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Mmamogopodi, Frengy Mapogo

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Knowledge and practices associated with exposure to nail products among informal nail technicians in Braamfontein, South Africa



UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

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Frengy Mapogo Mmamogopodi

Student number: 1497230

Supervisors: Prof. Gill Nelson and
Dr Goitsemang Keretetse

Faculty of Health Sciences, School of Public Health, Occupational Health Division
University of the Witwatersrand

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg in partial fulfilment of the requirements for the degree of Master of Science in Medicine (Exposure Science)

9 October 2025

Declaration

I, Frengy Mapogo Mmamogopodi (student number: 1497230), declare that the research project entitled *"*Knowledge and practices associated with exposure to nail products among informal nail technicians in Braamfontein, South Africa*"* is my research work undertaken under the supervision of Prof. Gill Nelson and Dr Goitsemang Keretetse. The work is being submitted in partial fulfilment of the degree of Master of Medicine in the field of Exposure Science at the School of Public Health, University of the Witwatersrand, Johannesburg. This report has not been submitted previously for any degree at this or any other university.

All the sources cited in this study have been acknowledged through comprehensive references. The University's plagiarism policy is signed and attached as an Annexure 5: Plagiarism Report Declaration Form.

Full Name of Student: Frengy Mmamogopodi

Student Number: 1497230

Signature: DocuSigned by: Frengy Mmamogopodi

Date: 9 October 2025

Dedication

I dedicate this report to my two children, Oratile and Katlo Mmamogopodi, my mother, and my three siblings.

ABSTRACT

Background

The global nail care industry is an annual $13 billion industry and attracts a large workforce market, comprising both formal and informal nail technicians. In Braamfontein, one of the busiest and mixed-use zones in Johannesburg, South Africa, the informal nail sector is thriving, with numerous salons operating from often overcrowded and poorly ventilated rooms. Exposure to nail polish, gel removers, adhesives, acrylics and other nail products increases the risk of acute respiratory and chronic health issues. Assessing the knowledge and practices of informal nail technicians regarding exposure to nail products is critical to help develop interventions to promote occupational health and safety.

Objectives

i. To describe the knowledge and practices of informal nail technicians regarding the chemicals in the products they use.

ii. To identify factors (sex, age and work experience) that are associated with informal nail technicians' knowledge about these chemicals.

iii. To identify factors (sex, age and work experience, knowledge) that are associated with nail technicians' practice regarding the use of nail products.

Methods

This was a quantitative, cross-sectional study, for which we recruited 60 participants, comprising 31 informal nail technicians who participated in a previous larger study on exposure to chemicals in nail products and 29 additional nail technicians who were selected using convenience sampling. The data were collected using an English interviewer-administered questionnaire with close-ended questions. The questionnaire was divided into sections related to 1) demographic characteristics, 2) knowledge, 3) symptoms, and 4) practices. Sections 2 to 4 consisted of multiple-choice questions with responses such as "yes" or "no", and "harmful" or "not harmful". Knowledge and practice scores were allocated for responses and then summed, after which participants were grouped into high or low (knowledge or practice) categories. Descriptive statistics were used to summarise the demographic and work-related characteristics of the study participants, and their reported symptoms, and their

knowledge and practice scores. Multivariable logistic regression analysis was used to assess the relationships between socio-demographic factors, and both practices and knowledge.

Results

Most of the participants were females (n=40, 66.7%). The mean age was 33 ±6.6; 50% had a tertiary education. Twenty-two (36.7%) reported experiencing symptoms that are associated with exposure to nail products. The average knowledge and practice scores were 33.3% and 78.3%, respectively. Work experience was negatively associated with knowledge: for every increase in years of work experience, the odds of having higher knowledge decreased by 19% (OR = 0.81, 95% CI = 0.67–0.97, p= 0.025). However, the association was not statistically significant in the adjusted model (OR = 0.85, 95% CI = 0.66–1.08, p=0.174). Age was positively associated with knowledge: with every year of increase in age, the odds of having higher knowledge increased by 14% (OR = 1.14, 95% CI = 1.02–1.26, p=0.021). However, this result was also not significant in the adjusted model (OR = 1.08, 95% CI = 0.95–1.24, p=0.237). There were no associations between demographic and work-related factors, and level of practice.

Conclusion

In this study, we found no significant associations between socio-demographic or work-related characteristics and the knowledge or practices of informal nail technicians regarding the chemical composition of nail products and associated health hazards. This is possibly due to the limited population to participate in the study. Overall, the findings suggest a disconnect between knowledge and practice. Although informal nail technicians demonstrated relatively good safety practices, their limited knowledge of chemical hazards may explain the persistence of exposure-related symptoms. These results highlight the urgent need for targeted educational programs to improve awareness and safety interventions to promote healthier practices in the informal sector.

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ACRONYMS

DBP	Dibutyl Phthalate
EMA	Ethyl Methacrylate
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
KAP	Knowledge, Attitudes, and Practices
MMA	Methyl Methacrylate
NRF	National Research Foundation
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PPE	Personal Protective Equipment
SAHPRA	South Africa Health Products Regulatory Authority
SDS	Safety Data Sheet
TVOC	Total Volatile Organic Compound
USA	United States of America
VOC	Volatile Organic Compound
WHO	World Health Organization

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CHAPTER 1 INTRODUCTION

This chapter presents an overview of the nail care industry, focusing on informal nail technicians' knowledge and practices regarding the products they use. It includes a review of peer-reviewed literature that is relevant to occupational health and safety in the informal nail sector. Literature on health risks associated with exposure to nail products is included, and some regulatory gaps that impact the work of informal nail technicians are identified. The problem statement and justification of the study are provided, and the chapter ends with the study aim and objectives.

