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ORIGINAL PAPER

Knowledge of Occupational Chemical Exposure and Smoking Behavior in Korean Immigrant Drycleaners

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Abstract To examine the association between knowledge of chemical exposure at work and cigarette smoking among Korean immigrant drycleaners. A cross-sectional survey was conducted with a total of 151 Korean immigrant drycleaners (mean age = 49 years, 64 % male) from 96 drycleaning shops in a Midwestern state. The data were collected on demographic and work-related characteristics, knowledge of occupational chemical exposure, health concerns associated with chemical exposure, and smoking status. Approximately 25 % of participants were current smokers. The multivariate regression showed that greater knowledge of occupational chemical exposures was significantly associated with a lower likelihood of current smoking [odds ratio (OR) .63; 95 % confidence interval (CI) .41–.95]. Furthermore, male gender (OR 6.32; 95 % CI 1.66–24.00), shorter-term residence in the US (OR .93; 95 % CI .88–.98), and having multiple duties (OR 2.76; 95 % CI 1.01–7.51) were important covariates associated with current smoking among Korean immigrant drycleaners. Knowledge on occupational chemical exposure was significantly associated with smoking among Korean immigrant drycleaners. Smoking cessation programs for this population should consider integrated approaches that incorporate work environment factors into individual and sociocultural components.

Keywords Smoking · Occupational chemical exposure · Korean immigrants · Drycleaners

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Introduction

Drycleaners are at a high risk of occupational exposure to toxic chemicals, such as perchloroethylene (PERC), petroleum solvents, and trichloroethylene (TCE), through the loading and unloading of garments from the drycleaning machine [1–5]. These solvents, commonly used in drycleaning shops, may enter the body by skin absorption, eye contact, or inhalation of vapors [6], increasing the risk of cancer [7–9], depression of the central nervous system [10–12], neurotoxic effects (e.g., schizophrenia) [13], lung disease [14], dementia [15], vision loss [16], renal disease [17], and liver damage [18], as well as skin, eye, nose, and throat irritation [19, 20]. Despite the many studies reporting the alarming risks and hazards related to chemical exposure in drycleaning industry, the majority (85 %) of drycleaning shops in the US still use PERC as their primary solvent [21].

Cigarette smoking is a well-known cause of multiple cancers, heart disease, stroke, complications of pregnancy, chronic obstructive pulmonary disease (COPD), and many other diseases [22]. Smoking among Korean Americans continues to be a public health challenge [23]. Healthy People 2020 set a goal of reducing adult cigarette smoking prevalence to 12 % [24]. Even though the rate of cigarette smoking has declined over the past 40 years in the US [25], Korean American men in particular continue to have high smoking prevalence. Over 30 % of Korean American men

still smoke cigarettes [26–30], which is significantly higher than current smoking rate (19 %) for the general US adult population [31]. Although the prevalence of smoking among Korean American women is still low, unlike other racial/ethnic groups, Korean American women's smoking prevalence has been increasing, from 7 % in 2001 to 9 % in 2007 [32]. While the importance of addressing health issues specific to this group has been acknowledged, few studies have been conducted in the US.

Korean Americans are one of the largest ethnic minority groups in the US. Koreans are the fifth largest Asian subgroup, and this group is a rapidly growing Asian immigrant group [33, 34]. According to the Korean American Research and Development Institute, first-generation immigrant Koreans have a high rate of self-employment (20 %), with drycleaning services being the most frequently held small business [35]. There are currently over 39,000 drycleaning businesses nationwide, and Korean Americans own 20 % of them. Korean immigrant drycleaners, the largest ethnic minority in the US drycleaning industry, are exposed hazardous work environments including chemicals.

Previous research showed significant associations of smoking behaviors with exposures to occupational hazards such as dust, chemicals, and fumes. Workers who reported higher exposure to hazards at work were significantly more likely to be smokers [36–39], while workers who were more concerned about exposure to occupational hazards were significantly less likely to be smokers [36]. Furthermore, workers who reported higher scores for dual hazard from cigarette smoking and exposure to dust, chemicals and fumes at work demonstrated an improved smoking cessation [39].

