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Original Article

A participatory approach to designing and implementing an occupational health intervention for the nail salon community in the Greater Philadelphia region

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Abstract

Background: The nail salon industry in the US comprises mostly immigrant-owned, small mom-and-pop salons that employ primarily first-generation immigrant workers from Asia. Because of the cultural and language barriers, both owners and workers may not avail themselves of the occupational safety resources. We formed an academic-community partnership to co-design a feasibility study and multi-level occupational health intervention for Vietnamese-speaking salon owners, workers, and community-based organization.

Methods: The intervention for each salon included (i) 2-h in-person training covering chemical safety, infection control, musculoskeletal prevention, and workers' rights for both the owners and their employees, (ii) a tailored recommendation report for the owner, and (iii) check-ins with the owner during the 3-month follow-up. Community partner was trained to deliver the in-language training with technical assistance from the research team. Baseline and post-intervention individual data about health symptoms and behaviors, as well as personal chemical exposures were collected and analyzed.

Results: A total of 44 participants from 12 consented salons enrolled in the study. One salon dropped out at follow-up due to change of ownership. Analysis of the differences between post-and pre-intervention showed a tendency toward reduction in some self-reported symptoms in the respiratory system, skin, and eyes, neurotoxicity score, as well as chemical exposures. We could not rule out seasonality as an explanation for these trends. Increase in self-efficacy in some areas was observed post-intervention.

Conclusions: Our study demonstrated a successful academic-community partnership to engage community members in the intervention study. While the intervention effects from this feasibility study should be interpreted with caution, our preliminary results indicated that our community-based intervention is a promising approach to reduce work-related exposures among Asian American nail salon workers.

Key words: chemical exposures; community-engaged research; community-based participatory research; health equity; nail salon intervention; nail salon workers

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What's Important About This Paper?

This article describes an approach for engaging community partners in the design and implementation of an intervention for nail salon workers and owners. Community participation in research is critical for getting community buy-in, making sure the intervention is relevant to the intended users. We demonstrated a successful academic-community partnership, and the approach taken may be useful to the occupational health professionals and research communities.

Introduction

Nail salon workers (NSW) are members of virtually every community in the United States and experience a constellation of occupational safety and health hazards that are not adequately addressed. Estimates of the number of NSWs ranged from approximately 126,000 (government source) to 400,000 (industry estimate) (NAILS Magazine 2018; Sharma et al. 2018). This wide range reflects the challenges of capturing accurate employment data among this largely immigrant and refugee workforce. Approximately 80% of NSW are women and immigrants from Asia, with more than half of Vietnamese descent (Sharma et al. 2018). The chief occupational health and safety concerns among them include chronic exposure to chemicals, notably volatile organic compounds (VOCs) such as ethyl acetate, *n*-butyl acetate, toluene, benzene and methyl methacrylate (Quiros-Alcala et al. 2019; Zhong et al. 2019). Phthalates and organophosphate esters were also detected in NSW's breathing zone (Craig et al. 2019; Nguyen et al. 2022a). These exposures have been linked with respiratory and dermal irritations, headaches, cognitive impairment, adverse endocrine, and reproductive health (LoSasso *et al.*, 2001; Quach et al. 2008, 2015, Ma et al. 2019; Quiros-Alcala et al. 2019; Nguyen et al. 2022a, 2022c). Other concerns include ergonomic hazards and exposure to blood-borne and airborne pathogens.

Despite calls to reduce workplace exposures among NSWs, there have been few documented intervention studies (Roelofs et al. 2010; Garcia et al. 2015; Ward et al. 2022). Among them, two (a pilot study and a full randomized intervention study by the same research team in California) were culturally tailored to Vietnamese NSWs and owners, focusing on chemical safety (Quach et al. 2018a, 2018b). The randomized intervention study by Quach et al. (2018a, 2018b) utilized the train-the-trainer approach, in which the research team trained the owners in a day-long workshop in Vietnamese and the owners then trained their employees. The intervention was reported to improve chemical safety knowledge and behaviors. The study did not detect notable differences in the measured chemicals (toluene, methyl methacrylate, and total volatile organic compounds (TVOCs)). Another intervention by Lux et al. (2014) was implemented by a health department and focused on infection control practices. It included multilingual educational materials, reminders sent to salons, outreach visits, and an inspection. Lux et al. (2014) reported a reduction in inspection infractions in both the intervention and control groups. However, a larger decrease was observed in the intervention compared to the control group. This effect may be due to the distribution of the educational intervention materials (Lux et al. 2014). Lastly, Mayer et al., (2015) developed training for cosmetology schools and their trainees. The materials included chemical exposure, infectious diseases, and other physical hazards and their control measures. The authors reported an increase in the knowledge assessment between post- and pre-tests. A positive impact on behavior such as use of personal protective equipment (PPE) was also noted. Overall, educational interventions tend to improve knowledge and self-reported safety behaviors. Improvements of the salon environment, such as product substitution or ventilation upgrades, were not assessed in the literature.

On the East Coast, particularly the Greater Philadelphia region, several needs assessment studies were conducted with the nail salon community (Huynh et al. 2019; Ma et al. 2019; Freeland et al. 2021). We are a partnership of academics and a local grassroots organization, Vietlead, who co-developed and piloted a healthy nail salon intervention in the Philadelphia area. While the main purpose of this article is to present our community participatory approach, feasibility measures and lessons learned to inform the larger study, we will also report effect estimates based on our behavioral survey, evaluation of respiratory and neurological symptoms, and personal air quality monitoring (which can help plan adequately powered future work).