1.1 Background

The nail industry started in the early 1900s in the United States of America (USA) and, by 1910, many 'pedicure clinics' were established in New York City, providing both manicures and pedicures (1). Today, there are thousands of nail salons operating in both developed and developing countries, including South Africa.

Nail technicians provide services such as nail grooming, hand and foot care, applying nail polish, UV gel enhancements, acrylic nail application, and fake nail enhancement. During these procedures, nail technicians use products such as nail polish, nail polish removers, nail hardeners, artificial nails, nail tips adhesives, artificial nail removers, and disinfectants - many of which comprise a cocktail of chemicals (2).

Nail technology refers to the skill and science of nail maintenance, including the application of artificial nails, and is an expanding field within the global personal care industry (3). The global nail care industry has grown immensely over the last four decades, especially since methyl methacrylate (MMA) was introduced into the artificial nail process for the application of acrylic nails (4,5). Methyl methacrylate is known for curing quickly at room temperature and hardens soon after application (4). It is also resistant to shear, peel, and impact stress. However, the Food and Drug Administration (FDA) banned MMA in 1974 because of health and safety concerns such as allergic reactions, skin and eye irritations, and respiratory problems, leading to it being replaced with ethyl methacrylate (EMA), which is considered safer than MMA (4).

Chemicals in nail products include the “toxic trio”, formaldehyde, toluene and dibutyl phthalate (6,7). Formaldehyde is a well-known human carcinogen (8). Dibutyl phthalate and toluene are endocrine disruptors, interfering with the normal functioning of the endocrine system (6,7). Toluene also poses a threat to exposed individuals because it is linked to adverse neurologic and reproductive effects (2,6,9,10).

Nail polish consists of ingredients such as film formers, plasticizers, thermoplastic resins, solvent-extenders, and pigments (6). Film formers are often composed of nitrocellulose and cellulose acetate butyrate. Plasticizers, such as camphor, triphenyl phosphate, trimethyl pentanyl diisobutyrate, and dibutyl phthalate (DBP), enhance adhesion and provide flexibility (6,7,11). Thermoplastic resin, tosylamide/epoxy resin, formalin, methylene glycol, and formaldehyde enhance adhesion while increasing gloss. Solvent extenders enable the nail varnish to remain in a liquid form and include ethyl acetate, isopropyl alcohol, butyl acetate, and toluene. The pigment component is highly variable and includes elements such as iron oxides, and mica (7,11).

During nail care procedures, the nail technician interacts closely with customers, with the nail care products within their breathing zone. Nail technicians are thus potentially exposed to chemicals that are associated with adverse health outcomes(12). The primary route of exposure is inhalation, although ingestion and dermal contact can also occur (9). An additional health hazard is UV light that is used to dry and harden products applied to nails. Exposure to UV light has been reported to have the potential to cause non-melanoma skin cancer, although studies regarding the carcinogenic risk of the use of UV nail lamps are controversial, and the evidence remains uncertain (9).

Informal nail salons are thriving in urban settings due to population growth and the increasing demand for services. Services procured through the informal sector are usually more affordable than those provided by the formal sector (13), which has added to their popularity and growth. The informal sector includes nail salons that operate without state registration or regulation, are typically self-owned or operate alongside other businesses like hair salons and have unpredictable working hours and fluctuating wages (2), while the formal sector comprises registered businesses with salaried employees and regulated working hours (2,14). Most of the nail technicians in the global informal sector are immigrants, with no higher or formal education, and

come from countries with poor economies (15). It is relatively easy to find employment in the informal sector because formal training and/or qualifications are not required, and skills can be learnt on the job (16). The lack of formal training, qualifications and poor English proficiency cause the nail technicians to struggle to fully understand the product labels, safety warnings and products provided by the manufacturers. This also puts informal nail technicians at risk of exposure to volatile organic compounds (VOCs) such as the 'toxic trio', and other chemicals such as pigments and resins emitted from the nail products (17).

In the USA, nail products used in the formal sector are governed by the Food and Drug Administration (FDA) and products are considered safe if used according to the instructions on the labels (18). In South Africa, they are governed by the Regulations Governing the Labelling, Advertising, and Composition of Cosmetics, (19), with the local authorities ensuring the enforcement of the Regulations. Informal nail technicians often use products that are not "approved" or regulated, which may pose health risks to both them and clients (7,20). When nail products are not labelled, nail technicians have no information about the contents of the nail products. Lack of knowledge about the nail products' contents contributes to incorrect handling and inadequate use of protective measures, increasing the risk of adverse health effects (7,21).

1.2 Literature review

1.2.1. Informal nail salon workers

Nail technicians often suffer from both short- and long-term health effects of exposures to chemicals in nail products, including damage to the central nervous system, respiratory issues, cancer, and disruption of the endocrine and reproductive systems (18,22). With the increasing move to online shopping, the use of imported nail products from countries where there are no stringent regulations regarding cosmetics potentially increases exposure to harmful ingredients (5).

