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Individual, Interpersonal, and Occupational Factors of Cigarette Smoking in Building Trades Workers

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Individual, Interpersonal, and Occupational Factors of Cigarette Smoking in Building Trades Workers

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DISSERTATION

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Individual, Interpersonal, and Occupational Factors of Cigarette Smoking in Building Trades Workers

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Abstract

Background: Cigarette smoking creates great challenges for blue-collar workers who are more likely to smoke, smoke more heavily, and are less likely to quit smoking compared to white collar workers. It is important to identify not only individual factors but also social and work environments that influence smoking behavior in order to reduce the occupational disparity in smoking behavior. Little is known about the combined effect of various factors that influence smoking behaviors among blue-collar workers.

Purpose: The aims of this dissertation were: 1) to estimate the contribution of occupational factors to current smoking; 2) to identify the determinants associated with heavy smoking, focusing on individual, interpersonal, and occupational factors; 3) to assess the impact of individual, interpersonal, and occupational predictors of quitting smoking among building trades workers.

Methods: The data was drawn from the MassBUILT smoking cessation intervention study. The first study included a total of 1,817 building trade apprentices and the second study included 763 current smokers at baseline. The third study used baseline data with follow-up data. Data collection included information about smoking behaviors, individual (e.g., sociodemographic), interpersonal (e.g., household smoking), and occupational factors (e.g., exposure to occupational hazards) obtained through self-report questionnaires.

Results: The first study found that current smoking was significantly associated with union commitment, exposure to dust and chemicals, and concern about exposure to occupational hazards. The second study revealed that heavy smoking was significantly associated with older age, male gender, poorer health status, higher nicotine dependence, earlier age of smoking initiation, higher temptation to smoke, greater perceived benefits of smoking, household smoking or living alone, trade type, and job satisfaction. The third study demonstrated that older age, higher educational attainment and higher household income level, fewer number of cigarettes smoked per day, and more concern about exposure to occupational hazards were significant predictors of quitting smoking.

Conclusion: Blue-collar workers' smoking behavior is influenced by various types of factors. The findings suggest that cessation interventions for this group may need to develop a comprehensive approach that addresses each type, rather than focusing on a single aspect of influence.

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CHAPTER 1

Introduction

Significance and Literature Review

Cigarette Smoking and Illness

Cigarette smoking continues to be the leading cause of disease and premature death in the United States (U.S.) (U.S. Department of Health and Human Services [U.S. DHHS], 2004). It is a well-known cause of multiple cancers, heart disease, stroke, complications of pregnancy, chronic obstructive pulmonary disease (COPD), and many other diseases (U.S. DHHS, 2004). Second-hand smoke (SHS) is also a major cause of substantial health dangers to healthy nonsmokers (U.S. DHHS, 2006). Cigarette smoking is responsible for an estimated 443,000 premature deaths–one in every five deaths– and $193 billion in smoking-attributable direct health-care expenditures and productivity losses each year in the U.S. (Centers for Disease Control and Prevention [CDC], 2008b). Therefore, cigarette smoking is a major public health concern.

Prevalence of Smoking in United States

Despite the adverse effects of smoking and the public's awareness of the health risks of smoking, smoking remains surprisingly prevalent. Approximately 21% of U.S. adults (46.6 million) were current cigarette smokers in 2009 (CDC, 2010). The prevalence of cigarette smoking has declined during the past 40 years among all sociodemographic subpopulations of adults in the U.S. (CDC, 2008a), from 40% in 1964 (U.S. DHHS, 1989) to 21% in 2009 (CDC, 2010). However, the rate of decline during the past decade has been less compared to previous decades (CDC, 2008a). In particular, during the last few years, the prevalence of current cigarette smoking among adults has remained virtually unchanged (21% in 2004, 2006, 2008, and 2009) (CDC, 2005, 2007, 2009a, 2010). Among states, current smoking prevalence was highest in West Virginia

(27%), Indiana (26%), and Kentucky (25%); and lowest in Utah (9%), California (14%), and New Jersey (15%) (CDC, 2009b). These variations by state might be attributed to a number of factors, including differences in population demographics, differing levels of tobacco control programs and policies, and variations in tobacco industry marketing and promotion (Farrelly, Pechacek, Thomas, & Nelson, 2008).

Occupational Disparity in Smoking Behavior

Blue collar workers are traditionally defined as working class people whose jobs consist of manual labor, including construction, crafts and kindred occupations, or who work as operatives, transportation operatives, and laborers (Giovino, Pederson, & Trosclair, 2000; Sorensen, Barbeau, Hunt, & Emmons, 2004). Most blue-collar workers have a high school education and commonly have low household incomes ranging from $16,000 to $30,000, as compared to the median household income in the U.S. of $49,777 (W. Thompson & Hickey, 2005; U.S. Bureau of the Census, 2010).

Smoking prevalence varies considerably by occupational groups in relation to skill and industry (e.g., “white collar” vs. “blue collar”) (Giovino, et al., 2000; D. J. Lee et al., 2007; Nelson et al., 1994). Blue-collar workers have nearly twice the smoking prevalence of both white-collar workers and the general population (Barbeau, Krieger, & Soobader, 2004; CDC, 2010; D. J. Lee, et al., 2007). For example, a study which used the National Health Interview Survey (NHIS), examined smoking trends in 41 major occupational categories in the U.S. workforce over two survey periods, 1987 to 1994 and 1997 to 2004 (N = 298,042). In the 1997 to 2004 survey period, the pooled rate for all workers was 24.5%. Prevalence was highest among construction workers (38.8%) and lowest among workers employed in the health diagnosing professions (5%). Of particular note, all of the

13 occupations with smoking rates above 30% were blue-collar (D. J. Lee, et al., 2007). Furthermore, the prevalence of smoking among blue collar workers has declined more slowly over time compared to white-collar workers (Giovino, et al., 2000; Sorensen, 2001), widening the persistent occupational disparity in smoking prevalence. According to the 1997 NHIS, blue-collar workers have lower quit rates compared to white-collar workers (36.8% vs. 51.3%) (Giovino, et al., 2000).

Smoking presents greater challenges for blue-collar workers. In addition to a higher prevalence of smoking over time, blue collar workers smoke more heavily (Giovino, et al., 2000; Lawrence, Fagan, Backinger, Gibson, & Hartman, 2007), start smoking at an earlier age (Giovino, et al., 2000), and are less successful in quitting compared to other workers (Barbeau, et al., 2004; Covey, Zang, & Wynder, 1992; Giovino, et al., 2000). Additionally, blue-collar workers reported less pressure to quit smoking, less social support for quitting, and they are more accepting of smoking among their co-workers (Sorensen, Emmons, Stoddard, Linnan, & Avrunin, 2002). They are also less likely than white-collar workers to be offered assistance with smoking cessation by their employers (Giovino, et al., 2000). Overall, consistent and increasing disparities in smoking behavior in this group may lead to corresponding smoking-related health disparities (Fagan et al., 2004; Vidrine, Reitzel, & Wetter, 2009).

Exposure to Second-hand Smoke

In recent years, public health concerns about smoking and the adverse impact of SHS have led to increasingly restrictive policies in the United States regarding public smoking behavior (Fendrich, Mackesy-Amiti, Johnson, Hubbell, & Wislar, 2005). Many employers and communities and certain states have implemented smoke-free policies and

laws in all workplaces, including restaurants and bars (CDC, 2006). Worksite smoking policies such as smoke free workplaces can decrease workers' exposure to SHS (Arheart et al., 2008; Hammond, Sorensen, Youngstrom, & Ockene, 1995) and can reduce cigarette smoking during working hours (Fichtenberg & Glantz, 2002). However, blue-collar workplaces are less likely to implement restrictive smoking policies (Gerlach, Shopland, Hartman, Gibson, & Pechacek, 1997; Plescia, Malek, Shopland, Anderson, & Burns, 2005; Shopland, Anderson, Burns, & Gerlach, 2004; U.S. DHHS, 2006). Furthermore, blue-collar workplaces have been slow to implement bans (U.S. DHHS, 2006). For this reason, worksite studies based on environmental monitoring have found higher exposure to SHS in persons in blue-collar and service occupations than in persons in white-collar occupations (Hammond, et al., 1995). In fact, by exposure to SHS, non-smoking blue-collar workers have been observed to have higher serum cotinine levels (a metabolite of nicotine), compared to white-collar workers (Wortley, Caraballo, Pederson, & Pechacek, 2002).

Worksite Smoking Cessation Intervention

Smoking cessation has substantial and immediate health benefits (U.S. DHHS, 2004). Smokers who use cessation interventions greatly increase their likelihood of quitting permanently (Fiore et al., 2008). Approximately 60% of the adult population in the United States is employed (U.S. Department of Labor, 2011) and spends about a third of each day in the worksite setting (Graham, Cobb, Raymond, Sill, & Young, 2007). The worksite remains an important setting for reaching the adult population with smoking cessation programs (U.S. DHHS, 2000). It can also be a key venue for lowering smoking rates, particularly within the blue-collar workforce, and for reducing occupational

disparities in smoking prevalence (D. J. Lee, et al., 2007).

Effective smoking cessation intervention strategies among blue-collar workers are needed to address growing occupational disparities in smoking (Barbeau et al., 2006). However, intervention programs targeted to blue-collar worker have not shown great success so far. Many blue-collar workers work in the transportation or construction industries, therefore access to worksite-based health promotion programs is limited by the nature of their work. Blue collar workers are often not situated at one location for long periods of time, but rather may move from one job site to another. They are less likely to participate in worksite health promotion programs than white-collar workers (Morris, Conrad, Marcantonio, Marks, & Ribisl, 1999; Sorensen, Stoddard, Ockene, Hunt, & Youngstrom, 1996). When they do participate, they may be less successful in changing health behaviors than white-collar workers (Niknian, Linnan, Lasater, & Carleton, 1991).

The majority of smoking cessation programs implemented in workplace settings have focused primarily on modifying individual smoking behaviors and life-styles, rather than changing the social and work environmental contexts that may maintain or reinforce positive changes through direct influence on individual health behaviors. For example, most worksite smoking cessation behavioral interventions for blue-collar workers (Lang et al., 2000; Ringen, Anderson, McAfee, Zbikowski, & Fales, 2002; Rodriguez-Artalejo et al., 2003) reflect the implicit assumption that the proximal causes of behavior and/or mechanisms for producing behavioral change lie within the individual.

Smoking is a multifactorial problem. Although approaches aimed at smoking cessation in individuals are still necessary and important, more comprehensive interventions have shown high efficacy in reducing smoking rates. Specifically, worksite

smoking cessation interventions may be missing important occupational elements. In developing comprehensive strategies, it is important to address the complexity of factors that influence smoking behavior among blue-collar workers with a secondary aim of creating healthy workplaces.

Individual, Interpersonal, and Occupational Factors for Smoking Behavior

Influences on smoking behavior include the person's individual characteristics, social and work environments. Much research has found that smoking prevalence or smoking cessation outcomes are associated with individual factors, including a number of sociodemographic characteristics such as age, race/ethnicity, educational attainment and income level, and self-rated health status (Barbeau, et al., 2004; Cavelaars et al., 2000; CDC, 2009a; Fagan, Shavers, Lawrence, Gibson, & O'Connell, 2007; C. W. Lee & Kahende, 2007; Manderbacka, Lundberg, & Martikainen, 1999). Furthermore, smoking history, such as age of smoking initiation, history of past quit attempts, smoking intensity, and nicotine dependence have been associated with success in quitting smoking (Dale et al., 2001; Fagan, et al., 2007; Ferguson et al., 2003; Hyland et al., 2006; Hyland et al., 2004; Murray et al., 2000; West, McEwen, Bolling, & Owen, 2001). There is considerable evidence that several psychological factors are critically associated with smoking behavior, including intention to quit, self-efficacy, temptation to smoke, and decision balance (perceptions of the pros and cons of smoking or quitting) (Breitling, Twardella, Raum, & Brenner, 2009; DiClemente, Prochaska, & Gibertini, 1985; Gwaltney, Metrik, Kahler, & Shiffman, 2009; Norman, Conner, & Bell, 1999; Van Zundert, Nijhof, & Engels, 2009).

Interpersonal factors in the social environment has been shown to be strongly

relevant to smoking behavior (B. Thompson, Thompson, Thompson, Fredickson, & Bishop, 2003). Several studies have shown that the presence or the absence of household members, friends, coworkers, and partners who smoke, is highly associated with smoking behavior (Chandola, Head, & Bartley, 2004; Manchon Walsh et al., 2007; Monden, de Graaf, & Kraaykamp, 2003; Park, Tudiver, Schultz, & Campbell, 2004).

Smoking behavior can also be influenced by occupational factors (Albertsen, Borg, & Oldenburg, 2006), which may explain occupational class differences in smoking behaviors. Occupational factors are important correlates of smoking behaviors and include stressful work conditions, including job strain, high workload, work-related stress (Albertsen, et al., 2006; Green & Johnson, 1990; Hellerstedt & Jeffery, 1997; Kouvonen, Kivimaki, Virtanen, Pentti, & Vahtera, 2005; Kouvonen et al., 2009; Landsbergis et al., 1998; Otten, Bosma, & Swinkels, 1999; Steptoe et al., 1998), exposures to occupational hazards (Albertsen, Hannerz, Borg, & Burr, 2004; Sorensen et al., 1996; Sterling & Weinkam, 1990), and job dissatisfaction (Peretti-Watel, Constance, Seror, & Beck, 2009). The worksite culture or norms for smoking and exposure to second hand smoking (Giovino, et al., 2000) and organizational support for quitting smoking such as health insurance coverage of smoking cessation (Barbeau et al., 2001) and worksite smoking policies (e.g., smoking restrictions, smoking bans) (Fichtenberg & Glantz, 2002) influence workers' smoking behavior.

In this population, it is important not only to identify individual factors but also interpersonal and occupational factors that influence smoking behaviors for efforts to reduce occupational disparities in smoking. However, little is known about the multiple factors related to smoking behaviors among blue-collar workers. The lack of information

about blue-collar workers is an obstacle to designing integrated effective worksite smoking cessation interventions. This dissertation considers the impact of varying factors on blue-collar workers' smoking behaviors. The findings from this dissertation may lead to the development of multiple component smoking cessation interventions for this group.

Theoretical Framework

Social ecological theory proposes that individual health behavior is supported and influenced by numerous other systems and groups (Wandersman et al., 1996). That is, the social ecological approach considers other external influences, including social and environmental contexts, cultural characteristics, and policy (Stokols, 1996). This theory can provide a comprehensive framework that addresses the multiple perspectives of health behaviors (Sallis, Owen, & Fisher, 2008; Stokols, 1996).

Social ecological theory offers a helpful framework for understanding the complexities of smoking behavior-related determinants. The application of this model can capture and explicate various types of factors that influence smoking behavior among blue-collar workers. More importantly, social ecological models can be used to develop comprehensive smoking intervention approaches that systematically target mechanisms of change with multiple components (Sallis, et al., 2008). They can also coordinate social networks and norms to support healthy behaviors (Sallis, et al., 2008; Whittemore, Melkus, & Grey, 2004).

This dissertation uses a theoretical framework that is derived from social ecological theory (McLeroy, Bibeau, Steckler, & Glanz, 1988; Sallis, et al., 2008; Stokols, 1996) to examine the relationship of building trades workers' social and work environment experiences with individual aspects of current smoking, smoking intensity (number of

cigarettes per day), and quitting smoking. Figure 1 presents a theoretical framework for this dissertation. The dissertation assesses the roles of individual factors (including sociodemographics, smoking history, and psychological factors), interpersonal factors (including household, partner, and friends/coworkers' smoking), and occupational factors (including trade type, union commitment, job satisfaction, exposure to occupational hazards, and concern about exposure to occupational hazards). The framework posits that three related factors (individual, interpersonal, and occupational) influence workers' cigarette smoking behavior.

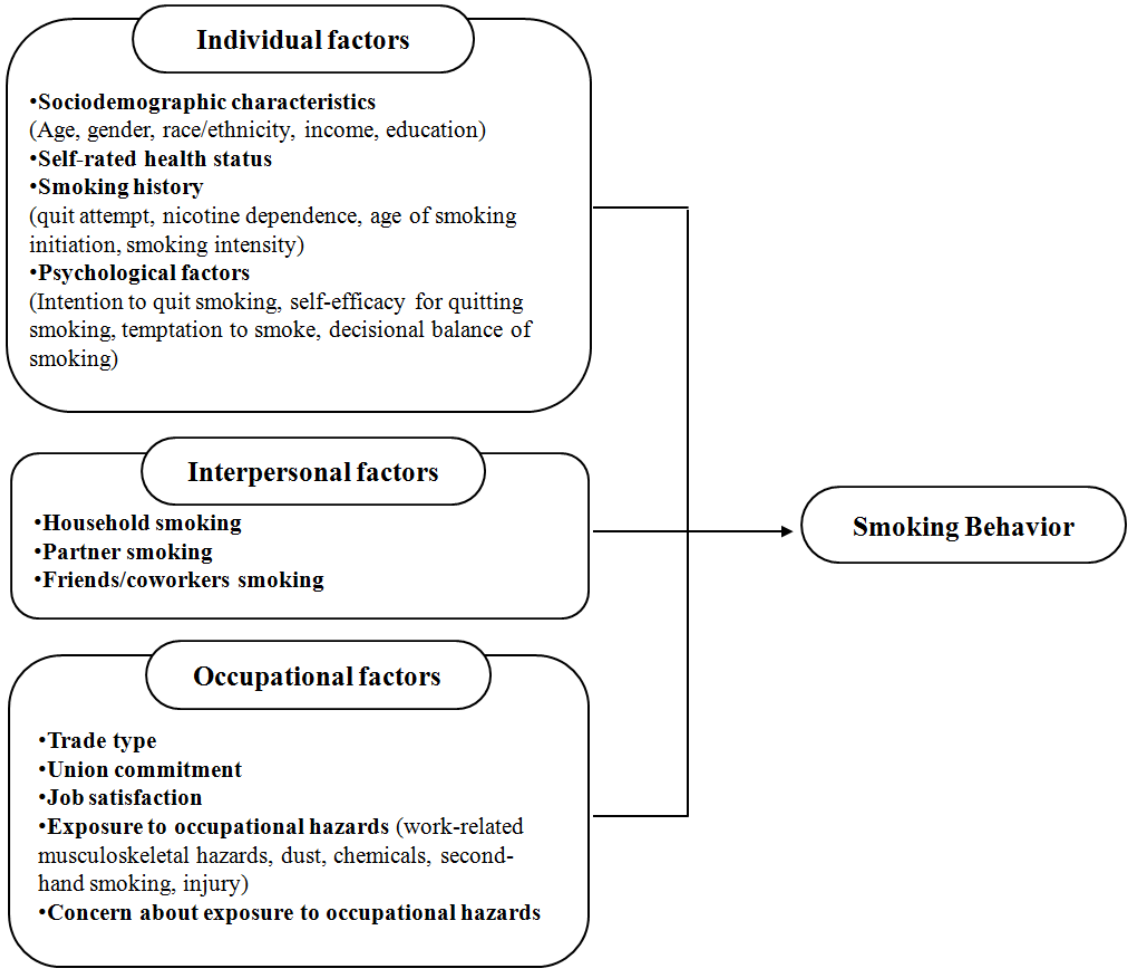

Figure 1.
Theoretical framework of smoking behavior derived from the social ecological theory (Sallis, et al., 2008)

Overview of the Dissertation

The purpose of this dissertation was to investigate the extent and determinants of cigarette smoking behavior in building trades workers. The study focused on identifying factors associated with current cigarette smoking, heavy smoking, and quitting smoking in building trades workers.