Methods

Study overview

Figure 1 illustrates the overview of our study's workflow and design. The design is a one-arm trial where the intervention was delivered to everyone. The primary outcomes were feasibility measures, such as recruitment and retention rates, and assessing the logistical

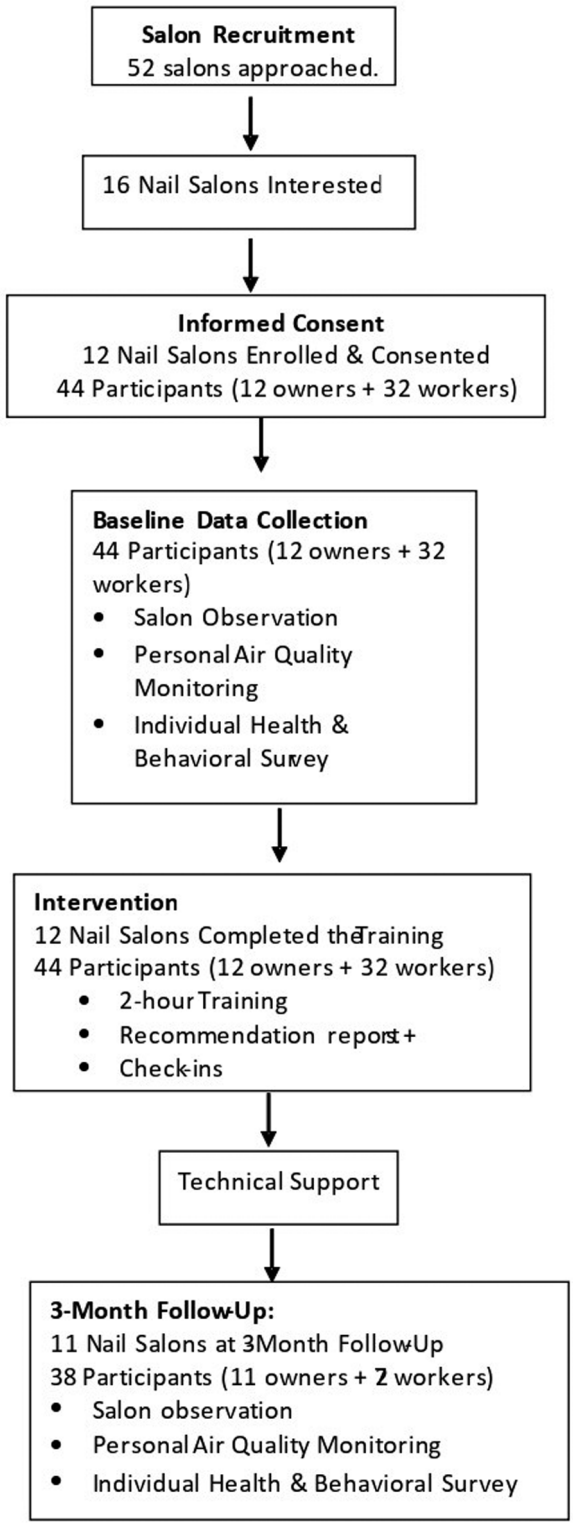

Figure 1. The schematic of the study.

challenges to inform a larger study. Secondary outcomes were individual health and behaviors, observation of the working environment within the salons, and monitoring of personal exposures. Pre- (baseline) and post-intervention data were analyzed to estimate the potential intervention effect, while noting that this pilot work was not powered to test the effectiveness of the intervention and the absence of a control arm left us with the aim of estimating potential effect size and variance for the purpose of design of future evaluation of the intervention. We also conducted parallel qualitative process evaluation to better understand the perceived benefits and barriers to implementing the recommended practices (Huỳnh et al. 2023). Each participant was compensated $50 each time they completed the survey, $100 if they wore the air monitors, and $100 for attending the training.

The ethics of our protocol was reviewed and approved by Drexel University Institutional Review Board (Protocol # 2104008506).

Community partnerships

We developed and implemented this study in partnership with Vietlead, a local community-based organization (CBO) serving the Vietnamese community in the Philadelphia and South Jersey areas. Prior to our collaboration on this study, the academic team and Vietlead had worked together on a community needs assessment (Freeland et al. 2021) and the initial testing of the training content (Huỳnh et al. 2023). Our approach is grounded in community-based participatory research (CBPR) (Wallerstein et al. 2018), where the academic team and Vietlead were involved in all steps of this study including grant proposal and study protocol development, creation of the intervention and survey tools, recruitment, intervention delivery, and outcome evaluation. Team members who speak Vietnamese (the PI and the project manager) met weekly with Vietlead staff to discuss project's progress and decision-making. The meetings were conducted in Vietnamese and English, so our Vietnamese collaborators could feel comfortable providing feedback. This reflected our community-centered collaboration and ensured that community voices were heard and carried weight (Thompson et al. 2021). The PI met with collaborators who do not speak Vietnamese separately.

