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Heavy and Light/Moderate Smoking Among Building Trades Construction Workers

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ABSTRACT ***Objective:*** The purpose of the study was to identify the correlates of heavy smoking (defined as more than one pack of cigarettes per day) in building trades construction workers. ***Design and Sample:*** This study used cross-sectional data from the MassBUILT smoking cessation intervention study at Massachusetts building trades unions with the sample of 763 smokers. ***Measures:*** Data collected included information about smoking behavior, individual, psychological, interpersonal, and occupational factors obtained through self-reported questionnaires. ***Results:*** Approximately 21% of smokers were heavy smokers. Significant factors related to heavy smoking were: older age (*OR* = 1.10; 95% CI: 1.06 –1.14), male gender (*OR* = 4.55; 95% CI: 1.62 –12.79), smoking the first cigarette of the day within 30 min of waking (*OR* = 4.62; 95% CI: 2.81 –7.59), smoking initiation at earlier age (*OR* = 0.93; 95% CI: 0.87 –1.00), higher temptation to smoke (*OR* = 1.55; 95% CI: 1.17 –2.05), household smoking (*OR* = 1.90; 95% CI: 1.18 –3.06) or living alone (*OR* = 4.11; 95% CI: 1.70 –9.92), and exposure to chemicals at work (*OR* = 1.61; 95% CI: 1.06 –2.53). ***Conclusion:*** Addressing the influence of these factors on heavy smoking could lead to the development of targeted, multiple components in comprehensive cessation strategies for blue-collar smokers.

Key words: blue-collar workers, cigarette smoking, construction workers, heavy smoking.

Background

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). Higher numbers of cigarettes smoked per day increases the risk of cancers, such as lung cancer (Flanders, Lally, Zhu, Henley, & Thun, 2003), liver and kidney cancers (Sasco, Secretan, & Straif, 2004), as well as cardiovascular and respiratory diseases (Doll, Peto, Boreham, & Sutherland, 2004), diabetes (Willi, Bodenmann, Ghali, Faris, & Cornuz, 2007), and adverse reproductive effects (Windham, Elkin, Swan, Waller, & Fenster, 1999).

Over the past 40 years, the prevalence of cigarette smoking among U.S. adults aged ≥18 years has been declining substantially, from 42.4% in 1965 to 19.3% in 2010 (Centers for Disease Control and Prevention [CDC], 2011b,c). In 2010, an estimated 45 million U.S. adults was current cigarette smokers (CDC, 2011c). In addition to the reduction in smoking prevalence, the preva-

lence of smoking 25 or more cigarettes per day has also decreased during the past three decades, from 25.3% of smokers in 1974 to 12.1% of smokers in 2004 (CDC, 2005; Giovino, 2002). However, the reduction trend was not the case for blue-collar workers who are more likely to be smokers over time (Bang & Kim, 2001; Covey, Zang, & Wynder, 1992; Lee et al., 2007; Nelson et al., 1994). In our previous study, building trades workers reported a surprisingly high prevalence of smoking–more than 40% (Chin, Hong, Gillen, Bates, & Okechukwu, 2012), nearly twice as high as that of the U.S. general working population and white-collar workers (Barbeau, Krieger, & Soobader, 2004; CDC, 2011a; Lee et al., 2007). Furthermore, the patterns of smoking intensity vary by occupational groups. According to the National Health Interview Survey data for smokers only, blue-collar workers (27.5%) were more likely to report smoking 25 or more cigarettes per day than white-collar workers (18%) (Giovino, Pederson, & Trosclair, 2000). In particular, among young adults aged 18–24 years, the odds of smoking 20 or more cigarettes per day among blue-collar workers were almost twice those for white-collar workers (*OR* = 1.97) (Lawrence, Fagan, Backinger, Gibson, & Hartman, 2007). Blue-collar workers are more likely to be exposed to hazards on the job, specifically carcinogens such as silica (Meeker, Susi, & Pellegrino, 2006; Rappaport, Goldberg, Susi, & Herrick, 2003), which might increase their smoking-related health risks. Due to their increased risk for smoking-attributable diseases (Doll et al., 2004; Flanders et al., 2003), heavy smokers represent a very important subgroup within blue-collar workers.

