

Results from a Community-based Occupational Health Survey of Vietnamese-American Nail Salon Workers

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Abstract A community-university collaborative partnership assessed self-reported work-related health effects and environmental factors in Boston's Vietnamese immigrant community via an interviewer-assisted survey. Seventy-one nail technicians responded. Musculoskeletal disorders, skin problems, respiratory irritation and headaches were commonly reported as work-related, as were poor air quality, dusts and offensive odors. The reporting of a work-related respiratory symptom was significantly associated with the reporting of exposure factors such as poorer air quality. Absence of skin disorders was associated with glove use and musculoskeletal symptoms were associated with years worked as a nail technician. Work-related health effects may be common in nail salon work. Chemical and musculoskeletal hazards should be reduced through product and equipment redesign.

Keywords Immigrant · Occupational health · Nail salon · Vietnamese-American

Introduction and Background

No longer an exclusive luxury, the utilization of manicure and pedicure services has grown dramatically in the past

20 years with the increase in “discount” salons owned and staffed by Vietnamese refugees and immigrants [1]. Over the same period of time, “artificial” or sculpted nails have also moved from the fringe to the fashion mainstream. Since 1991, the number of registered manicurists has increased by 345% in the US to over 393,000 [2]. Salon businesses are typically very small with fewer than five employees and employment relations may be informal. The industry estimates that almost 40% of nail technicians in the US are Vietnamese, but the numbers are likely much higher in cities on the east and west coasts; a recent study found that 59% of manicurists in California are Vietnamese [1]. Nail salons are the core of the Vietnamese immigrant and refugee community's economic support. Low entry requirements, limited need for English language skills, ethnic business networks, and flexible work schedules draw many Vietnamese women and some men to the work (professional experience of H. Nguyen).

Nail products contain—in small amounts—many toxic and potentially hazardous ingredients including solvents, plasticizers, resins, and acids (See Table 1). The chemical mixtures comprising nail products may affect workers through multiple routes of exposure and may be toxic to several body systems. Nail polishes contain xylene, toluene, toluene sulfonamide formaldehyde resin, formaldehyde and other chemicals. Artificial nails are generally made with a two-part liquid and powder polymer acrylic resin chemistry borrowed from dentistry. Ethyl methacrylate (EMA), the primary chemical used to make artificial nails, and the chemical that accounts for the characteristic strong odor in many nail salons, is recognized as a sensitizer, repeated exposure to which may cause asthma and dermatitis [3]. The Cosmetic Ingredient Review Expert Panel (a non-governmental organization with consumer, industry and government representation) determined that

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EMA is safe for use in salon cosmetics. However, the methacrylate producers industry association has advised that no methacrylates be used in cosmetics [4]. Animal studies have shown similar toxicity for EMA and its predecessor in artificial nail products, methyl methacrylate (MMA) [3, 5]. Phthalates, a chemical class with potential reproductive and developmental toxicity issues, have been ubiquitous in nail polish [6].

Few studies have reported on chemical exposures and health effects in nail salon workers. These studies have noted that nail salon workers may be at increased risk for respiratory and skin irritation, spontaneous abortion, and neuropsychological effects consistent with solvent exposure [7–10]. Industrial hygiene evaluations have found that airborne exposures are very low compared to those found in industry and occupational exposure standards [8, 11, 12]. We are not aware of any studies of skin absorption of nail product ingredients or skin health effects in salon workers, nor of biomonitoring studies of chemical body burden. However, the medical literature includes many case reports of skin and nail damage and sensitization in nail salon customers [13–16]. Skin sensitization is documented in dental personnel who, like salon workers, are exposed to EMA at work [17–20].

Nail salons are covered by the Occupational Safety and Health Act, but due to their small size and the perception that they do not have significant hazards, few have seen an inspector. Only 18 nail salons were inspected by OSHA in 2005. [OSHA, Integrated Management Information System Search by NAICS Code: 812113] For many substances found in the salon environment, including EMA, occupational exposure limits have not been set. Regulatory oversight of nail salons is generally limited to licensing and inspection by Boards of Cosmetology for compliance with basic sanitation and hygiene issues most relevant to protection of the public from infectious disease.