Healthy nail salon intervention and delivery

We developed the intervention using two frameworks. The first framework is the hierarchy of control—a commonly used approach to minimize exposure to workplace hazards in occupational health and safety field—that consists of 5 tiers in the order from the most to the least effective: eliminate the hazards entirely,

substitute them with safer alternatives, install engineering controls, implement administrative measures, such as training, and, lastly, the use of PPE (NIOSH 2023). While the hierarchy appears to be a linear approach, effective control of hazards in a dynamic workplace often requires a combination of measures from different tiers. Our second theoretical foundation was the Social Cognitive Theory (SCT) which posits that individual behaviors are influenced by their environment (Bandura 1988). The SCT is often represented by a triangle that describes the dynamic and reciprocal interplay between individual characteristics (i.e. knowledge, attitudes), behavioral factors (i.e. skills, practice, self-efficacy), and the environmental factors (i.e. social norms, access to resources) (Glanz et al. 2008). Our prior research with the nail salon community indicated that lack of knowledge of the hazards and safe practices was prevalent among immigrant, Vietnamese-speaking NSWs and salon owners (Huynh et al. 2019; Freeland et al. 2021). Additionally, the salon management practices and lack of resources were identified as some of the institutional challenges (Huynh et al. 2019, 2023).

We developed training materials based on nail salon safety materials from government sources (namely, OSHA, EPA) and prominent nonprofit organizations such as the California Healthy Nail Salon Collaborative. We collaborated with a Vietnamese production company in California (3,888 Films) to produce 3 short culturally tailored videos (about 3 min each) on infectious disease prevention, chemical safety, and musculoskeletal disorder prevention in Vietnamese with English subtitles. We also produced 2 bilingual animated movies on worker rights in collaboration with the Studios of New Mexico State University Innovative Media Research and Extension. The entire 2-h training covered 4 main topics. Each topic started with an overview video, followed by more details provided by the trainers. The videos are available on our bilingual website (healthysalonsproject.org).

The PI (TBH), project manager (DTN), and Vietlead's trainer (NV) co-developed the power point slides training. All 3 researchers (TBH, DTN, NV) have lived experiences of the nail salon environment either as former nail salon workers, or growing up with family members who are nail salon workers. The training was initially drafted in English and then translated into Vietnamese. The academic team worked closely with Vietlead trainer to refine the Vietnamese content based on her feedback and then translated the final version back to English for participants more comfortable receiving the training in English, and to ensure that the meaning was not altered in translation. We tested the training materials with a small group of Vietnamese nail salon workers and owners online (because of the COVID-19 pandemic). Vietlead trainers also practiced the training multiple times at the office and a nail salon. Vietlead trainers delivered in-person training at the salons. We also conducted synchronous online training to a small group of participants (primarily young English-speaking nail technicians) who were not able to attend the in-person training due to scheduling conflicts.

Another component of the intervention was the salon environment assessment checklist, which was designed to help owners assess their salon's environment. The academic team initially developed the checklists to help owners identify areas for improvement. However, after testing the tools with one owner, we learned that the tool was too complicated for a person without prior training in occupational health and safety. Our community trainer consequently suggested that the academic team conduct the salon observation and produce a recommendation report for the owners. Lastly, we added follow-up consultations with the owners to go over the recommendations and monthly check-ins during the 3-month follow-up. In summary, our intervention for each salon consisted of a 2-h training, a recommendation report based on the salon environment observation, 1 consultation to go over the report, and 2 follow-up check-ins with the owners.

Recruitment

We relied heavily on Vietlead's extensive connections within the community to recruit Vietnamese salons in the Philadelphia area. We also posted flyers near Vietlead's office located inside a strip mall that houses other Asian small businesses (i.e. restaurants, grocery store, hair salon). We also paid for advertisements in a regional Vietnamese language magazine, visited salons near Vietlead's office, and made cold calls. Word-of-mouth among Vietlead's staff and volunteers, clients and their family members happened concurrently. Recruitment started in July 2021 and lasted through November 2021.

Eligibility and informed consent

We recruited Vietnamese nail salons in the Philadelphia area within the state of Pennsylvania. It was important for us that the owners agreed to participate in the study to ensure their collaboration and minimize the threat of retaliation against workers due to participation in our research. We asked the owners for permission to recruit their employees, typically over the phone.

If emails were given to us, we would send a copy of the informed consent in advance. We went over the informed consent process at the salons. Participants were provided with a hard copy of the consent form. We developed a short presentation in Vietnamese (about 10–15 min) highlighting important points from the consent form. We made sure there was enough time

to answer questions from the participants. Vietlead staff were trained to conduct the informed consent process and shadowed the academic team to the first few salons. Then, they did most of the recruitment and consenting on their own. With English-speaking employees, the academic team went over the consent form with them in English. Written consent was obtained from each participant.

Health and behavioral survey

The survey consists of 3 main sections: health symptoms, current practices, and demographics. We used validated surveys if available and developed our own questions otherwise. In the heath section, we asked about their general health, respiratory symptoms using the European Community Respiratory Health Survey (ECRHS) short screening questionnaire (ECRHS 2023), skin symptoms adapted from the Nordic Occupational Skin Questionnaire (NOSQ) (Shamout and Adisesh 2016), eye symptoms, musculoskeletal discomfort from the Nordic Musculoskeletal Questionnaire (Kuorinka et al. 1987). We used the 34-question version of the Euroquest survey to screen for neurotoxic symptoms, although it should be emphasized that the use of this screening tool should not replace clinical diagnosis (Karlson et al. 2000; Carter et al. 2002; Kaukiainen et al. 2004). Responses were captured as never (0), sometimes (1), often (2), and very often (3). The total can range from 0 to 102 or analyzed by domains (neurological symptoms, psychosomatic symptoms, mood symptoms, memory and concentration, tiredness, sleep disturbances). Each domain score is calculated by the sum of score divided by the number of questions in each domain (Kaukiainen et al. 2004). The behavioral section includes questions about current practices (categorical) and self-efficacy (continuous). The demographic section includes smoking and drinking habits. Copy of the questionnaire is included as Supplemental Materials.