It is widely assumed that exposure to chemicals contributes to nuanced understanding of the health effects (7). However, knowledge of exposure risks does not necessarily translate into effective prevention or reduction of exposure (18). This gap may be because safety protocols taught during formal training are often very different to what is practiced in settings such as nail salons (11).

1.2.2. Nail products used in the nail industry and their chemical contents.

Exposure assessment studies have been conducted in nail salons across the world, and air samples have consistently been found to contain several potentially hazardous VOCs (23). These include acetone, tolune, ethyl acetate, isopropyl alcohol, methyl acrylate, formaldehyde, MMA/EMA, and xylene(7,21). Although total exposure to these harmful chemicals is unavoidable for nail technicians, it can be reduced with the use of ventilation.

Researchers analysing air samples in nail salons in the US recommend the installation of local exhaust ventilation near the breathing zone to reduce harm from exposure (18). However, it has been shown that the general ventilation, especially ceiling exhaust ducts, increases the concentration of VOCs by more than 2.5 times, (22). The additive health effects of these chemical compounds, which are almost always present as mixtures in nail salons, are unknown (2,23–25).

1.2.3. Factors associated with exposure to chemicals in nail products

In a recent study in South Africa, several factors associated with exposure to chemicals in nail products were identified, including the number of clients serviced, the type and duration of the nail application conducted, and the type of nail treatments performed - especially where acetone is used to remove nail polish (2). Other VOCs such as ethanol and EMA contributed to overall chemical exposure.

A study in the USA showed that the size of the nail salon also plays a major role in exposure to VOCs (23). Poor ventilation, confined spaces, and prolonged exposure to multiple chemicals and tasks that require the use of chemical products near the nail technician’s breathing zone and eyes increase exposure and therefore the risk of adverse health effects (26,27) .

1.2.4. Health effects associated with exposure to chemicals in nail products

Exposure to VOCs may have severe health consequences (2,28). Studies have shown that formaldehyde is emitted at much higher concentrations than other chemicals in nail products (7,21,27). Overexposure to formaldehyde can cause cancer, coughing wheezing, and dermatitis after prolonged exposure (21,26). Overexposure to toluene can cause liver and kidney damage, irritation to the eyes, throat, and nose, and damage to the central nervous system, which, in turn, can cause memory loss (7,26).

Overexposure to dibutyl phthalate (DBP) has been linked to reproductive damage and irritation to the eyes, stomach, and upper respiratory system (12,26,28–30).

Another contributing factor to ill health is the use of cheap, poor quality nail products. It has been shown that the cheaper the nail product, the more harmful it is to human health (11).
Health risks are not limited to women, who make up the larger proportion of the nail technician workforce. A recent study showed that oral exposure to phthalates can reduce sperm count in men and is associated with reproductive defects in developing male foetuses (29).

In South Africa, there has been very little research on chemical exposures and work-related ill-health in the nail industry until recently(2). There is also very little information available on the knowledge and health and safety practices in the nail sector (7). Most studies have been conducted in developed countries, but the potential health risks to workers are understudied in informal nail technicians in developing countries. This might be because it is perceived that the concentrations of chemicals in nail products are relatively low compared to those in other industries(18).

1.3. Problem statement

Very little information is available on the knowledge and health and safety practices in the informal nail sector (7). This is because most of the nail technicians in this sector are not familiar with the risks associated with exposure to nail products that they use in the salons. They work long hours, which results in cumulative and prolonged exposure to chemicals, increasing the risk of adverse health effects. In addition, most nail technicians in the informal sector work in very close proximity to their customers, often in narrow and poorly ventilated spaces, which also increases their exposure to the chemicals in nail products (18).

1.4. Justification

To our knowledge, there are no published studies in South Africa that describe the knowledge of risks associated with exposure to chemical emissions from nail products, and practices to avoid exposure, in the informal nail sector. It is important to assess the knowledge and practices of nail technicians, given the growing informal nail sector.

The findings from this study may provide a basis for interventions to enhance our understanding of exposure to harmful chemicals and inform appropriate harm-reduction practices for informal nail technicians in South Africa. The findings may also contribute to the formulation of guidelines, policies and regulations for the safe usage of nail products. Collectively, these efforts have the potential to minimise exposure to hazardous chemicals amongst informal nail technicians and reduce the risk of associated health effects.

1.5. Study aim

To assess knowledge and practices associated with exposure to chemicals in to nail products among informal nail technicians in Braamfontein, South Africa, regarding chemical composition and associated health risks.

1.6. Objectives

i. To describe the knowledge and practices of informal nail technicians regarding the chemicals in the products they use.
ii. To identify factors (sex, age and work experience) that are associated with informal nail technicians' knowledge about these chemicals.
iii. To identify factors (sex, age and work experience, knowledge) that are associated with nail technicians' practice regarding the use of nail products.

CHAPTER 2 METHODS

The chapter describes the data collection tools and activities, including details about the study design, area and participants recruited for this analysis. The questionnaire and data collection methods are described, followed by a description of the generation of the knowledge and practice scores (data management). The chapter concludes with a description of the data analysis used to address each of the three objectives.

2.1. Study design

This was a cross-sectional analytical study conducted among informal nail technicians in Braamfontein, Johannesburg. Data were collected using a structured questionnaire designed to assess participants' knowledge and practices related to the use of nail products, as well as demographic and work-related factors.