Evaluation of nail product safety is conducted by the industry itself through the Cosmetic Industry Review (<http://www.cir-safety.org/info.shtml>). The Environmental Working Group found that the Cosmetic Industry Review has reviewed only 11% of the 10,500 cosmetic ingredients listed with FDA and almost all products contain at least some un-assessed ingredients [21]. FDA has limited authority to regulate toxics in salon products, although in the 1970's, in response to consumer complaints of nail damage, the agency used hearings and a lawsuit to pressure the nail products industry to restrict the use of 100% MMA in artificial nail products (<http://www.cfsan.fda.gov/~dms/qa-cos7.html>). Many states have banned use of MMA through their Boards of Cosmetology. California passed the Safe Cosmetics Act in 2005 to address growing concerns about the many ingredient “unknowns” in cosmetics. The Act requires manufacturers to disclose the potential health effects of their products [22].

This study was conducted to better understand nail technicians' work environment and potential health effects related to their work. Specifically, we sought quantitative and qualitative data on workplace hazards and health effects self-reported by Vietnamese immigrants and refugees engaged in this industry in the Boston area. We also investigated potential associations between aspects of the work environment and symptoms reported by this population.

Methods

The study was designed and implemented through a collaborative partnership of university researchers, the Vietnamese economic development and community organization the Vietnamese-American Initiative for Development, Inc. (Viet-AID), and the environmental advocacy and research group New Ecology, Inc. (NEI), all of the Boston, Massachusetts area. The university researchers wanted to better understand the potential for hazardous exposures in small, immigrant businesses. The economic and health impacts of the concentration of Vietnamese community members in this industry were of particular interest to Viet-AID. A mission to promote “Green” grassroots economic development drove NEI's involvement. Together we developed a work, occupational health and work environment questionnaire consisting of open and closed-ended questions. The project was conceived and undertaken as a community-based participatory research project, although we did not involve research subjects themselves in the research design or analysis of the results.

We incorporated standardized and validated health questions where possible. For respiratory health we drew from the American Thoracic Society questionnaire and its updated and expanded version, the Protocol for the European Community Respiratory Health Survey (<http://www.ecrhs.org/quests.htm>). Our general health question came from the SF-36[®] (<http://www.sf36.com/demos/SF-8.html>). Skin questions were based on the Nordic Occupational Skin Questionnaire - NOSQ 2002 (<http://www.ami.dk/english/redskaber/2.html>) [23]. We obtained expert advice for designing questions related to occupational asthma, musculoskeletal and reproductive health outcomes and the work environment. Work-relatedness of a health symptom was assessed by asking if a reported symptom improved after a period of time away from work [24]. In order to capture the experience of these immigrant workers and to compensate for our lack of direct knowledge of this work environment, we offered many opportunities in the questionnaire for respondents to give answers in their own words. The questionnaire was piloted with 10 subjects and

Table 1 Nail products: some chemical ingredients and potential health effects

Nail products	Common chemical ingredients	Potential health effects
Nail polish (Basecoat, Colors, and Topcoats) <i>Includes: Pigments, Resins, Solvents, Plasticizers, Dispersants, and UV Stabilizers</i>	Ethyl acetate	Irritation eyes, skin, nose, throat; dermatitis
	Butyl acetate	Irritation eyes, skin, upper respiratory system; headache
	Ethyl alcohol	Irritation eyes, skin, nose; headache, CNS syndrome; cough; liver damage; anemia; reproductive effects
	Isopropyl alcohol	Irritation eyes, nose, throat; CNS syndrome, headache; dry, cracking skin
	Acetone	Irritation eyes, nose, throat; headache; CNS syndrome; dermatitis
	Methyl ethyl ketone	Irritation eyes, nose, throat; headache; CNS syndrome; dermatitis
	Toluene	Irritation eyes, nose, throat; headache; CNS syndrome; dermatitis; dilated pupils, lacrimation; anxiety, muscle fatigue, insomnia; paresthesia; liver, kidney damage;
	Xylene	Irritation eyes, nose, throat; headache; CNS syndrome; corneal damage; dermatitis; reproductive effects
	Dibutyl phthalate	Irritation eyes, upper respiratory system, stomach; reproductive effects (fetotoxic)
	Nitrocellulose	Unknown
Toluene Sulfonamide Formaldehyde Resin	Dermatitis	
Titanium dioxide	Lung fibrosis; potential occupational carcinogen	
Nail polish removers	Acetone	see above
	Ethyl acetate	see above
	Butyl Acetate	see above
Artificial Nails <i>Includes: acrylic polymers, hardeners, primers, dehydrators</i>	Ethyl methacrylate	Irritation eyes, skin, nose, throat; allergic contact dermatitis; respiratory sensitizer (asthmagen)
	Methyl methacrylate	Irritation eyes, skin, nose, throat; allergic contact dermatitis; respiratory sensitizer (asthmagen)
	Butyl methacrylate	Irritation eyes, skin, nose, throat; allergic contact dermatitis; respiratory sensitizer (asthmagen)
	Methacrylic acid	Irritation eyes, skin, mucous membrane; eye, skin burns
	Methyl ethyl ketone	see above
Nail tips adhesives	Ethyl cyanoacrylate	Irritation eyes, skin, nose, throat; allergic contact dermatitis
Artificial nail removers	Acetone	see above
	<i>N</i> -methyl pyrrolidone	Dermatitis, reproductive effects
	Acetonitrile	Irritation nose, throat; asphyxia; nausea, vomiting; chest pain; CNS syndrome; convulsions; in animals: liver, kidney damage
Disinfectants	Formalin/ paraformaldehyde (formaldehyde)	Irritation eyes, nose, throat, respiratory system; lacrimation; cough; wheezing; dermatitis; potential occupational carcinogen
	Isopropyl alcohol	see above
	Bleach (sodium hypochlorite)	Irritation eyes, nose, throat, respiratory system; skin sensitizer
	Hospital grade disinfectants, e.g. Quaternary ammonium compounds	Respiratory sensitizers (asthmagens)