The health, behavioral, and demographic data were collected through a 30- to 45-min phone survey at baseline and 3 months after the intervention. The survey was conducted in Vietnamese (n = 40) and in English (n = 4) by trained bilingual research assistants from both the academic team and Vietlead staff. Study data were collected and managed using REDCap electronic data capture tools hosted at Drexel University (Harris et al. 2009, 2019).

Environmental exposure

In each nail salon, personal air quality data were collected for 2 workers on 2 workdays at both baseline and 3-month follow-up (a total of up to 4 measurements per person). The days were selected to reflect one busy day (a Friday, a Saturday, or a Sunday) and a less busy weekday, at both baseline and follow-up. We asked the employees to wear a passive air-sampling monitor (546 Organic Vapor Badge, Assay Technology) near their personal breathing zones. On each sampling morning, a team member visited the salon to set up the equipment when the salon was open or at the beginning of the participating employee's shift. We then came back to retrieve the air monitors either near the closing hour in the evening, or when the employee's shift ended. We also instructed the participants to fill out a form to record services they did for that day (Supplementary Material 2). We sent the badges to Assay Technology (an American Industrial Hygiene Association accredited lab) to analyze for acetone, ethyl acetate, methyl methacrylate (MMA), and toluene. These chemicals were selected based on previous nail salon studies (for comparison purpose), their known toxicity, and budgetary constraints. On average, a field blank was used for each salon per campaign. The badges were brought back to the lab for processing (i.e. checking samples and filling out the chain of custody forms) and were shipped within 2 weeks after sampling as recommended by Assay Technology. Requested analytes were analyzed using gas chromatography with flame ionization detector (GC/FID) method (Assay Technology 2021). Sampling durations were between 4.5 h and—9 h with the median duration close to 8 h.

Statistical analysis

Summary measures for the individual health and behavioral survey items, knowledge and self-efficacy scores, neurological outcomes, and personal air quality measurements were computed for the baseline and follow-up periods. We estimated the differences between the two periods using conditional mixed effects models to adjust for correlation within salons and across time for individual participants. For binary heath outcome measurements, relative risks were estimated using a modified Poisson regression model (Zou 2004). Current practices were grouped into "usually or always" versus "never or seldom or about half of the time" to create a binary outcome. For continuous self-efficacy measures, we used linear regressions, and reported mean differences. For neurological measures and personal air quality measures, we analyzed the outcomes on log scale based on the observed empirical distributions and lack of apparent normality. Personal chemical exposures below the laboratory limit of detection (LOD) were substituted with LOD/2 (Hornung and Reed 1990). For the log-linear models, we reported the estimated multiplicative changes in the average from baseline to follow up.

Results

Recruitment and loss to follow up

We reached out to 52 nail salons, 16 of which expressed interests in participating. Four salons did not meet inclusion criteria due to being located in either New Jersey or Delaware, leaving 12 nail salons to enroll, our target number. The recruitment took us close to 6 months. Only about a fifth of contacted salons were eligible and recruited. A total of 44 participants (12 owners and 32 employees) consented to participate in the study. It is worth noting that the numbers of contacted salon owners and NSW reached may have been greater than noted above, since our community partner reported having many informal conversations with community members about our project, while interacting with them regarding other matters. Most frequently reported reasons for refusal included inconvenience, lack of time, and salons perceived as being too old to upgrade. In some instances, the workers wanted to participate in the study but said that their owners did not. Sometimes, some but not all co-owners (from the same family) wanted to participate, due to fear of getting involved in the research; in such cases, the salon was not enrolled.

We completed baseline data collection and delivered the in-person training to all salons. One salon dropped out of the study after the training due to change of ownership; 11 salons completed the entire program (training and consultation) and post-program data collection. Four employees in the dropped-out salon naturally did not participate in the follow-up interviews.

Environmental, behavioral, and health outcomes

Table 1 presents demographic characteristics of the participants for 11 completed salons (N = 38). A full demographic table for all participants (12 salons, N = 44) is included in the Supplementary Materials. Most participants were women (82%), born outside the United States (90%), had either high school or lower education (79%), and reported difficulty speaking English (58%). The median age was 43 years; the median years in the United States was 17 years. The median year in the nail industry was 11, median number of days worked in a week was 6 and hours worked per day—9. Just over a fourth of the participants reported not having health insurance and have not visited a doctor in the last 12 months.

Table 2 outlines self-reported symptoms related to the respiratory system, skin and eyes, and musculoskeletal disorders. At baseline, the most common respiratory symptoms reported were hay fever (48%), cough when sleeping (18%), and shortness of breath after strenuous activity (21%). Some participants reported that respiratory symptoms improved when away from work, most notably chest tightness (8%) and hay fever (16%). Approximately 40% of participants reported having eczema, most commonly at the hands (18%). A third reported eye irritation. About half of the participants who reported having eczema and eye irritation noted that their symptoms improved when away from work. Analysis of the relative risks (RR) between the post- versus pre-intervention showed a tendency toward reduction for some respiratory symptoms: aRR = 0.93, 95% confidence interval (CI): 0.51, 1.69 for hay fever; aRR = 0.50, 95% CI: 0.12, 2.02, for chest tightness. The adjusted RR for eczema showed reduction (0.77, 95% CI: 0.39, 1.53) but symptoms for hand eczema and eye irritation appeared to increase after intervention (aRR = 1.94, 95% CI: 0.99, 3.80, aRR = 1.34, 95% CI: 0.68, 2.66, respectively). About a fifth of skin and eyes symptoms were reported to improve when away from work. The intervention did not appear to impact the reported number of symptoms that improved when away from work. For musculoskeletal symptoms (Table 2), we observed reduction of symptoms and adjusted RR after the intervention for most symptoms (e.g. neck pain, pain in elbows, hands, upper and lower back), except hip pain and pain in one or both shoulders during the last 12 months. Most participants reported an increase in pain that prevented them from doing normal activities for most areas of the body asked.