Many studies have analyzed the association of heavy smoking with regard to various types of 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; Wilson, Wakefield, Owen, & Roberts, 1992). Furthermore, heavy smoking may be influenced not only by these individual factors but also by the social and work environment. Heavy smokers reported that they felt many social pressures from family and friends to smoke and that their job situations were stressful (Thompson, Thompson, Thompson, Fredickson, & Bishop, 2003). Exposure to occupational hazards (e.g., dust, chemicals) is a typical job stressor for construction workers (Goldenhar, Swanson, Hurrell, Ruder, & Deddens, 1998). We previously reported 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 (Chin et al., 2012).

Heavy smokers face greater challenges in smoking cessation. Compared with light smokers, heavy smokers are less likely to succeed in quitting smoking (Farkas, 1999; Hymowitz et al., 1997; Myung et al., 2007), are at higher risk of relapse (Zhou et al., 2009), and are more at risk for long-term smoking, suggesting an urgent need for interventions (Nordstrom et al., 2000). Thus, it is important to understand significant factors that are related to heavy smoking to develop and implement more effective interventions and workplace strategies for blue-collar workers. Despite the higher prevalence of heavy smoking in blue-collar workers, no studies have assessed the characteristics of heavy smokers in this group.

The present study used a theoretical framework that was derived from social ecological theory (McLeroy, Bibeau, Steckler, & Glanz, 1988; Sallis, Owen, & Fisher, 2008; Stokols, 1996) to identify correlates of heavy cigarette smoking among building trades smokers. Social ecological theory proposes that individual health behavior is supported and influenced by other external influences, including social and environmental contexts (e.g., interpersonal and occupational factors) (McLeroy et al., 1988; Sallis et al., 2008; Stokols, 1996; Wandersman et al., 1996). We used a dataset previously collected for a smoking cessation intervention study among building trades workers. Based on theoretical considerations, we selected variables including interpersonal and occupational factors in addition to individual and psychological factors to examine various contextual factors that influence heavy smoking among smokers of this population.

Research questions

The purpose of this study is to compare subgroup differences among current smokers and to identify the correlates associated with heavy smoking in building trades workers, focusing on individual, psychological, interpersonal, and occupational factors.

Methods

Design and sample

This study used cross-sectional data from MassBUILT study that assessed the effectiveness of a multipronged smoking cessation intervention among apprentices of Massachusetts building trades. A detailed description of the MassBUILT study has been published elsewhere (Okechukwu, Krieger, Sorensen, Li, & Barbeau, 2009, 2011; Okechukwu, Nguyen, & Hickman, 2010b).

The sample for the present study consisted of apprentices who were 18 years of age or older and completed self-administered questionnaires on smoking. Among the full sample of 1,817 apprentices at baseline, for the purpose of the present 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 a cigarette in the last 30 days (National Center for Health Statistics, 2009). The original MassBUILT study was approved by the Dana-Farber Cancer Institute Institutional Review Board. All study procedures for the present study were approved by the committee on Human Subjects of the University of California, San Francisco (UCSF).

Measures

Dependent variable: Heavy cigarette smoking. Participants who were classified as current smokers were asked the question "During the past 30 days, on the days that you smoked, about how many cigarettes did you usually smoke that day?" Heavy smoking was defined as smoking more than one pack of cigarettes per day (>20 cigarettes/day) during the past 30 days, whereas light to moderate smoking was defined as one pack of cigarettes or less a day (≤20 cigarettes/day), based on the cutoff of one pack of cigarettes per day (20 cigarettes/day) in the tobacco literature (Husten, 2009; Mucha, Stephenson, Morandi, & Dirani, 2006; Sweitzer, Donny, Dierker, Flory, & Manuck, 2008; Szklo & Coutinho, 2009).

Independent variables. Four categories of factors (Individual, psychological, interpersonal, and occupational) were considered. Detailed description of each factor is provided in the following section.