2.2. Description of the study area

The study was conducted in informal nail salons located in Braamfontein, a central suburb in Johannesburg, South Africa, bordering the city centre and joined to Newtown by the famous Nelson Mandela Bridge. The area is populated mostly with students and young people as it is close to higher learning institutions such as the University of Witwatersrand and the University of Johannesburg. It also incorporates numerous restaurants and night clubs, and many formal and informal businesses operate in the area. There are many informal nail salons in Braamfontein, which are operated by both South Africans and foreign nationals (31).

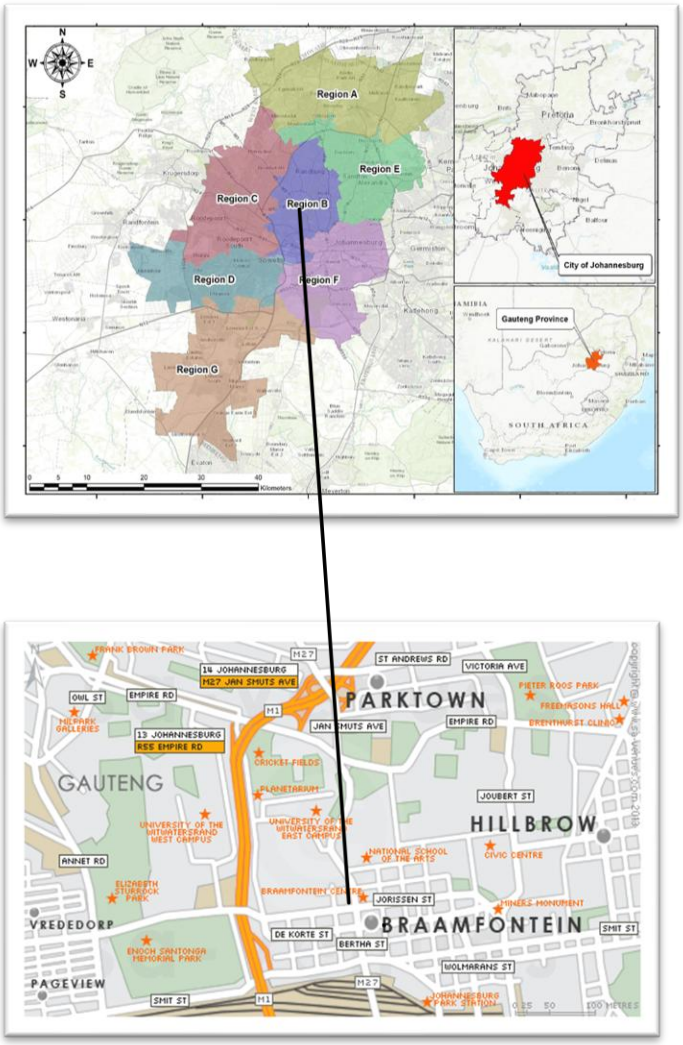


Figure 1. Map showing geographical location of study area

2.3. Study population

Initially, the study population comprised 60 informal nail technicians working in Braamfontein who had participated in a larger study on exposure to chemicals in nail products in the period January 2018 to May 2020 (2). This was expanded to include all informal nail technicians working in Braamfontein in June 2024. The nail technicians needed to have worked in the industry for at least one year and be 18 years or older to participate in the study. Nail technicians who performed hair and other cosmetic treatments, and those involved in other activities outside work that might have generated the release of solvents, were excluded.

2.4. Study participants

Participants were enrolled in two phases. In the first phase, the list of 60 informal nail technicians was obtained. All 60 participants were contacted but only 31 were available for this study. Ten had moved to formal nail salons outside of Gauteng, 15 declined to participate, and four could not be contacted telephonically. According to other nail technicians questioned, two of the four nail technicians had relocated to other countries, and two had passed away after the larger study was conducted.

In the second phase, an additional 29 participants were recruited from the informal nail salons in April 2024, using convenience sampling, bringing the total number of participants to 60. The nail technicians were selected from nail salons in the same area as those in the previous study.

2.5. Data collection tool

The data were collected using an English interviewer-administered questionnaire with close-ended questions (Annexure 1). The questionnaire was divided into sections related to: 1) demographic characteristics, 2) knowledge, 3) symptoms, and 4) practices. The questionnaire contained multiple-choice questions with single word answers (e.g. “yes” or” no”) and binary questions (e.g. “harmful” or” not harmful”). The questions were adapted from knowledge, attitude, and practices (KAP) questionnaires used in previous studies (4,12,32).

The symptoms section comprised seven questions aimed at assessing the symptoms experienced by nail technicians while working with nail products. It examined the frequency of these symptoms, how the study participants felt when away from work, whether they had ever sought treatment due to exposure, and if their symptoms persisted despite any treatment they might have received.

The knowledge section comprised 11 questions aimed at assessing informal nail technicians' awareness of risks, exposures, norms and standards within the nail product industry.

The practice section comprised 32 questions aimed at assessing the practices followed by nail technicians while they were servicing their clients. It covered the types of applications they performed, the frequency of these procedures, incidents of exposure to nail products, how the exposure occurred, and the measures taken to prevent exposure to nail products. Additionally, it assessed whether they had ever received occupational health and safety training regarding the products they used and the potential health risks.