Source: [32]; AOEC, ACGIH, 2002 TLVs[®] and BEIs[®]; NIOSH Pocket Guide to Chemical Hazards; numerous nail products MSDS available at <http://www.siri.org>;

revised to shorten it and for clarity. The result was a 45-min, 93-item interviewer-assisted questionnaire in both English and Vietnamese.

Our sampling strategy considered that immigrant workers in small businesses would be very difficult to access and enroll by traditional workplace-based approaches. We utilized a community-based rather than workplace-based approach for identifying and enrolling participants in a convenience sample of the population. The core of this strategy was to reach out to the community through ethnic networks, personal contacts and a “snowball” effect where participants identified other potential participants. This method was also designed to capture the experience of workers who had left a job due to work-related health problems. Eligible participants self-identified as Vietnamese, were at least 17 years old, had worked for money in the past year and lived in the Boston area (broadly defined by the interviewer).

Ten bilingual interviewers were recruited by Viet-AID staff and trained in conducting surveys and research ethics by both the university researchers and Viet-AID staff. The interviewers ranged in age from 18 to 60, were mostly women, and included students, medical interpreters and health workers. These interviewers recruited family, friends, and others from their own networks as participants. For completing the survey, participants were offered a \$20 grocery gift certificate. Interviewers worked on their own time and were paid per interview conducted. All questionnaires and the Informed Consent process were conducted in Vietnamese with written materials translated by project staff and back translated by professionals external to the project. Following the 8-month survey period, we held a debriefing meeting with the interviewers on factors affecting participation, quality and utility of the questionnaire, the interview process and potential biases affecting the results. Interviewers did not feel that respondents were less forthcoming for being interviewed by someone they knew. Additionally, they felt that they had succeeded in interviewing even very busy people—a potential selection bias of concern to the research team.

Prevalence rates of self-reported health effects and work environment characteristics are reported with 95% binomial confidence intervals. Prevalence rate ratios were calculated for exposure-response relationships between binary symptom outcomes and binary or continuous exposures using a log-binomial model (SAS Proc Genmod) and are reported with a 95% confidence interval [25]. Two-way variable tests of association, either Chi-square or Fisher’s exact tests (SAS Proc Freq), were also used to examine exposure-response relationships between binary/categorical variables. Fisher’s exact test is appropriate when 25% of the expected cell counts are less than 5 and results are described by a two-sided *p*-value.

For statistical analysis of the relationship between health symptoms and exposure factors, composite variables were created that grouped related symptoms. The composite variable for work-related respiratory symptoms was coded as “yes” if there was a “yes” response to any of the four respiratory symptoms that got better away from work; “don’t know” responses were grouped with “no” responses. Other work-related symptom variables were similarly defined. Years since immigration was examined as a predictor of some health effects, such as skin problems.

Open-ended qualitative data were noted in Vietnamese on the instrument in the form of words, phrases or one or two sentences per question. These data were translated by H. Nguyen, a native speaker. In some cases, responses were consistent enough in form to allow us to quantify these results, as in the cases of our questions regarding the sources of irritating smells and allergies. In most cases, open-ended responses were subject-coded only. The qualitative data we chose to report below represented to the investigators samples of the diversity of responses to a given question or exemplary responses.