This dissertation is organized into five chapters. *Chapter 1* presents the introduction with background information about cigarette smoking and blue-collar workers, the theoretical framework, and overall aims of the dissertation. *Chapter 2* presents the findings of a research study investigating the relationship between occupational factors and current cigarette smoking among building trades workers. This study included a total of 1,817 apprentices who completed a baseline questionnaire. *Chapter 3* presents the findings of a research study comparing differences within subgroups (heavy smokers vs. light smokers) among 763 current smokers at baseline and identifying determinants associated with heavy smoking, focusing on individual, interpersonal, and occupational factors. *Chapter 4* presents the research findings of a longitudinal study, identifying predictors such as baseline individual, interpersonal, and occupational factors associated with short-term smoking cessation, regardless of the effects of participating in a multi-pronged smoking cessation intervention. This study used baseline data with follow-up data. Finally, *Chapter 5* summarizes the findings of the three studies relevant to cigarette smoking. It also presents implications and recommendations for future research.

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CHAPTER 2

Cigarette Smoking in Building Trades Workers: The Impact of Work Environment

Abstract

Background: Blue-collar workers smoke at higher rates than white-collar workers and the general population. Occupational factors may contribute to smoking behavior in this group. However, little is known about the role of occupational factors in explaining cigarette smoking patterns. The purpose of this study was to estimate the contribution of occupational factors to current cigarette smoking among building trades workers.

Methods: This study used cross-sectional data from the MassBUILT smoking cessation intervention study. A total of 1,817 unionized, Massachusetts building trades workers from 10 sites (mean age = 28.5 ± 6.6 years, 92% male, 76% white) participated in the study. Multivariate logistic regression analyses were used to investigate the association of occupational factors with current cigarette smoking.

Results: Over 40% of the participants reported current cigarette smoking. Smoking was significantly associated with the following occupational factors: union commitment (OR = 1.06; 95% CI: 1.00–1.12); exposure to dust (OR = 1.50; 95% CI: 1.15–1.95) and chemicals (OR = 1.41; 95% CI: 1.11–1.79); and concern about exposure to occupational hazards (OR = 0.93; 95% CI: 0.91–0.95).

Conclusion: The findings suggest that occupational factors might be related to smoking in this population. Smoking cessation programs for this population should consider work-related occupational factors along with individual approaches.

Introduction

Cigarette smoking remains the single largest preventable cause of disease and premature death in the U.S. (U.S. Department of Health and Human Services [U.S. DHHS], 2004). Even though the rate of cigarette smoking has declined over the past 40 years in the U.S. (Centers for Disease Control and Prevention [CDC], 2008), blue-collar workers continue to have high smoking prevalence (Bang & Kim, 2001; Covey, Zang, & Wynder, 1992; Lee et al., 2007; Nelson et al., 1994). Over 35% of blue-collar workers still smoke cigarettes, compared with about 20% of both white-collar workers and the general population (Barbeau, Krieger, & Soobader, 2004; CDC, 2009). Specifically, construction workers had the highest prevalence of smoking at 38.8% (Lee, et al., 2007). In addition, the prevalence of smoking among blue collar workers has declined more slowly over time as compared to white-collar workers (Giovino, Pederson, & Trosclair, 2000; Sorensen, 2001), widening the growing occupational disparity in smoking prevalence. This persistent and growing occupational disparity in smoking prevalence represents a critical public health concern because this gap might be associated with corresponding smoking-related health disparities (Fagan et al., 2004; Vidrine, Reitzel, & Wetter, 2009).

Cigarette smoking among U.S. adults (age 18 and older) has been shown to be associated with individual factors, including sociodemographic characteristics such as age, gender, racial/ethnic group, educational attainment, and income level (Barbeau, et al., 2004; CDC, 2008, 2009; Escobedo & Peddicord, 1996). For example, in the 2008 National Health Interview Survey (NHIS), smoking prevalence was higher among men, non-Hispanic whites, and among those aged 25-44 years, with a General Education

Development certificate (GED), and with incomes below the federal poverty level (CDC, 2009). Furthermore, self-rated health status is also associated with current smoking (Blaylock & Blisard, 1992; Kaleta, Makowiec-Dabrowska, Dziankowska-Zaborszczyk, & Jegier, 2006; Manderbacka, Lundberg, & Martikainen, 1999; Nakata, Takahashi, Swanson, Ikeda, & Hojou, 2009). The majority of previous studies have focused on the influence of these individual factors on cigarette smoking without addressing environmental contextual factors.

Work environment and experiences can have a substantial influence on the health and health related behaviors of workers. Occupational factors in the work environment might be one of the key factors in explaining persistent disparities in smoking prevalence by occupation. Blue-collar workers are more likely to be exposed to hazards on the job (Burkhart et al., 1993; Meeker, Susi, & Pellegrino, 2006; Rappaport, Goldberg, Susi, & Herrick, 2003; Sorensen et al., 1996) which can have adverse health effects, including cancer. Workers exposed to occupational hazards have higher smoking rates than workers without such exposures (Sorensen, et al., 1996; Sterling & Weinkam, 1990). Likewise, less concern about hazardous job exposures is associated with higher smoking rates (Sorensen, Quintiliani, Pereira, Yang, & Stoddard, 2009; Sorensen, et al., 1996). These multiple risks, exposure to occupational hazards and higher smoking prevalence, may have a synergistic effect on workers' health (Sorensen, 2001; Sorensen, Barbeau, Hunt, & Emmons, 2004; U.S. DHHS, 1989). Cigarette smoking is also associated with increased risk of occupational accidents and injuries (Chau et al., 2008; Ryan, Zwerling, & Orav, 1992; Sacks & Nelson, 1994). Furthermore, job dissatisfaction is also correlated with current smoking (Peretti-Watel, Constance, Seror, & Beck, 2009). Stressful working

conditions may contribute to increased smoking (Alexander & Beck, 1990; Landsbergis et al., 1998; Peretti-Watel, et al., 2009; Radi, Ostry, & Lamontagne, 2007; Westman, Eden, & Shirom, 1985). Cigarette smoking may be a way of coping with stressful work situations in order to get short-term relief from physically or mentally demanding work (Lundberg, 1999; Sorensen, et al., 2004). Thus, it is important to identify the occupational factors in the work environment which might contribute positively or negatively to smoking status. However, there have been few empirical studies investigating the influence of occupational factors on smoking behaviors among blue-collar workers.

In blue collar workers, exploring the contribution of occupational factors in relation to current cigarette smoking may provide important information about the work environment that can be used to reduce disparities in smoking and to improve work environments that promote smoking. Therefore, the purpose of this study was to investigate the relationship between occupational factors and current cigarette smoking among building trades workers.

Methods

Design

Data were used from the MassBUILT study (2004 – 2007) which was designed to test an intervention to promote smoking cessation using randomized controlled trial (RCT) methodology. The data collection methodology and intervention has been described elsewhere (Okechukwu, Krieger, Sorensen, Li, & Barbeau, 2009, 2011; Okechukwu, Nguyen, & Hickman, 2010). In brief, the original study was delivered in collaboration with the Massachusetts building trades unions. Union halls, where the

apprentice programs were located, were the sites for the study surveys and interventions. Each participating union conducts apprenticeship training programs for individuals wishing to become boilermakers, bricklayers, electricians, hoisting and portable engineers, ironworkers, painters, plumbers, pipefitters, sprinkler fitters, or refrigeration workers. All apprentices who were 18 years of age or older and were currently enrolled in the apprenticeship program were eligible to participate in the study (Okechukwu, et al., 2009).

A self-reported baseline survey was conducted at ten union sites with 1,817 apprentices (93.6% response rate). The data described here were derived from these baseline surveys. The Dana-Farber Cancer Institute Institutional Review Board approved all methods and materials used in the original study. The University of California, San Francisco (UCSF) Committee on Human Subjects Research approved all study procedures for the present study.

Measures

Dependent variable

Current cigarette smoking. Participants' current cigarette smoking was measured using two criteria from the CDC guidelines: lifetime smoking of at least 100 cigarettes and smoking a cigarette in the last 30 days (National Center for Health Statistics, 2009). All current smokers were asked about smoking intensity (number of cigarettes smoked per day in the last 30 days), previous quit attempts (number of quit attempts in the last 6 months), age of smoking initiation (year of first starting to smoke fairly regularly), and time to the first cigarette after waking ($\leq$ 30 minutes vs. > 30 minutes).

Independent variables

The independent variables were comprised of individual and occupational factors.

Individual factors. Individual factors included sociodemographic characteristics and self-rated health status.

Sociodemographic characteristics. Sociodemographic characteristics included age, gender, race/ethnicity, education, and household income. Race/ethnicity was categorized as Hispanic, Non-Hispanic African American, Non-Hispanic White, and 'Other' (American Indian/Alaska Native, Asian, Native Hawaiian or other Pacific Islander). Educational attainment was originally organized into seven categories, which we subsequently collapsed to three: high school/GED or less, some college or 2 year degree, and 4 year college degree or more. Household annual income was categorized into seven $10,000 increments, which we also collapsed into three categories: less than $50,000, $50,000-74,999, and $75,000 or more.

Self-rated health status. Self-rated health was assessed by a single question: "Would you say that, in general, your health is excellent, very good, good, fair, or poor?"

Occupational factors. Occupational factors included trade type, union commitment, job satisfaction, exposure to occupational hazards, and concern about exposure to occupational hazards.

Trade type. Ten building trade unions were categorized into seven trades: electrician, plumber & pipefitter, bricklayer, ironworker, painter, sprinkler fitter, and operating engineer.

Union commitment. Union commitment was assessed by participants' attitudes toward their unions on five statements: "I am proud to tell others that I am a union apprentice"; "I trust the information about health that I get from my union"; "I feel the

problems faced by my union are also my problems"; "People I work with give me help and support"; "People I work with are willing to listen to my work-related problems" (Barbeau et al., 2005; Lambert & Hopkins, 1995). Responses to each item were measured on a four-point Likert scale from 1 (*completely disagree*) to 4 (*completely agree*) (Cronbach's $\alpha = .73$). The scale score obtained by summing the five items ranged from 5 to 20 with a higher score indicating a more positive view toward their union.

Job satisfaction. Job satisfaction was measured by a single question: "How satisfied are you with your job?" Responses were categorized as very, somewhat, not too, and not at all satisfied.

Exposure to occupational hazards. Exposure to occupational hazards included work-related musculoskeletal hazards, chemicals, dust, injury, and second-hand smoke (SHS) at work. *Work-related musculoskeletal hazards* modified from the Washington State Ergonomics Rule (2000) were assessed by asking the number of hours of exposure per full shift (almost never, <1, 1-4, and >4 hours) that included awkward postures of the shoulder, neck, back, or knee, repetitive hand motions, and hand force required to pinch or grip an object at work. For these questions, images of a human figure illustrating a particular posture were also shown on questionnaires. The frequency of exposure to *Dust*, *Chemicals* and *SHS* was assessed using a three category scale (never, rarely, and a lot). *Injury* was determined by assessing the frequency of slips and falls, being struck by hoisted or falling objects, and cuts, strains, or sprains using the same scale as above. Exposure to occupational hazards was classified as the high exposure category (Okechukwu, Krieger, et al., 2010; Quinn et al., 2007): exposed more than four hours per work shift to awkward postures of the shoulder, neck, back, and knee, repetitive hand

motions, or hand force; and exposed a lot to dust, chemicals, SHS, and injury. Based on these criteria, participants were classified as either exposed or unexposed to each hazard.

Concern about exposure to hazards. Concern about exposure to hazards (e.g., dust, chemicals, SHS and work-related injuries) was assessed using six items on a four-point Likert scale from 1 (*not at all*) to 4 (*very concerned*) (Cronbach's $\alpha = .82$). The scale scores obtained by summing the six items ranged from 6 to 24 with a higher score indicating more concern about exposure to hazards at work.

Data Analysis

Statistical analysis was conducted using SPSS, version 19.0. Descriptive statistics were used to describe the participants in terms of individual and occupational factors using means, standard deviations, and range for continuous variables, and frequencies and percentages for categorical variables. Factors associated with smoking status were investigated using both bivariate and multivariate analysis. Bivariate analysis was performed using chi-square tests and *t*-tests for categorical variables and continuous variables, respectively.

After bivariate analysis, multivariate logistic regression analysis was used to determine the significance of the associations between current cigarette smoking and individual and occupational factors. For the multivariate analysis, as an initial step, assessment for multicollinearity was conducted to check for high intercorrelations among independent variables. There was no strong correlation between independent variables. Individual factors (age, gender, race/ethnicity, education, household annual income, and self-rated health) were entered in the first block. In the second block, occupational factors

(trade type, union commitment, job satisfaction, exposure to occupational hazards, and concern about exposure to hazards) were added to the model.

Even though less than 5% of the data were missing for most variables, a substantial number of study participants (20.4%) were missing data on at least one key sociodemographic variable in the analyses. Income was the most frequently missing entry (n = 278, 15.3%). Because regression analysis is conducted with a number of variables that have a certain percentage of missing values, a method using listwise deletion may have led to loss of observations and biased estimates, and statistical power would have been reduced (Little & Rubin, 2002; Patrician, 2002). Therefore, multiple imputation methods using SPSS Multiple Imputation were used to handle missing data (SPSS Inc., 2010). Five imputed datasets which were considered to be appropriate were created (Allison, 2002; Rubin, 1996; Schafer, 1999). All variables included in the analysis model were part of the imputation model used to predict the missing data. Multivariate analysis was performed on each of the imputed data sets separately, and then finally statistically pooled (i.e., combined) to achieve single parameter estimates. For each variable, pooled estimates from the five imputed datasets were used to report the odds ratios (ORs) and 95% confidence intervals (95% C.I.), along with a corresponding p-value. The level of statistical significance was set at a p-value of $< .05$.

Results

Characteristics of the Participants

The individual and occupational characteristics of the participants are shown in Table 1, prior to imputing missing covariates. The vast majority of the study participants were male (92.4%) and non-Hispanic white (76.4%) with an average age of 28.5 years.

Slightly less than half (49.2%) had earned a high school degree or less and only 8.5% of the study participants had completed 4 years of college or more. About 37% reported a household annual income less than $50,000. Over 56% of the participants reported their health as being very good or excellent. The majority of them were electricians (41.5%), followed by plumbers and pipefitters (31.7%). More than half (59.5%) reported being very satisfied with their jobs. The most commonly reported exposure was dust (76.7%), followed by work-related musculoskeletal hazards (57%), SHS (42.7%), injuries (29%), and chemicals (27.5%).

Smoking Behavior

Approximately 43% of the participants (n = 763) were classified as current smokers. Over 60% (n = 468) of current smokers reported smoking more than 10 cigarettes per day during the past 30 days. On average, current smokers started smoking fairly regularly at age 17 years with a range from 8 to 38 years. Approximately 42% of current smokers had high nicotine dependence as measured by smoking the first cigarette of the day within 30 minutes of waking. Almost half of the current smokers (47.3%) reported trying to quit smoking one or more times in the last 6 months.

Participant Characteristics by Smoking Status

Table 1 also lists the differences in individual and occupational factors by current smoking status. Current smokers were significantly younger (27.7 years vs. 29.1 years, $p < 0.001$), more likely to be non-Hispanic white (81.1% vs. 73.5%, $p = 0.002$) to report a high school education or less (51.4% vs. 47.8%, $p = 0.026$), and were less likely to report their health as being excellent (10.1% vs. 17.4%, $p < 0.001$), compared to non smokers. Also, current smokers were significantly more likely than non smokers to report exposure

to dust (80.1% vs. 74.2%, $p = 0.015$), and chemicals (31.2% vs. 24.8%, $p = 0.011$), and were significantly less likely to be concerned about exposures to occupational hazards (14.9 vs. 16.2, $p < 0.001$).

Multivariate Logistic Regression Analyses

Table 2 presents the factors associated with current smoking in the multivariate logistic regression models. Model 1, which included the individual factors as predictors of current cigarette smoking, shows that older age was significantly associated with lower likelihood of current smoking (OR = 0.97; 95% CI: 0.95–0.98). Male workers were less likely to be current smokers than female workers (OR = 0.60; 95% CI: 0.38–0.94). Hispanics (OR = 0.44; 95% CI: 0.25–0.78) and non-Hispanic African Americans (OR = 0.57; 95% CI: 0.38–0.86) were significantly less likely to report current smoking than non-Hispanic whites. Workers who reported a household annual income of $50,000–74,999 were significantly more likely to report current smoking than those whose income was more than $75,000 (OR = 1.40; 95% CI: 1.06–1.86), followed by those with less than $50,000 in income (OR = 1.30; 95% CI: 1.01–1.66). Similarly, workers with some college or a 2 year college degree were significantly more likely to report current smoking than those who had 4 years of college or more (OR = 1.67; 95% CI: 1.13–2.46), followed by those with high school or less (OR = 1.59; 95% CI: 1.08–2.32). Workers who reported their health status as being poor were significantly more likely to report current smoking than those who reported excellent health status (OR = 4.91; 95% CI: 1.32–18.23).

With the addition of occupational factors in Model 2, age, race/ethnicity, household annual income, education, and self-rated health status continued to demonstrate similar

effects to those observed in Model 1. However, gender was no longer significantly associated with the likelihood of current smoking (p = 0.178). Regarding occupational factors, having a positive view of the union was significantly associated with a higher likelihood of current smoking (OR = 1.06; 95% CI: 1.00–1.12). Also, higher exposure to dust (OR = 1.50; 95% CI: 1.15–1.95) and chemicals (OR = 1.41; 95% CI: 1.11–1.79) were significantly associated with increased likelihood of current smoking while more concern about exposure to these occupational hazards was significantly associated with a lower likelihood of current smoking (OR = 0.93; 95% CI: 0.91–0.95). However, the type of trade, job satisfaction, exposures to work-related musculoskeletal hazards, SHS, and injuries were not significantly associated with any differences in the odds of current smoking after adjusting for the other variables in the model.

Discussion

Main Findings and Implications

The study investigated the association between occupational factors and current smoking among building trades workers. The building trades workers in this study reported a smoking prevalence of more than 40%, nearly twice as high as that of the U.S. general population and white-collar workers during the same period (Barbeau, et al., 2004; CDC, 2009; Lee, et al., 2007). The high prevalence of cigarette smoking among blue-collar workers is consistent with findings from prior U.S. national studies of smoking and occupation (Barbeau, et al., 2004; Giovino, et al., 2000; Lee, et al., 2007). For example, in an analysis of data from the 1997 to 2004 NHIS (N = 298,042), all of the 13 occupations with smoking rates above 30% were blue-collar (Lee, et al., 2007). As mentioned earlier, cigarette smoking is a well-known cause of premature morbidity and

mortality from lung and other cancers, coronary heart disease (CHD), stroke, chronic respiratory disease, and other diseases (U.S. DHHS, 2004). Overall, it is conceivable that this surprisingly high prevalence of smoking among blue-collar workers may be a substantial contributor to health disparities between this group and white collar workers.