We noted a reduction in the neurotoxicity scores in all domains, albeit with small differences (Table 3). For example, largest reduction was observed for memory domain at 6% (0.94; CI: 95% CI: 0.81, 1.09).

We observed increased frequency of self-reported gloves use during services but a reduction of mask use, stretches and going outside to get fresh air post-intervention (Table 4). Self-efficacy increased in all assessed areas, except self-efficacy to clean foot spa (Table 4). The largest improvement in self-reported self-efficacy was with respect to protecting yourself from chemicals with a mean difference of 8.2 points, (95% CI: 1.5, 14.9), followed closely by adjusting body position to prevent pain 7.8 points (95% CI: 0.7, 14.9).

Table 5 suggests that there may have been a reduction in some chemical exposures between the baseline and the follow-up evaluations. The most convincing evidence of reduction in personal exposure was for MMA, which dropped by 25% (ratio = 0.76, 95% CI: 0.47, 1.23), personal exposure to acetone reduced on average by about 25% in the follow-up period (ratio = 0.78, 95% CI: −50%, 9.1%) and ethyl acetate 6% lower (ratio = 0.94; 95% CI: 0.68, 1.30), but the effect estimates were not precise. All toluene measurements were below the laboratory detection limits.

Table 1. Salon characteristics and participant demographics from 11 enrolled salons in Philadelphia area ($N = 38$) (One salon dropped out of the study).

Salon characteristics	Median	Min—Max, IQR
Size in cubic feet[a]	7,305	4,028–12,820, 2,841
Number of manicure tables	6	4–12, 1
Number of pedicure chairs	5	3–8, 0.5
Number of employees (full time and part time)	4	2–8, 2.5
Participant characteristics	*n*	%
Female	31	81.6
Male	7	18.4
Age, year (median = 43)		
<30	8	21.1
30–39	10	26.3
40–49	8	21.1
50–59	9	23.7
60+	3	7.9
Country of birth		
Vietnam	34	89.5
United States	5	10.5
Job title		
Owner	11	28.9
Employee	24	63.2
Manager	3	7.9
Education		
<High school/High school	30	78.9
Some college	2	5.3
College	5	13.2
Refused to answer	1	2.6
English speaking proficiency		
Not well at all	4	10.5
Not well	18	47.4
Well	12	31.6
Very well	4	10
Health insurance coverage		
Yes	30	78.9
No	8	21.1
Doctor visit last 12 months		
Yes	28	73.7
No	10	26.3
	Median	Min-Max, IQR
Years in the United States	17	3–34, 14.0
Years in the nail industry	11	1[b] –31, 14.8
Number of working days a week	6	2–7, 1.0
Number of working hours a day	9	3–10.5, 1.8

[a]Two salons had missing dimension measurements;
[b]Less than 1 year was rounded to 1.
IQR, Interquartile Range.

Discussion

We report the process and results of our feasibility study to implement a participatory occupational health and safety intervention program tailored to the Vietnamese nail salon community in Philadelphia area. We partnered with Vietlead early in the process including their assessment of our ability to recruit 12 salons given timing of the study and short timeframe of the grant. The academic team and Vietlead co-developed the intervention program which included a 2-h in-person training for both owners and employees, a recommendation report based on salon observations conducted by the academic team, a consultation session to go over the report, and check-in calls during the 3-month follow-up. We observed some increases in occupational health and safety knowledge and self-efficacy, as well as a reduction in personal exposure to some chemicals. While these results should be interpreted with caution due to our small sample size and lack of a control arm, the study has achieved its primary aim of giving the academic team and community partner a valuable experience carrying out the research project together and learning to collaborate.

Our study was initially delayed due to the COVID-19 pandemic because at the time the study was slated to start in September 2020, it was deemed unsafe to gather in-person by the city of Philadelphia and state of Pennsylvania. Initial test of the training content had to be moved to Zoom platform (Huỳnh et al. 2023). We encountered significant challenges related to recruitment and thus, the time it took to recruit 12 salons was longer than initially anticipated. A majority of the enrolled salons either had a close connection to Vietlead staff or had been introduced to the program by someone they trusted. As such, involvement of trusted CBOs like Vietlead was critical to the success of our recruitment efforts. In addition to the reasons for

refusal reported by the participants, Vietlead staff also shared that because this program was too new to the community, there was no one from the community to vet the program, which made it challenging to convince people of its potential benefits. After the participants went through the program, a few owners voluntarily spread the word about the program and told Vietlead staff of new salons who might be interested in the program in the future. While recruitment for this study was met with challenges, we are optimistic that future recruitment will be a bit easier with the help from participants in the first cohort.