No study has been conducted to assess the association between drycleaners' knowledge about chemical exposure at work and current smoking behavior among Korean immigrant drycleaners. The purpose of this study is to identify smoking rates among Korean immigrant drycleaners and examine if their knowledge of occupational chemical exposure is associated with their smoking behaviors, controlling for other significant factors.

Methods

Study Design and Participants

This cross-sectional study was conducted with Korean immigrant drycleaners from about 300 members of the Korean Drycleaners Association and their employees in a Midwestern state. A total of 151 participated in this study. The study was approved by the Institutional Review Board of the University of Michigan. Participation in the study was voluntary. All participants received a $10 gift card for their contribution to the study.

Measures

The survey questionnaire was developed through an extensive literature review, focus group discussions, expert review, and pilot test. The survey questionnaire was developed in English based on an extensive literature review and modified after focus group discussions with English speaking Korean immigrant drycleaners, and then revised after the review by the expert panel that included one NIOSH researcher and two state-employed inspectors. The final version of the English questionnaire was translated into Korean language by two bilingual translators, using the back translation method. The principal investigator compared the back-translated English versions and the original English version questionnaire and identified a few discrepancies. Translations were corrected and finalized through consultations with third bilingual person. Finally, the Korean version was piloted with 13 Korean immigrant drycleaners.

To address the purpose of this study, this paper included the data on demographic and work-related characteristics, alcohol use, knowledge of chemical exposure, health concerns associated with chemical exposure, and smoking status.

Demographics were included in age, gender, education, years lived in the US, health insurance status, and general health status. *Education attainment* was categorized as less than high school, high school, associate degree or trade school, bachelor, and graduate degree.

Health insurance was assessed by asking "Do you have any health insurance (Yes/No)? What does your insurance cover?" Response options were none, general practitioner, medical prescriptions, prescribed tests, hospitalization expenses, and dental services.

General health status was measured by a single question, "In general, would you say your health is?" Response categories are excellent, very good, good, fair, or bad.

Alcohol use was categorized as daily, 2 or 3 times weekly, once a week or less, about 5–6 times a year, and never drank alcohol.

Work-related characteristics included years of drycleaning work, position at their drycleaning store, and job duty. *Position at the store* was categorized as owner only (not working), owner and worker, and worker only. *Job duty* was categorized as drycleaner, spotter, presser, counter (cashier), deliverer, sewer, launderer, and others.

Knowledge of occupational chemical exposure was measured by asking participants about how much they agree/or disagree with 13 statements about the possible sources of chemical exposure while working in the

drycleaning industry (Cronbach's alpha = .92). Detailed items are: (1) "Loading dirty clothes into the machine"; (2) "Removing clothes, especially thick items, before the dry cycle is finished"; (3) "For transfer machines, transferring solvent-laden clothes to the dryer"; (4) "Cleaning lint and button traps"; (5) "Raking out the still"; (6) "Changing the solvent filter"; (7) "Maintenance of the water separator"; (8) "Handling and storage of hazardous waste"; (9) "Pressing freshly dry-cleaned clothes"; (10) "Using a chemical-based spotting agent"; (11) "Using a chemical-based waterproofing agent"; (12) "Exposure to chemical emissions not captured by vapor"; and (13) "Exposure to chemical emissions from leaks in machines, hoses, valves, or ducts". Responses to each item were measured on a 6-point Likert scale (1 = *strongly disagree,* 6 = *strongly agree*). The scale scores were obtained by the average of 13 items with a higher score indicating more knowledge on chemical hazards (range 1–6).

Health concerns associated with chemical exposure were measured by asking participants about how much they agree/or disagree with nine statements about health effects associated with chemical exposure (Cronbach's alpha = .96). Detailed items are: (1) "I might suffer sore eyes from breathing chemical fumes or getting chemical on my skin"; (2) "I might suffer skin irritation from breathing chemical fumes or getting chemical on my skin"; (3) "I might suffer headaches from breathing chemical or getting chemical on my skin"; (4) "I might suffer dizziness from breathing chemical or getting chemical on my skin"; (5) "I might suffer dermatitis from long term exposure to chemical"; (6) "I might suffer memory loss from long term exposure to chemical"; (7) "I might suffer damage to my liver from long term exposure to chemical"; (8) "I might suffer damage to my kidneys from long term exposure to chemical"; (9) "I might suffer damage to my nervous system from long term exposure to chemical". Responses to each item were measured on a 6-point Likert scale (1 = *strongly disagree,* 6 = *strongly agree*). The scale scores were obtained by the average of nine items with a higher score indicating higher level of concern about health effects of chemical exposure (range 1–6).