2.6. Pilot testing of the data collection tool

The questionnaire was piloted on 10 informal nail technicians outside the study site to test the feasibility of the study and to check if the questions were clear and easily understood. These 10 respondents were not included in the study. Subsequently, some of the questions in the questionnaire were removed, while others were rephrased.

2.7. Data collection procedure

The 60 participants who had agreed, telephonically, to participate in the study were contacted and appointments were made to explain the study and get written consent for their participation. The purpose of the study was explained in detail, and their contact details were obtained. Data were collected by the researcher, using the interviewer-administered questionnaire described, in June 2024. Each interview took 30-45 minutes.

2.8. Data management and outcome ascertainment

The data from the questionnaires were captured in Microsoft Office Excel, after which they were cleaned. The total scores were calculated according to the method presented by (9).

Continuous data for the socio-demographic and work-related variables were categorised. Age was divided into 5-year categories. The number of clients serviced per day (1-4, 5-8, ≥9) and the number of hours spent servicing each client (2-4, 5-8, 9-12) were also divided into categories.

Symptoms

Each positive response to a symptom question was scored as one, the negative response was scored as zero, and the scores were summed. The criteria for assessing knowledge and practices were developed specifically for this study based on the structure of the questionnaire and informed by occupational health literature focusing on informal nail technicians. The scoring system was adapted from previous studies on chemical exposure and safety behaviors in salon environments and aligned with health recommendations from international bodies such as the WHO and OSHA. It was also refined to reflect the informal nature of nail salons in South Africa. A pilot test was conducted with a small group of informal nail technicians to ensure clarity and appropriateness of the questions and scoring system.

Knowledge

Knowledge questions assessed participants' understanding of the harmful effects of nail products, awareness of chemical ingredients, and familiarity with product labels. Correct responses were scored as one, while incorrect responses were scored as zero. For the question on whether nail products are harmful, responses were scored as follows: "Harmful" (correct) = three, "Not harmful" (incorrect) = two, and "Don't know" = one. The maximum possible score for knowledge was 11. Total scores were summed and categorised into two groups: high knowledge (scores of 8-11) and low knowledge (scores below 8).

Practice

The practice questions assessed both the use of protective measures and broader occupational practices among informal nail technicians. These included the application of nail products, responses to accidental exposure (e.g. skin contact, inhalation, or eye contact), cleaning and sterilisation procedures, and prior training related to occupational health and safety. Responses were scored according to the level of safety demonstrated. Safe or appropriate practices were awarded a score of three, less safe practices a score of two, and unsafe or uncertain responses a score of one. For frequency-based items, responses of "Always" or "Daily" were scored as three; "Sometimes" or "Weekly" as two; and "Never" or "Monthly" as one. The maximum possible practice score was 8, with participants categorised as having good practice (scores of 6-8) or poor practice (scores of 0).

The scoring system for symptoms, knowledge, and practices related to nail product use is shown in Table 1. Scores were assigned based on the level of health risk awareness and safety behaviours, with higher scores indicating greater risk perception or safer practices. This framework supports quantitative analysis of participants' responses.

Table 1. Scoring system for symptoms, knowledge, and practices related to nail product use.

Component	Question	Response	Score
Symptoms	Have you experienced any symptoms (e.g. headache, dizziness, coughing, skin irritation) since working with nail products	Yes	1
		No	0
Knowledge	How harmful do you think nail products are to your health?	Harmful	3
		Not harmful	2
		Don't know	1
	Do you think nail products are safe for use?	Yes	1
		No	0
Practices	Have any of the products been in contact with your skin?	Yes	3
		No	2
		Uncertain	1
	Have you ever read the label, including instructions for use of any of the nail products? If yes, which ones?	Always	1
		Sometimes	2
		Never	3
	How often do you perform the nail applications?	Daily	1
		Weekly	2
		Monthly	3

2.9. Data analysis

The data were analysed using STATA 18 and Microsoft Excel, version 16.1. The demographic and work-related variables were age, education level, work experience, number of clients seen, and number of hours worked daily. These data are summarised as frequencies and means and standard deviations.

Objective 1: To describe the knowledge and practices of informal nail technicians about the chemicals in the products they use. Descriptive statistics were used to analyse the data. Frequencies, percentages, means, standard deviations, and interquartile ranges are presented.

Objective 2: To identify independent factors (e.g. sex, age, work experience, and educational level) that are associated with knowledge among informal nail salons. Multivariable logistic regression analysis was used to analyse this. Knowledge was scored and categorised as either good or poor. Variables were selected for inclusion in the multivariable model based on findings from previous studies and logical reasoning. Additionally, variables with a p-value less than 0.20 in the bivariate analysis were considered for inclusion The significance level was set at 0.05.

Objective 3: To identify independent factors (e.g. sex, age, work experience, and educational level) that are associated with practices among informal nail salons. Multivariable logistic regression analysis was used to analyse this. Practice was scored and categorised as either good or poor. Variables were selected for inclusion in the multivariable model based on findings from previous studies and logical reasoning. Additionally, variables with a p-value less than 0.20 in the bivariate analysis were considered for inclusion. The significance level was set at 0.05.

2.10. Ethical considerations

Ethics clearance for the study was obtained from the University of the Witwatersrand Human Research Ethics Committee (HREC), Medical prior to data collection (Certificate no. M240116 M240606-B-0001, Annexure 4). The purpose of the study was explained to the study participants, and the information leaflet was provided. Copies of the information leaflet and informed consent are contained in annexures 3 and 4. Confidentiality was maintained throughout the interview, and only participant numbers were used on the questionnaires.

