

**Chemical Exposure and Personal Protective Behavior
among Korean-American Drycleaners**

Specific Aims

Drycleaners have numerous health and safety risks in hazardous work environments. Specifically, drycleaners are exposed to toxic chemicals such as perchloroethylene (PERC) commonly used in the drycleaning industry, which may cause cancer, neuropathies, renal disease, or other significant illnesses. Among over 39,000 drycleaning businesses in the U.S., Korean-Americans comprise the largest ethnic minority in the drycleaning industry. They may be at great risk for occupational injuries and illnesses in the drycleaning industry. Even though several studies highlight the health risks of hazardous chemical exposure in drycleaning environments, little is known about health symptoms associated with chemical exposure and actual protective behaviors to minimize chemical exposure among Korean-American drycleaners. A study of a large number of Koreans employed in the drycleaning industry is needed.

The purpose of the proposed study is to identify chemical-related health symptoms, occupational injuries, work environments, and personal protective behaviors among Korean-American drycleaners in California to guide intervention development to reduce occupational exposure and illness. The specific aims are: 1) To assess health symptoms associated with chemical exposure, occupational injuries, and risk perception of chemical exposure; 2) To describe drycleaners' experiences of chemical exposure, control measures of chemical exposure, and indoor air problems; 3) To identify the use of personal protective equipment (PPE: gloves, mask or respirator, protective clothes or apron, safety glasses or goggles, and safety shoes) and

drycleaners' safe work practices to reduce chemical exposure; and 4) To examine factors associated with personal protective behaviors among Korean-American drycleaners.

The findings from this study will provide the scientific basis for the development of more effective occupational health and safety strategies to ultimately reduce chemical exposure and to prevent occupational injuries and illness among Korean drycleaners.

Background and Significance

Drycleaners are occupationally exposed to hazardous chemicals, such as PERC, petroleum solvents, and TCE, through the loading and unloading of the drycleaning machine.¹⁻⁵ These solvents, commonly used in dry cleaning shops, can enter the body by skin absorption, eye contact, or inhalation of the vapors.⁶

Numerous studies have documented adverse health effects associated with solvents among dry cleaners. These solvents can increase the risk of cancer,⁷⁻⁹ depression of the central nervous system,¹⁰⁻¹² neurotoxic effects (e.g., schizophrenia),¹³ spontaneous abortions,¹⁴ heart disease,¹⁵ lung disease,¹⁶ dementia,¹⁷ vision loss,¹⁸ renal disease,¹⁹ and liver damage,²⁰ as well as skin, eye, nose, and throat irritation.^{21, 22} Despite several studies highlighting the alarming risks and hazards related to working in dry cleaning environments, approximately 85% of drycleaning shops in the U.S. use PERC as their primary solvent.²³

Koreans are the fifth largest Asian subgroup, and this group is a rapidly growing immigrant Asian group.^{24, 25} According to the Korean American Research & Development Institute, first-generation immigrant Koreans have a high self-employment rate (20%), with dry cleaning services being the most frequently held small business.²⁶ There are currently over 39,000 drycleaning businesses nationwide, and nationally Korean Americans own 20% of all drycleaning businesses. Korean-American drycleaners, who are the largest ethnic minority in the

drycleaning industry in the U.S., have been working in hazardous work environments. Thus, Korean drycleaners comprise a group at high risk for occupational illness and injury in the drycleaning industry. It is important to reduce their exposure to chemicals to reduce possible adverse health effects among them. Information about the toxic health risks of drycleaning solvents is important for dry cleaners. Furthermore, it is important to assess chemical-related symptoms, drycleaners' knowledge about chemical exposure, and their perceptions of these health risks. However, little is known about occupational health and safety problems among Korean-American drycleaners.