Smoking status was measured by a single question, "Have you ever smoked?" Response categories include "Never smoked", "Smoked but Stopped", and "Now smoke". We defined current smokers as those who responded "Now smoke".

Data Analysis

Data were analyzed using SPSS version 19 [40]. Descriptive statistics were analyzed for each study variable, using means and standard deviations for continuous variables, and frequencies and percentages for categorical variables. Knowledge of chemical exposure at work and health concerns associated with chemical exposure were assessed by multiple items that should intercorrelate. These items were checked for internal consistency reliability using alpha coefficients. Scale reliability was considered acceptable if the alpha coefficient is at least .70 [41]. Bivariate analysis was performed using Chi square tests and *t* tests for categorical variables and continuous variables, respectively. Multivariate logistic regression analysis was used to determine the significance of the associations between smoking behavior and related factors. Variables for the multivariate analysis were selected based on their significance levels in bivariate analyses ($p < .05$). Prior to the multivariate analysis, multicollinearity among independent variables was assessed. We detected no high intercorrelations among independent variables.

Data showed that about 18 % (27/151) of the study participants did not answer for at least one of key variables included in the multivariate analysis. Data were analyzed by imputing missing values using the SPSS multiple imputation method [40]. The multiple imputation method preserved information from missing data in estimating the logistic regression model, and minimized validity bias, unlike the listwise method of deleting all observations with mission values on any factors [42, 43]. Five imputed data sets were created, and each of them had different imputed values for the missing data [43–45]. Multivariable logistic regression analysis was performed on each of the imputed data sets separately, and then the results obtained from each of them were pooled to achieve single parameter estimates. Pooled estimates from the five imputed datasets were used to report the odds ratios (ORs) and 95 % confidence intervals (95 % CI), along with a corresponding *p* value. The level of statistical significance was set at a *p* value of <.05.

Results

Characteristics of the Study Participants

Demographic and work characteristics of the study participants are shown in Table 1. About 64 % of the participants were male with an average age of 48.5 years. Over 50 % of the participants reported that they received bachelor's degrees or higher. Participants had lived in the US for about 17 years (ranged from 2 to 39 years) and worked in the drycleaning industry for about 11 years (ranged from 6 months to 30 years). About 40 % reported their general health was fair or bad, yet 44 % had no health insurance. Approximately 25 % of the participants were current smokers and 32 % reported alcohol drinking at least once a week.

Table 1 Characteristics of the study participants (N = 151)[a]

Characteristics	Mean (SD)
Age (Years) (23–71)	48.5 (10.2)
Years in the US (2–39)	17.4 (8.9)
Years in dry cleaning work (.5–30)	11.0 (7.1)
Knowledge of chemical exposure at work (1–6)	3.7 (1.1)
Health concerns associated with chemical exposure (1–6)	4.0 (1.3)
	N (%)
Education	
Less than high school	6 (4.0)
High school	41 (27.3)
Associate degree or trade school	22 (14.7)
Bachelor	76 (50.7)
Graduate	5 (3.3)
Gender	
Male	96 (64.0)
Female	54 (36.0)
Health insurance	
None	65 (44.2)
General practitioner	14 (9.5)
Medical prescriptions	5 (3.4)
Prescribed tests	3 (2.0)
Hospitalization expenses	52 (35.4)
Dental services	8 (5.4)
Health status	
Excellent	12 (7.9)
Very good	45 (29.8)
Good	33 (21.9)
Fair	52 (34.4)
Bad	9 (6.0)
Alcohol use	
Daily	3 (2.0)
2 or 3 times weekly	13 (8.8)
Once a week or less	31 (21.1)
About 5–6 times a year	30 (20.4)
Never drank alcohol	70 (47.6)
Smoking status	
Current smokers	37 (24.5)
Never/former smoker	114 (75.5)
Position	
Owner only (not working)	15 (10.6)
Owner and worker	90 (63.4)
Worker only	37 (26.1)
Duty[b]	
Drycleaner	90 (60.8)
Spotter	87 (58.8)
Presser	72 (48.6)
Counter (Cashier)	113 (76.4)
Deliverer	21 (14.3)
Sewer	55 (37.2)
Laundry	53 (36.1)
Other	11 (7.3)
Multiple Duty (≥3 duties)	87 (57.6)