The association between smoking behavior among U.S. adults and sociodemographic characteristics is well known (Barbeau, et al., 2004; CDC, 2008, 2009; Escobedo & Peddicord, 1996).This study also found a number of sociodemographic characteristics associated with smoking: that is, older age, being Hispanic or non-Hispanic African American, having higher levels of household annual income and higher educational attainment were significantly associated with a lower likelihood of current smoking, similar to that of recent reports (Barbeau, et al., 2004; Cavelaars et al., 2000; CDC, 2008, 2009; Escobedo & Peddicord, 1996; Osler & Prescott, 1998; Townsend, Roderick, & Cooper, 1994). However, gender was no longer significantly associated with current smoking in the second model after the addition of occupational factors. Consistent with prior research findings (Blaylock & Blisard, 1992; Kaleta, et al., 2006; Manderbacka, et al., 1999; Nakata, et al., 2009), the present study found that poorer health status was significantly associated with increased odds of current smoking.

Union commitment was significantly associated with current smoking, even after adjustment for the individual factors. Although the extent of the odds of current smoking with union commitment was small, the finding indicated that most study participants felt a strong union commitment, and those who had more positive views about their union had a higher likelihood of current smoking. Barbeau and colleagues (2005) found that an important theme connected to union membership for unionized construction workers was

a sense of belonging (Barbeau, et al., 2005). They concluded that, as with smoking, workers may feel a sense of belonging–instant membership–with a group of smoking coworkers, which is something they potentially lose when they don't smoke or quit smoking (Barbeau, et al., 2005). Smoking cessation efforts targeting this group of workers have to consider this important role of unions. Such efforts should also consider ways that unions can advocate for work environments that promote smoking cessation, such as worksite smoking policies (e.g., smoking restrictions, smoking bans) (Sorensen et al., 2000) or health insurance coverage of smoking cessation (Barbeau, 2001; Barbeau et al., 2001; Curry, Grothaus, McAfee, & Pabiniak, 1998).

Another important finding of the present study was that exposures to dust and chemicals at work were significantly associated with an increased likelihood of current smoking while more concern about exposure to occupational hazards was significantly associated with a lower likelihood of current smoking. Previous research in craftspersons and laborers showed that workers reporting exposure to chemical hazards on the job were significantly more likely to be smokers than were unexposed workers (Sorensen, et al., 1996). Also, compared with unexposed workers, smokers exposed to chemical hazards were significantly more likely to be thinking of quitting or taking action to quit (Sorensen, et al., 1996). Concern about chemical hazards was further associated with an increased interest in quitting among men (Sorensen, et al., 1996). Similarly, from analyses of the U.S. NHIS, Sterling and Weinkam (1990) found that smoking was much more prevalent among workers who were more exposed to hazards (such as irritating, toxic dusts, and fumes) in the workplace and much less prevalent among those less exposed to such hazards. In contrast, Okechukwu et al. (2010) found no significant difference in the

association between exposure to occupational hazards (i.e., dust, chemicals, noise and ergonomics strain) and smoking among blue-collar workers. However, workers exposed to chemicals and dust tended to be at increased risk of smoking (Okechukwu, Krieger, et al., 2010). Therefore, there is limited evidence about whether exposure to occupational hazards is associated with smoking behavior.

Blue-collar workers tend to have higher exposures to occupational hazards, specifically carcinogens such as silica (Burkhart, et al., 1993; Meeker, et al., 2006; Rappaport, et al., 2003; Sorensen, et al., 1996), which might exacerbate smoking-related health problems. This potential for synergistic harm from smoking and occupational hazards has led to a call for interventions that address both hazards, such as integrated approaches to smoking cessation. Such interventions may help to reduce smoking rates among blue-collar workers and may also improve worker health by creating healthier workplaces.

In the U.S. Surgeon General's Report, SHS is a major cause of substantial health dangers in healthy nonsmokers (U.S. DHHS, 2006). Even though the present study found that exposure to SHS was not significantly associated with smoking, 42% of non-smokers in the present study were exposed to SHS at work. The National Health and Nutrition Examination Survey (NHANES) studies have consistently found that blue-collar workers have higher exposure to SHS than workers in other occupations (Arheart, Lee, Fleming, et al., 2008; Wortley, Caraballo, Pederson, & Pechacek, 2002). Smoking policies that restrict or ban smoking in the workplace can decrease workers' exposure to SHS (Arheart, Lee, Dietz, et al., 2008; Hammond, Sorensen, Youngstrom, & Ockene, 1995) and can reduce cigarette smoking during working hours (Fichtenberg & Glantz, 2002).

Smoke-free workplace policies vary by occupation (Gerlach, Shopland, Hartman, Gibson, & Pechacek, 1997; Plescia, Malek, Shopland, Anderson, & Burns, 2005; Shopland, Anderson, Burns, & Gerlach, 2004; U.S. DHHS, 2006). Blue-collar workers are less likely to report smoke-free workplaces than white-collar workers (Shopland, et al., 2004). Furthermore, blue-collar workplaces have been slow to implement smoking bans (U.S. DHHS, 2006). Therefore, implementation of smoke-free policies at blue-collar workplaces may protect nonsmokers from SHS exposure at work.

Strengths and Limitations

This study has a number of strengths. First, the study had a high response rate and was able to obtain data confidentially from a large number of apprentices from diverse building trades. Thus, it had high statistical power to detect moderate to small effects. This also suggests that selection bias in which those who were differentially exposed to smoking were more likely to answer the study questionnaire is not a likely problem. Also, multiple imputation methods allowed us to preserve information on variables with missing data in estimating the regression model. Therefore, these methods minimized validity bias and had more statistical power than the often used listwise method of deleting all observations with missing values on any covariate (Allison, 2002; Little & Rubin, 2002; Patrician, 2002; Rubin, 1987).

Despite these strengths, several study limitations should be noted. First, due to the cross-sectional nature of the design of the current study, it is not possible to determine temporality or causal direction between significant factors and current smoking. Second, the use of self report of exposures and outcomes in the study might have led to differential or non-differential misclassification. Self-report of exposure to occupational

hazards may under- or overestimate actual hazardous exposures (Birdsong, Lash, Thayer, Kumekawa, & Becker, 1992; Brower & Attfield, 1998; Spielholz, Silverstein, Morgan, Checkoway, & Kaufman, 2001; Van Eerd et al., 2009). The study also uses self report of smoking status without the benefit of biochemical verification. However, smoking status was assessed by standard measures drawn from a national survey (National Center for Health Statistics, 2009), which requires smokers to meet two criteria. Also, self-reports are generally reliable for classifying smoking status (Caraballo, Giovino, Pechacek, & Mowery, 2001; Patrick et al., 1994). Furthermore, the study sample included apprentices, who are in the younger age range for blue-collar workers. The findings from this study might not be representative of the general blue-collar worker population, which includes workers with longer work years in the trades. Finally, all variables that would have been useful to analyze from an occupational perspective were not available, raising the possibility of residual confounding by unmeasured or unadjusted factors. It would have been useful to have information about job strain (Green & Johnson, 1990; Hellerstedt & Jeffery, 1997; Kouvonen et al., 2007; Landsbergis, et al., 1998), shift work (Shields, 1999), and worksite smoking policies (Fichtenberg & Glantz, 2002), all of which may contribute to the increased likelihood of smoking.

Conclusion

Despite these limitations, the study findings highlight the need to explicate the pathways by which occupational factors may contribute to current smoking behavior among building trades workers. Specifically, there was strong evidence that higher exposure to chemicals and dust was associated with increased current smoking among building trades workers, although any directionality in the association could not be

inferred. This study provides strong support for future studies to consider work-related occupational factors along with individual approaches in understanding smoking and when developing smoking cessation programs for this population.

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Table 1

Individual and Occupational Factors by Current Smoking among Building Trades Workers (N=1,817)

Characteristics	Total N=1,817	Total [#] Current Smoker N=763, 42.7%	Total [#] Non Smoker N=1025, 57.3%	P-value[*]
Individual factors				
Age (year)				**<0.001**
Mean ± SD	28.5 ± 6.6	27.7 ± 5.9	29.1 ± 7.0	
(Range)	(18–53)	(18–49)	(18–53)	
Gender, n (%)				0.351
Male	1679 (92.4)	700 (91.7)	957 (93.4)	
Female	88 (4.8)	44 (5.8)	44 (4.3)	
Missing	50 (2.8)	19 (2.5)	24 (2.3)	
Race/Ethnicity, n (%)				**0.002**
Hispanic	65 (3.6)	18 (2.4)	44(4.3)	
African America, non-Hispanic	125 (6.9)	40 (5.2)	85(8.3)	
Other, non-Hispanic	114 (6.3)	44 (5.8)	69(6.7)	
White, non-Hispanic	1389 (76.4)	619 (81.1)	753 (73.5)	
Missing	124 (6.8)	42 (5.5)	74 (7.2)	
Education, n (%)				**0.026**
High school/GED[a] or less	894 (49.2)	392 (51.4)	490 (47.8)	
Some college or 2-year degree	674 (37.1)	287 (37.6)	379 (37.0)	
4-year college degree or more	155 (8.5)	48 (6.3)	105 (10.2)	
Missing	94 (5.2)	36 (4.7)	51 (5.0)	
Income, n (%)				0.090
<$50,000	675 (37.1)	301 (39.4)	365 (35.6)	
$50,000-74,999	390 (21.5)	172 (22.5)	211 (20.6)	
≥$75,000	474 (26.1)	181 (23.7)	291 (28.4)	
Missing	278 (15.3)	109 (14.3)	158 (15.4)	
Self-rated health, n (%)				**<0.001**
Excellent	260 (14.3)	77 (10.1)	178 (17.4)	
Very good	768 (42.3)	282 (37.0)	475 (46.3)	
Good	655 (36.0)	332 (43.5)	316 (30.8)	
Fair	108 (5.9)	63 (8.3)	41 (4.0)	
Poor	11 (0.6)	7 (0.9)	4 (0.4)	
Missing	15 (0.8)	2 (0.3)	11 (1.1)	
Occupational factors				
Trade type, n (%)				0.807
Electricians	754 (41.5)	303 (39.7)	439 (42.8)	
Plumbers & Pipefitters	576 (31.7)	245 (32.1)	327 (31.9)	
Bricklayers	152 (8.4)	68 (8.9)	76 (7.4)	
Ironworkers	110 (6.1)	50 (6.6)	59 (5.8)	
Painters	117 (6.4)	50 (6.6)	63 (6.1)	
Sprinkler fitters	78 (4.3)	33 (4.3)	45 (4.4)	
Operating engineers	30 (1.7)	14 (1.8)	16 (1.6)	
Union commitment[b]				0.215
Mean ± SD	17.7±2.0	17.8 ± 2.0	17.6 ± 2.0	
(range)	(9–20)	(9–20)	(9–20)	

Table 1 (*Continued*)

Characteristics	Total N=1,817	Total [#] Current Smoker N=763, 42.7%	Total [#] Non Smoker N=1025, 57.3%	P-value[*]
Job satisfaction, n (%)				0.144
Very satisfied	1081 (59.5)	468 (61.3)	599 (58.4)	
Somewhat satisfied	525 (32.0)	232 (30.4)	341 (33.3)	
Not too satisfied	101 (5.6)	40 (5.2)	59 (5.8)	
Not at all satisfied	24 (1.3)	14 (1.8)	8 (0.8)	
Missing	29 (1.6)	9 (1.2)	18 (1.8)	
Exposure to occupational hazards				
Work-related musculoskeletal hazards, n (%)				0.064
Exposed	1036 (57.0)	456 (59.8)	565 (55.1)	
Not exposed	770 (42.4)	305 (40.0)	452 (44.1)	
Missing	11 (0.6)	2 (0.3)	8 (0.8)	
Dust, n (%)				**0.015**
Exposed	1394 (76.7)	611 (80.1)	761 (74.2)	
Unexposed	397 (21.8)	143 (18.7)	249 (24.3)	
Missing	26 (1.4)	9 (1.2)	15 (1.5)	
Chemicals, n (%)				**0.011**
Exposed	499 (27.5)	238 (31.2)	254 (24.8)	
Unexposed	1290 (71.0)	516 (67.6)	756 (73.8)	
Missing	28 (1.5)	9 (1.2)	15 (1.5)	
SHS[c], n (%)				0.073
Exposed	776 (42.7)	339 (44.4)	429 (41.9)	
Unexposed	1021 (56.2)	421 (55.2)	582 (56.8)	
Missing	20 (1.1)	3(0.4)	14 (1.4)	
Injuries, n (%)				0.760
Exposed	527 (29.0)	227 (29.8)	295 (28.8)	
Unexposed	1272 (70.0)	530 (69.5)	719 (70.1)	
Missing	18 (1.0)	6 (0.8)	11 (1.1)	
Concern about exposure to occupational hazards[d]				**<0.001**
Mean ± SD (range)	15.6 ± 4.5 (6–24)	14.9 ± 4.3 (6–24)	16.2 ± 4.6 (6–24)	

[a] GED = general educational development
[b] A high score indicates more a positive view toward the union
[c] SHS = second-hand smoke
[d] A high score indicates more concern about exposure to occupational hazards
[#] 29 participants did not reply to the smoking outcome variable
[*] P value for χ^2 test or *t-test*
All values were calculated prior to imputing missing covariates.

Table 2

Multivariable Association of Individual and Occupational Factors with Current Smoking (N = 1,817)

Variables	Model 1		Model 2	
	OR (95% C.I.)	**P-value**	**OR (95% C.I.)**	**P-value**
Individual factors				
Age (continuous)	0.97 (0.95–0.98)	**<0.001**	0.97 (0.96–0.99)	**0.002**
Gender				
Male	0.60 (0.38–0.94)	**0.026**	0.73 (0.46–1.15)	0.178
Female	reference			
Race				
Hispanic	0.44 (0.25–0.78)	**0.005**	0.46 (0.26–0.83)	**0.010**
African America	0.57 (0.38–0.86)	**0.007**	0.61 (0.40–0.93)	**0.021**
Other	0.79 (0.52–1.20)	0.271	0.89 (0.58–1.36)	0.580
White, non-Hispanic	reference			
Income				
<$50,000	1.30 (1.01–1.66)	**0.041**	1.31 (1.01–1.70)	**0.040**
$50,000-74,999	1.40 (1.06–1.86)	**0.019**	1.44 (1.08–1.92)	**0.013**
≥$75,000	reference			
Education				
High school/GED[a] or less	1.59 (1.08–2.32)	**0.018**	1.49 (1.01–2.20)	**0.044**
Some college or 2-year degree	1.67 (1.13–2.46)	**0.010**	1.61 (1.08–2.39)	**0.019**
4-year college degree or more	reference			
Self-rated health				
Poor	4.91 (1.32–18.23)	**0.018**	6.33 (1.66–24.17)	**<0.007**
Fair	3.61 (2.21–5.90)	**<0.001**	3.79 (2.27–6.34)	**<0.001**
Good	2.41 (1.76–3.31)	**<0.001**	2.63 (1.89–3.66)	**<0.001**
Very good	1.37 (1.00–1.88)	**0.047**	1.48 (1.08–2.05)	**0.016**
Excellent	reference			
Occupational factors				
Trade type				
Plumbers & Pipefitters			0.93 (0.73–1.18)	0.552
Bricklayers			1.13 (0.77–1.67)	0.533
Ironworkers			1.40 (0.91–2.15)	0.130
Painters			1.11 (0.72–1.72)	0.636
Sprinkler fitters			1.10 (0.66–1.81)	0.724
Operating engineers			1.23 (0.57–2.63)	0.603
Electricians			reference	
Union commitment (continuous)			1.06 (1.00–1.12)	**0.043**
Job satisfaction				
Not at all satisfied			1.75 (0.64–4.76)	0.269
Not too satisfied			0.76 (0.48–1.20)	0.234
Somewhat satisfied			0.85 (0.67–1.07)	0.157
Very satisfied			reference	
Exposure to occupational hazards[b]				
Work-related musculoskeletal hazards			1.11 (0.90–1.37)	0.313
Dust			1.50 (1.15–1.95)	**0.002**
Chemicals			1.41 (1.11–1.79)	**0.005**
SHS[c]			1.12 (0.91–1.39)	0.290
Injuries			1.03 (0.82–1.30)	0.798
Concern about exposure to occupational hazards (continuous)			0.93 (0.91–0.95)	**<0.001**

[a] GED = general educational development; [b] Unexposed to each occupational hazard is the reference group
[c] SHS = second-hand smoke; OR = odds ratio, CI = confidence interval

CHAPTER 3

Determinants of Heavy Cigarette Smoking among Building Trades Workers

Abstract

Background: Blue collar workers are at increased risk for health challenges associated with heavy cigarette smoking due to their occupational exposures. Little is known about factors associated with this practice among blue-collar workers. The purpose of the study was to identify the determinants of heavy cigarette smoking in building trades workers, focusing on individual, interpersonal, and occupational factors.

Methods: This study used cross-sectional data from the MassBUILT study which assessed the effectiveness of a multipronged smoking cessation intervention at 10 Massachusetts building trades unions. The sample included 763 current smokers (92% male; mean age = 28 years; 81 % non-Hispanic White). Current smokers who smoked more than one pack of cigarettes per day (>20 cigarettes/day) were defined as heavy cigarette smokers. Multivariate logistic regression analysis was used to identify significant factors.

Results: Approximately 21% of current smokers were heavy smokers. Older age (OR = 1.10; 95% CI: 1.06–1.15), male gender (OR = 5.49; 95% CI: 1.70–17.80), poorer health status (OR = 2.09; 95% CI: 1.06–4.10), higher nicotine dependence (OR = 6.00; 95% CI: 3.50–10.29), and earlier age of smoking initiation (OR = 0.93; 95% CI: 0.86–0.99) were significantly associated with heavy cigarette smoking. Two psychological factors, higher temptation to smoke (OR = 1.53; 95% CI: 1.14–2.05) and greater perceived benefits of smoking (OR = 1.24; 95% CI: 1.04–1.49), were significantly associated with heavy smoking. Of the interpersonal factors, household smoking was significantly associated with heavy smoking. Those who lived alone were 4.7 times (95% CI: 1.74–12.78) more likely to report heavy smoking, followed by those who lived with a

household member who currently smoked (OR = 2.01; 95% CI: 1.17–3.47). Among occupational factors, only trade type and job satisfaction were significantly associated with heavy smoking.

Conclusion: Multiple factors are associated with heavy smoking. Addressing the influence of these factors on heavy smoking could lead to the development of targeted, multiple components in comprehensive smoking cessation strategies for blue-collar smokers.

Introduction

Cigarette smoking in the United States is the leading cause of preventable morbidity and mortality (U.S. Department of Health and Human Services [U.S. DHHS], 2004). In particular, higher numbers of cigarettes smoked per day increases the risk of cancers such as lung cancer (Doll, Peto, Boreham, & Sutherland, 2004; Flanders, Lally, Zhu, Henley, & Thun, 2003; Hubbard, Venn, Lewis, & Britton, 2000), liver or kidney cancer (Sasco, Secretan, & Straif, 2004), and a variety of cardiovascular diseases (e.g., peripheral arterial disease and coronary artery disease) (Doll, et al., 2004; Price et al., 1999), as well as various respiratory diseases (Doll, et al., 2004), diabetes (Willi, Bodenmann, Ghali, Faris, & Cornuz, 2007), psychiatric disorders (Johnson et al., 2000), and adverse reproductive effects (Windham, Elkin, Swan, Waller, & Fenster, 1999). Despite the fact that these health risks of smoking are well documented, smoking remains surprisingly prevalent.