There are various methods that can be used to reduce chemical exposure and prevent hazards, including engineering controls, work practices, and personal protection. The most effective way to reduce exposure to solvents in the dry cleaning industry may be to retrofit engineering controls.^{22, 27} However, these controls are often costly or impractical to fully achieve. Personal protective behaviors such as the use of PPE have proven to be effective in reducing chemical exposure.^{28, 29} However, no study has examined the use of PPE to reduce chemical exposure at work and the factors associated with the use of personal protection among Korean American drycleaners.

This proposed study will specifically focus on Korean-American drycleaners' personal protective behaviors and proper safe work practices in the drycleaning industry. The findings from this pilot study will be used to guide the development of occupational health and safety training programs to promote knowledge of hazardous exposure at work and to increase preventive behaviors among Korean drycleaners in the U.S. Gathering in-depth information regarding their self-protective behaviors can provide the basis for developing effective

culturally-integrated occupational health and safety programs for minority workers in the drycleaning industry.

Methods

Study design

A cross-sectional study design will be conducted using a self-reported survey to address the specific aims of the study. The findings from this study will provide the scientific basis for the development of an effective intervention to improve occupational health and safety behavior among drycleaners.

Institutional Review Board. This study will be approved and monitored by the University of California San Francisco (UCSF) Committee on Human Subjects. The protection of confidentiality for the study participants will be discussed in detail in the Human Subjects Protection. Participation will be voluntary. After being recruited and providing informed consent, each participant will be asked to complete a questionnaire survey.

Study participants

A total of 200 Korean-American drycleaners who are 18 years of age or older will be recruited through the Korean Drycleaners Association of Northern California (KDANC) and the Southern California Korean Drycleaners-Laundry Association (SCKDLA); posters and flyers at Asian or Korean grocery stores and restaurants; advertisements in local ethnic Korean newspapers and websites (e.g., <http://fkda.us/home>, <http://kdanc.fkda.us/home>, <http://www.sckdla.org/home>); and referrals from Korean churches and Korean-American communities. To achieve power of at least 80% and a medium effect size ($d = .40$), a sample size of 198 is required to detect a significant model at a 5% significance level.³⁰ Thus, a sample of 200 Korean-American drycleaners will be adequately powered.

Measures: A draft of the survey questionnaire is attached in *Appendix A*.

The survey instrument will be initially developed in English. The English version will be translated into Korean and then back-translated into English by a qualified bilingual translator. The English-Korean translation process will be repeated to optimize isomorphism between concepts in each language. The study consent form and survey questionnaire can be conducted in the participants' language of choice (available in an English version and a Korean version). The questionnaire will be administered in a face-to-face interview. Participants will receive \$10 for completion of the survey. The survey questionnaire will include demographics, work-related characteristics, occupational injury experiences, chemical-related health symptoms, risk perception of chemical exposure, source of chemical exposure, control measures of chemical exposure from equipment, amount of chemicals used, indoor air problems, and personal protective behaviors (use of PPE and safe work practices), and needs for occupational health and safety training program.

Sociodemographic characteristics include age, gender, annual household income, education level, marriage status, health insurance, years in the U.S., and language preference.

Health status variables include health functioning, medical health history, and lifestyle variables. *Health functioning* will be assessed by the Short Form 8-item Health Survey (SF-8)³¹ comprised of a subset of the SF-36.³² The SF-8 is divided into eight subscales (physical functioning, role physical, bodily pain, general health, vitality, social functioning, and role emotional and mental health) and two summary components (physical health and mental health).

Medical health history will also be assessed by asking the participants whether they have ever been diagnosed or treated for health problems.

Lifestyle variables include smoking, alcohol consumption, physical activity, sleep, and obesity.

Health Symptoms related to chemical exposure will be assessed by a checklist which asks the participants whether they have ever experienced health symptoms or problems associated with chemical exposure, including skin, eye, nose, and throat irritation, headache, dizziness, loss of memory, or nausea, in the past 12 months. Response categories are: daily, weekly, monthly, yearly, or never.