Results

One hundred and forty surveys were collected over the 8-month survey period; 71 of these were from nail technicians. (The others were from floor finishers, factory workers, dry cleaning workers and other professions). These nail technicians were predominately female (65 female, 6 male), young (mean age 34; age range: 17–55 years) and relatively recent arrivals to the US (median of 6 years since arrival with 42% having arrived in the prior 5 years). All spoke Vietnamese as their first language. The average hours worked per week was 46 and the range was 12–80. Sixty-five percent rated their general health good or better; 31% fair; with only 4% rating their health as poor. Only one person was a smoker, although 26 (37%) reported living with a smoker.

Health Effects

Tables 2 and 3 show frequencies and confidence intervals for nail technician survey respondents’ self-reported health effects. More than three-quarters of the sample reported being very or somewhat concerned about the health effects of chemicals at work ($n = 55$, 77%). Questions regarding respiratory symptoms included “In the past 6 months, have you had...” “difficulty breathing? (Khó thở?),” “regular cough? (Ho thường xuyên?),” “sinus pressure or inflammation [*point to sinuses*] or nasal congestion? (Viêm, xung hay đau rất xoang?)” “irritation in your throat, nose, or

Table 2 Self-reported health effects and work relatedness among Vietnamese-American nail technicians (*n* = 71)

Health effect	Frequency (%) (95% CI)	Better when away from work: Frequency (%) (95% CI)
Respiratory irritation	22 (31) (21, 43)	16 (23) (13, 34)
Difficulty breathing	13 (18) (10, 29)	8 (11) (5, 21)
Doctor-diagnosed asthma	2 (3) (0.3, 10)	1 (1) (0.0, 7.6)
Any respiratory symptom (difficulty breathing, regular cough, sinus/nasal, irritation)	31 (44) (32, 56)	21 (30) (19, 42)
Skin problems	22 (31) (21, 43)	12 (17) (9, 28)
Musculoskeletal problems	33 (46) (35, 59)	20 (28) (18, 40)

Table 3 Self-reported health effects among Vietnamese-American nail technicians (*n* = 71)

Health effect	Frequency (%) (95% CI)
Concerned about the health effects of chemicals at work	55 (77) (66, 87)
Allergic to something at work	17 (25) (15, 36)
Seen a doctor for work-related health problem	15 (21) (12, 32)
Asthma	4 (6) (2, 14)
Doctor-diagnosed asthma	2 (3) (0.3, 10)
Know others with work-related health problem	24 (34) (23, 46)
Headaches that get better away from work	31 (44) (32, 56)
Difficulty concentrating at work, better away	20 (28) (18, 40)
Difficulty conceiving	1 (1) (0.04, 8)

chest?” (Khó chịu ở mũi, họng hay ngực?) If the respondent answered “yes” to any of these questions, it was followed with “Does [*name symptom*] get better when you are away from work for more than one day?”

As shown in Table 2, almost one-third of the nail technicians surveyed reported a respiratory symptom that got better when they were away from work, with 43% of these reporting irritation only and not other respiratory symptoms. Thirteen (18%) reported difficulty breathing; eight of these said this symptom got better away from work (four others weren’t sure).

Additionally, four technicians responded “yes” to the question “do you have asthma?” of whom two also replied “yes” when asked “has a doctor told you that you have asthma?” These two also reported difficulty breathing, and one reported work-related difficulty breathing. Almost one-quarter [17] answered “yes” to “Do you feel that you are allergic to anything at work?” of whom 12 identified “nail liquid” (primarily EMA) as the allergen; the remaining five identified other nail product chemicals as the allergen, e.g.,

acetone or the “primer,” methacrylic acid. Fifteen (21%) nail technicians reported that they had seen a doctor for job-related health problem and 24 (34%) knew others with work-related health problems.

Skin problems are prevalent with 22 (31%) answering “yes” when asked “In the past 6 months, have you had redness, itching, rashes, burning, dryness, or scaliness on any part of your skin?” Twelve of these said that their skin gets better when away from work for 2 days. Eleven mentioned skin problems on their face or cheeks and nine mentioned skin problems on their hands.

To assess musculoskeletal problems in this population, we asked if they had experienced pain, numbness, or tingling that occurred more than three times or lasted more than 1 week in the past 6 months and in what part of their body. Forty-six percent noted such pain with 60% of these reporting relief when away from work for 1 week. Hands and wrists, back, shoulders and the neck were the most common site of such pain. They observed the causes as sitting, bending, holding the filing machine, giving massages, and non-work activities.