Vietlead trainers delivered the training in-person at the salons, usually after work hours. While this process was time-consuming, it provided Vietlead and the academic team the opportunity to build relationships with the community as relationship building is a key part of CBPR and also essential for Vietlead to work effectively within the community. At the end of study, we organized a community appreciation event to share preliminary results and to provide the academic team, community partners, and participants an additional opportunity to connect in-person. Our future work will likely incorporate both in-person and online training to accommodate training preferences. Our research team have had experience with online training during the pandemic (Huỳnh et al. 2023). While online training was easy for most people, we have had individuals with limited technology skills and English proficiency, thus budgeting for additional time and effort for technology assistance (both in-person and remotely) should be part of the initial planning.

For outcome measures, we used a combination of acute health symptoms, self-reported practices and self-efficacy, and environmental changes. Given that this study has a short 3-month follow-up, reductions of health symptoms are not expected to be detected as evidenced by the wide confidence intervals of the effect estimates. Rather, the acute self-reported health symptoms may help us understand the baseline health symptoms. For example, about half of the participants reported having hay fever in the past 12 months. Our prevalence rate is on par with previously reported study conducted with Asian NSW in other parts of the country. A study of Asian NSW in the Boston area found that about 44% of their participants reported any respiratory symptoms (difficulty breather, regular cough, sinus/nasal, irritation) (Roelofs et al. 2008). Quach et al.'s (2008) study indicated that 47% of Vietnamese NSW in California reported health symptoms that may be associated with solvent exposure including skin irritations, breathing problems, eye, and throat irritations. The burden of adverse respiratory and skin conditions among NSW is generally higher than the general population. The European Respiratory Health Study that used the same instrument found that among the 193,912 adults in 43 centers in 17 countries the estimated overall prevalence of symptoms was 6.6% (0.9–32.7%) for current wheeze, 4.4% (0.9–29.0%) for asthma ever, 14.4% (2.8–45.7%) for hay fever ever, and 9.9% (1.6–29.5%) for eczema ever (Mortimer et al. 2022). While the prevalence estimates for wheeze and asthma among our participants were similar to the general population, the prevalence of hay fever symptoms and eczema were approximately 3 times higher than the general population. It is notable that we observed a number of symptoms such as hay fever, chest tightness, eczema, and eye irritation that appear to have occupational causes due to their improvement when away from work. We may wish to target understanding these specific symptoms and implied conditions in the future.

We observed an increase in glove use but not in mask use, stretches, or going outside to get fresh air. Our high self-reported mask use (100%) at baseline is likely to due to the then on-going pandemic primarily for COVID-19 protection. As the country emerged from the pandemic and restrictions eased, participants appeared to also relax their mask use. Future education campaigns should also emphasize the benefits of mask use for both chemical and/or dust and airborne pathogens protection in the salons. Our training recommended going outside to get fresh air, but we also recognize that in some cases, it may not be feasible if the salon is located in neighborhoods that may not be safe to do so or in cold weather. This stresses the importance of having good ventilation in the salon for those instances.

We observed a reduction of exposure of some chemicals but our ability to attribute the reduction of exposure is extremely limited given the small sample size and lack of a control arm. There are likely confounding factors due to seasonality. For example, the baseline data collection took place mostly during winter, and when we collected follow-up data during the summer season, we noted some owners opening doors when the weather was nice. Summer is typically the busiest time of year for salons and may potentially increase worker exposure if salons use air conditioners and cannot open doors. Because such behavior was not assessed at baseline, we could not ascertain how much of that was attributed to the training. There was also likely high variability in exposures during the summer months within salons that we were not able to capture with just 2 days of sampling per salon. In our future assessment, we will likely modify our outcome measure to help us better capture "low-hanging fruit" behaviors such as these from the owners. Our chemical exposure levels were all below the occupational exposure limits. Despite this fact, the prevalence rates of acute

Table 2. Prevalence of self-reported respiratory, musculoskeletal, skin, and eye symptoms.

Symptoms	Pre-intervention (*N* = 38)		Symptoms improved away from work (yes) (*N* = 38)		Post-intervention (*N* = 38)		Symptoms improved away from work (yes) (*N* = 38)		Adjusted RR (95% CI) post versus pre any symptoms	Adjusted RR (95% CI) post versus pre symptoms improved away from work
	n	%	*n*	%	n	%	*n*	%		
Respiratory symptoms										
Wheezing/ Whistling	4	10.5	1	2.6	4	10.5	1	2.6	1.00 (0.21, 4.85)	---
Chest tightness	5	13.2	3	7.9	2	5.3	2	5.3	0.50 (0.12, 2.02)	1.00 (0.15, 6.65)
Woken up by SOB	1	2.6	1	2.6	1	2.6	1	2.6	---	---
Cough when sleeping	7	18.4	2	5.3	6	15.8	3	7.9	0.61 (0.16, 2.33)	0.50 (0.03, 9.53)
Asthma	2	5.3	0	0.0	0	0.0	0	0.0	---	--
Hay fever	18	47.4	6	15.8	17	44.7	8	21.1	0.93 (0.51, 1.69)	1.50 (0.45, 5.02)
SOB during day	7	18.4	---	---	1	2.6	---	---	0.17 (0.02, 1.35)	---
SOB strenuous activity	8	21.1	---	---	7	18.4	---	---	1.00 (0.30, 3.27)	---
Persistent cough (>3 months)	3	7.9	1	2.6	1	2.6	0	0	---	---
Chest phlegm	1	2.6	0	0.0	0	0.0	0	0.0	---	---
COPD	0	0.0	0	0.0	0	0.0	0	0.0	---	---
Skin and eye		0.0		0.0						
Eczema	16	42.1	8	21.1	12	31.6	8	21.1	0.77 (0.39, 1.53)	1.33 (0.51, 3.45)
Hand eczema	7	18.4	-	-	11	28.9	-	-	1.94 (0.99, 3.80)	---
Eye irritation	13	34.2	8	21.1	15	39.5	9	23.7	1.34 (0.68, 2.66)	1.60 (0.57, 4.51)