Over the past 40 years, the prevalence of cigarette smoking among U.S. adults has been declining substantially, from 40.4% in 1964 (U.S. DHHS, 1989) and to 20.6% in 2009 (Centers for Disease Control and Prevention [CDC], 2010). In addition to the reduction in smoking prevalence, the prevalence of heavy smoking ($\geq$25 cigarettes per day) has also decreased during the past 11 years, from 19.1% of smokers in 1993 to 12.1% of smokers in 2004 (CDC, 2005).

Patterns of smoking vary by occupational groups. Blue-collar workers have nearly twice the smoking prevalence of both white-collar workers and the general population (Barbeau, Krieger, & Soobader, 2004; CDC, 2009; Lee et al., 2007). In addition, blue-collar workers are more likely to be heavy smokers over time (Covey, Zang, & Wynder,

1992; Giovino, Pederson, & Trosclair, 2000; Lawrence, Fagan, Backinger, Gibson, & Hartman, 2007). According to 1997 NHIS data for smokers only, blue-collar workers (27.5%) were more likely to report heavy smoking (>25 cigarettes/ day) than white-collar workers (18%) (Giovino, et al., 2000). In particular, among young adults aged 18–24 years, the odds of heavy smoking (smoking 20 cigarettes/day or more) among blue-collar workers were almost twice those for white-collar workers (OR=1.97) (Lawrence, et al., 2007). Blue-collar workers are at especially high risk for smoking-attributable diseases, because of increased intensity of smoking and the effects on disease processes (U.S. DHHS, 1989).

Heavy smokers face greater challenges in smoking cessation. They are less likely than light smokers to succeed in quitting smoking (Farkas, 1999; Hennrikus, Jeffery, & Lando, 1995; Hymowitz et al., 1997; Myung et al., 2007), and they are more at risk than lighter smokers for long-term smoking, suggesting an urgent need for interventions (Nordstrom et al., 2000). In addition, heavy smokers are at higher risk of relapse (Piper et al., 2008; Zhou et al., 2009). It is important to understand the characteristics of heavy smoking in terms of the development of appropriate smoking cessation programs.

Separate studies have analyzed the association of heavy smoking with various types of factors. For individual factors, sociodemographic characteristics, such as older age, male gender, race/ethnicity, and lower levels of education and income are associated with heavy smoking (Lawrence, et al., 2007; Messer, Trinidad, Al-Delaimy, & Pierce, 2008; U.S. DHHS, 1998, 2001; Wilson, Wakefield, Owen, & Roberts, 1992). Heavy smoking is also associated with poorer health status (Szklo & Coutinho, 2009; Wilson, Parsons, & Wakefield, 1999). Moreover, it is associated with more serious nicotine addiction

(Heatherton, Kozlowski, Frecker, Rickert, & Robinson, 1989; Wilson, et al., 1992), early age at smoking initiation (Chassin, Presson, Pitts, & Sherman, 2000; D'Avanzo, La Vecchia, & Negri, 1994; Wilkinson, Schabath, Prokhorov, & Spitz, 2007), and lack of previous attempts to quit (Goldberg et al., 1993).

In addition, heavy smokers have little confidence in their ability to quit smoking (Goldberg, et al., 1993; Wilson, et al., 1992), and have perceived difficulty in quitting smoking (Marques-Vidal et al., 2011; Thompson, Thompson, Thompson, Fredickson, & Bishop, 2003; Wilson, et al., 1992). Heavy smokers perceive many barriers to quitting (e.g., stress) and benefits to continuing to smoke (e.g., coping, relaxing) (Thompson, et al., 2003). Intention to quit in the next 30 days has a correlation with low cigarette consumption (Farkas et al., 1996). Temptation to smoke in specific situations (e.g., at a party with friends) is positively correlated with the number of cigarettes smoked (Breitling, Twardella, Raum, & Brenner, 2009).

The social environment is relevant to smoking behavior as well (Thompson, et al., 2003). Having a partner, friends or coworkers who smoke, and having a smoker in the household tends to make quitting more difficult (Chandola, Head, & Bartley, 2004; de Leeuw, Engels, Vermulst, & Scholte, 2009; Ferguson, Bauld, Chesterman, & Judge, 2005; Manchon Walsh et al., 2007; Monden, de Graaf, & Kraaykamp, 2003; Park, Tudiver, Schultz, & Campbell, 2004). In a qualitative study, heavy smokers reported that they felt many social pressures from family and friends to smoke (Thompson, et al., 2003). In particular, smokers with a partner who smokes reported more cigarettes smoked daily (Manchon Walsh, et al., 2007).

Occupational factors in the work environment may be important in explaining

occupational class differences in smoking behaviors and they may contribute to smoking behavior (Albertsen, Borg, & Oldenburg, 2006). Heavy smokers perceive that they have stressful job situations (Thompson, et al., 2003). In previous studies, job strain with high job demand or low job control, work-related stress, and high workload were associated with heavy smoking (Albertsen, et al., 2006; Green & Johnson, 1990; Hellerstedt & Jeffery, 1997; Kouvonen, Kivimaki, Virtanen, Pentti, & Vahtera, 2005; Otten, Bosma, & Swinkels, 1999; Steptoe et al., 1998; Steptoe, Wardle, Pollard, Canaan, & Davies, 1996; Tsutsumi et al., 2003). Blue-collar workers are more likely to be exposed to hazards on the job which may increase their overall health risk (Burkhart et al., 1993; Meeker, Susi, & Pellegrino, 2006; Rappaport, Goldberg, Susi, & Herrick, 2003; Sorensen et al., 1996).Hazardous exposures on the job (e.g., dust, chemicals) are typical job stressors for construction workers (Goldenhar, Swanson, Hurrell, Ruder, & Deddens, 1998).

Heavy smokers represent a high-risk subpopulation of building trades workers. To reduce the high smoking prevalence of blue-collar workers, it is important to assess the unique characteristics of the targeted subgroup, heavy smokers. Despite the higher prevalence of heavy smoking in blue-collar workers, no studies have examined differences in the characteristics of heavy smokers compared to light smokers. Therefore, the purpose of the present study is compare within subgroup differences (heavy smokers vs. light smokers) among current smokers and to identify the determinants associated with heavy cigarette smoking in building trades workers, focusing on individual, interpersonal, and occupational factors.

Methods

This study used cross-sectional data from the MassBUILT study that assessed the

effectiveness of a multipronged smoking cessation intervention among unionized building trades workers (Grant #: 1R01 DP000097-01, PI. Dr. Elizabeth M. Barbeau). A detailed description of the study design, sample and intervention has been published elsewhere (Okechukwu, Krieger, Sorensen, Li, & Barbeau, 2009, 2011; Okechukwu, Nguyen, & Hickman, 2010). The intervention study was delivered in collaboration with unions to apprentices at 10 building trades union sites in Massachusetts. Each union site runs apprenticeship training programs for individuals wishing to become unionized boilermakers, bricklayers, electricians, hoisting and portable engineers, ironworkers, painters, plumbers, pipefitters, sprinkler fitters, or refrigeration workers (Okechukwu, et al., 2009).

The sample for this study consisted of apprentices who voluntarily completed self-administered questionnaires on smoking, including potential individual, interpersonal, and occupational factors. All apprentices who were 18 years of age or older and were currently enrolled in the apprenticeship program were eligible to participate in the study. The sample used in the analysis (N=763) consisted of current smokers, which is defined as those who had smoked at least 100 cigarettes in life and had smoked in the last 30 days (National Center for Health Statistics, 2009). They were drawn from the full sample of 1,817 apprentices (93.6% response rate) at baseline. The Dana-Farber Cancer Institute Institutional Review Board approved all methods and materials used in the original study. All study procedures for the present study have received approval from the University of California San Francisco (UCSF) Committee on Human Subjects.

Measures

Dependent variable

Heavy cigarette smoking. Smoking intensity was defined by the question "During the past 30 days, on the days that you smoked, about how many cigarettes did you usually smoke that day?" and was categorized as 1 to 20 cigarettes versus more than 20 cigarettes per day. Respondents who indicated that they smoked more than one pack of cigarettes a day (>20 cigarettes/day) were classified as heavy smokers. The reference group consisted of those who smoked one pack of cigarettes or less a day (≤20 cigarettes/day).

Independent variables

The independent variables were comprised of three categories of factors—individual, interpersonal, and occupational.

Individual factors. Individual factors included sociodemographic characteristics, self-rated health status, smoking history, and several psychological factors.

Sociodemographic characteristics. Sociodemographic characteristics included: age; gender; race/ethnicity in four categories (Hispanic, Non-Hispanic African American, Non-Hispanic White, and other); education in three categories (high school/GED or less, some college or 2 year degree, and 4 years or more); household income in three categories (less than $50,000, $50,000–$74,999, and $75,000 or more).

Self-rated health status. Self-rated health status was assessed with a single question: "Would you say that in general your health is?" rating their status as excellent, very good, good, fair, or poor. Due to the low proportion of smokers with poor self-rated health status, the response was dichotomized into poor (fair or poor) and good (excellent, very good, or good) for logistic regression analysis.

Smoking history. Smoking history included previous quit attempts (number of quit attempts in the last 6 months), age of smoking initiation (year of first starting to smoke

fairly regularly), and time to the first cigarette after waking (≤30 minutes vs. >30 minutes).

Psychological factors. Psychological factors included intention *to quit smoking*, self-efficacy *for quitting smoking*, temptation *to smoke*, and decisional balance of smoking. *Intention to quit smoking* was assessed by asking whether participants who were current smokers were seriously thinking about quitting smoking in the next 6 months and/or 30 days, using yes/no response categories. *Self-efficacy for quitting smoking* was assessed by asking whether participants who were current smokers were confident that they would be able to stop smoking in the next 6 months and/or 30 days using a 5-point Likert scale from 1 (*not confident*) to 5 (*extremely confident*). A higher score indicates more confidence in the ability to quit smoking.

Temptation to smoke was assessed by a short form (9-item) situational temptation scale (Velicer, Diclemente, Rossi, & Prochaska, 1990), which describes a total of nine situations and asks participants to rate how tempted they may be to smoke in each situation (e.g., "with friends at a party"). A 5-point Likert scale ranging from 1 (*not at all tempted*) to 5 (*extremely tempted*) was used to rate each item. A higher score indicates more temptation to smoke. The reliability of the measure in the present study was high (Cronbach's $\alpha = 0.90$).

Decisional balance of smoking was assessed by a short form (6-item) smoking decisional balance scale (Velicer, DiClemente, Prochaska, & Brandenburg, 1985), composed of pros and cons of smoking. The three pro items measured perceptions of the advantages of smoking, such as "Smoking helps me concentrate and do better work." The three con items measured perceptions of the disadvantages of smoking, such as "People

think I'm foolish for ignoring the warnings about cigarette smoking." A 5-point Likert scale ranging from 1 (*not important*) to 5 (*extremely important*) rated each item. To calculate the decisional balance score, the average score for the cons subscale was subtracted from the average score for the pros subscale. If the number is positive, the participant is endorsing more "pros" than "cons" for smoking. If the number is negative, the participant is endorsing more "cons" than "pros" for smoking. The reliability of the subscale in the present study for the "pros" of smoking was Cronbach's $\alpha = .77$, and .68 for "cons" of smoking.

***Interpersonal factors*.** Interpersonal factors included household, partner, and friends/coworkers smoking.

Household smoking. Household smoking was assessed with one item asking "Does anyone who lives in the home currently smoke?" Responses were categorized as yes, live alone, or no.

Partner smoking. Partner smoking was assessed with one item asking "Do you have a partner/ spouse/ significant other who currently smokes cigarettes?" using yes/no response categories.

Friends/coworkers' smoking. Friends/coworkers' smoking was assessed with one item asking "how many of your friends/coworkers smoke cigarettes?" Responses were categorized as most/all, some, or few/none.

***Occupational factors*.** Occupational factors included trade type, union commitment, job satisfaction, exposure to occupational hazards, and concern about exposure to occupational hazards.

Trade type. Ten building trade unions were categorized into seven trades:

Electrician, plumber & pipefitter, bricklayer, ironworker, painter, sprinkler fitter, and operating engineer.

Union commitment. Union commitment was assessed by participants' attitudes toward their unions on five items, such as "I am proud to tell others that I am a union apprentice" (Barbeau et al., 2005; Lambert & Hopkins, 1995). A 4-point Likert scale ranging from 1 (*completely disagree*) to 4 (*completely agree*) rated each item. A higher score indicates more a positive view toward the union. The reliability of the measure in the present study was Cronbach's $\alpha = .73$.

Job satisfaction. Job satisfaction was measured by a single question: "How satisfied are you with your job?" Responses were categorized as very, somewhat, not too, or not at all satisfied.

Exposure to occupational hazards. Exposure to occupational hazards included work-related musculoskeletal hazards, chemicals, dust, injuries, and second-hand smoke (SHS) at work.

Work-related musculoskeletal hazards modified from the Washington State Ergonomics Rule (Washington State, 2000) were assessed by asking the number of hours per full shift (almost never, <1, 1–4, and >4 hours) requiring awkward postures of the shoulder, neck, back, or knee, repetitive hand motions, and hand force required to pinch or grip an object at work. Dust, chemicals, SHS, and injury exposures were assessed by the self-reported frequency of exposure to each, using three categories (a lot, rarely, and never). Exposure to occupational hazards was classified as the high exposure category (Okechukwu, Krieger, et al., 2010; Quinn et al., 2007): exposed more than four hours per work shift to awkward postures of the shoulder, neck, back, and knee, repetitive hand

motions, or hand force; exposed a lot to dust, chemicals, SHS, and injury. Based on these criteria, participants were classified as either exposed or unexposed to each occupational hazard.

Concern about exposure to occupational hazards. Concern about exposure to occupational hazards was assessed with six items about the level of concern about exposure to dust, chemicals, SHS, and injuries at work using a four-point Likert scale ranging from 1(*not at all*) to 4 (*very concerned*). A higher score indicates more concern about exposure to occupational hazards. The reliability of the measure in the present study was Cronbach's $\alpha = .82$.

Data Analysis

Data analyses were conducted using the SPSS, version 19.0. The study variables were characterized using descriptive statistics. Bivariate analysis was calculated to compare the individual, interpersonal, and occupational factors to smoking intensity (heavy smoker vs. light smoker), using chi-square for categorical variables and t-test for continuous variables. Multivariate logistic regression analysis was used to determine the relative influence of individual, interpersonal, and occupational factors on heavy cigarette smoking. The variables were entered as sets at each step. All variables entered in earlier steps were automatically included in the next steps. Individual factors (sociodemographics, self-rated health status, smoking history, psychological factors) were entered in Step 1. Interpersonal factors (household smoking, partner smoking, friends/coworkers' smoking) were added in Step 2. Occupational factors (trade type, union commitment, job satisfaction, exposure to occupational hazards, and concern about exposure to hazards) were added in Step 3.

For the multivariate analysis, assessment for multicollinearity was conducted first to deal with the issues related high intercorrelations among independent variables. There was strong correlation between intention to quit smoking at 30 days and 6 months (r = .58, p<.001) and self-efficacy for quitting smoking at 30 days and 6 months (r = .79, p <.001).Thus, intention to quit smoking at 30 days and self-efficacy for quitting smoking at 30 days, which had more objective and significant correlation with smoking intensity, were selected for the multivariate analyses.

A substantial number of current smokers (147/763, 19.3%) had missing data on at least one key sociodemographic variable in the analyses. Multiple imputation methods using SPSS Multiple Imputation were used to handle the missing data (SPSS Inc., 2010). Five imputed datasets, which were considered to be appropriate, were created (Allison, 2002; Rubin, 1996; Schafer, 1999). Statistical analysis was finally pooled to achieve single parameter estimates from the five multiple imputed datasets. For each variable, pooled estimates were used to report the odds ratios (ORs) and 95% confidence intervals (95% C.I.), along with a corresponding p-value. The ORs represent the probability of being a heavy smoker. A p-value of 0.05 or less was considered statistically significant.

Results

Characteristics of the Study Participants

The distribution of the study participants by individual (e.g., sociodemographic, smoking history, psychological factors), interpersonal, and occupational characteristics prior to imputing missing covariates is shown in Table 1. For individual factors, among current smokers, the mean age was 27.7 years, 91.7% were male, 81.1% were non-Hispanic White, 51.4% had a high school education or less, and 39.4% reported a

household income less than $50,000 yearly. The majority (90.6%) of current smokers reported their health as being excellent, very good or good. On average, current smokers started smoking fairly regularly at age 17 years. Approximately 42% of current smokers had high nicotine dependence as measured by smoking the first cigarette of the day within 30 minutes of waking. Almost half of the current smokers (47.3%) reported trying to quit smoking one or more times in the last 6 months.

In addition, about 66% of current smokers reported seriously thinking about quitting smoking in the next 6 months, this decreased to 44% for quitting in the next 30 days. Their mean self-efficacy score for quitting smoking was 3.3 for the next 6 months and 3.0 for the next 30 days. The mean score for temptation to smoke was 3.3, with a range from 1 to 5. The mean score for decisional balance was −0.2, with a range from −4–4; perceived cons of smoking (2.5) were higher than pros of smoking (2.3).

For interpersonal factors, about half of current smokers (49.7%) reported that a household member currently smoked, 40.8% reported that a partner/ spouse/ significant other smoked, and 26.9% reported most or all of their friends/coworkers smoked.

For occupational factors, almost 40% were electricians, followed by 32% plumbers and pipefitters. The mean union commitment score was 17.8, with a range from 9 to 20. Most respondents (61.3%) reported being very satisfied with their jobs. The most commonly reported occupational hazardous exposure was dust (80.1%), followed by work-related musculoskeletal hazards (59.8%), SHS (44.4%), chemicals (31.2%), and injuries (29.8%). The mean score for concern about exposure to hazards was 14.9, with a range of 6 to 24.

Heavy Cigarette Smoking

Of the 763 current smokers, approximately 21% of them were heavy smokers per the study definition.

Participant Characteristics by Heavy Smoking

Table 1 also compares individual, interpersonal and occupational factors by heavy cigarette smoking.

***Individual factors and heavy smoking*.** Of the sociodemographic characteristics, age and health status were significantly associated with smoking intensity. Heavy smokers (n = 156) compared to light smokers were significantly older (29.2 vs. 27.2 years respectively, p <.001), and were more likely to report poor/fair self-rated health status (15.4% vs. 7.7%, p = .010).

Of the smoking history, heavy smokers reported starting smoking fairly regularly at a younger age (15.7 vs. 16.8 years, p = .001) and had higher nicotine dependence as measured by smoking the first cigarette of the day within 30 minutes of waking (78.8% vs. 32.9%, p = <.001), compared with light smokers. There was no significant difference in quit attempts (p = .576), but over half of both heavy and light smokers reported never trying to quit smoking in the last 6 months.

Of the psychosocial factors, heavy smokers were significantly less likely to report seriously thinking about quitting smoking in the next 30 days (37.2% vs. 45.7% , p = .046) or in the next 6 months (65.4 % vs. 66.1%, p =.040), compared with light smokers. Heavy smokers reported nearly twice the intention to quit smoking at 6 months than at 3 months. They were also less likely to be confident in their ability to quit smoking in the next 6 months (2.8 vs. 3.5, p <.001) and 30 days (2.5 vs. 3.2, p <.001), and were more likely to be tempted to smoke (3.8 vs. 3.1 respectively, p < .001). Heavy

smokers reported a positive decisional balance (0.3), compared to light smokers (−0.3) (p <.001). They were more likely to report pros for smoking (2.6 vs. 2.2, p < .001), but less likely to report cons for smoking (2.3 vs. 2.5, p = .029).