Potential reproductive health effects are of great concern to nail technicians (personal communication A. Bracker June 2004), but difficult to assess through symptom surveys. We asked if they had tried to conceive for 12 months without success: one said yes, while 18 (25%) said they didn’t know. Thirty-one participants (44%) reported work-related headaches and 20 (28%) reported difficulty concentrating, or feeling spacey, lightheaded or faint at work that got better away from work.

Work Environment Characteristics

Summaries of responses to questions related to work environment factors, exposures and protection are presented in Table 4. When asked, “How would you rate the quality of the air you breathe in your workplace on an average day during an average level of business? Would you rate the air quality ‘Terrible,’ ‘Poor/Needs improvement,’ ‘Good/Acceptable,’ or ‘Excellent?’” Twelve (17%) rated the air as “terrible” or “poor/needs improvement.” Fourteen (20%) answered “yes” when asked whether there was not enough fresh air in their workplace on an average day, and 12 (17%) replied “no” to the question “Does your work area have fresh air brought in from the outside?”

When asked which products they work with have a strong or irritating smell, 56 (79%) identified at least one product, mostly artificial nail liquid or paste. Forty-one (58%) reported chemicals in the air and 45 (63%) said there were odors at work that made them feel bad. The following are some characteristic responses:

Table 4 Work environment characteristics as reported by Vietnamese-American nail technicians ($n = 71$)

Characteristic	Frequency	% (95% CI)
Average air quality terrible or needs improvement	12	17 (9, 28)
Chemicals in air	41	58 (45, 69)
Dust in air	65	92 (83, 97)
Not enough fresh air	14	20 (11, 31)
No fresh air brought in from outside	12	17 (9, 28)
Absence of ventilation devices	19	27 (17, 39)
Named product with strong or irritating odor	56	79 (68, 88)
Odors at work that make you feel bad	45	63 (51, 75)
Wear a mask at work	64	90 (81, 96)
Wear gloves at work	50	70 (58, 81)

“When making the paste, I have to use the primer; this liquid has a really bad smell that makes me very uncomfortable.”

“No, I’m used to the smell of the chemicals but the customers are not used to it.”

“Acetone to remove nail polish, liquid and powder to make paste to put on the nail, soap used during pedicure, toxic and smelly.”

“Besides the bad smell, the process of filing the toe nails is uncomfortable because sometimes I have to hold my breath so my body gets tired.”

Most had no response or said “None” to our question “What has your employer told you about the hazards of the chemicals in your work?” Some nail technicians expressed these views on the subject of hazard communication:

“We know chemicals are dangerous, the owner tells us to wear mask.”

“Owner said you should wear mask so you will not inhale liquid smell.”

“Says that the chemicals are harmful so always need to keep the ventilator on and close lids, covers of chemicals surely.”

“Owner doesn’t address issue because the employee doesn’t bring it up.”

Cloth and paper masks of the medical or surgical type are used almost universally by nail technicians (64 or 90% reported wearing a mask.) Such masks are designed for infection control and do not prevent the inhalation of chemical vapors. When asked “Why do you wear a mask?” 35 mentioned protection from dust, 36 mentioned bad smell, odor or chemicals. Others said they wear a mask “To protect my health” or mentioned smelly feet. Other responses were:

“Because I am young and pregnant and I don’t want to breathe in the dust and chemicals; I’m afraid that it might affect my child later on.”

“Keep hygiene for self and others.”

“Polite way to protect health, avoid chemicals.”

“Prevent coughing, itching of neck, redness of skin, itching of face, tearing.”

“Prevent dust, bad odors when sanding and filing acrylic nails, I have to bend very close.”

Exposure-Response Relationships

Exposure-response relationships were described by prevalence ratios (PR) and significance is reported as either a 95% confidence interval (CI) or a Fisher’s exact test p -value if cell counts were small (see Table 5). Reporting of a work-related respiratory symptom was significantly associated with poorer air quality (PR = 3.2; exact $p < 0.01$), not enough fresh air (PR = 3.1; exact $p < 0.01$), absence of ventilation devices (No devices versus Yes/Don’t Know; PR = 4.3; CI = 2.1, 9.0) and concern about the health effects of chemicals (PR = 5.5; exact $p = 0.03$). Reporting of “chemicals in the air” at work was not significantly associated with the reporting of a respiratory symptom, nor was a report that the subject lived with a smoker. Confounding due to exposure to smoking in the home was examined for the four exposure-response models that were significant. For all of the considered models, there was no evidence of confounding due to smoking in the home.