Musculoskeletal disorders	Pre-intervention (*N* = 38)		Can't do normal activities (*N* = 38)		Post-intervention (*N* = 38)		Can't do normal activities (*N* = 38)		Adjusted RR (95% CI) post vs pre ANY symptoms	Adjusted RR (95% CI) can't do normal activities
	n	%	n	%	n	%	n	%		
Neck	18	47.4	5	13.2	16	42.1	7	18.4	0.88 (0.51, 1.51)	1.20 (0.40, 3.63)
One or both shoulders	18	47.4	7	18.4	21	55.3	10	26.3	1.19 (0.74, 1.89)	1.60 (0.58, 4.44)
One or both elbows	8	21.1	5	13.2	7	18.4	7	18.4	0.88 (0.35, 2.19)	1.40 (0.47, 4.13)
One or both hands	14	36.8	10	26.3	12	31.6	11	28.9	0.82 (0.39, 1.73)	1.29 (0.54, 3.09)
Upper back	11	28.9	4	10.5	10	26.3	5	13.2	0.78 (0.35, 1.72)	1.00 (0.30, 3.34)
Lower back	21	55.3	9	23.7	17	44.7	12	31.6	0.79 (0.49, 1.28)	1.57, 0.68, 3.61)
Hip	3	7.9	3	7.9	4	10.5	2	5.3	3.00 (0.60, 14.91)	2.00 (0.31, 12.81)
Knees	12	31.6	5	13.2	10	26.3	5	13.2	0.89 (0.40, 1.96)	1.33 (0.35, 5.03)
Ankles/feet	5	13.2	3	7.9	4	10.5	2	5.3	0.75 (0.20, 2.74)	1.00 (0.17, 6.03)

The total # of participants with completed baseline and follow-up data is 38.
COPD, chronic obstructive pulmonary disease; RR, relative risks; SOB, shortness of breath.
Relative risks were estimated using a modified Poisson regression model adjusted for English proficiency and years in the United States.
"-"= did not ask; "---" = RR could not be computed due to few observations;

Table 3. Summary statistics and mean difference of the neurotoxicity score based on the 34-item Euroquest questionnaire.

Domains	Pre-intervention		Post-intervention		Mean ratio (95% CI)
	Mean	SD	Mean	SD	
Neurological	0.30	0.28	0.29	0.28	0.99 (0.90, 1.10)
Psychosomatic	0.38	0.32	0.33	0.31	0.97 (0.89, 1.07)
Mood	0.37	0.42	0.34	0.32	1.00 (0.88, 1.12)
Memory	0.66	0.55	0.56	0.47	0.94 (0.81, 1.09)
Tiredness	0.64	0.74	0.62	0.76	0.97 (0.80, 1.19)
Sleep Disturbance	0.53	0.47	0.54	0.52	1.00 (0.87, 1.15)
All questions	0.45	0.33	0.41	0.32	0.98 (0.88, 1.09)

Missing values were imputed using row means.
SD = standard deviation; Outcome was analyzed on log-scale in the linear models that calculated within-person changes, akin to paired *t*-test; adjusted for English proficiency and years in the United States.

respiratory and skin irritations from solvent exposures should be of concern to the community as these acute effects do impact quality of life including neurological impairment from exposure to low level of solvents. We presented the results post- versus pre-intervention of the neurotoxicity score to estimate potential intervention effects to be consistent with the theme of this paper. A more thorough analysis is forthcoming to better understand health effects of low-level solvent exposures on the neurological system.

We conducted parallel in-depth process evaluation reported in Huỳnh et al. (2023). All owner participants, except one, reported to us that they did not make substantial changes to the salon environments since our initial observations. Our Vietlead trainer reported to us that the salon owner who purchased new nail salon manicure tables with built-in local exhaust ventilation (LEV) did so because the salon was already in the process of being upgraded. After learning about the function of LEV to protect health through our training, the owner decided to purchase them to protect his family who worked in the salons. Through interviews with the participants, we learned that even though the participants acknowledge the benefits of the training in increasing their awareness of the hazards, there were many perceived barriers to implementing changes related to the salon environment. These barriers included high cost, lack of the availability of alternative products at the local nail suppliers, lack of motivation from some owners, and work practices such as long work hours and low wage impacting employee morale (Huỳnh et al. 2023). Consideration of these barriers may require external policy to incentivize and support salons such as the voluntary Healthy Nail Salon Recognition Program (Nguyen et al. 2022b). In a survey of community stakeholders in Philadelphia, we learned that all stakeholders support the creation of the program. However, lack of funding for the local health department to adopt and implement the program was identified as a major barrier as well as the need for the community mobilization to have their voices heard that such a program is important to the health of the immigrant communities (Nguyen et al. 2022b).