CHAPTER 3 RESULTS

In this chapter, the results of the analysis of the data collected through questionnaires administered to nail technicians working in nail salons in Braamfontein, Johannesburg are presented. The socio-demographic and work-related characteristics of the study participants are summarised, followed by the symptoms experienced by the nail technicians. The results of the multivariable logistic regression analyses, examining the relationships between socio-demographic factors and both knowledge and practices related to the use of harmful nail products are provided.

3.1. Demographic characteristics

Most of the study participants were women (n=40, 66.7%) as shown in Table 2: Demographic and work-related characteristics of study participants. Most were aged 35 to 39 years (n=17, 28.3%); the mean age was 33 ± 6.6 years. Half of the study participants had a tertiary education (n=30, 50.0%). Work experience in the nail industry ranged from 1 to 15 years. Most of the study participants reported that they served between five to eight clients per day (n=39, 65.0%). Each client took a mean of 2.2 ± 1.0 hours to serve.

Table 2. Demographic and work-related characteristics of study participants (N=60)

Characteristic	n	%
Sex		
Male	20	33.3
Female	40	66.7
Age (years)		
18-24	4	6.7
25-29	11	18.3
30-34	16	26.7
35-39	17	28.3
≥40	8	13.3
Missing	4	6.7
Education		
None	4	6.7
Primary	5	8.3
Secondary	21	35.0
Tertiary	30	50.0
Work experience (years)		
1-2	14	23.3
3-5	14	23.3
6-9	20	33.3
10-15	12	19.9
Number of clients seen daily		
1-4	19	31.7
5-8	39	65.0
≥9	2	3.3
Number of working hours daily		
2-4	6	10.0
5-8	27	45.0
9-12	27	45.0

3.2. Symptoms

Numbers and percentages of symptoms reported by the study participants are shown in Table 3: Work related symptoms of study participants (N=60). Twenty-two (36.7%) participants reported experiencing symptoms associated with exposure to nail products, with headache being the most frequently reported symptom (n=17, 28.3%). Fourteen (23.2%) of the nail technicians said that they had received treatment after experiencing such symptoms.

Table 3. Work related symptoms of study participants (N=60)

Question/symptom	n	%
Any ill health experienced since working with nail products?		
No	29	48.3
Yes	22	36.7
Missing	9	15.0
Symptoms		
Headache	17	28.3
Eye irritation	10	16.7
Allergy	8	13.3
Skin irritation	7	11.7
Burn	6	10.0
Itching	4	6.7
Nausea	3	5.0
Eczema	3	5.0
Yellow discolouration of nails	2	3.3
Ever treated for symptom(s)		
No	17	28.3
Yes	14	23.3

3.3. Knowledge and practice

Most of the participants (n=40, 66.7%) were scored as having poor knowledge about the nail products they used. Fewer (n=20, 33.3%) were scored as having a high knowledge. Most of the study participants followed good practices (n=47, 78.3%) while performing procedures; practices were poor for 13 (21.7 %).

Table 4. Study participants' knowledge and practice scores, regarding chemicals in nail products (N=60)

Knowledge score	**n**	**%**
Low (0-7)	40	66.7
High (8-11)	20	33.3
Practice score	**n**	**%**
Low (0-5)	13	21.7
High (6-8)	47	78.3

Age was associated with knowledge in the unadjusted model (p = 0.021), but not in the adjusted model (p = 0.237), as shown in Table 5: Association between knowledge scores and socio-demographic and work characteristics (N=60). The OR of 1.14 implies that, for every one-unit increase of age (years), the odds of having higher knowledge scores increased by 14%. However, this association was no longer statistically significant when other factors were adjusted for in the regression model. For each additional year of age, the odds of having higher knowledge increased by 1.08, the 95% confidence interval (0.95 to 1.24) includes 1, indicating that the observed effect could be due to random variation. Although there was a slight positive trend, suggesting that older individuals might have higher knowledge scores, the evidence is not strong enough to conclude that age had a meaningful impact on knowledge.

Similarly, there was a statistically significant negative relationship between work experience and knowledge in the unadjusted model (p = 0.025), implying that each additional year of work experience decreased the odds of higher knowledge scores by 19%. This association was not statistically significant in the adjusted model (p=0.174). Sex was not significantly associated with knowledge scores in either the unadjusted model (p= 0.889) or the adjusted model (p = 0.659). Similarly, education (unadjusted OR, p = 0.753; adjusted OR, p = 0.871), number of clients seen daily (unadjusted OR,

p = 0.483; adjusted OR, p = 0.707), and number of working hours daily (unadjusted OR, p = 0.458; adjusted OR, p = 0.993) were not significantly associated with knowledge.

Age was not significantly associated with practice scores in either the bivariate model (p = 0.159) or the multivariate model (p = 0.273), as shown in Table 6: Association between practice scores and socio-demographic and work characteristics (N=60). Sex (unadjusted OR, p = 0.334; adjusted OR, p = 0.514), education (unadjusted OR, p = 0.491; adjusted OR, p = 0.575), work experience (unadjusted OR, p = 0.252; adjusted OR , p = 0.920), number of clients seen daily (unadjusted OR, =0.958, adjusted OR, p = 0.768), and number of working hours daily (unadjusted OR, p = 0.970; adjusted OR, p = 0.904) were not significantly associated with practice. Although there were slight trends suggesting that older individuals might have slightly higher practice scores, the evidence was not strong enough to conclude that any of the variables had a meaningful impact on practices.