The prevalence of skin symptoms was significantly lower for those who ever used gloves compared to those who never used gloves (PR = 0.5; CI = 0.26, 0.98). When glove use was categorized into frequency of use, skin symptom prevalence went in the expected direction—fewer symptoms with more frequent glove use—but the association was not significant. The prevalence of skin symptoms was 5.5 times higher among those who were concerned about the health effects of chemicals compared to those who were not concerned (exact $p = 0.03$). Skin symptoms were associated with glove use only and not with age, years as a nail technician, or years since immigration.

The reporting of any musculoskeletal disorder in the past 6 months was significantly associated with years worked as a nail technician (PR = 1.08; CI = 1.01, 1.14; $p = 0.02$). Work-related headache was marginally associated with years as a nail technician (PR = 1.05; CI = 0.99, 1.11; $p = 0.09$).

Discussion

These results suggest a prevalence of self-reported work-related health effects, including musculoskeletal disorders,

Table 5 Variable associations tested for the study results *p*-values are specified as either from a chi-square test (Chisq) or a Fisher’s exact test for small numbers (Exact)

Exposure variable	Count	Prevalence of work-related respiratory symptoms (%)	Prevalence rate ratio (PR) & <i>p</i> -value
Air quality			
Bad	12	67	PR = 3.2; Exact = 0.003*
Good	58	21	–
Fresh air			
Not enough	14	64	PR = 3.1; Exact = 0.003*
Enough	57	21	–
Chemicals in air			
Yes	41	27	PR = 0.8; Chisq = 0.5
No	30	33	–
Air brought in from outside			
Yes	59	25	PR = 2.0; Exact = 0.16
No	12	50	–
Ventilation devices in salon			
Yes	38	18	Chisq = 0.016*
No	31	45	–
Concerned about chemicals			
Very/Somewhat	55	36	PR = 5.5; Exact = 0.03*
Not concerned	15	7	–
Anyone smoke at work			
Yes	4	50	PR = 1.8; Exact = 0.03*
No	67	28	–
Exposure variable	Count	Prevalence of skin itch	Prevalence rate ratio (PR) & <i>p</i> -value
Glove use			
Yes	50	24	PR = 0.5; Chisq = 0.05*
No	21	48	–
Concerned about chemicals			
Very/Somewhat	55	36	PR = 5.5; Exact = 0.03*
Not concerned	15	7	–

– denotes the reference category

* significant *p*-value < 0.05

respiratory symptoms, skin problems and headaches among Vietnamese-American technicians who generally work long hours in nail salons. In comparison to available general population data, this population of nail technicians’ symptom prevalence is elevated. For example, data from National

Health and Nutrition Examination Study for 2004 shows a raw prevalence of 14% wheezing, 7% regular cough and 12% dermatitis or rashes in the general adult population (not adjusted for age, race, or smoking status) [26]. In this survey population of almost all non-smoking Asian women, we found that 18% experienced difficulty breathing, 14% had a regular cough, and 31% reported skin problems.

Working populations are generally healthier than the general population that includes elderly people and those too infirm to work [27]. However, only 65% of our sample rated their overall health good or better. This compares with 85% of US residents included in the 2003 Behavioral Risk Factor Surveillance Data who rated their physical health as good or better [28]. Adjusting these figures for age would strengthen the interpretation that the generally younger population of nail technicians are rating their health status lower than the general population. Still, this working population may discount health problems if they are able to work. Of those who reported their overall health as excellent or good, 31% also reported one or more respiratory symptoms.

The common reporting of respiratory irritation and headaches may be due to a lack of adequate general ventilation combined with exposure to low concentrations of mixed volatile chemicals and to strong odors over extended work days and weeks. The National Institute for Occupational Safety and Health (NIOSH) has developed guidance for local exhaust ventilation for artificial nail applications, however these systems are not in widespread use in salons [29].

There may be multiple causes of the skin irritation reported by almost 1/3 of the respondents. Nail technicians are required to wash their hands after each customer and this, in itself, can damage the skin. Many nail product ingredients’ Material Safety Data Sheets note that skin contact should be avoided and local exhaust ventilation used [30, 31]. One of the most common chemicals in salons, isopropyl alcohol, is well known to cause skin irritation. The frequency of reports of skin irritation on the cheeks and face is similar to that reported by dental nurses who also work with methacrylates and who wear similar masks [17].