Occupational injury experiences will be assessed by asking the participants whether they have experienced any injury in the drycleaning industry in the past 12 months. All drycleaners who have been injured on the job will be asked about the type and frequency of injury. Response categories are: daily, weekly, monthly, yearly, or never.

Risk perception of chemical exposure will be assessed by participants' perception of risks for adverse health effects from chemical exposure using the following statements: 1) "My health is at risk when chemicals are used in the drycleaning industry"; 2) "I might suffer sore eyes from breathing chemical fumes or getting chemicals on my skin"; 3) "I might suffer skin irritation from breathing chemical fumes or getting chemicals on my skin"; 4) "I might suffer headaches from breathing chemicals or getting chemicals on my skin"; 5) "I might suffer dizziness from breathing chemicals or getting chemicals on my skin"; 6) "I might suffer dermatitis from long term exposure to chemicals"; 7) "I might suffer memory loss from long term exposure to chemicals"; 8) "I might suffer damage to my liver from long term exposure to chemicals"; 9) "I might suffer damage to my kidneys from long term exposure to chemicals"; 10) "I might suffer damage to my nervous system from long term exposure to chemicals" Responses

will be recorded with a 5-point Likert-type scale with response categories ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Source of chemical exposure will be assessed by asking the participants about their levels of agreement for sources of chemical exposure while working in the dry cleaning industry, including the following 13 sources: 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 will be recorded on a 5-point Likert-type scale with response categories ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Control measures of chemical exposure will be assessed by asking about the proper use and maintenance of dry cleaning equipment to minimize chemical leakage based on recommendations and guidelines by Occupational Safety and Health Administration (OSHA)³³, including the following six items: 1) “Perform daily checks for leaks in door gaskets, valves, hoses, pumps, tubing, and piping connections,”; 2) “Replace gaskets before they become hard, cracked, or worn”; 3) “Use an air or vapor detection device to detect vapor leaks in piping, exhaust ductwork, and associated components.”; 4) “Use CO detector to detect CO gas in your facility”; 5) “Use chemical resistant seals and fittings recommended by the machine

manufactures”; 6) “Repair leaks immediately”. Responses will be recorded on a 5-point Likert-type scale with response categories ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Personal protective behaviours will be assessed by asking about the participant’s current *use of the PPE* (gloves, mask or respirator, protective clothes or apron, safety glasses or goggles, and protective shoes) in order to reduce their risk for chemical exposure and their intention of using them. Response categories are: always, usually, sometimes, rarely, or never.

Also, *safe work practices* will be assessed by asking participants how often they practice methods for dry cleaning operators to minimize exposure to vapor chemicals and whether they intend to do them. Detailed work practices are as follows: 1) “Do not overload the machine”; 2) “Do not open the machine door when the cycle is running”; 3) “Keep the machine door CLOSED as much as possible”; 4) “Do not shortcut the drying cycle by removing garments from the machine before the cycle is finished”; 5) “Keep head and face turned away from the machine door and clothes when removing solvent-laden clothes from the washer”; 6) “Do not transfer chemical to machines by hand or with open buckets”; 7) “Wait until the machine and solvent are cold before performing maintenance”; 8) “Use spotting agents sparingly”; 9) “Use chemical-free spotting agents”; 10) “Clean up chemical spills immediately”; 11) “Store containers of chemical and chemical wastes in tightly sealed containers”; 12) “Position head away from the door when opening transfer machines”; 13) “Hold a breath when removing solvent-laden clothes from the washer”. Response categories are: always, usually, sometimes, rarely, or never.

Chemical exposure will be classified into chlorinated solvents, non-chlorinated solvents, and spotting chemicals, which are commonly used in the drycleaning industry. These include the chemicals PERC, TCE, Trichlorethane (TCA), Valclene, Stoddard solvent, DF2000, Green Earth, Rynex, Pure Dry, liquid CO₂, and spotting chemicals. The amount of chemicals used annually

will also be collected. Also, participants will be asked if they are regularly exposed to vapors, gas, dust, or fumes at work, if they have regularly handled or come in skin contact with chemical products or substances at work during the past 12 months, and how much they are concern about exposure to chemicals at work.