Our study has several limitations. First, the salons and participants in the study may be early adopters and may be not representative of salons in the region. Second, self-reported measures of health symptoms, behaviors, and self-efficacy may suffer from recall bias. We cannot exclude correlated errors in questionnaire responses, such that persons under- or over-reporting at one point in time, exhibiting the same tendency at another time. While we used validated research instruments whenever possible, there is lack of evidence of validity for the Vietnamese population, although this concern is mitigated by the fact that some instruments have a history of successful use in diverse populations.

Despite these limitations and being a small sample, our study's participants reflected the demographic characteristics of the minority workers employed in the nail salon sector. Most of them are foreign-born women with limited English proficiency and low socioeconomic status. The vulnerability of this workforce calls for a comprehensive and flexible approach to workplace and public health interventions. Our community-based participatory research (CBPR) approach, which prioritizes building trusting relationships with community partners, understanding the significance of shared experiences, and taking into accounts of fears and stigma of being immigrant workers, allowed our community partners to be empowered and included in the decision-making process. This allowed us to better understand and work closely with the community, but also required us to be flexible and adjust our study design to meet their needs (Katigbak et al.

Table 4. Change in current practices and self-efficacy after follow-up.

Current practices	Pre-intervention		Post-intervention		RR (95% CI) post versus pre*
	n	%	*n*	%	
Frequency of glove use for manicures in a typical day (usually/always)	13	34	14	37	0.92 (0.46, 1.81)
Frequency of glove use for pedicures in a typical day (usually/always)	32	89	35	95	1.04 (0.93, 1.16)
Frequency of mask use in a typical day (usually/always)	38	100	37	97	0.97 (0.91, 1.03)
Frequency of performing stretches in a week (daily/4–6× per week)	19	50	22	58	1.20 (0.73, 1.98)
Frequency of going outside to get fresh air in a week (daily/4–6× per week)	19	50	22	58	1.82 (1.04, 3.17)

Self-efficacy	Pre-intervention		Post-intervention		Mean difference
	Mean	SD	Mean	SD	
Confidence in knowledge of cleaning and disinfection as required by State Board	75.32	21.95	83.21	14.63	6.30 (–1.83, 14.42)
Confidence in ability to clean reusable tools	83.62	14.81	87.62	10.64	5.16 (–1.07, 11.38)
Confidence in ability to clean foot spa	86.19	14.63	87.68	12.38	0.72 (–6.05, 7.49)
Confidence in ability to safely handle blood	84.49	15.64	88.35	11.14	4.63 (–1.99, 11.24)
Confidence in ability to adjust body position to prevent pain	76.03	19.93	82.95	12.26	7.78 (0.67, 14.89)
Confidence in ability to keep yourself safe from chemicals at work	75.11	16.78	83.26	11.76	8.17 (1.49, 14.85)
Able to talk to someone about work-related health concerns	80.70	15.30	80.53	17.21	2.30 (–4.47, 9.07)

Missing values were removed using na.rm=T.
Relative risks were estimated using a modified Poisson regression model adjusted for English proficiency and years in the United States.

Table 5. Change in personal exposure to volatile chemicals (in ppm, where appropriate) for 11 enrolled salons.

	Pre-intervention				Post-intervention				Ratio of GM diff (95% CI ratio GM) post-pre
	N	% below LOD[a]	AM/GM (ppm)	GSD	*N*	% below LOD	AM/GM (ppm)	GSD	
Acetone	42	0	11.10/7.39	2.77	40	0	9.07/5.72	2.86	0.78 (0.53, 1.15)
MMA	42	2.4	2.86/1.68	3.54	40	0	2.37/1.28	3.28	0.76 (0.47, 1.23)
Ethyl acetate	42	26.2	0.29/0.22	2.18	40	30	0.29/0.21	2.39	0.94 (0.68, 1.30)

[a]The average reported limit of detection (LOD) for acetone, ethyl acetate, methyl methacrylate (MMA), and toluene were 0.147, 0.140, 0.060, and 0.126 ppm, respectively. All toluene measurements were below the LOD.
AM, arithmetic mean; GM, geometric mean; GSD, geometric standard deviation.

2016; Vaughn et al. 2017). Our study demonstrates the utility of CBPR approaches in gaining support for research among Vietnamese immigrant nail salon workers and small business owners. The US nail salon workforce comprises diverse minority workers and owners (e.g. Black, Chinese, Korean, Mexican, Nepali)

(Sharma et al. 2018) and this community participatory approach could also translate to working with other ethnic nail salon communities in the Philadelphia region and other cities. This approach, however, requires substantial upfront time and commitment to building trusting relationships between the researchers and the local CBOs and community leaders who have deep ties with their communities and thus in the absence of such relationships, it may not work as well. Future research funding opportunities should consider the benefits of CBPR and encourage researchers to explore innovative ways to ensure their studies are truly inclusive, equitable and relevant to the communities they address.

Conclusion

Our research study demonstrates a participatory approach to designing and implementing an occupational health intervention study for the underserved nail salon worker population in the Philadelphia area. Getting buy-in from community leaders and community partners early in the process was a key factor in our recruitment success. Our outcome assessments, while small in sample size, provided early evidence of potential effectiveness of the intervention for behavioral outcomes. Future use of the intervention materials will likely need further tailoring but overall, the multi-level intervention focusing on providing support to salon owners and community organizations offers a promising approach to work with primarily immigrant small businesses owners and their employees.

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Conflict of interest statement. None declared.

Data availability

Data may be available upon request from the corresponding author.

Supplementary data

Supplementary data are available at *Annals of Work Exposures and Health* online.

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