The type of mask used by nail technicians is not appropriate for protection from chemical vapors—only respirators with organic carbon chemical cartridges (or supplied air respirators) can prevent inhalation of vapors from solvents and the acrylics. And while the masks in use may provide some protection from dusts, they were not designed for dust protection. The N95 NIOSH-approved dust mask with organic vapor/odor control may be a reasonable alternative although anecdotal feedback from nail technicians who have evaluated these masks is that the size and shape of these masks may not fit the predominantly female Asian population of nail technicians.

Study limitations include a non-random and potentially non-representative sample, and a relatively small sample in

comparison to the size of the population. Because the study was cross-sectional, results cannot be used to infer causality. While we used many questions that had been validated in English and other languages, the survey as a whole has not been validated in English or Vietnamese or with a Vietnamese immigrant population. Self-reported symptoms have not been corroborated with physical evidence of effect. Our survey strategy of interviewers surveying people known to them may have influenced responses. Finally, error may have been introduced by the process of translation.

Conclusion

There are known hazards associated with many chemicals in used in nail salon products. Our study found that many Vietnamese nail technicians are reporting health effects that may be related to their work. Toxic product ingredients, limited ventilation, and a lack of knowledge of hazards and appropriate controls characterize the nail salon work environment. We were able to survey this hard-to-reach population through a community-based approach. This process urged us to link assessment strategies to intervention efforts. We used the results of this study to provide relevant health and safety information to nail salon workers via ethnic media outlets and an innovative and culturally appropriate strategy: the production of an English and Vietnamese language nail salon health and safety calendar that integrates health information and business marketing. We hope to expand upon this work to reduce hazards in this work environment.

Providing information is a critical, but not sufficient step toward reducing hazards in this work environment. Interventions from the salon to the policy level might accomplish this: salon equipment could be redesigned to lessen strain; salon licensing boards could assure that salons have appropriate ventilation, and nail product manufacturers could reformulate their products to reduce their hazard potential. Some US cosmetics makers, including OPI, Revlon, Proctor and Gamble and Estee Lauder, have begun to reformulate their nail products in response to new European restrictions on toxic cosmetics ingredients. (<http://www.cosmeticsdesign.com/news/ng.asp?id=57387-cosmetic-giants-remove>) (<http://www.safe-cosmetics.org>) These product changes, and those that reduce allergenic potential and irritating properties of cosmetics, may help prevent health effects in nail salon workers and customers alike. Following these precautionary interventions, follow-up studies integrating biological monitoring, symptom surveys and workplace assessment may be necessary to assess the effectiveness of the interventions and to ensure the safety of these workers.