Indoor air problems will be assessed by participants' experiences with the quality of the indoor air in the past three months, including the following 12 items: Draught; Temperature too high; Temperature varies; Temperature too low; Stuffy air; Dry air; Unpleasant odor; Static electricity; Passive smoking; Noise; Illumination problems (Dim light or glare/reflections); Dust or dirt. Response categories are: always, usually, sometimes, rarely, or never.

Work-related factors include type of drycleaning shop (e.g., owner, worker), participants' current job duties (e.g., drycleaner, spotter, presser, counter, deliverer, sewer, laundry), years in the dry cleaning industry, hours worked per week, job satisfaction, and job stress.

Job Stress will be assessed using the Effort-Reward Imbalance (ERI).³⁴ The ERI questionnaire consists of six items for extrinsic effort (e.g., time pressure) and 11 items for reward (e.g., financial reward).³⁴ The effort and reward scales will be answered in two steps. Participants will first be asked about exposure to each item using a dichotomous response of "agree" or "disagree." Then, they will be asked about the level of distress, ranging from "not at all distressed" to "very distressed." The responses to each item of effort and reward will be scored on a five-point scale. An ERI ratio will be generated by summing the effort items and dividing them by the product of the summed reward score and a multiplier of 0.5454 according to the coding protocol.³⁵ An ERI ratio greater than 1.0 indicates an imbalance between efforts and rewards.

Needs for Occupational Health and Safety training Program will be assessed by asking about the type of safety training participants received within the past 12 months, participants' preferred method of information, education, and training, frequency of inspection in their facilities, and training programs what they want to include in.

Data Analysis

Statistical analysis will be conducted using SPSS, version 21.0. Descriptive statistics will be analyzed for each study variable, using means and standard deviations for continuous variables, and frequencies and percentages for categorical variables. Some of the variables (e.g., knowledge and risk perception of chemical exposure, and job stress) will be assessed by multiple items that should intercorrelate. These items will be checked for internal consistency reliability using alpha coefficients. Scale reliability will be considered acceptable if the alpha coefficient is at least .70.³⁶ Bivariate analysis will be performed using chi-square tests and *t*-tests for categorical variables and continuous variables, respectively. For the multivariate analysis, as an initial step, assessment for multicollinearity will be conducted to check for high intercorrelations among independent variables. Multivariate logistic regression analyses will be used to determine the significance of the associations between personal protective behaviors and related factors. The odds ratios and 95% confidence intervals will be calculated to estimate the independent contribution of related factors and their effects on personal protective behaviors, along with a corresponding p-value. The level of statistical significance will be set at a p-value of < 0.05.

Limitations

Several limitations should be noted. Due to the cross-sectional nature of the design of the current study, it will be not possible to determine temporality or causal direction between significant factors and personal protective behaviors. Furthermore, collection of information

about factors will be retrospective, running the risk of recall bias. The data will be collected from Korean drycleaners in one Western state, which limits the generalizability of the findings. The findings from this study might not be representative of the general drycleaner population or other minority workers in drycleaning industry in the U.S. The use of self-report measures might lead to differential or non-differential misclassification. Self-reported exposure to occupational hazards may under- or over-estimate actual hazardous exposure.³⁷⁻⁴⁰ The use of biomonitoring in this study is limited by the cost, and it is difficult to find a private laboratory and trained professionals to do the testing.

Time Frame

This research project will require a total of 12 months: to refine research procedures and self-reported survey questionnaires; to recruit participants; to conduct the survey; to perform data analyses; and to prepare the manuscript and final report.