***Interpersonal factors and heavy smoking*.** Compared to light smokers, heavy smokers were significantly more likely to report that household members currently smoked cigarettes (63.5% vs. 46.4%, p <.001), or to live alone (9.6% vs. 3.8%, p<.001). The same was true for partners/spouse/significant other smoking (51.3% vs. 38.2%, p = .005).

***Occupational factors and heavy smoking*.** No significant differences were found for any occupational factor and heavy smoking. Heavy smokers were only marginally more likely to be exposed to chemicals at work than light smokers (35.9% vs. 30.2%, p = .068).

Determinants of Heavy Smoking by Multivariate Logistic Regression Analyses

Table 3 presents the variables significantly associated with heavy smoking in the logistic regression model. Model 1, which included the individual factors, older age (OR = 1.10; 95% CI: 1.06–1.14), male smokers (OR = 3.95; 95% CI: 1.38–11.25), and poorer health status (OR = 1.98; 95% CI: 1.04–3.78) were significantly associated with an increased likelihood of heavy smoking. Those who smoked the first cigarette of the day within 30 minutes of waking (OR = 5.32; 95% CI: 3.26–8.67) and perceived higher temptation to smoke (OR = 1.67; 95% CI: 1.23–2.26) were significantly more likely to be heavy smokers. Those who started smoking earlier and had a higher decisional balance (more perceived pros of smoking) were marginally more likely to be heavy smokers (p <.10).

Model 2, which added interpersonal factors, demonstrated ORs that were similar to those of individual factors observed in Model 1. That is, older age (OR = 1.09; 95% CI: 1.05–1.14), male smokers (OR = 4.16; 95% CI: 1.43–12.12), poorer health status (OR = 1.98; 95% CI: 1.03–3.79), smoking the first cigarette of the day within 30 minutes of waking (OR = 5.32; 95% CI: 3.26–8.67) and higher perceived temptation to smoke (OR = 1.47; 95% CI: 1.12–1.94) were significantly associated with an increased likelihood of heavy smoking. In addition, those who started smoking earlier were significantly more likely to be heavy smokers (OR = 0.93; 95% CI: 0.87–1.00). Of the interpersonal factors, only household smoking was significantly associated with heavy smoking. Those who lived alone were 4.46 times (95% CI: 1.76–11.26) more likely to be heavy smokers compared to those who lived with household members who did not currently smoke, followed by those who lived with a household member who currently smoked (OR = 1.88; 95% CI: 1.13–3.14).

Finally, occupational factors were added in Model 3. Similar to the previous models, age, gender, self-rated health status, smoking the first cigarette of the day within 30 minutes of waking, perceived temptation to smoke, age of smoking initiation, and household smoking were significant associated with heavy smoking. In addition, greater decisional balance was significantly associated with an increased likelihood of heavy smoking (OR = 1.24; 95% CI: 1.04–1.49). By trade, bricklayers (OR = 2.38; 95% CI: 1.02–5.54), and operating engineers (OR = 9.00; 95% CI: 1.81–44.76), were significantly more likely to be heavy smokers as compared to electricians. Those who were not at all satisfied with their jobs were significantly less likely to be heavy smokers than those who were very satisfied with their jobs (OR = 0.07; 95% CI: 0.01–0.63). Higher exposure to

chemicals was marginally associated with heavy smoking (OR = 1.53; 95% CI: 0.94–2.51).

Discussion

Main Findings and Implications

The present study is the first to examine multiple factors, such as individual, interpersonal, and occupational factors of heavy smokers compared with light smokers and to investigate the determinants of heavy smoking among building trade workers who have higher smoking rates. The findings indicated that 21% of current smokers were heavy smokers (n = 156), as defined by smoking more than a pack of cigarettes per day. This was slightly lower than the estimate of heavy smoking from the Tobacco Use Supplement to the Current Population Survey data among young adults aged 18–24 years (Lawrence, et al., 2007). Blue-collar workers have already been described as being more likely than white-collar workers to be heavy smokers (Covey, et al., 1992; Giovino, et al., 2000; Lawrence, et al., 2007). The present study shows that heavy smokers are characteristically different from light smokers within the smoker population. Recognizing these differences is important for developing improved and more effectively targeted smoking cessation intervention strategies for high risk heavy smokers.

Individual factors.

In contrast to previous studies in the general population that have shown that several sociodemographic characteristics are significantly associated with heavy smoking, the present study of construction workers found that age and gender were the only sociodemographic characteristic associated with heavy smoking. Older age was significantly associated with heavy smoking, consistent with prior research findings

(Messer, et al., 2008; Wilson, et al., 1992). And, male smokers were significantly more likely to be heavy smokers in the multivariate analysis. Similar to the findings from this study, a study which used NHIS data found that men were almost twice as likely to be heavy smokers as women (22.6% vs. 12.1%) (U.S. DHHS, 2001). The gender difference in the prevalence of heavy smoking was not as severe among unionized construction workers in the present study. In fact, there were no differences in smoking by gender in the unadjusted analysis.

In contrast to the present study findings, the Surgeon General's report indicated that heavy smoking was associated with race/ethnicity and educational attainment (U.S. DHHS, 1998). Also, analysis of nationally representative data from the census found that men and those with low income (<$20,000) were slightly more likely to report heavy smoking. The odds ratio for reporting heavy smoking among white smokers was more than two and a half times that of black smokers among young adults aged 18–24 years (Lawrence, et al., 2007). These studies used nationally representative samples. The present study uses a sample of unionized construction workers whose smoking prevalence and level of heavy smoking is almost twice the national prevalence for the same period. This study contends that the differences in sociodemographic variables associated with smoking between the two groups point to the differences between this group of smokers and smokers in the general population. It also speaks to the importance of the present study in concentrating on this group to understand the determinants of heavy smoking among them.

The present study found that heavy smoking was significantly associated with higher nicotine dependence as measured by the time to smoke the first cigarette of the

day after awakening. This finding is consistent with results from prior investigations that supported the nicotine addiction association (Heatherton, et al., 1989; Wilson, et al., 1992). The time to smoke the first cigarette of the day after awakening is a single-item measure of nicotine dependence, which has been proven to be valid (Baker et al., 2007; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). In particular, high nicotine dependence is most consistently associated with an increased risk of smoking cessation relapse (Baker, et al., 2007; Piper, et al., 2008). Heavy smoking related to nicotine dependence is related to higher risk of relapse, and nicotine replacement therapy may be a very important aid for more nicotine dependent heavy smokers.

Blue-collar workers usually initiate smoking earlier than white collar workers (Giovino, et al., 2000). Prior studies have indicated a strong association between early age of smoking initiation and subsequent heavy smoking (Chassin, et al., 2000; D'Avanzo, et al., 1994; Wilkinson, et al., 2007). Similarly, the present study found that heavy smokers started smoking fairly regularly at a significantly younger age than lighter smokers. Younger age at smoking initiation is associated with increased lung cancer mortality (Hegmann et al., 1993; Knoke, Shanks, Vaughn, Thun, & Burns, 2004). Therefore, the present study points to the importance of addressing both an earlier age of smoking initiation and heavy smoking among blue-collar workers.

Previous studies have demonstrated that several psychological factors are associated with smoking behavior. Intention to quit smoking (Ajzen & Madden, 1986; Norman, Conner, & Bell, 1999)and self-efficacy (de Vries & Backbier, 1994; DiClemente, Prochaska, & Gibertini, 1985) are strong predictors of the individual’s success in taking action to quit smoking or maintain smoking cessation. Furthermore, decisional balance

(perceptions of the pros and cons of smoking and quitting) and temptation to smoke, which are key constructs in the Transtheoretical Model (Prochaska & DiClemente, 1983; Prochaska & Velicer, 1997), influence quitting behavior (Breitling, et al., 2009; Dijkstra, de Vries, & Bakker, 1996; Pollak, Carbonari, DiClemente, Niemann, & Mullen, 1998). In the present study, even though intention to quit and self-efficacy were not significant determinants of heavy smoking in multivariate logistic regression models, in bivariate analyses, there were significant differences in all psychological factors in heavy as compared to lighter cigarette smokers. This finding indicates that heavy cigarette smokers are significantly less likely to intend to quit smoking, to express confidence in the ability to quit smoking, and are more likely to perceive temptation to smoke and perceive the pros of smoking. Similarly, prior studies found that lack of confidence in the ability to quit smoking was significantly related to current heavy cigarette smoking (Goldberg, et al., 1993; Wilson, et al., 1992). In a qualitative study which conducted intensive interviews of heavy smokers, heavy smokers reported the emotional support provided by smoking as reinforcing their perception of smoking as relaxing (Thompson, et al., 2003). In that respect, this group of smokers with low readiness (e.g., no intention to quit, lack of confidence in their ability to quit smoking, higher temptation to smoke, higher pros for smoking) may be a high-risk group which needs tailored interventions to improve their desire to quit.

Interpersonal factors

Another important finding of the present study was the impact of household smoking as a determinant of heavy smoking. Smokers living with household members who smoked were significantly more likely to be heavy smokers. Also, heavy smokers

were significantly more likely to report partner smoking than light smokers in the bivariate analysis. Consistently, smokers with a smoking partner or household members who smoked reported more cigarettes smoked daily (Baumert et al., 2010; Manchon Walsh, et al., 2007). Heavy smokers have much in their social environment that leads to the pressure to smoke, including friends and family members who smoke (Thompson, et al., 2003).

On the other hand, surprisingly, those who lived alone were also significantly more likely to be heavy smokers and were twice as likely to be heavy smokers than those who lived with other smokers. There is no information about specific differences in smoking behaviors by living situation. This present study did not collect information about the reasons why workers lived alone such as their marital status (e.g., single, widowed, divorced). In future studies, additional qualitative research may be needed to assess in more detail the social contexts and perceptions smokers have about why they smoke more heavily. However, the findings indicate that even though smokers living together with other smokers consumed a higher number of cigarettes daily, those living alone were at higher risk for heavy smoking. The presence of household members may affect trying to cut down on the number of cigarettes than the absence of them regardless of whether they are smokers or not. It is important that smoking cessation programs should involve household members, partners, and coworkers to enhance social support for helping smokers adopt positive smoking behavior changes. Furthermore, a strong social support network for smokers who live alone should be provided.

Occupational factors

Most of the occupational factors were not associated with an increased likelihood of

heavy smoking but the factors that were point to the importance of understanding occupational contributions to heavy smoking. Bricklayers and operating engineers were more likely to report heavy smoking than electricians. However, the results for the operating engineers should be interpreted with caution because of small sample (n = 14) thus reduced power. Thompson and colleagues (2003) reported that heavy smokers in stressful job situations had pressure to continue to smoke. Compared to other construction workers, bricklayers have potentially high exposures to various toxic chemicals, such as silica or asbestos (Flanders, et al., 2003; Lynge, Kurppa, Kristofersen, Malker, & Sauli, 1986), physically demanding work (one handed repetitive lifting of bricks) and musculoskeletal symptoms in one or more body regions (Van Der Molen, Veenstra, Sluiter, & Frings-Dresen, 2004). Furthermore, operating engineers are those workers who, in general, operate and maintain heavy earthmoving equipment, thus are faced with risk factors for work-related musculoskeletal disorders (Stern & Haring-Sweeney, 1997; Zimmermann, Cook, & Rosecrance, 1997). Because they perform many varied duties, they also have potential for exposure to numerous chemical, physical, and biological agents (Stern & Haring-Sweeney, 1997). The results of the present study suggest that bricklayers and operating engineers as groups should be targeted specifically for smoking cessation interventions. Bricklayers and operating engineers work outside; thus, they are not subject to Clean Indoor Air rules about smoking on the job.

Exposure to hazards such as silica has been associated with excess mortality from lung cancer, stomach cancer, and respiratory diseases among construction workers (Finkelstein & Verma, 2005; Flanagan, Seixas, Majar, Camp, & Morgan, 2003; Knutsson, Damber, & Jarvholm, 2000; Lynge, et al., 1986; Robinson et al., 1995; Salg & Alterman,

2005; Stern et al., 1995). In particular, smoking may have synergistic effects with a variety of occupational exposures (dusts, chemicals, fumes) therefore increasing the cancer risk for blue-collar workers (Sorensen, 2001; Sorensen, Barbeau, Hunt, & Emmons, 2004). Heavy smoking may elevate the risk for lung and other cancers, diseases associated with heavy exposure to dust or chemicals among blue-collar workers. Smokers who were not at all satisfied with their jobs were significantly less likely to be heavy smokers than those who were very satisfied with their jobs. This finding indicated that the workplace might be an important avenue for interventions for heavy smokers since they have more positive feelings about their workplaces.

Strengths and Limitations

The strengths of the present study include a large sample size from multiple union trade sites and use of standardized and validated instruments to elicit current and prior smoking-rated characteristics. Also, we used multiple imputation methods, which uses information on variables with missing data to more accurately estimate regression models. This method is superior to listwise deletion which involves a loss of observations and reduced statistical power (Allison, 2002; Rubin, 1987). Overall the present study attained a high response rate in a hard to reach population comprised of diverse trades.

Limitations include the cross-sectional design, which limits conclusions about possible causality due to the inability to establish temporal precedence. Also, the present study has limited generalizability because the data are from a smoking cessation intervention study, thus blue collar workers in this sample may have been more willing to quit smoking. The fact that the present study participants were unionized further limits the generalizability of this study. Although skilled construction workers are more likely

to be unionized than other workers, unionized workers make up a limited proportion of workers in the United States (U.S. Bureau of Labor Statistics, 2011; Yates, 1998). Furthermore, although the study drew from diverse union sites and had an overall large sample size, non-white racial and ethnic groups and females had small sample sizes. This represents the sociodemographic characteristics of skilled unionized construction workers but it did not allow for further stratification of the data and limited generalization of the findings to the general population. Finally, smoking behavior was self-reported and was not validated by any biochemical markers in this study. Therefore, it is possible that participants underreported their cigarette consumption; however, several studies have demonstrated that self-reported smoking behavior is valid (Caraballo, Giovino, Pechacek, & Mowery, 2001; Patrick et al., 1994).

Conclusion

The findings from this present study helped us better understand the multiple factors (e.g., sociodemographic factors, psychological variables) that influence heavy cigarette smoking among building trades workers. These findings provide data that will help researchers develop effective targeted prevention and cessation interventions for subpopulations of smokers at high risk of heavy smoking. More tailored interventions that enhance the knowledge and perception of the benefits of quitting and which increase intentions to quit, intensive pharmacological interventions, and intervention strategies which include smokers' partners or household members, may be needed to help heavy smokers quit. The design of worksite smoking cessation interventions should consider the varying characteristics of different subgroups of the smoking population.

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Table 1

Individual, Interpersonal, and Occupational Factors by Heavy Smoking among Building Trades Smokers (N = 763)

Variables	Current Smokers N=763	Total [#] Light smokers (≤20cigs/day) n=599, 79.3%	Total [#] Heavy smokers (>20cigs/day) n=156, 20.7%	P-value*
Individual factors				
Age (year)				**<0.001**
Mean ± SD	27.7 ± 5.9	27.2 ± 5.8	29.2 ± 6.2	
(Range)	(18–49)	(18–49)	(18–47)	
Gender, n (%)				0.495
Male	700 (91.7)	546 (91.2)	146 (93.6)	
Female	44 (5.8)	38 (6.3)	6 (3.8)	
Missing	19 (2.5)	15 (2.5)	4 (2.6)	
Race/Ethnicity, n (%)				0.653
Hispanic	18 (2.4)	14 (2.3)	4 (2.6)	
African America, non-Hispanic	40 (5.2)	34 (5.7)	5 (3.2)	
Other, non-Hispanic	44 (5.8)	33 (5.5)	10 (6.4)	
White, non-Hispanic	619 (81.1)	487 (81.3)	126 (80.8)	
Missing	42 (5.5)	31 (5.2)	11 (7.1)	
Education, n (%)				0.584
High school/GED[a] or less	392 (51.4)	302 (50.4)	87 (55.8)	
Some college or 2-year degree	287 (37.6)	229 (38.2)	55 (35.3)	
4-year college degree or more	48 (6.3)	40 (6.7)	7 (4.5)	
Missing	36 (4.7)	28 (4.7)	7 (4.5)	
Income, n (%)				0.618
<$50,000	301 (39.4)	232 (38.7)	67 (42.9)	
$50,000–74,999	172 (22.5)	133 (22.2)	36 (23.1)	
≥$75,000	181 (23.7)	144 (24.0)	35 (22.4)	
Missing	109 (14.3)	90 (15.0)	18 (11.5)	
Self-rated health[b], n (%)				**0.010**
Good	691 (90.6)	551 (92.0)	132 (84.6)	
Poor	70 (9.2)	46 (7.7)	24 (15.4)	
Missing	2 (0.3)	2 (0.3)	0 (0.0)	
Smoking history				
Number of attempts to quit smoking, n (%)				0.386
None	385 (50.5)	299 (49.9)	83 (53.2)	
≥1	361 (47.3)	287 (47.9)	72 (46.2)	
Missing	17 (2.2)	13 (2.2)	1 (0.6)	
Time to first cigarette after waking, n (%)				
≤ 30minutes	320 (41.9)	197 (32.9)	123 (78.8)	**<0.001**
> 30minutes	429 (56.2)	395 (65.9)	31 (19.9)	
Missing	14 (1.8)	7 (1.2)	2 (1.3)	
Age of smoking initiation				**0.001**
Mean ± SD	16.6 ± 3.7	16.8 ± 3.7	15.7 ± 3.5	
(Range)	(8–38)	(8–38)	(8–29)	
Psychological factors				
Intention to quit at 6 months, n (%)				
Yes	502 (65.8)	396 (66.1)	102 (65.4)	**0.040**
No	221 (29.0)	168 (28.0)	52 (33.3)	
Missing	40 (5.2)	35 (5.8)	2 (1.3)	
Intention to quit at 30 days, n (%)				
Yes	333 (43.6)	274 (45.7)	58 (37.2)	**0.046**
No	383 (50.2)	288 (48.1)	92 (59.0)	
Missing	47 (6.2)	37 (6.2)	6 (3.8)	
Self-efficacy for quitting at 6 months				
Mean ± SD	3.3 ± 1.3	3.5 ± 1.3	2.8 ± 1.3	**<0.001**
(Range)	(1–5)	(1–5)	(1–5)	

Table 1 (*Continued*)