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References

1. Federman MN, Harrington DE, Krynski KJ. Vietnamese manicurists: displacing natives or finding new nails to polish? *Ind Labor Relat Rev* 2006;59(2):302–18.
2. Nails Magazine Nails fact book 2004–2005. Torrance: Nails Magazine; 2004.
3. Cosmetic Industry Review Expert Panel Amended final report on the safety assessment of ethyl methacrylate. *Int J Toxicol* 2002;21 (Supp 1):63–79.
4. Methacrylate Producers Association. The methacrylate producers association's position on use of methacrylic acid and unreacted methacrylate monomers liquid form in cosmetic products; 2002 <http://www.mpausa.org/mpapos.htm>.
5. Hazardous Substances Data Bank. Methyl methacrylate; hazardous substances databank number:195; Bethesda: National Library of Medicine (US); 2005: <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>.
6. Marsee K, Woodruff TJ, Axelrad DA, Calafat AM, Swan SH. Estimated daily phthalate exposures in a population of mothers of male infants exhibiting reduced anogenital distance. *Environ Health Perspect* 2006;114(6):805–9.
7. John EM, Savitz DA, Shy CM. Spontaneous abortions among cosmetologists. *Epidemiology* 1994;5(2):147–55.
8. Hiipakka D, Samimi B. Exposure of acrylic fingernail sculptors to organic vapors and methacrylate dusts. *Am Ind Hyg Assoc J* 1987;48(3):230–7.
9. LoSasso GL, Rapport LJ, Axelrod BN. Neuropsychological symptoms associated with low-level exposure to solvents and (meth)acrylates among nail technicians. *Neuropsychiatry Neuropsychol Behav Neurol* 2001;14(3):183–9.
10. LoSasso GL, Rapport LJ, Axelrod BN, Whitman RD. Neurocognitive sequelae of exposure to organic solvents and (meth) acrylates among nail-studio technicians. *Neuropsychiatry Neuropsychol Behav Neurol* 2002;15(1):44–55.
11. Spencer AB, Estill CF, McCammon JB, Mickelsen RL, Johnston OE. Control of ethyl methacrylate exposures during the application of artificial fingernails. *Am Ind Hyg Assoc J* 1997;58(3):214–8.
12. Froines JR, Garabrant DH. Quantitative evaluation of manicurists exposure to methyl, ethyl and isobutyl methacrylates during production of synthetic fingernails. *Appl Ind Hyg* 1986;1(2):70–4.
13. Belsito DV. Contact dermatitis to ethyl-cyanoacrylate-containing glue. *Contact Dermatitis* 1987;17(4):234–6.
14. Baran RL, Schibli H. Permanent paresthesia to sculptured nails. A distressing problem. *Dermatol Clin* 1990;8(1):139–41.
15. Freeman S, Lee MS, Gudmundsen K. Adverse contact reactions to sculptured acrylic nails: 4 case reports and a literature review. *Contact Dermatitis* 1995;33(6):381–5.
16. Guin JD, Baas K, Nelson-Adesokan P. Contact sensitization to cyanoacrylate adhesive as a cause of severe onychodystrophy. *Int J Dermatol* 1998;37(1):31–6.
17. Alanko K, Susitaiva P, Jolanki R, Kanerva L. Occupational skin diseases among dental nurses. *Contact Dermatitis* 2004;50:77–82.

18. Savonius B, Keskinen H, Tuppurainen M, Kanerva L. Occupational respiratory disease caused by acrylates. *Clin Exp Allergy* 1993;23(5):416–24.
19. Piirila P, Hodgson U, Estlander T, Keskinen H, Saalo A, Voutilainen R, Kanerva L. Occupational respiratory hypersensitivity in dental personnel. *Int Arch Occup Environ Health* 2002;75(4):209–16.
20. Piirila P, Kanerva L, Keskinen H, Estlander T, Hytonen M, Tuppurainen M, Nordman H. Occupational respiratory hypersensitivity caused by preparations containing acrylates in dental personnel. *Clin Exp Allergy* 1998;28(11):1404–11.
21. Environmental Working Group. Skin deep: a safety assessment of ingredients in personal care products; 2004 <http://www.ewg.org/reports/skindeep>.
22. California safe cosmetics act of 2005; 2005 <http://www.leginfo.ca.gov/cgi-bin/waisgate?WAISdocID=53453324010+0+0+0&WAIAction=retrieve>.
23. Susitaival P, Flyvholm MA, Meding B, Kanerva L, Lindberg M, Svensson A, Olafsson JH. Nordic occupational skin questionnaire (nosq-2002): A new tool for surveying occupational skin diseases and exposure. *Contact Dermatitis* 2003;49(2):70–6.
24. Lax MB, Grant WD, Manetti FA, Klein R. Recognizing occupational disease—taking an effective occupational history. *Am Fam Physician* 1998;58(4):935–44.
25. SAS Institute I SAS statistical software. Cary, NC; 2001.
26. Centers for Disease Control and Prevention (CDC). National health and nutrition examination survey data: Hyattsville: National Center for Health Statistics U.S. Department of Health and Human Services; 2004 http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/rdq_c.pdf.
27. McDonald C, Checkoway H. Methodology: 18 study design. In: McDonald C, editor. *Epidemiology of work related diseases*. London: BMJ Books; 2000. p. 385.
28. National Center for Chronic Disease Prevention and Health Promotion Centers for Disease Control and Prevention. Behavioral risk factor surveillance system online prevalence data: Atlanta, GA; 2003.
29. NIOSH. Hazard controls: Controlling chemical hazards during the application of artificial fingernails: Cincinnati: National Institute for Occupational Safety and Health; 1999.
30. OPI Products. Material safety data sheet: Nail lacquer. 1996.
31. Nail Systems International. Material safety data sheet: NSI universal nail liquid; 2002.
32. Feeney M. Ventilation—methods for investigating odor complaints related to nail salons: Bureau of Environmental Health Assessment, MA Dept. of Public Health; 2002 <http://www.state.ma.us/dph/beha/iaq/nails/nails.htm>.