Table 1. Timetable for Project Activities

Activities	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Refinement of research procedures	■											
Designing self-reported survey questionnaires	■	■										
Recruitment of subjects for survey		■	■	■	■	■	■	■	■			
Conducting self-reported survey			■	■	■	■	■	■	■			
Analysis of survey data									■	■	■	
Manuscript and final report preparation										■	■	■

Expected Impact

The findings of this pilot study will be used to guide the development of occupational health and safety training program strategies to reduce chemical exposure and to increase preventive behaviors among Korean drycleaners. Specifically, the findings of this project will

make a significant contribution to developing culturally-integrated occupational safety programs for minority workers in the drycleaning industry. The findings of this project will provide compelling preliminary data needed to submit NIH applications to garner funding for more definitive intervention study.

Dissemination

The findings of the proposed work will be directly disseminated to the Korean-American drycleaning associations or industry, Korean-American drycleaners, as well as to professional audiences. The following methods will be used for dissemination:

- a) Websites and local Korean newspapers.
- b) Presentations of key findings to the Northern and Southern California Drycleaner Associations and the Federation of Korean Drycleaners Association.
- c) Presentations at an ERC-wide meeting and regional, national and international scientific occupational and public health conferences, such as the American Public Health Association annual meeting, the American Association of Occupational Health Nurses conference, and the American Occupational Health Conference.
- d) Publication in peer-reviewed journals, such as the Occupational Medicine, the Journal of Occupational and Environmental Medicine, the American Journal of Industrial Medicine, the Journal of Immigrant and Minority Health, the Workplace Health and Safety
- e) Guest lectures at universities and public organizations

Human Subjects Protection

This research involves human subjects in California. Immediately upon notification of the award, we will secure Institutional Review Boards (IRB) approvals from UCSF. The IRB

application and approval process is expected to take about 1-2 months. All study personnel participating in this study will complete the Human Subject Training established by the UCSF.

Procedure of Consent: Each participant will be informed of the details of the research study including the purpose of the study, the data collection procedure, and possible benefits and risks. Informed consent will be obtained from all participants prior to obtaining any participant information and prior to participant inclusion in the study. Informed consent will be signed in the presence of the principal investigator. Each participant will also be informed that participation is voluntary and their data is confidential. A copy of the signed informed consent will also be retained for the study file. All participants will be assured that they may choose to withdraw from the study at any time. All participating Korean-Americans will be compensated for their time and contribution (\$10 for completion of the survey).

Potential Risks and Protections against Risk: There appear to be no more than minimal risks to participants. The potential risk to subjects is loss of privacy or confidentiality of the data. The following procedures will be used to minimize the risks to privacy and confidentiality of data. All data collected during the course of this study will be stored under lock and key in the research office assigned to the principal investigator. All data will be coded with anonymous identifiers, assigned in numerical order as subjects are enrolled. Only the consent form will have the participant's name and signature. All other data collection modalities will have the anonymous identifier. The consent forms and all other data with anonymous identifiers will be stored in separate locked file cabinets in the research office. All computers used for research will be secure and require a login and password. Further, issues regarding confidentiality will be reinforced prior to data collection with project personnel. If an adverse event is reported, the PI will forward all appropriate information to the UCSF Committee on Human Subjects Research.

Facilities Available

UCSF School of Nursing consistently ranks among the top schools of nursing in the U.S., providing national and global leadership in research, education, and service. Its Office of Research facilitates the nursing research enterprise by offering programs and resources to support faculty and research staff in the development, submission, conduct, and publication of research. *Computer Resources* - Computer staffs develop and maintain the school's computing infrastructure and carry out the school's programming needs, including webpage construction and maintenance, while statisticians provide analytical and design consultation. UCSF provides a rich environment to support the data management activities.

Center of Occupational and Environmental Health within the University of California (Berkeley, Davis, and San Francisco). Dr. Chin (PI) is a postdoctoral scholar in the Occupational and Environmental Health Nursing program within the Center. The Center will provide world-class facilities, resources, and highly experienced research administrative staffs to ensure the success of the proposed work.