Variables	Current Smokers N=763	Total [#] Light smokers (≤20cigs/day) n=599, 79.3%	Total [#] Heavy smokers (>20cigs/day) n=156, 20.7%	P-value*
Self-efficacy for quitting at 30 days				
Mean ± SD (Range)	3.0 ± 1.5 (1–5)	3.2 ± 1.4 (1–5)	2.5 ± 1.5 (1–5)	**<0.001**
Temptation to smoke				
Mean ± SD (Range)	3.3 ± 1.0 (1–5)	3.1 ± 1.0 (1–5)	3.8 ± 0.9 (1–5)	**<0.001**
Decisional balance (pros−cons) [c]				
Mean ± SD (Range)	−0.2 ± 1.4 (−4–4)	−0.3 ± 1.3 (−4–4)	0.3±1.5 (−3.67–4)	**<0.001**
Pros of smoking				
Mean ± SD (Range)	2.3 ± 1.0 (1–5)	2.2 ± 1.0 (1–5)	2.6 ± 1.1 (1–5)	**<0.001**
Cons of smoking				
Mean ± SD (Range)	2.5 ± 1.1 (1–5)	2.5 ± 1.1 (1–5)	2.3 ± 1.0 (1–5)	**0.029**
Interpersonal factors				
Household smoking, n (%)				
Yes	379 (49.7)	278 (46.4)	99 (63.5)	**<0.001**
Live alone	38 (5.0)	23 (3.8)	15 (9.6)	
No	332 (43.5)	289 (48.2)	38 (24.4)	
Missing	14 (1.8)	9 (1.5)	4 (2.6)	
Partner smoking, n (%)				**0.005**
Yes	311 (40.8)	229 (38.2)	80 (51.3)	
No	435 (57.0)	359 (59.9)	71 (45.5)	
Missing	17 (2.2)	11 (1.8)	5 (3.2)	
Friends/coworkers smoking, n (%)				0.874
Most or all	205 (26.9)	158 (26.4)	44 (28.2)	
Some	480 (62.9)	380 (63.4)	96 (61.5)	
Few or none	58 (7.6)	47 (7.8)	11 (7.1)	
Missing	20 (2.6)	14 (2.3)	5 (3.2)	
Occupational factors				
Type of trade, n (%)				0.542
Electricians	303 (39.7)	247 (41.2)	54 (34.6)	
Plumbers & Pipefitters	245 (32.1)	190 (31.7)	53 (34.0)	
Bricklayers	68 (8.9)	51 (8.5)	17 (10.9)	
Ironworkers	50 (6.6)	38 (6.3)	11 (7.1)	
Painters	50 (6.6)	39 (6.5)	10 (6.4)	
Sprinkler fitters	33 (4.3)	26 (4.3)	6 (3.8)	
Operating engineers	14 (1.8)	8 (1.3)	5 (3. 2)	
Union commitment [d]				0.657
Mean ± SD	17.8 ± 2.0	17.8 ± 2.0	17.7 ± 1.8	
(Range)	(9–20)	(9–20)	(12–20)	
Job satisfaction, n (%)				0.606
Very satisfied	468 (61.3)	372 (62.1)	92 (59.0)	
Somewhat satisfied	232 (30.4)	176 (29.4)	53 (34.0)	
Not too satisfied	40 (5.2)	32 (5.3)	8 (5.1)	
Not at all satisfied	14 (1.8)	13 (2.2)	1 (0.6)	
Missing	9 (1.2)	6 (1.0)	2 (1.3)	
Exposure to occupational hazards				
Work-related musculoskeletal hazards, n (%)				0.712
Exposed	456 (59.8)	357 (59.6)	96 (61.5)	
Not exposed	305 (40.0)	240 (40.1)	60 (38.5)	
Missing	2 (0.3)	2 (0.3)	0 (0.0)	

Table 1 (*Continued*)

Variables	Current Smokers N=763	Total [#]		P-value*
		Light smokers (≤20cigs/day) n=599, 79.3%	Heavy smokers (>20cigs/day) n=156, 20.7%	
Dust, n (%)				0.367
Exposed	611 (80.1)	474 (79.1)	131 (84.0)	
Unexposed	143 (18.7)	118 (19.7)	23 (14.7)	
Missing	9 (1.2)	7 (1.2)	2 (1.3)	
Chemicals, n (%)				0.068
Exposed	238 (31.2)	181 (30.2)	56 (35.9)	
Unexposed	516 (67.6)	413 (68.9)	96 (61.5)	
Missing	9 (1.2)	5 (0.8)	4 (2.6)	
SHS[e], n (%)				0.833
Exposed	339 (44.4)	269 (44.9)	68 (43.6)	
Unexposed	421 (55.2)	328 (54.8)	87 (55.8)	
Missing	3(0.4)	2 (0.3)	1 (0.6)	
Injuries, n (%)				0.480
Exposed	227 (29.8)	181 (30.2)	45 (28.8)	
Unexposed	530 (69.5)	413 (68.9)	111 (71.2)	
Missing	6 (0.8)	5 (0.8)	0 (0.0)	
Concern about exposure to hazards[t]				
Mean ± SD	14.9 ± 4.3	15.0 ± 4.4	14.5 ± 4.1	0.164
(range)	(6–24)	(6–24)	(7–24)	

[a] GED = general educational development
[b] Good=excellent, very good, good, Poor=fair, poor
[c] Decisional balance = pros of smoking – cons of smoking
[d] A high score indicates more a positive view toward the union
[e] SHS = secondhand smoke
[f] A high score indicates more concern about exposure to occupational hazards
[#] 8 participants did not reply to the smoking intensity variable
*P value for χ^2 test or *t-test*
All values were calculated prior to imputing missing covariates.

Table 2
Multivariate Logistic Regression Models of Heavy Smoking (N = 763)

Variables	Model 1	Model 2	Model 3
	OR (95% C.I.)	**OR (95% C.I.)**	**OR (95% C.I.)**
Individual factors			
Age (continuous)	**1.10 (1.06–1.14)*****	**1.09 (1.05–1.14)*****	**1.10 (1.06–1.15)*****
Gender			
Male	**3.95 (1.38–11.25)***	**4.16 (1.43–12.12)****	**5.49 (1.70–17.80)****
Female	reference		
Race			
Hispanic	1.78 (0.37–8.53)	1.86 (0.39–8.99)	2.79 (0.53–14.62)
African American, non-Hispanic	0.43 (0.14–1.31)	0.60 (0.20–1.82)	0.58 (0.18–1.89)
Other, non-Hispanic	1.25 (0.53–2.96)	1.17 (0.47–2.87)	1.34 (0.52–3.47)
White, non-Hispanic	reference		
Income			
<$50,000	0.85 (0.47–1.54)	0.72 (0.39–1.34)	0.71 (0.37–1.39)
$50,000–74,999	0.88 (0.47–1.62)	0.84 (0.45–1.56)	0.80 (0.42–1.52)
≥$75,000	reference		
Education			
High school/GED[a] or less	1.54 (0.56–4.21)	1.62 (0.56–4.69)	1.60 (0.54–4.80)
Some college or 2year college	1.92 (0.68–5.43)	2.15 (0.71–6.49)	2.27 (0.73–7.11)
4year college or more	reference		
Self-rated health[b]			
Poor	**1.98 (1.04–3.78)***	**1.98 (1.03–3.79)***	**2.09 (1.06–4.10)***
Good	reference		
Smoking history			
Number of attempts to quit smoking			
≥1	1.06 (0.66–1.71)	1.11 (0.68–1.80)	1.25 (0.75–2.07)
None	reference		
Time to first cigarette after waking			
≤ 30minutes	**5.32 (3.26–8.67)*****	**4.86 (2.95–8.02)*****	**6.00 (3.50–10.29)*****
> 30minutes	reference		
Age of smoking initiation (continuous)	0.94 (0.88–1.00)†	**0.93 (0.87–1.00)***	**0.93 (0.86–0.99)***
Psychological factors			
Intention to quit at 30 days			
Yes	0.69 (0.41–1.16)	0.69 (0.41–1.16)	0.67 (0.39–1.17)
No	reference		
Self-efficacy for quitting 30 days (continuous)	0.95 (0.81–1.12)	0.97 (0.83–1.15)	1.01 (0.85–1.20)
Temptation to smoke(continuous)	**1.46 (1.12–1.90)****	**1.47 (1.12–1.94)****	**1.53 (1.14–2.05)****
Decisional balance (continuous)	1.18 (1.00–1.39)†	1.18 (0.99–1.39)†	**1.24 (1.04–1.49)***
Interpersonal factors			
Household smoking			
Yes		**1.88 (1.13–3.14)***	**2.01 (1.17–3.47)***
Live alone		**4.46 (1.76–11.26)****	**4.71 (1.74–12.78)****
No		reference	reference
Partner/spouse/significant other smoking			
Yes		1.23 (0.78–1.93)	1.19 (0.74–1.90)
No		reference	reference
Friends/Coworkers smoking			
Most or all		0.83 (0.34–2.03)	0.72 (0.28–1.87)
Some		0.88 (0.39–2.02)	0.84 (0.35–2.01)
Few or none		reference	reference

Table 2 (*Continued*)

Variables	Model 1	Model 2	Model 3
	OR (95% C.I.)	**OR (95% C.I.)**	**OR (95% C.I.)**
Occupational factors			
Trade type			
Plumbers & Pipefitters			1.28 (0.74–2.20)
Bricklayers			**2.38 (1.02–5.54)**[*]
Ironworkers			1.49 (0.61–3.66)
Painters			1.67 (0.66–4.22)
Sprinkler fitters			1.12 (0.35–3.56)
Operating engineers			**9.00 (1.81–44.76)**[**]
Electricians			reference
Union commitment (continuous)			0.97 (0.86–1.11)
Job satisfaction			
Not at all satisfied			**0.07 (0.01–0.63)**[*]
Not too satisfied			1.50 (0.56–4.04)
Somewhat satisfied			0.98 (0.57–1.69)
Very satisfied			reference
Exposure to occupational hazards[c]			
Work-related musculoskeletal hazards			0.76 (0.47–1.22)
Dust			1.33 (0.71–2.49)
Chemical			1.53 (0.94–2.51)[†]
SHS[d]			0.81 (0.50–1.30)
Injuries			1.08 (0.65–1.80)
Concern about exposure to hazards (continuous)			0.97 (0.92–1.03)

[**] P<0.05, [**] P<0.01, [***] P<0.001, [†] P<0.1

[a] GED = general educational development

[b] Poor = fair and poor, Good=good, very good, and excellent

[c] Unexposed to each occupational hazard is the reference group

[d] SHS = secondhand smoke

OR = odds ratio, CI = confidence interval

CHAPTER 4

Individual, Interpersonal, and Occupational Predictors of Quitting Cigarette Smoking among Building Trades Workers

Abstract

Objective: The purpose of the study was to assess the impact of individual, interpersonal, and occupational predictors of quitting cigarette smoking, after controlling for the effects of participating in a smoking cessation intervention for building trades workers.

Methods: Longitudinal data came from the MassBUILT smoking cessation intervention study for unionized building trades workers. Multivariate logistic regression analyses were applied to identify the significant predictors of quitting smoking which assessed 7-day point prevalence abstinence at 1 month follow-up and prolonged abstinence at least 6 months. Potential predictors for abstinence from smoking included baseline individual, interpersonal, and occupational factors.

Results: More concern about exposure to occupational hazards was significantly associated with increased likelihood of quitting smoking at 1 month (OR = 1.06; 95% CI: 1.01–1.11). Furthermore, older age, higher levels of educational attainment and household income, and fewer cigarettes smoked per day were important predictors of quitting smoking.

Conclusion: Addressing concern of exposures to hazards at work might be helpful when developing comprehensive smoking cessation intervention programs for building trades workers. Additionally, appropriate interventions should be targeted at the lower socioeconomic groups and smokers who smoke more heavily.

Introduction

Quitting smoking has immediate as well as long-term benefits, reducing the risk for diseases caused by smoking and improving health in general (U.S. Department of Health and Human Services [U.S. DHHS], 2004). According to the National Health Interview Survey (NHIS), the overall quit ratio was stable and ranged from 49% (1998) to 51% (2008) in U.S. adults (Centers for Disease Control and Prevention [CDC], 2009). Despite the fact that the health risks of smoking and the benefits of quitting are well known, blue-collar workers have lower quit rates compared to white-collar workers (37% vs. 51%) (Giovino, Pederson, & Trosclair, 2000). In addition to the slow declines in blue-collar workers' smoking prevalence over time, the quit ratio, which differs by occupational class, may lead to a widening of the persistent occupational disparity in smoking behavior (Barbeau, Krieger, & Soobader, 2004; Covey, Zang, & Wynder, 1992; Giovino, et al., 2000; Sorensen, 2001) and corresponding smoking-related health disparities.

Numerous studies have addressed individual factors associated with smoking cessation. In particular, previous studies using national data obtained from U.S. adults have found that a number of sociodemographic characteristics have been related to smoking cessation outcomes, including age, gender, race/ethnicity, income level, and educational attainment (CDC, 2009; Fagan, Shavers, Lawrence, Gibson, & O'Connell, 2007; Lee & Kahende, 2007; U.S. DHHS, 1998). Furthermore, fewer cigarettes smoked per day have been associated with increasing the likelihood of future cessation (Dale et al., 2001; Hyland et al., 2006; Hyland et al., 2004).

The interpersonal factors in the social environment could influence smoking behavior among blue-collar workers. There is evidence that the absence of household

members, friends, coworkers, or partners who smoked is highly associated with successful smoking cessation (Chandola, Head, & Bartley, 2004; J. Ferguson, Bauld, Chesterman, & Judge, 2005; Manchon Walsh et al., 2007; Monden, de Graaf, & Kraaykamp, 2003; Park, Tudiver, Schultz, & Campbell, 2004). A previous study of this population found that have a partner who smoked was associated with lower odds of smoking cessation (Okechukwu, Nguyen, & Hickman, 2010).

Furthermore, smoking cessation can be influenced by occupational factors (Albertsen, Borg, & Oldenburg, 2006). Occupational factors in the work environment may play a role in explaining occupational class differences in smoking behaviors. Stressful work conditions, including job strain with high job demand or low job control, decision-making latitude, high workload, work-related stress (Albertsen, et al., 2006; Albertsen, Hannerz, Borg, & Burr, 2004; Green & Johnson, 1990; Hellerstedt & Jeffery, 1997; Kouvonen, Kivimaki, Virtanen, Pentti, & Vahtera, 2005; Kouvonen et al., 2009; Landsbergis et al., 1998; Otten, Bosma, & Swinkels, 1999; Steptoe et al., 1998; Steptoe, Wardle, Pollard, Canaan, & Davies, 1996; Tsutsumi et al., 2003), exposures to occupational hazards (Albertsen, et al., 2004; Sorensen et al., 1996; Sterling & Weinkam, 1990), and job dissatisfaction (Peretti-Watel, Constance, Seror, & Beck, 2009) may contribute to increased smoking or to difficulties with cessation. For example, Sorensen and colleagues (2002) found that smoking quit rates among blue-collar workers in a smoking cessation intervention integrated with occupational health and safety more than doubled relative to those in a smoking cessation-only intervention. Additional controls were implemented for the reduction of workplace hazards perhaps contributing to the increase in the effect of the smoking intervention (Sorensen, et al., 2002). Thus, efforts to

reduce disparities in smoking should consider exposure to occupational hazards that may influence smoking cessation. However, little is known about the impact of occupational factors on smoking cessation among blue-collar workers.

A recently completed MassBUILT intervention study demonstrated the feasibility of integrating smoking cessation programs into training programs for apprentices in the building trades (Okechukwu, Krieger, Sorensen, Li, & Barbeau, 2009). The intervention study addressed significantly higher quit rates in the intervention versus the control group (26% vs. 16.8%; $p = 0.014$) at 1 month after the intervention. However, the effects diminished over time so that the difference in quit rates was not significant 6 months post-intervention (9% vs. 7.2%; $p = 0.48$) (Okechukwu, et al., 2009).

The purpose of this study was to identify significant baseline individual, interpersonal, and occupational factors that influenced short- and long-term smoking cessation, after controlling for the intervention condition and potential cluster effect.

Methods

Longitudinal data were used from the MassBULT study, a multipronged randomized controlled trial, to test a smoking cessation intervention in Massachusetts between 2004 and 2007. Details of the research design and procedures, and results have been previously reported elsewhere (Okechukwu, et al., 2009; Okechukwu, Krieger, Sorensen, Li, & Barbeau, 2011; Okechukwu, Nguyen, et al., 2010). Briefly, ten union sites met the eligibility criteria for the study and agreed to participate. They were size matched and randomly assigned to four intervention sites (n = 1,044 apprentices) and six control sites (n = 897 apprentices). The multipronged intervention strategy included: (1) toxics and tobacco curriculum; (2) group-based behavioral counseling; (3) nicotine

replacement therapy; (4) do it yourself quit kit; and (5) environmental cues for smoking cessation. The study conducted a baseline survey, implemented a four month smoking cessation intervention, and follow-up surveys at 1 and 6 months after the intervention to assess changes in smoking behaviors (Okechukwu, et al., 2009).

All enrolled apprentices aged 18 years or older were eligible to complete the surveys. Baseline and follow-up data were collected from apprentices using self-administered questionnaires. Baseline information included individual, interpersonal, and occupational factors, which might potentially be associated with the worker's quitting smoking. The baseline survey was completed by 1,817 apprentices (93.6% response rate) and approximately 43% of the participants (n = 763) were classified as current smokers who had smoked at least 100 cigarettes in life and had smoked in the last 30 days (National Center for Health Statistics, 2009). A total of 621 smokers (81.4% response rate) among baseline smokers completed both the baseline and 1 month follow-up survey and 490 smokers (64.2% response rate) completed the baseline and 1 month and at least 6-months follow-up surveys after the intervention. The Harvard University Dana-Farber Cancer Institute Institutional Review Board approved all methods and materials used in the original study. All study procedures for the present study received approval from the University of California San Francisco (UCSF) Committee on Human Subjects.

Measures

Dependent variable

Quitting smoking. Quitting smoking was assessed by (1) 7-day point prevalence abstinence at 1 month follow-up; and (2) 6-month prolonged abstinence at least 6 months after receiving smoking cessation intervention.

Independent variables

The independent variables were comprised of individual factors, interpersonal factors, and occupational factors.

Individual factors included sociodemographics, self-rated health status, and smoking intensity**.**

Sociodemographic characteristics. Sociodemographic characteristics included age, gender, and racial/ethnic groups (Hispanic, Non-Hispanic African American, Non-Hispanic White, and other). Educational levels were classified into three groups (high school/GED or less, some college or 2 year degree, and 4 years or more). Three household income levels (less than 50,000, $50,000–74,999, and $75,000 or more) were used.

Self-rated health status. Self-rated health status was assessed by the question: "Would you say that in general your health is excellent, very good, good, fair, or poor?" Five point responses were dichotomized as poor (fair/poor) and good (excellent/very good/good) for the current study.

Smoking intensity. Smoking intensity was defined by the question "During the past 30 days, on the days that you smoked, about how many cigarettes did you usually smoke that day?" and was categorized as 1 to 20 cigarettes versus more than 20 cigarettes per day.

Interpersonal factors. Interpersonal factors included household, partner, and friends/coworkers smoking.

Household smoking. Household smoking was assessed with one item asking "Does anyone who lives in the home currently smoke?" Responses were categorized as yes and

live alone or no.

Partner smoking. Partner smoking was assessed with one item asking "Do you have a partner/spouse/ significant other who currently smokes cigarettes?" using yes/no response categories.

Friends/coworkers' smoking. Friends/coworkers' smoking was assessed with one item asking "How many of your friends/coworkers smoke cigarettes?" Responses were categorized as most/all, and some or few/none.

Occupational factors. Occupational factors included union commitment, job satisfaction, exposure to occupational hazards, and concern about exposure to occupational hazards.

Union commitment. Union commitment was assessed by participants' attitudes toward their unions on five statements, such as "I am proud to tell others that I am a union apprentice" (Barbeau et al., 2005; Lambert & Hopkins, 1995). The scale used a 4-point Likert scale ranging from 1 (*completely disagree*) to 4 (*completely agree*) (Cronbach's $\alpha = .70$). A higher score indicates a more positive view toward the union.

Job satisfaction. Job satisfaction was measured by one item "How satisfied are you with your job?" with responses collapsed into two groups: very or somewhat satisfied, and not too or not all satisfied.

