F., & Prochaska, J. O. (2004). A comparison of four self-report smoking cessation outcome measures. *Addictive Behaviors, 29*(1), 51-60. doi:10.1016/S0306-4603(03)00084-4

Vgontzas, A. N., Lin, H., Papaliaga, M., Calhoun, S., Vela-Bueno, A., Chrousos, G. P., & Bixler, E. O. (2008). Short sleep duration and obesity: The role of emotional stress and sleep disturbances. *International Journal of Obesity, 32*(5), 801-809.

Viala-Danten, M., Martin, S., Guillemin, I., & Hays, R. (2008). Evaluation of the reliability and validity of the medical outcomes study sleep scale in patients with painful diabetic peripheral neuropathy during an international clinical trial. *Health and Quality of Life Outcomes, 6*(113)

Vitiello, M. V. (1997). INVITED REVIEW sleep, alcohol and alcohol abuse. *Addiction Biology, 2*(2), 151-158.

Voinescu, B., Coogan, A., Orasan, R., & Thome, J. (2010). PW01-251 - alcohol consumption: Links between sleep and diurnal preference. *European Psychiatry, 25*(1), 1679.

Vorona, R. D., Winn, M. P., Babineau, T. W., Eng, B. P., Feldman, H. R., & Ware, C. (2005). Overweight and obese patients in a primary care population report less sleep than patients with a normal body mass index. *Archives of Internal Medicine, 165*(1), 25-30.

Walsh, J. K. (2004). Clinical and socioeconomic correlates of insomnia. *The Journal of Clinical Psychiatry, 65*(8), 13-19.

Wang, E., Dement, J. M., & Lipscomb, H. (1999). Mortality among North Carolina construction workers, 1988-1994. *Applied Occupational and Environmental Hygiene, 14*(1), 45-58.

Ward, K. D., Weg, M. W. V., Kelsges, R. C., Kovach, K. W., Elrod, M. C., DeBon, M., … Lando, H. A. (2003). Characteristics of highly physically active smokers in a population of young adult military recruits. *Addictive Behaviors, 28*(8), 1405-1418. doi:10.1016/S0306-4603(02)00267-8

Ware, J. E. (2000). SF-36 health survey update. *Spine, 25*(24), 3130.

Ware, J. E., Kosinski, M., Keller, S. D., & New England Medical Center Hospital. (1994). *SF-36 physical and mental health summary scales: A user's manual*. Boston: The Health Assessment Lab, New England Medical Center.

Ware, J. E., Snow, K. K., Kosinski, M., & Gandek, B. (1993). *SF-36 health survey : Manual and interpretation guide*. Boston: The Health Institute, New England Medical Center.

Warner, K., Smith, R. J., Smith, D. G. & Fries, B. E. (1996). Health and economic implications of a work-site smoking-cessation program: A simulation analysis. *Journal of Occupational & Environmental Medicine, 38*(10), 981-992.

Wetter, D. W., Fiore, M. C., Baker, T. B., & Young, T. B. (1995). Tobacco withdrawal and nicotine replacement influence objective measures of sleep. *Journal of Consulting and Clinical Psychology, 63*(4), 658-667. doi:10.1037/0022-006X.63.4.658

Wetter, D. W., Young, T. B., Bidwell, T. R., Badr, S., & Palta, M. (1994). Smoking as a risk factor for sleep-disordered breathing. *Archives of Internal Medicine, 154*(19), 2219-2224.

Wiles, N. J., Haase, A. M., Gallacher, J., Lawlor, D. A., & Lewis, G. (2007). Physical activity and common mental disorder: Results from the Caerphilly study. *American Journal of Epidemiology, 165*(8), 946-954. doi: 10.1093/aje/kwk070

Willett, W., Sampson, L., Stampfer, M. J., Rosner, B., Bain, C., Witschi, J., … Speizer, F. E. (1985). Reproducibility and validity of a semiquantitative food frequency questionnaire. *American Journal of Epidemiology, 122*(1), 51-65.

Williams, K., Sassler, S., & Nicholson, L. M. (2008). For better or for worse? the consequences of marriage and cohabitation for single mothers. *Social Forces, 86*(4), 1481-1511.

Wolk, R., Gami, A. S., Garcia-Touchard, A., & Somers, V. K. (2005). Sleep and cardiovascular disease. *Current Problems in Cardiology, 30*(12), 625-662. doi:10.1016/j.cpcardiol.2005.07.002

Youngstedt, S. (2005). Effects of exercise on sleep. *Clinics in Sports Medicine, 24*, 355-365.

Zhang, L., Samet, J., Caffo, B., & Punjabi, N. M. (2006). Cigarette smoking and nocturnal sleep architecture. *American Journal of Epidemiology, 164*(6), 529-537. doi: 10.1093/aje/kwj231