Individual factors. Sociodemographic characteristics included age, gender, race/ethnicity (Hispanic, Non-Hispanic African American, Non-Hispanic White, and Other), education level (≤high school/GED, some college or 2 year degree, and ≥4 years), and household income level (<$50,000, $50,000–$74,999, and ≥$75,000). *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 the time to smoke the first cigarette of the day after awakening (≤30 min vs. >30 min).

Psychological factors. Intention to quit smoking was measured by asking whether participants were seriously thinking about quitting smoking in the next 6 months and/or 30 days, using yes/no response categories (Prochaska, Velicer, Guadagnoli, Rossi, & DiClemente, 1991; van Zundert, van de Ven, Engels, Otten, & van den Eijnden, 2007). *Self-efficacy for quitting smoking* was assessed by asking whether participants 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*). Self-efficacy, adapted from Bandura's self-efficacy theory (Bandura, 1977, 1982), represents an individual's level of confidence in their ability to perform their desired behavioral change. Temptation construct is conceptualized in the transtheoretical model and assesses how tempted an individual is to engage in a specific behavior when in difficult situations (Velicer, Diclemente, Rossi, & Prochaska, 1990). *Temptation to smoke* was evaluated using a 9-item situational temptation scale (Velicer et al., 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"). Responses were measured using a 5-point Likert scale from 1 (*not at all tempted*) to 5 (*extremely tempted*). The reliability of the measure in the present study was Cronbach's $\alpha = .90$. *Decisional balance of smoking* was assessed by a 6-item smoking decisional balance scale (Velicer, DiClemente, Prochaska, & Brandenburg, 1985) composed of pros and cons of smoking. Decisional balance, which is one of constructs in the transtheoretical model, reflects the individual's relative weighing of the benefits of and barriers to changing a specific behavior (Velicer et al., 1985). The three pro items measured

perceptions of the benefits of smoking, such as "Smoking helps me concentrate and do better work." and the three con items measured perceptions of the barriers of smoking, such as "People think I'm foolish for ignoring the warnings about cigarette smoking." This instrument uses a 5-point Likert scale from 1 (*not important*) to 5 (*extremely important*). To calculate the decisional balance score, the average score for the cons subscale was subtracted from the average score for the pros subscale. The reliability of each subscale in this study was Cronbach's $\alpha = .77$ and .68 for pros and cons, respectively.

Interpersonal factors. Interpersonal factors were assessed by the presence or absence of household members, friends/coworkers, or partners who smoke, as follows: *Household smoking* was evaluated by asking "Does anyone who lives in the home currently smoke?" using yes, live alone, or no response categories. *Partner smoking* was assessed by asking "Do you have a partner/spouse/significant other who currently smokes cigarettes?" using yes/no response categories. Finally, *friends/coworkers' smoking* was assessed by asking "how many of your friends/coworkers smoke cigarettes?" using "most/all" and "some/few/none" response categories. Interpersonal factors in the social ecological model refer to social influence from and norms with family members, friends, contacts at work, and significant others (McLeroy et al., 1988). Interpersonal relationships are important sources of influence on individual's health behaviors, including smoking behavior (McLeroy et al., 1988). Several previous studies have shown that the presence or the absence of household members, friends, coworkers, and partners who smoke is highly associated with smoking behavior (Baumert et al., 2010; Chandola, Head, & Bartley, 2004; Manchon Walsh et al., 2007; Monden, de Graaf, & Kraaykamp, 2003; Park, Tudiver, Schultz, & Campbell, 2004).

Occupational factors. The degree of *Union commitment* was determined 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) using a 4-point Likert scale from 1 (*completely disagree*) to 4 (*completely agree*). The reliability of the measure in the present study was Cronbach's $\alpha = .73$. A higher score indicates more a positive view toward the union.

Exposure to occupational hazards included work-related exposure to musculoskeletal hazards, chemicals, dust, injuries, and secondhand smoke (SHS). Work-related musculoskeletal hazards, modified from the Washington State Ergonomics Rule (Washington State, 2000), were determined by asking the number of hours per full shift (almost never, <1, 1–4, and >4 hrs) requiring awkward postures at work. Dust, chemicals, SHS, and injury exposures were assessed by the frequency of exposure to each, using a lot or rarely/never. Based on previous studies (Okechukwu et al., 2010a; Quinn et al., 2007), exposure to each occupational hazard was classified as the high exposure category: exposed "more than 4 hrs per work shift" to awkward postures; exposed "a lot" to dust, chemicals, SHS, and injury as compared with "rarely/never". Each participant reporting these high exposures was classified as exposed to each hazard at work.