[a] Numbers for characteristics do not total the same number due to missing data

[b] Multiple choice. Percentages may not add up to 100 % due to the option to select more than one response

The majority of the participants (63.4 %) owned and worked their own drycleaning stores. The most commonly reported job duty was counter (cashier) (76.4 %) followed by drycleaner (60.8 %), spotter (58.8 %), presser (48.6 %), sewer (37.2 %) and launderer (36.1 %). Over half (57.6 %) had multiple duties (defined as more than three). The mean scores of knowledge of chemical exposure at work and health concerns associated with chemical exposure were 3.7 and 4.0 (ranged from 1 to 6 for both), respectively.

Comparison of Characteristics by Current Smoking

Table 2 presents the comparison of participants' characteristics by current smoking status. Compared to never/former smokers, current smokers were significantly more likely to be male (92 vs. 55 %, $p < .001$), drink alcohol (at least once a week) (53 vs. 25 %, $p = .002$), and perform multiple duties (78 vs. 51 %, $p = .003$). Compared to never/former smokers, current smokers lived in the U.S for significantly shorter period of time (14 vs. 18 years, $p = .012$) and reported less knowledge on chemical exposure (3.3 vs. 3.8, $p = .013$). While current smokers showed slightly lower level of health concerns associated with chemical exposure than never/former smokers (3.8 vs. 4.1), the difference was not statistically significant.

Association of Individual and Work-related Characteristics with Current Smoking

Table 3 presents the factors associated with current smoking in the multivariable logistic regression model. As stated in the data analysis section, the multivariate analysis included variables that showed significance to current smoking in bivariate analyses. Five variables (gender, years lived in the US, alcohol use, knowledge of occupational chemical exposure, and multiple duties) were significantly associated with smoking. While knowledge of occupational chemical exposure and health concerns associated with

Table 2 Comparison of individual and work-related characteristics between current smokers and never/former smokers (N = 151)[a]

	Current smokers (N = 37, 24.5 %) Mean (SD)	Never/former smokers (N = 114, 75.5 %) Mean (SD)	*p* value*
Age (Years)	47.9 (9.5)	48.7 (10.5)	.713
Years in the US	14.2 (8.0)	18.4 (8.9)	.012
Years in dry cleaning work	11.0 (6.4)	11.0 (7.3)	.987
Knowledge of chemical exposure at work	3.3 (1.0)	3.8 (1.1)	.014
Health concerns associated with chemical exposure	3.9 (1.5)	4.1 (1.3)	.633
	n (%)	n (%)	*p* value*
Gender (Male)	34 (91.9)	62 (54.9)	<.001
Education (≥bachelor)	21 (56.8)	60 (53.1)	.926
Health insurance (None)	18 (51.4)	47 (42.0)	.325
Health status (bad or fair)	15 (40.5)	46 (40.4)	.984
Alcohol use (≥once a week)	19 (52.8)	28 (25.2)	.002
Position (Worker only)	11 (32.4)	26 (24.1)	.620
Duty[b]			
Drycleaner	30 (83.3)	60 (53.6)	.001
Spotter	28 (77.8)	59 (52.7)	.008
Presser	22 (61.1)	50 (44.6)	.085
Counter (Cashier)	30 (83.3)	83 (74.1)	.257
Deliverer	11 (31.4)	10 (8.9)	.001
Sewer	7 (19.4)	48 (42.9)	.011
Laundry	20 (55.6)	33 (29.7)	.005
Other	3 (8.3)	8 (7.1)	.813
Multiple Duty (≥3 duties)	29 (78.4)	58 (50.9)	.003