Table 5. Association between knowledge, socio-demographic and work characteristics (N=60)

Variable	Unadjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Sex --Male --Female	0.90	0.19 – 4.30	0.889	1.43	0.28 – 7.30	0.659
Age (per year increase)	1.14	1.02 – 1.26	0.021	1.08	0.95 – 1.24	0.237
Education	0.87	0.37 – 2.05	0.753	0.93	0.39 – 2.21	0.871
Work experience (years)	0.81	0.67 – 0.97	0.025	0.85	0.66 – 1.08	0.174
Number of clients seen daily	1.15	0.78 – 1.70	0.483	0.92	0.60 – 1.41	0.707
Number of working hours daily	1.13	0.82 – 1.56	0.458	1.00	0.71 – 1.41	0.993

Table 6. Association between practice, socio-demographic and work characteristics (N=60)

Variable	Unadjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Sex (Female vs Male)	1.47	0.31 – 4.08	0.334	0.74	0.30 – 1.84	0.514
Age	1.04	0.98 – 1.11	0.159	1.04	0.97 – 1.12	0.273
Education	3.16	0.75 – 1.80	0.491	1.14	0.71 – 1.85	0.575
Work experience (years)	0.94	0.85 – 1.04	0.252	1.01	0.88 – 1.15	0.920
Number of clients seen daily	0.99	0.82 – 1.23	0.958	0.97	0.76 – 1.22	0.768
Number of working hours daily	1.00	0.85 – 1.18	0.970	1.01	0.84 – 1.23	0.904

CHAPTER 4 DISCUSSION

This chapter interprets the study findings in relation to the objectives, highlighting patterns in knowledge and practices of informal nail technicians regarding chemical hazards. It discusses possible explanations, compares findings with previous studies, notes study limitations, and considers implications for occupational health interventions and future research.

4.1. Overall findings

The informal nail technicians that participated in this study generally demonstrated limited knowledge of chemical hazards but reported relatively good safety practices. Despite this, a high proportion experienced symptoms linked to chemical exposures, suggesting that current exposure control measures may not be fully protective. No significant associations were observed between socio-demographic or work-related factors and knowledge or practices.

4.2. Socio-demographic profile of participants

Most of the study participants were female, as expected, since the beauty industry comprises mainly women (18). Half of the participants had tertiary education, showing that higher education does not necessarily lead individuals away from informal employment. This might also be related to the high unemployment rate amongst graduates in South Africa (33). A third of the study participants had been in the industry for six to nine years, reflecting a considerable level of expertise. The variability in the number of clients seen daily may be influenced by factors such as service efficiency, pricing strategies, or customer demand. The combination of industry experience and a relatively high level of education may influence their service quality, health and safety awareness and business sustainability. Moreover, variations in workload, influenced by the socio-demographic characteristics of the participants such as age, education and work experience could impact productivity, income stability and increase the risk of occupational health issues within the sector.

4.3. Knowledge and practice

Knowledge about the products used and their potential to cause ill health was poor, which could be due to limited formal training. Other studies have found that knowledge of the additive health effects of these chemical compounds, which are ubiquitous in formulations of nail products in salons, is limited (2,23,25,32).

The unadjusted analysis indicated that older nail technicians were more knowledgeable than younger technicians about the use of nail products, health risks, and safety practices, as indicated by the study's findings. However, the association between age and knowledge was not statistically significant in the adjusted regression model. This might have been due to the small sample size, as other studies have found that older workers are more knowledgeable about their working environment, including understanding potential hazards, using products safely, and applying best practices. In contrast, the lack of statistical significance in this study suggests that, although a slight positive trend was observed, age may not be a strong determinant of knowledge in this context. The findings could also reflect other underlying factors, such as access to training or differences in work experience, that may play a more substantial role in shaping knowledge levels among nail technicians.

Most of the study participants scored high in practice (n=47, 78.3%) indicating that they tended to follow practices that align with expected industry standards. However, given the lack of regulation in South Africa's nail industry, the validity of the reports about compliance with these standards should be questioned. It is vital that personal protective equipment is used in nail salons. While the study did not explicitly measure the use of PPE, it likely touches on the broader concern that informal nail technicians may not always have access to or be aware of the necessity of protective gear, contributing to increased health hazards. Emerging data shows that exposure to these chemicals endangers the health of nail technicians and severity is profound when appropriate personal protective equipment (PPE) is not used (4,9,20,26,34).

There were no statistically significant associations between participants' demographic and work-related characteristics and practices. It is possible that the small sample size lacked statistical power to detect a significant association.

A qualitative study in a group of Vietnamese migrant nail practitioners working for more than 10 years in the US, identified the lack of continued education opportunities and found that many of the skills learnt during their vocational education/training were not maintained (11). This knowledge gap can be mediated by business owners conducting routine upskilling and training, improving the knowledge and practices of nail technicians. Parallel activities for employees, such as monitoring trends on social media and subscribing to industry news, will assist nail technicians to stay updated on the latest safety practices, chemical usage, and regulations in the industry and on industry norms.