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

Analytic strategy

Data analyses were conducted using SPSS version 19.0 and Stata/SE version 12. Bivariate analysis was used to compare the characteristics of heavy and light/moderate smokers, using chi-square tests for categorical variables and *t*-test for continuous variables.

Due to the potential within-cluster (union site) correlation, multivariable analysis was conducted using generalized linear mixed models in Stata to control for the random effect of sites. Multivariable logistic regression analysis was used to determine the relative influence of individual, psychological, interpersonal, and occupational factors on heavy smoking. Variables for adjustment in the multivariable analysis were selected based on their significance in bivariate analyses ($p < .20$) and sociodemographic variables that have theoretically important relevance. There was a strong correlation between intention to quit at 30 days and 6 months ($r = .58$, $p < .001$) and self-efficacy for quitting at 30 days and 6 months ($r = .79$, $p < .001$). To avoid

multicollinearity, intention to quit at 30 days and self-efficacy for quitting at 30 days, which had more objective and significant correlation with smoking intensity, were selected for the multivariable analyses. Partner smoking and household smoking were highly collinear. A total of 311 smokers reported that their partner currently smokes, and 227 of them (73%) also reported that someone who lives with them smokes. Thus, household smoking was selected for regression analysis based on its higher significance in bivariate analysis.

A substantial number of current smokers (19%) had missing data on at least one key sociodemographic variable in the analyses. Multiple imputation methods in Stata were used to handle the missing data. Ten imputed datasets were created and analyzed separately, and then the results obtained from each of them were combined. For each variable, pooled estimates were used to report the odds ratios and 95% confidence intervals, along with a corresponding *p*-value. A *p*-value of .05 or less was considered statistically significant.

Results

Comparison of characteristics between heavy and light/moderate smoking

Of the 763 current smokers who were included in the analysis, approximately 21% ($n = 156$) were heavy smokers. Table 1 compares individual, psychological, interpersonal, and occupational factors by smoking intensity (heavy vs. light/moderate), prior to imputing missing covariates.

Heavy smokers compared to lighter smokers were significantly older (29.2 vs. 27.2 years, $p < .001$), started smoking at a younger age (15.7 vs. 16.8 years, $p = .001$), and were more likely to report smoking the first cigarette of the day within 30 min of waking (79.9% vs. 33.3%, $p < .001$). Heavy smokers were significantly less likely to have an intention to quit in the next 30 days or self-efficacy for quitting in the next 30 days and the next 6 months and were more likely to be tempted to smoke and perceive pros of smoking, compared with lighter smokers. Regarding interpersonal factors, heavy smokers were significantly more likely to report that household members currently smoked cigarettes (65.1% vs. 47.1%, $p < .001$). The same was true for partner smoking (53.0% vs. 38.9%, $p = .002$). However, in the bivariate analysis, the two groups did not show significant differences for any occupational factor.

Correlates of heavy smoking by multivariable logistic regression analysis

Table 2 presents the variables associated with heavy smoking in the logistic regression model. Older age (*OR* = 1.10; 95% CI: 1.06–1.14), male smokers (*OR* = 4.55; 95% CI: 1.62–12.79), smoking the first cigarette of the day within 30 min of waking (*OR* = 4.62; 95% CI: 2.81–7.59), earlier age of smoking initiation (*OR* = 0.93; 95% CI: 0.87–1.00), and higher temptation to smoke (*OR* = 1.55; 95% CI: 1.17–2.05) were significantly associated with heavy smoking. Smokers who lived alone were 4 times more likely to be heavy smokers, followed by those who lived with a household member who currently smoked (*OR* = 1.90; 95% CI: 1.18–3.06). Also, higher exposure to chemicals (*OR* = 1.61; 95% CI: 1.06–2.53) was significantly associated with increased likelihood of heavy smoking.