Exposure to occupational hazards. Exposure to occupational hazards including work-related musculoskeletal hazards, chemicals, dust, injuries, and second-hand smoke (SHS) at work, was also collected by the self-reported questionnaire. *Work-related musculoskeletal hazards*, modified from the Washington State Ergonomics Rule (Washington State, 2000), were assessed by asking the number of hours per full shift

(almost never, <1, 1–4, and >4 hours) requiring awkward postures of the shoulder, neck, back, or knee, repetitive hand motions, and hand force required to pinch or grip an object at work. Most of the questions used to assess the following exposures asked about the frequency over the past 12 months. *Dust, chemicals, SHS, and injury exposures* were assessed by asking the frequency of exposure to each exposure at work, using a three-category scale (never, rarely, and a lot). Exposure to occupational hazards was classified as the highest exposure category (Okechukwu, Krieger, et al., 2010; Quinn et al., 2007): exposed more than four hours per work shift to awkward postures of the shoulder, neck, back, and knee, repetitive hand motions, or hand force; exposed a lot to dust, chemicals, SHS, and injury. Based on these criteria, participants were classified as either exposed or unexposed to each occupational hazard.

Concern about exposure to occupational hazards. Concern about exposure to occupational hazards was assessed with six items by asking the level of concern about exposure to dust, chemicals, SHS, and injuries at work, using a four-point Likert scale ranging from 1 (*not at all*) to 4 (*very concerned*) (Cronbach's $\alpha = .82$). A higher score indicates more concern about exposure to occupational hazards.

Data Analysis

Statistical analyses were performed with SPSS version 19 (SPSS Inc, Chicago, Illinois) and Stata/SE version 12 (Stata Corp, College Station, Texas). The dependent variables in the analyses were 7-day point prevalence abstinence at 1 month follow-up and 6-month prolonged abstinence, comparing quitters and non-quitters. Descriptive statistics were analyzed for each potential predictor. Values for continuous variables were presented as means and standard deviations and categorical variables were summarized

by frequencies and percentages. The difference in the characteristics between the quitters and non-quitters was compared using chi-squares for categorical variables and t-tests for continuous variables.

The worksite was the unit of randomization and location of the intervention in the original study. Thus, there is need to control for potential clustering by site. Generalized linear mixed models (GLMMs) were used for multivariate analyses to control for the random effect of sites. As an initial step, for the multivariate analysis, assessment for multicollinearity was conducted to check for high intercorrelations among predictors. There were significant correlations between exposure to occupational hazards, such as dust, chemicals, injuries, SHS, and work-related musculoskeletal hazards ($r < .20$). Also, relatively large correlations were found between household smoking and partner smoking ($r = .42$). However, these were below the level indicating possible multicollinearity ($r > .80$) (Glantz & Slinker, 2001). Thus, all these variables were included in the multivariate models. Multivariate analyses assessed the predictive relationship of each variable separately with dichotomous outcomes (quitter = 1 vs. non-quitter = 0) at 1-and 6-month post intervention follow-up and controlled for the intervention condition and potential cluster effect. Potential predictors in the logistic regression equation were individual, interpersonal, and occupational factors. Due to the small sample size, the Hispanic, African American, and Other categories were collapsed into the ‘‘Non-White’’ category for the logistic regression model.

In the case of most variables, data were missing from 5% or less of the respondents, although information on household income level was missing from 13.4% (83/621). Data were analyzed by imputing missing values. The present study used the multiple

imputation method to create ten complete data sets, each with different imputed values for the missing data (Allison, 2002; Rubin, 1996; Schafer, 1999). All variables that were included in the logistic model were part of the imputation model used to predict missing data. The multivariate analyses presented here was based on the combined results from the ten imputed datasets. The GLMMs and multiple imputation methods were conducted using Stata/SE version 12.

Results

Quitting Smoking

Of the 621 smokers at baseline who completed the 1 month follow-up survey, 21% reported that they had not smoked in the past 7 days. The 6-month prolonged abstinence rate was only 8% among 490 baseline smokers who completed the 1-and 6-month follow-up surveys.

Characteristics of Smokers by Quitting Smoking at Follow-up

Table 1 characterizes the quitters and non-quitters by 7-day point prevalence abstinence at the 1 month follow-up by the baseline variables, prior to imputing missing covariates. Short-term quitters were significantly more likely to report 4-year college degree or more educational level (11.5% vs. 4.7%, $p = .004$), and a household income more than $75,000 yearly (35.9 % vs. 22.1%, $p = .007$), and to report fewer smoking intensity (<20 cigarettes per day) (87.0% vs. 75.6%, $p = .011$), compared to non-quitters. Of the occupational factors, quitters were significantly more likely to report concerns about exposure to occupational hazards (15.6 vs. 14.7, $p = .042$), compared to non-quitters. Quitters were more likely to report a positive view toward their union than non-quitter; however, the association was not statistically significant (18.1 vs. 17.8, $p = .080$).

Table 2 lists the differences in baseline characteristics of participants by 6-month prolonged abstinence, prior to imputing missing covariates. Long-term quitters were only significantly older (30.0 years vs. 27.7 years, $p = .024$) and more likely to report a household income more than $75,000 yearly (41.0% vs. 23.4%, $p = .044$). However, no significant differences were found with any occupational factor.

Predictors of Quitting Smoking

Table 3 shows the baseline variables that predict quitting smoking at 1-and 6-month follow-ups, after controlling for the effects of the intervention and the potential random effect of sites. In terms of sociodemographic factors, a household annual income level of less than $50,000 (OR = 0.46; 95% CI: 0.27–0.77), a high school education or less (OR = 0.34; 95% CI: 0.16–0.73) or some/2 year college degree (OR = 0.44; 95% CI: 0.20–0.94) were significantly associated with lower likelihood of quitting smoking at the 1 month follow-up. Furthermore, lower smoking intensity (≤20 cigarettes /day) had a strong effect on an increased likelihood of short-term quitting smoking (OR = 1.97; 95% CI: 1.07–3.65). Of the occupational factors, more concern about exposure to occupational hazards was significantly associated with an increased likelihood of quitting smoking (OR = 1.06; 95% CI: 1.01–1.11). Only older age (OR = 1.06; 95% CI: 1.01–1.12) were significantly associated with maintaining abstinence for at least 6 months.

Discussion

Main Findings and Implications

This study is the first to demonstrate the relationship between quitting smoking while taking into account not only individual, but interpersonal, and occupational factors, as well, in blue-collar workers, after controlling for intervention and clustering effects.

Baseline characteristics of participants may be associated with positive or negative smoking behavior changes.

The disparities in quitting smoking by sociodemographic characteristics among U.S. adults are well known (CDC, 2009; Fagan, et al., 2007; Lee & Kahende, 2007; U.S. DHHS, 1998). The present study also found that of the sociodemographic factors, higher levels of educational attainment and household annual income and older age independently predicted short- or long-term quitting smoking after controlling for participating in the intervention and the potential cluster effect, consistent with prior intervention studies (Bjornson et al., 1995; Dale, et al., 2001; Murray et al., 2000; Nides et al., 1995; Nollen et al., 2006). Several studies have already documented that the social group with lower education and income levels have more difficulties in quitting smoking, which could lead to smoking inequalities and smoking-related health disparities. Appropriate interventions should be targeted at the lower socioeconomic groups among blue-collar workers.

Another finding of the present study, which confirms findings from prior studies, was the impact of baseline smoking intensity (number of cigarettes smoked per day) as a predictor of quitting smoking, even after adjustment for the intervention effect. Smokers who smoked less than 20 cigarettes per day were twice as likely to report quitting smoking compared to those who smoked more than 20 cigarettes per day. Several previous intervention studies have identified a lower number of cigarettes smoked per day as a significant predictor of smoking cessation (Dale, et al., 2001; J. A. Ferguson et al., 2003; Hymowitz, Sexton, Ockene, & Grandits, 1991). Reducing the number of cigarettes smoked per day has benefits in lowering the risk for smoking related diseases

(e.g., lung cancer) (Godtfredsen, Prescott, & Osler, 2005). Therefore, reduced smoking is believed to represent an important step toward successful smoking cessation in heavy smokers who have difficulty changing their smoking habits. More intensive and/or tailored pharmacological and behavioral interventions may be needed to help smokers who smoke more cigarettes per day to quit smoking.

Previous intervention studies have indicated that having a smoking partner, having smoking friends or coworkers, or having a smoker in the household were associated with lower odds of successful smoking cessation (Manchon Walsh, et al., 2007; Murray, et al., 2000; Park, et al., 2004; Senore et al., 1998). A previous study of this same population also found that those whose partners smoked were less likely to quit smoking (Okechukwu, Nguyen, et al., 2010). On the other hand, this current study additionally included occupational factors in the multivariate models, quitting smoking was not independently associated with living with smokers in the household or living alone, or with a partner's or friends'/coworkers' smoking behaviors. The difference in the two studies in same population might have resulted in different results.

The influence of occupational factors on quitting smoking should be more intensively discussed in this study, with the influence of individual and interpersonal factors on quitting smoking. Although the extent of the odds of quitting smoking was small, more concern about exposure to occupational hazards at baseline was significantly associated with increased odds of short-term quitting smoking. Smokers' concerns of hazardous exposures such as dust and chemicals on the job are an important influence in quitting smoking. Similarly, a study of craftspersons and laborers (N = 1,841) at 22 worksites showed that concern about exposure to job hazards was significantly associated

with an increased intention to quit (Sorensen, et al., 1996), the most powerful predictor of successful cessation (Ajzen, 1991; Moan & Rise, 2005; Norman, Conner, & Bell, 1999). Smoking cessation strategies that address workers' concerns about exposures of occupational hazards may promote smoking cessation.

Sorensen and colleagues (1996) also found that that workers reporting exposure to hazards on the job were significantly more likely to be smokers than unexposed workers. Blue-collar workers are more likely to be exposed to occupational hazards, specifically carcinogens such as silica (Burkhart et al., 1993; Meeker, Susi, & Pellegrino, 2006; Rappaport, Goldberg, Susi, & Herrick, 2003; Sorensen, et al., 1996). Workers exposed to occupational hazards also have higher smoking rates than workers without such exposures (Sorensen, et al., 1996; Sterling & Weinkam, 1990). These occupational hazards may be barriers to quit smoking in blue-collar workers. However, the present study did not find any relationship between quitting smoking and the occupational hazards. Okechukwu et al. (2010) reported no significant difference in the association between exposure to occupational hazards (i.e., dust, chemicals, noise and ergonomic strain) and smoking among blue-collar workers. Albertsen et al. (2004) found an association between exposure to noise and smoking. Therefore, it is still unclear whether exposure to occupational hazards is associated with smoking behavior.

Only one smoking cessation intervention study in blue-collar workers tested the effectiveness of an intervention integrating smoking cessation *plus* an occupational health and safety program. It reported that this intervention led to a doubling of 6-month smoking cessation quit rates compared to blue-collar workers exposed only to the smoking cessation program (Sorensen, et al., 2002). The results demonstrated that

workplace changes reducing workers' exposure to hazardous substances used in work processes were associated with improved smoking cessation rates among blue-collar workers (Sorensen, et al., 2002). Therefore, even though any association with exposure to occupational hazards and quitting was not significant in the present study, it may still be important to address the contribution of occupational hazards on smoking behaviors among blue-collar workers. An in-depth examination of the relationship between exposure to occupational hazards and smoking behavior is needed.

Strengths and Limitations

The strengths of the present study include its prospective design and randomized design, which increased the internal validity of the study and decreased selection bias. The present study adjusted for multiple covariates not only at the individual factors but also at the interpersonal and occupational factors, thereby limiting confounding bias. Multiple imputation methods, which preserved information on variables with missing data in estimating the regression model, minimized validity bias and had more statistical power than the often used listwise method of deleting all observations with missing values on any covariate (Allison, 2002; Little & Rubin, 2002; Patrician, 2002; Rubin, 1987).

Several limitations to the present study also need to be noted. First, the sample included only unionized workers working at construction worksites limits the generalizability of the findings. In addition, the participants in this study were comprised predominantly of younger, male, non-Hispanic white smokers. Second, even though there is no evidence that dropouts were related to any smoking characteristic, the dropout rate was higher in females than in males and participants who dropped out had lower union

commitments. It might have reduced or limited the associations between predictors and quitting smoking.

Finally, the information about exposures and outcomes in the study was based on self-report and might have lead to misclassification. Self report of exposure to occupational hazards may result in an under-or overestimation of the actual hazardous exposures (Birdsong, Lash, Thayer, Kumekawa, & Becker, 1992; Brower & Attfield, 1998; Spielholz, Silverstein, Morgan, Checkoway, & Kaufman, 2001; Van Eerd et al., 2009). And, smoking status was not validated by any biochemical test. However, earlier studies have demonstrated that self-reported smoking status is valid and reliable (Caraballo, Giovino, Pechacek, & Mowery, 2001; Patrick et al., 1994).

Conclusion

This study describes the various factors that might be related to quitting smoking and extends the understanding of the process of smoking cessation among building trades workers. To better guide smokers in this group, the underlying dynamics of the quitting process with respect not only to smokers' individual characteristics but also their social and working environments need to be better understood. The present findings suggest that tailored and more intensive interventions that focus on reducing smoking intensity need to be developed for this group. More importantly, addressing concern of exposures to occupational hazards might be helpful when developing comprehensive smoking cessation intervention programs for building trades workers.

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Table 1

Characteristics of Participants and 7-day Point Prevalence Abstinence at 1 Month Follow-up (N = 621)

Characteristics	Baseline	7-day point prevalence abstinence at 1 month follow-up [#]		
	Smoker N=621	Quitter n=131, 21.2%	Non-quitter n=488, 78.8%	P-value*
Individual factors				
Age (year)				0.620
Mean ± SD	27.7 ± 6.0	27.9 ± 6.1	27.6 ± 6.0	
(Range)	(18–49)	(19–47)	(18–47)	
Gender, n (%)				0.243
Male	577 (92.9)	126 (96.2)	449 (92.0)	
Female	30 (4.8)	3 (2.3)	27 (5.5)	
Missing	14 (2.3)	2 (1.5)	12 (2.5)	
Race/Ethnicity, n (%)				0.591
Hispanic	13 (2.1)	1 (0.8)	12 (2.5)	
African America, non-Hispanic	31 (5.0)	6 (4.6)	25 (5.1)	
Other, non-Hispanic	35 (5.6)	10 (7.6)	25 (5.1)	
White, non-Hispanic	509 (82.0)	108 (82.4)	399 (81.8)	
Missing	33 (5.3)	6 (4.6)	27 (5.5)	
Education, n (%)				**0.004**
High school/GED[a] or less	319 (51.4)	53 (40.5)	265 (54.3)	
Some college or 2-year degree	235 (37.8)	55 (42.0)	180 (36.9)	
4-year college degree or more	39 (6.3)	15 (11.5)	23 (4.7)	
Missing	28 (4.5)	8 (6.1)	20 (4.1)	
Income, n (%)				**0.007**
<$50,000	245 (39.5)	39 (29.8)	205 (42.0)	
$50,000–74,999	138 (22.2)	30 (22.9)	108 (22.1)	
≥$75,000	155 (25.0)	47 (35.9)	108 (22.1)	
Missing	83 (13.4)	15 (11.5)	67 (13.7)	
Self-rated health[b], n (%)				0.762
Good	691 (90.6)	121 (92.4)	448 (91.8)	
Poor	70 (9.2)	10 (7.6)	38 (7.8)	
Missing	2 (0.3)	0 (0.0)	2 (0.4)	
Smoking intensity (cigarettes/day)				**0.011**
≤ 20	485 (78.1)	114 (87.0)	369 (75.6)	
> 21	129 (20.8)	15 (11.5)	114 (23.4)	
Missing	7 (1.1)	2 (1.5)	5 (1.0)	
Interpersonal factors				
Household smoking, n (%)				.070
Yes	309 (49.8)	54 (41.2)	255(52.3)	
No/ Live alone	301 (48.5)	75 (57.3)	224 (45.9)	
Missing	11 (1.8)	2 (1.5)	9 (1.8)	
Partner smoking, n (%)				0.414
Yes	254 (40.9)	48 (36.6)	206 (42.2)	
No	354 (57.0)	81 (61.8)	271 (55.5)	
Missing	13 (2.1)	2 (1.5)	11 (2.3)	
Friends/coworkers smoking, n (%)				0.078
Most or all	156 (25.1)	24 (18.3)	131 (26.8)	
Some/few or none	449 (72.3)	105 (80.2)	343 (70.3)	
Missing	16 (92.6)	2 (1.5)	14 (2.9)	

Table 1 (*Continued*)

Characteristics	Baseline	7-day point prevalence abstinence at 1 month follow-up [#]		
	Smoker N=621	Quitter n=131, 21.2%	Non-quitter n=488, 78.8%	P-value*
Occupational factors				
Union commitment[d]				0.080
Mean ± SD	17.9 ± 1.9	18.1 ± 1.6	17.8 ± 1.9	
(range)	(9–20)	(12–20)	(9–20)	
Job satisfaction, n (%)				0.374
Very/Somewhat satisfied	575 (92.6)	125 (95.4)	448 (91.8)	
Not too/not at all satisfied	38 (6.1)	5 (3.8)	33 (6.8)	
Missing	8 (1.3)	1 (0.8)	7 (1.4)	
Exposure to occupational hazards				
Work-related musculoskeletal hazards, n (%)				0.535
Exposed	360 (58.0)	72 (55.0)	287 (58.8)	
Not exposed	259 (41.7)	59 (45.0)	199 (40.8)	
Missing	2 (0.3)	0 (0.0)	2 (0.4)	
Dust, n (%)				0.771
Exposed	502 (80.8)	104 (79.4)	396 (81.1)	
Unexposed	112 (18.0)	26 (19.8)	86 (17.6)	
Missing	7 (1.1)	1 (0.8)	6 (1.2)	
Chemicals, n (%)				0.267
Exposed	198 (31.9)	34 (26.0)	162 (33.2)	
Unexposed	416 (67.0)	95 (72.5)	321 (65.8)	
Missing	7 (1.1)	2 (1.5)	5 (1.0)	
SHS[e], n (%)				0.365
Exposed	270 (43.5)	51 (38.9)	218 (44.7)	
Unexposed	349 (56.2)	80 (61.1)	268 (54.9)	
Missing	2 (0.3)	0 (0.0)	2 (1.4)	
Injuries, n (%)				0.849
Exposed	189 (30.4)	42 (32.1)	145 (29.7)	
Unexposed	426 (68.6)	88 (67.2)	338 (69.3)	
Missing	6 (1.0)	1 (0.8)	5 (1.0)	
Concern about exposure to occupational hazards[f]				**0.042**
Mean ± SD	14.9 ± 4.3	15.6 ± 4.5	14.7 ± 4.2	
(range)	(6–24)	(6–24)	(7–24)	

[a] GED = general educational development
[b] Good=excellent, very good, good, Poor=fair, poor
[d] A high score indicates more a positive view toward the union
[e] SHS = second-hand smoke
[f] A high score indicates more concern about exposure to occupational hazards
[#] 2 respondents did not reply to the smoking status at 1 month follow-up
[*] P value for χ^2 test or *t-test*
All values were calculated prior to imputing missing covariates.