The significance criteria: *p* value <.05

* *p* value for t-test or $\chi 2$ test

[a] Numbers for characteristics do not total the same number due to missing data

[b] Multiple choice

Table 3 Multivariable association of individual and work-related characteristics with current smoking (N = 151)

Characteristics	OR (95 % CI)	*p* value
Gender		
Male	6.32 (1.66–24.00)	.007
Female	reference	
Alcohol use		
≥once a week	1.88 (.77–4.59)	.163
No, or 5–6 times/year	reference	
Years in the US (continuous)	.93 (.88–.98)	.007
Knowledge of chemical exposure at work (continuous)	.63 (.41–.95)	.028
Multiple duty		
≥3 duties	2.76 (1.01–7.51)	.047
<3 duties	reference	

The significance criteria: *p* value <.05

chemical exposure were moderately correlated (r = .42, $p < .001$), only knowledge was significantly associated with smoking in bivariate analysis. Thus, we dropped 'health concerns' from the multivariate model.

As shown in Table 3, significant factors associated with current smoking were gender, years lived in the US, knowledge of occupational chemical exposure, and multiple duties. People who had more knowledge of occupational chemical exposure were less likely to be a current smoker (OR .63; 95 % CI .41–.95). Also, participants who lived in the US for longer years were less likely to be current smokers (OR .93; 95 % CI .88–.98). Male workers (OR 6.32; 95 % CI 1.66–24.00) and those who performed multiple duties (OR 2.76; 95 % CI 1.01–7.51) were more likely to be current smokers.

Discussion

The most interesting thing about this study was the relationship between smoking and lack of knowledge of occupational exposures. This is similar to other studies. For example, in a study of crafts persons and laborers at 22 work sites, workers exposed to chemical hazards on the job were significantly more likely to be smokers and those who had concerns about their exposure to chemical hazards at work demonstrated an increased interest in quitting (Sorensen and colleagues [37]. Moreover, among building

trade workers, occupational exposures to dust and chemicals were significantly associated with an increased likelihood of current smoking and greater concern about exposure to occupational hazards was significantly associated with a lower likelihood of current smoking [36].

Conversely, in a recent study including specific types of occupational hazards, Hong et al. [46] found that operating engineers exposed to asphalt fumes, heat stress, concrete dust, and welding fumes were less likely to smoke. Hong et al. [46] suggested the possibility that operating engineers may become more concerned about their health when they were exposed to visually recognizable hazards such as asphalt fumes, heat stress, concrete dust, and welding fumes, thus workers with higher exposure to these hazards were less likely to smoke. Thus, assessing knowledge and concerns about chemical exposures at work and perceptions of these risks is important for developing more targeted smoking cessation intervention strategies for this population. Another study, MassBUILT smoking cessation intervention study with unionized blue-collar apprentices in the building trades, also showed similar findings [39]. In that study, workers who reported high scores for exposures to multiple hazards (e.g., smoking plus occupational exposure to dust, chemical, and fumes) showed an improved smoking cessation regardless of intervention group. Okechukwu et al. [39] stated that the worker's understanding about their exposures to multiple hazardous agents at work and personal cigarette smoking would lead to an increase in smoking cessation.

More than half of Korean drycleaners reported performing multiple (more than three) job tasks. Korean drycleaners who had multiple job duties were three times more likely to be current smokers in this study. Multiple job duties might result in stressful working conditions, which in turn could contribute to increased smoking [47–50]. Future studies should consider assessing more detailed information about job strain and exploring the effect of job strain on smoking among this population.

Koreans are less likely to have health insurance (33 %) or an usual source for health care (25 %) than other ethnic groups [51]. In this study, a large percent (44 %) of the participants did not have any health insurance. No or limited health care access and utilization among Korean Americans with high smoking prevalence is a concern because they may not have opportunity for cessation assistance or for early detection and treatment of smoking-related chronic diseases. [52]. This is particularly problematic as the smoking prevalence among Korean immigrant drycleaners in this study was 25 %, higher than that of the US general population (19 %) [31]. It is therefore not surprising that previous studies with Korean immigrants have reported a high prevalence of smoking-related diseases such as cancer and hypertension [53–55].