Discussion

To our knowledge, this study is the first to investigate the correlates of heavy smoking among building trades construction workers. The study found that 21% of current smokers were heavy smokers. Blue-collar workers have already been described as being more likely than white-collar workers to be heavy smokers (Giovino et al., 2000; Lawrence et al., 2007). This study shows that heavy smokers are characteristically different from lighter smokers within the smoker population. The present study found that older age was significantly associated with heavy smoking, consistent with prior research findings (Messer et al., 2008; Wilson et al., 1992). The gender difference in heavy smoking, which previous studies in the general population have found, was not as severe among unionized construction workers in this study (Lawrence et al., 2007; U.S. DHHS, 1998). In fact, there were no differences in smoking by gender in the unadjusted analysis, but male smokers were significantly more likely to be heavy smokers in the multivariable analysis. Women only represented 6% of the sample in this study. Therefore, the interpretation of this significant result in the multivariable analysis is limited due to relatively small numbers of women.

TABLE 1. *Individual, Psychological, Interpersonal, and Occupational Factors by Heavy Smoking among Building Trades Smokers (N = 763)*[a]

Variable	Total[a]	Light/moderate smokers (79.3%)	Heavy smokers (20.7%)	*p*-value*
Individual factors				
Age (year), *M* (*SD*)	27.7 (5.9)	27.2 (5.8)	29.2 (6.2)	<.001
Gender (male), *n* (%)	700 (94.1)	546 (93.5)	146 (96.1)	.236
Race/ethnicity (White), *n* (%)	619 (85.9)	487 (85.7)	126 (86.9)	.650
Education (≤high school/GED[b]), *n* (%)	392 (53.9)	302 (52.9)	87 (58.4)	.381
Income (<$50,000), *n* (%)	301 (46.1)	232 (45.6)	67 (48.6)	.762
Attempts to quit smoking (No), *n* (%)	385 (51.6)	299 (51.0)	83 (53.5)	.576
First cigarette after waking (≤30 min), *n* (%)	320 (42.7)	197 (33.3)	123 (79.9)	<.001
Age of smoking initiation, *M* (*SD*)	16.6 (3.7)	16.8 (3.7)	15.7 (3.5)	.001
Psychological factors				
Intention to quit at 6 months (Yes), *n* (%)	502 (69.4)	396 (70.2)	102 (66.2)	.342
Intention to quit at 30 days (Yes), *n* (%)	333 (46.5)	274 (48.8)	58 (38.7)	.028
Self-efficacy for quitting at 6 months, *M* (*SD*)	3.3 (1.3)	3.5 (1.3)	2.8 (1.3)	<.001
Self-efficacy for quitting at 30 days, *M* (*SD*)	3.0 (1.5)	3.2 (1.4)	2.5 (1.5)	<.001
Temptation to smoke, *M* (*SD*)	3.3 (1.0)	3.1 (1.0)	3.8 (0.9)	<.001
Decisional balance (pros−cons)[c], *M* (*SD*)	−0.2 (1.4)	−0.3 (1.3)	0.3 (1.5)	<.001
Pros of smoking	2.3 (1.0)	2.2 (1.0)	2.6 (1.1)	<.001
Cons of smoking	2.5 (1.1)	2.5 (1.1)	2.3 (1.0)	.029
Interpersonal factors				
Household smoking (Yes), *n* (%)	379 (50.6)	278 (47.1)	99 (65.1)	<.001
Partner smoking (Yes), *n* (%)	311 (41.7)	229 (38.9)	80 (53.0)	.002
Friends/coworkers smoking (most/all), *n* (%)	205 (27.6)	158 (27.0)	44 (29.1)	.601
Occupational factors				
Union commitment[d], *M* (*SD*)	17.8 (2.0)	17.8 (2.0)	17.7 (1.8)	.657
Work-related musculoskeletal hazards, *n* (%)	456 (59.9)	357 (59.8)	96 (61.5)	.693
Dust exposure at work, *n* (%)	611 (81.0)	474 (80.1)	131 (85.1)	.158
Chemical exposure at work, *n* (%)	238 (31.6)	181 (30.5)	56 (36.8)	.132
SHS at work[e], *n* (%)	339 (44.6)	269 (45.1)	68 (43.9)	.833
Injuries at work, *n* (%)	227 (30.0)	181 (30.5)	45 (28.8)	.694
Concern about exposures to occupational hazards[f], *M* (*SD*)	14.9 (4.3)	15.0 (4.4)	14.5 (4.1)	.164