Table 2

Characteristics of Participants and 6-month Prolonged Abstinence (N = 490)

Characteristics	Baseline	6-month prolonged abstinence [#]		
	Smoker N=490	**Quitter n=39, 8.1%**	**Non-quitter n=441, 91.9%**	**P-value***
Individual factors				
Age (year)				**0.024**
Mean ± SD	27.9 ± 6.2	30.0 ± 6.8	27.7 ± 6.1	
(Range)	(18–47)	(20–45)	(18–47)	
Gender, n (%)				0.667
Male	457 (93.39)	37 (94.9)	410 (93.0)	
Female	24 (4.9)	2 (5.1)	22 (5.0)	
Missing	9 (1.8)	0 (0.0)	9 (2.0)	
Race/Ethnicity, n (%)				0.842
Hispanic	8 (1.6)	0 (0.0)	8 (1.8)	
African America, non-Hispanic	21 (4.3)	2 (5.1)	17 (3.9)	
Other, non-Hispanic	23 (4.7)	2 (5.1)	20 (4.5)	
White, non-Hispanic	413 (84.3)	34 (87.2)	373 (84.6)	
Missing	25 (5.1)	1 (2.6)	23 (5.2)	
Education, n (%)				0.068
High school/GED[a] or less	246 (50.2)	16 (41.0)	223 (50.6)	
Some college or 2-year degree	185 (37.8)	17 (43.6)	167 (37.9)	
4-year college degree or more	35 (7.1)	8 (15.4)	28 (6.3)	
Missing	24 (4.9)	0 (0.0)	23 (5.2)	
Income, n (%)				**0.044**
<$50,000	195 (39.8)	11 (28.2)	178 (40.4)	
$50,000–74,999	112 (22.9)	10 (25.6)	99 (22.4)	
≥$75,000	120 (24.5)	16 (41.0)	103 (23.4)	
Missing	63 (12.9)	2 (5.1)	61 (13.8)	
Self-rated health[b], n (%)				0.784
Good	450 (91.8)	35 (89.7)	405 (91.8)	
Poor	38 (7.8)	4 (10.3)	34 (7.7)	
Missing	2 (0.4)	0 (0.0)	2 (0.5)	
Smoking intensity (cigarettes/day)				0.513
≤20	383 (78.2)	32 (82.1)	341 (77.3)	
> 20	101 (20.6)	6 (15.4)	95 (21.5)	
Missing	6 (1.2)	1 (2.6)	5 (1.1)	
Interpersonal factors				
Household smoking, n (%)				.822
Yes	244 (49.8)	19 (48.7)	224 (50.8)	
No/ Live alone	239 (48.8)	19 (48.7)	211 (47.8)	
Missing	7 (1.4)	1 (2.6)	6 (1.4)	
Partner smoking, n (%)				
Yes	205 (41.8)	15 (38.5)	186 (42.2)	0.831
No	277 (56.5)	23 (59.0)	248 (56.2)	
Missing	8 (1.6)	1 (2.6)	7 (1.6)	
Friends/coworkers smoking, n (%)				0.595
Most or all	132 (26.9)	8 (20.5)	124 (28.1)	
Some/few or none	347 (70.8)	30 (76.9)	307 (69.6)	
Missing	11 (2.2)	1 (2.6)	10 (2.3)	

Table 2 (*Continued*)

Characteristics	Baseline	6-month Prolonged Abstinence [#]		
	Smoker N=490	Quitter n=39, 8.1%	Non-quitter n=441, 91.9%	P-value*
Occupational factors				
Union commitment[d]				0.679
Mean ± SD	17.9 ± 1.9	18.0 ± 2.1	17.9 ± 1.9	
(range)	(9–20)	(9–20)	(12–20)	
Job satisfaction, n (%)				0.306
Very/Somewhat satisfied	455 (92.9)	35 (89.7)	410 (93.0)	
Not too/not at all satisfied	27 (5.5)	4 (10.3)	23 (5.2)	
Missing	8 (1.6)	0 (0.0)	8 (1.8)	
Exposure to occupational hazards				
Work-related musculoskeletal hazards, n (%)				0.908
Exposed	281 (57.3)	22 (56.4)	252 (57.1)	
Not exposed	207 (42.2)	17 (43.6)	187 (42.4)	
Missing	2 (0.4)	0 (0.0)	2 (0.5)	
Dust, n (%)				0.628
Exposed	397 (81.0)	31 (79.5)	360 (81.6)	
Unexposed	86 (17.6)	8 (20.5)	74 (16.8)	
Missing	7 (1.4)	0 (0.0)	7 (1.6)	
Chemicals, n (%)				0.207
Exposed	156 (31.8)	8 (20.5)	148 (33.6)	
Unexposed	331 (67.6)	31 (79.5)	290 (65.8)	
Missing	3 (0.6)	0 (0.0)	3 (0.7)	
SHS[e], n (%)				0.737
Exposed	213 (43.5)	19 (48.7)	190 (43.1)	
Unexposed	275 (56.1)	20 (51.3)	249 (56.5)	
Missing	2 (0.4)	0 (0.0)	2 (0.5)	
Injuries, n (%)				0.406
Exposed	152 (31.0)	9 (23.1)	138 (31.3)	
Unexposed	332 (67.8)	30 (76.9)	297 (67.3)	
Missing	6 (1.2)	0 (0.0)	6 (1.4)	
Concern about exposure to occupational hazards[f]				
Mean ± SD	14.8 ± 4.3	15.5 ± 4.5	14.8 ± 4.3	0.337
(range)	(6–24)	(6–23)	(6–24)	

[a] GED = general educational development
[b] Good=excellent, very good, good, Poor=fair, poor
[d] A high score indicates more a positive view toward the union
[e] SHS = second-hand smoke
[f] A high score indicates more concern about exposure to occupational hazards
[#] 10 respondents did not reply to the smoking status at 6 month follow-up
[*] P value for χ^2 test or *t-test*
All values were calculated prior to imputing missing covariates.

Table 3

Predictors of Quitting Smoking at 1- and 6-months Post Intervention Follow-up

Baseline Variables	1-month follow-up (n=621)	6-month prolonged abstinence (n=490)
	OR (95% C.I.)	OR (95% C.I.)
Individual factors		
Age (continuous)	1.00 (0.97–1.04)	**1.06 (1.00–1.12)***
Gender		
Male	2.11 (0.58–7.72)	1.10 (0.21–5.75)
Female	reference	
Race		
Non-White	0.93 (0.48–1.78)	0.59 (0.17–1.98)
White	reference	
Income		
<$50,000	**0.46 (0.27–0.77)****	0.46 (0.20–1.08)†
$50,000–74,999	0.62 (0.35–1.11)	0.53 (0.22–1.31)
≥$75,000	reference	
Education		
High school/GED[a] or less	**0.34 (0.16–0.73)****	0.39 (0.13–1.16) †
Some college or 2 year college	**0.44 (0.20–0.94)***	0.46 (0.15–1.40)
4 years college or more	reference	
Self-rated health[b]		
Good	0.82 (0.37–1.79)	0.64 (0.19–2.14)
Poor	reference	
Smoking intensity (cigarettes/day)		
≤ 20	**1.97 (1.07–3.65)***	1.65 (0.62–4.36)
> 20	reference	
Interpersonal factors		
Household smoking		
Yes	0.77 (0.48–1.22)	1.31 (0.57–2.98)
No/live alone	reference	
Partner/spouse/significant other smoking		
Yes	0.95 (0.60–1.51)	0.86 (0.38–1.94)
No	reference	
Friends/Coworkers smoking		
Most or all	0.79 (0.46–1.34)	0.75 (0.30–1.84)
Some/Few or none	reference	
Occupational factors		
Union commitment (continuous)	1.10 (0.98–1.25)	1.03 (0.83–1.27)
Job satisfaction		
Very or somewhat satisfied	1.43 (0.51–3.98)	0.51 (0.14–1.84)
Not too or not at all satisfied	reference	
Exposure to occupational hazards[c]		
Work-related musculoskeletal hazards	0.98 (0.60–1.51)	1.17 (0.57–2.41)
Dust	0.87 (0.50–1.52)	0.65 (0.26–1.61)
Chemicals	0.86 (0.53–1.41)	0.53 (0.22–1.27)
SHS[d]	0.80 (0.51–1.25)	1.60 (0.76–3.38)
Injuries	1.18 (0.73–1.90)	0.66 (0.28–1.56)
Concern about exposure to occupational hazards (continuous)	**1.06 (1.01–1.11)***	1.06 (0.97–1.15)

* P<0.05, ** P<0.01, *** P<0.001, † P<0.1; [a] GED = general educational development; [b] Poor = fair and poor, Good=good, very good, and excellent; [c] Unexposed to each occupational hazard is the reference group; [d] SHS = second-hand smoke; OR = odds ratio, controlling for the intervention condition and cluster effect, CI = confidence interval

CHAPTER 5

Summary and Conclusion

Summary

Cigarette smoking has higher prevalence in blue-collar workers compared to white-collar workers (Bang & Kim, 2001; Covey, Zang, & Wynder, 1992; Giovino, Pederson, & Trosclair, 2000; D. J. Lee et al., 2007; Nelson et al., 1994). This persistent occupational disparity in smoking prevalence represents a critical public health concern. In this dissertation study, building trades workers reported a surprisingly high prevalence of smoking–more than 40%. It is conceivable that this surprisingly high prevalence of smoking among blue-collar workers may contribute to smoking-related health disparities between this group and other groups of workers. In order to address this occupational disparity in smoking behavior, it is important to identify various factors that influence blue-collar workers' smoking behaviors, not only individual factors but also social and work environment influences.

This dissertation described the nature of blue-collar workers' smoking behaviors focusing on identifying the various types of factors associated with current cigarette smoking, heavy cigarette smoking, and quitting smoking. In particular, the relationship between occupational factors and smoking behaviors is poorly understood so far. Most importantly, the findings from the three research studies in this dissertation contribute to the extant literature about the role of occupational factors in explaining cigarette smoking patterns.

The first study (Chapter 2) identified the meaningful occupational factors which contributed to current smoking status among building trades workers. These findings provide important information about work environments of building trades that can be used to understand the surprisingly high prevalence of smoking among blue-collar

workers. Specifically, the findings provide strong evidence that higher exposure to occupational hazards such as chemicals and dust positively affect current smoking and greater concern about these hazardous exposures at work is negatively related to current smoking. The significant relationship between exposure to occupational hazards and smoking poses a serious health challenge in this population, because the combination of exposures might exacerbate smoking-related health problems. The findings strongly suggest smoking cessation programs for this population should consider occupational influences along with individual approaches.

Despite a higher prevalence of heavy smoking in blue-collar workers, no study has focused on assessing the unique characteristics of the targeted subgroup, heavy smokers. The second research study (Chapter 3) demonstrates that heavy smokers are a very important high-risk subpopulation and they are characteristically different from light smokers within the current smoker population. The findings provide a better understanding of the association between multiple factors (e.g., sociodemographic characteristics, psychological factors) and heavy cigarette smoking. The findings suggested the need to develop tailored smoking cessation interventions or possibly reduce smoking intensity in this high-risk group of smokers.

The third research study (Chapter 4) investigated predictors such as baseline individual, interpersonal, and occupational factors associated with short- and long-term smoking cessation, after controlling for the effects of the intervention and the potential random effect of sites. The findings help identify better approaches to helping blue-collar workers quit smoking. The findings emphasize that the social groups with lower income and education levels are the more important target groups among blue-collar workers.

The findings suggest that reducing the number of cigarettes per day may represent an important step toward successful smoking cessation. Importantly, the findings suggest that addressing concern of exposures to hazards at work might be helpful for developing new comprehensive smoking cessation intervention approaches for building trades workers.

Implications and Recommendations for Future Studies

The dissertation findings have several important implications for smoking cessation research, practice, and policy at worksites. Overall, the dissertation findings underscore that smoking behaviors among blue-collar workers are influenced by individual, interpersonal, and occupational factors. Understanding the complexities of smoking-related determinants may advance smoking cessation interventions for blue-collar workers. This suggests that smoking cessation programs for blue-collar workers may need to take a comprehensive approach, rather than focusing on programs developed for other groups or with a singular focus.

First of all, this dissertation research found that higher exposure to occupational hazards, such as chemicals and dust, was associated with increased current smoking among the study population. The findings also suggest that further smoking research in blue-collar occupations with high smoking rates should consider the potential for synergistic occupational exposures (Sorensen, 2001; Sorensen, Barbeau, Hunt, & Emmons, 2004; U.S. Department of Health and Human Services [U.S. DHHS], 1989). The results also acknowledge that overall worksite health and safety can be a key contextual factor in smoking cessation interventions among blue-collar workers. Smoking cessation interventions integrated with occupational health and safety programs could

potentially result in substantial increases in smoking cessation compared to smoking cessation-only programs for blue-collar workers (Sorensen et al., 2002). An approach that integrates smoking cessation programs with occupational health protection programs to reduce hazardous occupational exposures, may help to reduce occupation-based smoking disparities and improve worker health by creating healthier workplaces. Implementing occupational health and safety interventions with a smoking cessation intervention may be an important approach to blue-collar workforce. However, there is limited evidence that smoking cessation programs that combine individual and occupational strategies are more effective for providing support for smoking cessation. Further research is needed to consider improving occupational health and safety along with smoking cessation intervention and to assess whether an intervention integrating smoking cessation with occupational health and safety results in significant increases in smoking cessation for blue-collar workers.

Furthermore, another important finding is that greater concern about exposure to occupational hazards was associated with lower odds of current smoking and increased odds of quitting smoking. The findings show that smokers' perceptions of occupational hazardous exposures such as dust and chemicals may be an important influence in smoking behavior in this population. It is important to address concern of exposures to hazards at work and incorporate them into smoking cessation strategies.

Union commitment was identified as an important occupational factor in smoking behaviors. This dissertation research showed that workers who were proud to be a part of their union were more likely to report current smoking. Unions are an important channel for blue-collar workers (Barbeau et al., 2005). They can provide resources and work

environmental support such as worksite smoking policies (e.g., smoking restrictions, smoking bans) (Sorensen et al., 2000) or health insurance coverage for smoking cessation (Barbeau, 2001; Barbeau et al., 2001; Curry, Grothaus, McAfee, & Pabiniak, 1998), which may lead to reductions in smoking rates and may protect nonsmokers from SHS exposure at work. Therefore, it may be feasible to design future intervention strategies for blue-collar workers in collaboration with their unions.

It is even more important to identify the contribution of the key occupational factors in smoking behaviors in order to develop smoking cessation interventions. There have been few empirical studies illustrating the influence of occupational factors on smoking behavior. Therefore, further study is needed to examine the relationship of occupational factors to smoking behaviors among blue-collar workers. The study participants in this dissertation were limited to unionized apprentices, who may well be younger than most blue-collar workers. Further research is needed to determine the impact of occupational factors in other trades or occupations, or to explicate other potential occupational influences, such as job strain (Green & Johnson, 1990; Hellerstedt & Jeffery, 1997; Kouvonen et al., 2007; Landsbergis et al., 1998), shift work (Shields, 1999), and worksite smoking restrictions (Fichtenberg & Glantz, 2002).

The disparities in smoking behaviors by sociodemographic characteristics among U.S. adults are well known (Barbeau, Krieger, & Soobader, 2004; Centers for Disease Control and Prevention [CDC], 2008, 2009; Escobedo & Peddicord, 1996; Fagan, Shavers, Lawrence, Gibson, & O'Connell, 2007; C. W. Lee & Kahende, 2007; U.S. DHHS, 1998). The findings from this dissertation also found social disparities in smoking behaviors: that is, lower levels of annual income and educational attainment were

associated with increased odds of current smoking and lower odds of quitting smoking. Because these socioeconomic groups might experience higher with smoking prevalence and difficulties in quitting smoking, smoking-attributable illnesses might be increasingly concentrated in these socially disadvantaged groups, further exacerbating existing health disparities. Therefore, more intensive interventions should be targeted at lower income and educational attainment social groups among blue-collar workers. Additionally, future studies need sufficient sample sizes of non-white racial/ethnic groups and females to capture the ethnic and gender heterogeneity of smoking behaviors among blue-collar workers.

This dissertation found that smokers who smoke more heavily are an important high risk group with low quit rates. The findings reinforce the fact that the number of cigarettes smoked per day is an important factor in quitting smoking. This information suggests that new intervention approaches for this group are needed. Given the strong relationship of number of cigarettes smoked per day with quitting smoking, interventions that focus on reducing the number of cigarettes smoked may direct smokers toward future successful smoking cessation techniques. This dissertation research study shows that heavy smokers, one of the high risk groups, have unique characteristics within the smoker population. Specifically, they are more dependent on nicotine, started smoking at an earlier age, and are less ready to quit (e.g., no intention to quit, lack of confidence in their ability to quit smoking, higher temptation to smoke, higher pros for smoking). Further smoking research study should consider the varying characteristics of different subgroups of the smoking population among blue-collar workers. These differences reinforce the need for developing more effectively targeted smoking cessation

interventions for heavy smokers who are at especially high risk for smoking-related diseases. In that respect, comprehensive tailored interventions that focus on their readiness to quit, the number of cigarettes smoked per day, the time to first cigarette of the day, and/ or intensive pharmacological interventions may be more effective. Further research is also required to determine the efficacy of these interventions for smokers who are in high risk groups.

Another important point is the impact on heavy smoking of the presence or absence of household members, friends or coworkers, and partners who smoke. Smokers with a smoking partner or household members who smoke, smoke more heavily, and they might face difficulty in quitting smoking. Interventions that involve household members, partners, friends, and coworkers may provide social support for assisting in positive smoking behavior changes. Interestingly, smokers who live alone are the highest risk group for heavy smoking. The findings indicated that the presence of household members can provide social support that may aide heavy smokers cut down on the number of cigarettes, regardless of whether they are smokers or not. Therefore, smoking cessation interventions should provide a strong social support network for smokers who live alone. The dissertation research study did not collect information about the reasons workers lived alone such as their marital status (e.g., single, widowed, divorced). In future studies, additional qualitative research may be needed to assess in more detail the social contexts and perceptions about why they smoke more heavily.

Smoking behaviors are complex involving various components including starting, quitting, maintaining, heavy smoking, intermittent smoking, and returning (relapse) to smoking. Smoking cessation research should inform a broader conceptualization of the

complex factors that determine blue-collar workers' smoking behaviors. A theoretical framework in this dissertation was derived from social ecology theory. It may be useful in efforts to expand the scope and reach of smoking cessation interventions at worksites. The lack of information about blue-collar workers is an obstacle to designing effective integrated worksite smoking cessation interventions. More research is needed to improve the understanding of occupational factors that influence on smoking behavior. Further study should also consider other external influences on blue-collar workers, including health insurance coverage (Barbeau, et al., 2001), tobacco brand advertising at the community level (Barbeau, Wolin, Naumova, & Balbach, 2005; Laws, Whitman, Bowser, & Krech, 2002), cigarette prices (Farrelly, Pechacek, Thomas, & Nelson, 2008), and policies that restrict or ban smoking at the policy level (Fichtenberg & Glantz, 2002).

Overall, this dissertation suggests that smoking cessation programs or smoking research need to take a comprehensive approach. Blue-collar workers' individual characteristics, interpersonal factors, and their working environments significantly affect their smoking behaviors. Accordingly, effective programs will need to promote reducing the numbers of cigarettes smoked among smokers, build up their desire to quit smoking, encourage social support for quitting, involve their family members, friends, and coworkers, and at the same time integrate occupational health programs to improve healthy work environments with union support for smoke-free policies.

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