Another important finding of the study was the significant association of time living in the US with smoking with individuals who lived in the US for shorter time period smoking significantly more. This finding is consistent with earlier studies that reported an inverse relationship between length of residency in the US and smoking [30, 56, 57]. This may be due to acculturation, which is a process by which individuals or groups adopt the values, customs, norms, attitudes, and behaviors of another mainstream culture [58] and years of living in the US is one of measures to capture level of acculturation [30, 57, 59]. Previous studies found that smoking rates were higher for Korean American men with low acculturation (immigrants, limited in English, born in Korea, or lived in the US for shorter period). Moreover, studies have shown that smoking interventions among Vietnamese communities were less successful than among those who speak English [60].

Interestingly, smoking was more prevalent among Korean women with higher acculturation [27, 28, 57, 59]. Nonetheless, smoking rates were generally low among women and extraordinarily high (35.4 %) among the men in this sample, which is consistent with earlier studies with Korean American men [26–30]. Societal norms in Korea promote men's smoking but discourage women to smoke [61]. Initiation of smoking among Korean men is usually influenced by peer pressure in school and the military [62]. Also, Korean men offer cigarettes to each other as part of doing business and social interactions [62]. In Korea, smoking is socially acceptable for men and the exchange of cigarettes is common social events. Another reason for the higher rates of smoking among the men in this study was that the men were more likely to drink alcohol [27] and smoking and drinking alcohol have been found to be highly correlated [30, 57]. In the bivariate analysis, current smokers were significantly more likely to drink alcohol than never/former smokers in this study.

There have been few smoking cessation studies conducted in Asian communities showing mixed results. One of these, the Racial and Ethnic Approaches to Community Health (REACH) project, which targeted multiple behavior changes and showed decreases in smoking among Asians [60]. Successful strategies included creating change among change agents (e.g., community advocates, advisors, ministers and Buddhist monks), culturally tailored, language appropriate health communication campaigns, education, and health promotion programs, fact sheets and audiotapes and CDs (for low literacy participants) distributed to community settings including worksites. While the REACH study focused on multiple behavior changes, future smoking cessation interventions targeting Korean drycleaners can build on the strategies of the REACH study and the findings of this study and other similar studies,

which suggest increasing knowledge of the hazards of occupational exposures and smoking.

Strengths and Limitations

This study has a number of strengths. This study is the first to assess the relationship of smoking with knowledge of occupational chemical exposure with Korean immigrant workers. Also, multiple imputation methods that used 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 [42, 43].

Several limitations should be noted. First, this was a cross-sectional study, thus it is not possible to determine a causal direction between significant factors and current smoking. Second, the data were collected from Korean immigrant drycleaners in one mid-western state and the sample size is fairly small, thus the findings cannot be generalized. Third, the study used self-reported smoking status without the benefit of biochemical validation (i.e., testing of saliva, blood, and/or urine samples, or exhaled carbon monoxide). Lastly, this study used the secondary data from the Drycleaner's Protective Behavior Study (Grant Number: T42 OH008455-01, PI: Hong), so other smoking related characteristics (smoking intensity, age of smoking initiation, attempts to quit smoking, nicotine dependence level, etc.) were not collected.

In conclusion, this study showed a relationship between smoking and lack of knowledge about occupational chemical exposure among Korean drycleaners. Moreover, smoking rates were high among this population, especially among males, those with multiple job responsibilities, and those who are more recent immigrants. Smoking cessation interventions targeting Korean dry cleaners may need to consider concurrent intervention about chemical exposures on the job and culturally tailored interventions, particularly for Korean for more recent immigrants. Cigarette smoking has been viewed as an individual health risk behavior. But recent research including the present study demonstrated that an occupational exposure to various hazards such as PERC in drycleaners. Recognizing the roles of occupational chemical exposure on workers' smoking behavior, it is important for primary health care providers to consider occupational exposures for inclusion in a smoking cessation program. Furthermore, drycleaning shop owners should reduce chemical exposures as much as they can through proper control measures such as substituting PERC with a less toxic solvent, upgrading equipment, and improving ventilation systems in the shops. It is also important to educate workers in the drycleaning shops about the risks of chemical exposure they encounter at work and personal protection through good work practices.

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Conflict of interest The authors declare no conflict of interest.

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