[a]Totals do not add up to the same number because values were calculated prior to imputing missing covariates. Eight participants did not reply to the smoking intensity variable.
[b]GED = general educational development.
[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.
*p-value for χ^2 test or t-test.

The present study found that heavy smoking was strongly associated with the time to smoke the first cigarette of the day after awakening. It is a valid single-item measure of nicotine dependence level (Baker et al., 2007). Prior investigations support the nicotine dependence association with heavy smoking (Wilson et al., 1992). High nicotine dependence is most consistently associated with an increased risk of smoking cessation relapse (Baker et al., 2007). Nicotine replacement therapy may be a very important aid for more nicotine dependent heavy smokers.

The present study found a significant association between early age of smoking initiation and subsequent heavy smoking, which is consistent with prior research findings (D'Avanzo, La Vecchia, & Negri, 1994; Wilkinson, Schabath, Prokhorov, & Spitz, 2007). Other studies reported that younger age at smoking initiation is associated with increased lung cancer mortality (Hegmann et al., 1993; Knoke,

TABLE 2. *Correlates of Heavy Smoking by Multivariable Logistic Regression (*N = 763)

Variable	*OR* (95% CI)	*p*-value
Age (continuous)	1.10 (1.06–1.14)	<.001
Gender		
Male	4.55 (1.62–12.79)	.004
Female	Reference	
Race		
Hispanic	1.88 (0.47–7.45)	.369
African American, non-Hispanic	0.54 (0.17–1.66)	.278
Other, non-Hispanic	1.33 (0.56–3.15)	.511
White, non-Hispanic	Reference	
Income		
<$50,000	0.70 (0.40–1.25)	.227
$50,000–74,999	0.85 (0.46–1.57)	.600
≥$75,000	Reference	
Education		
High school/GED[a] or less	1.37 (0.49–3.81)	.546
Some college or 2 year college	1.74 (0.61–4.95)	.300
4 years college or more	Reference	
Time to first cigarette after waking		
≤30 min	4.62 (2.81–7.59)	<.001
>30 min	Reference	
Age of smoking initiation (continuous)	0.93 (0.87–1.00)	.046
Intention to quit at 30 days		
Yes	0.74 (0.46–1.17)	.196
No	Reference	
Self-efficacy for quitting 30 days (continuous)	1.00 (0.85–1.19)	.989
Temptation to smoke (continuous)	1.55 (1.17–2.05)	.002
Decisional balance (continuous)	1.18 (0.99–1.40)	.065
Household smoking		
Yes	1.90 (1.18–3.06)	.008
Live alone	4.11 (1.70–9.92)	.002
No	Reference	
Dust exposure at work[b]	1.26 (0.70–2.27)	.443
Chemicals exposure at work[b]	1.61 (1.06–2.53)	.036
Concern about exposure to occupational hazards (continuous)	0.97 (0.92–1.02)	.247

CI = confidence interval, *OR* = odds ratio.
[a]GED = general educational development.
[b]Unexposed to each occupational hazard is the reference group.

Shanks, Vaughn, Thun, & Burns, 2004). Thus, it is important to educate workers at young age about the harmful health effect of cigarette smoking to reduce nicotine addiction and negative health outcomes at later time of their life.

The results indicate that temptation to smoke was the only significant predictor of smoking in adjusted analysis that controlled for individual, psychological, interpersonal, and occupational factors. Heavy smokers are more likely to perceive temptation to smoke. Temptation to smoke evaluates how tempted smokers feel to smoke in nine social situations (Velicer et al., 1990). Prior studies provide insight to the potential mechanism through which temptation to smoke and heavy smoking are connected. In a qualitative study, heavy smokers reported that the emotional support provided as part of smoking reinforced their perception of smoking as relaxing (Thompson et al., 2003). Temptation to smoke is also a predictor of the individual's success in taking action to quit smoking and in maintain smoking cessation (Breitling, Twardella, Raum, & Brenner, 2009). In that respect, this group of smokers may be a high-risk group that needs tailored interventions that addresses the situations in which they are tempted to smoke along with their high addiction to nicotine and their heavy cigarette use.

Heavy smokers were significantly more likely to report a smoking partner or household members who smoked than lighter smokers in the bivariate analysis, consistent with earlier studies (Baumert et al., 2010; Manchon Walsh et al., 2007). Heavy smokers have been found to have an environment that may increase pressures to smoke, including the presence of 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 in the extant literature about specific differences in blue-collar workers' smoking behaviors by living situation. Future studies should consider additional qualitative research to assess in more detail the social contexts and perceptions smokers have about why they smoke more heavily. The presence of household members may affect more positive smoking behavior change than 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.

Most of the occupational factors were not associated with an increased likelihood of heavy smoking. Construction workers have potentially high exposures to various toxic chemicals, such as silica (Flanagan, Seixas, Majar, Camp, & Morgan, 2003; Lynge, Kurppa, Kristofersen, Malker, & Sauli, 1986; Rappaport et al., 2003). In our previous work, we found that higher exposure to chemicals and dust significantly associated with increased odds of current smoking (Chin et al., 2012). The present study found that exposure to chemicals at work became significantly associated with heavy smoking in the multivariable analysis that controlled for other factors. This is a concern because exposure to chemicals has been associated with excess mortality from cancers among construction workers (Finkelstein & Verma, 2005; Knutsson, Damber, & Jarvholm, 2000; Salg & Alterman, 2005). The significant relationship between exposure to occupational hazards and heavy smoking poses a serious health challenge in this population. Heavy smoking may elevate the risk for lung and other cancers or diseases associated with chemical exposure among blue-collar workers. This finding suggests smoking cessation programs for this population need to integrate information about occupational factors such as occupational hazardous exposures, along with individual approaches. Sorensen et al. (2002) found that smoking cessation interventions integrated with occupational health and safety programs (e.g., reduction in workplace hazards) could potentially result in substantial increases in smoking cessation compared with smoking cessation-only programs for blue-collar workers (Sorensen et al., 2002).

The identification of the high-risk subgroup among smokers may help to develop targeted smoking cessation interventions in this unique population (i.e., building trades construction workers). In the present study, these differences between heavy and lighter smokers highlight the need of different approaches in intervention strategies for the heavy smoking group among blue-collar workers with a high risk of smoking-related disease. Not only using individual approaches, including pharmacotherapies such as nicotine replacement or bupropion, and assessing all temptations to smoke but also including smokers' household members may be needed to help these heavy smokers reduce smoking intensity. Furthermore, to develop more effective smoking cessation interventions for blue-collar workers with higher hazardous exposures, it is also important to address the contribution of occupational hazards to smoking behaviors.

Limitations include the cross-sectional nature of the data, which limits conclusions about possible causality due to the inability to establish temporal precedence. The fact that the present study participants were unionized 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 a large sample size over all, low numbers of women and those from non-White racial and ethnic groups participated. Although their participation represents the sociodemographic characteristics of skilled unionized construction workers, the low numbers 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).

The findings from this present study helped us better understand various types of factors that influence heavy smoking among building trades construction workers. Understanding the unique characteristics of heavy smokers is important for developing improved and more effectively targeted smoking cessation intervention strategies for high-risk heavy smokers among blue-collar workers. This study suggests that the targeted smoking cessation programs need to take a comprehensive approach considering the varying characteristics of different subgroups of the smoking population. Intervention strategies should address blue-collar smokers' individual characteristics, interpersonal norms, and their

environments at work. More intensive pharmacological (e.g., reducing nicotine addiction) and behavioral (avoiding situations where they are tempted to smoke) interventions, and programs which encourage smokers' social networks and improve healthy work environments may promote reducing the numbers of cigarettes smoked among smokers.

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