4.4. Limitations of the study

It is possible that this study was affected by social desirability bias - nail technicians may not have been entirely truthful in terms of their response data on knowledge and practices regarding the nail products they use. This may be attributed to contextual factors within the salon environment, including the pressure to maintain a professional image and to demonstrate confidence and expertise. The results are unlikely to be generalisable beyond the study area (Braamfontein) due to the limited population available to participate in the study.

4.5. Recommendations

The findings of this study highlight several areas requiring targeted intervention to enhance occupational health and safety among informal nail technicians. Given the limited regulation in this sector, and the potential risks associated with chemical exposure, it is critical to implement evidence-based strategies that are both accessible and contextually appropriate. The following recommendations are proposed to guide policymakers, health authorities, and industry stakeholders in improving working conditions and promoting safer practices within informal nail salons:

1. **Expand research to diverse settings**

   Future studies should be conducted in smaller towns, townships, and rural communities to determine whether informal nail technicians in these areas share similar knowledge and practices about chemical exposure as those in urban areas.

2. **Implement ongoing training programmes**

   Accessible and ongoing health and safety training should be introduced for informal nail technicians. These programmes should cover correct chemical handling, use of personal protective equipment (PPE), and strategies to reduce harmful exposures in the workplace.

3. **Improve access to PPE in informal settings**

   Efforts should be made to ensure that informal nail technicians have reliable access to appropriate PPE. Business owners and salon operators should take responsibility for providing these essential resources to protect worker health.

4. **Develop awareness campaign and industry collaboration**

   Collaborative awareness campaigns, involving health organisations, local authorities, and industry stakeholders should be launched to educate informal nail technicians on chemical safety. Standardised safety protocols and materials should be co-developed to promote safer practices across the sector.

CHAPTER 5 CONCLUSION

This study is one of the first in South Africa to describe knowledge and practices associated with exposure to nail products among informal nail technicians. Most of the participants were female, with a mean age of 33 years, and half had tertiary educations. While the average knowledge score was low (33.3%), the average practice score was high (78.3%). This suggests that, although many technicians lacked a full understanding of chemical risks, they followed safety measures, showing a disconnect between knowledge and practice.

Factors associated with knowledge and practice were also identified. Although age was positively associated with knowledge, and work experience was negatively associated with knowledge in the unadjusted analyses, the associations were not statistically significant after adjustment. Nor were there any significant associations between sex, age, work experience, and knowledge and safety practices.

By describing the levels of knowledge and practice, and examining how sex, age, work experience, and knowledge relate to each, the study successfully met all three objectives, even though no associations were identified. These findings highlight the need for targeted health and safety education for informal nail technicians, especially to improve understanding of chemical risks, even where good safety practices already exist.

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ANNEXURE 1: QUESTIONNAIRE

Date:

Knowledge and practices associated with exposure to nail products among informal nail technicians in Braamfontein, South Africa.

All the information provided will remain confidential.

DEMOGRAPHIC INFORMATION				
1. Participant number:				
2. Age:				
3. Sex				
4. Highest level of education	No formal	Primary	Secondary	Tertiary
5. Current job title:				
6. When did you start working in this current job? (date)				
7. What was your previous job/s?				
8. How many clients do you see daily, on average?				
9. How many hours do you work on average, in a day?				

KNOWLEDGE			
Question	Yes	No	Don't know
1. Do you think the nail products are safe for use?			
2. Does curing gel nails under UV light correlate to cancer?			
3. Is "acetone" dangerous?			
4. Is formaldehyde carcinogenic?			
5. Some nail polish contains toxic chemicals known as "toxic trio". Do you know the toxic trio contained in the nail products?			
6. Is nail polish application during pregnancy harmful?			
7. Is nail polish application during breastfeeding harmful?			
8. Some nail polishes contain dibutyl phthalate classified as an endocrine disruptor			
9. Do vapours from nail products cause respiratory problems?			
10. Can one be exposed to nail chemicals contained in nail products through direct handling or skin contact?			

11. How harmful do you think these nail products are to your health?	harmful	Not harmful	Don't know

Nail polish			
Nail polish remover			
Liquid and powder acrylic			
UV gel			
Primer			
Nail tips glue			
Artificial nail tips remover			
Other:			

SYMPTOMS			
1. Have you suffered any ill health since working with nail products?	Yes	No	
2. If yes, which ill-health symptoms have you suffered from?			
Eye irritation			
Skin irritation			
Itching			
Allergy			
Burn			
Headache			
Nausea			
Yellow discoloration of the nails			
Eczema			
3. How often do you experience the ill-health symptoms?			
4. Do the ill health symptoms get better when you are away from work?	Yes	No	Never
5. Have you received medical treatment for these symptoms? If yes, what medical treatment?	Yes	No	Never
6. Do you still experience the symptoms?	Yes	No	Uncertain
7. How often?			

PRACTICES					
1. What type of nail applications do you perform?					
2. Have you ever read the label, including instructions for use of any of the nail products? If yes, which ones?	always	sometimes	Never		
3. How often do you perform the nail applications?	Daily		Weekly	Monthly	
4. Have any of the products been in contact with your skin?	Yes		No	Uncertain	
5. How did the contact happen?	Spillage		Direct contact	Accidental	
6. What do or would you do if the nail products meet your skin?					
7. Have you ever inhaled nail products?	Yes		No	Uncertain	
8. What do/would you do if you inhale the nail products?					
9. Have the nail products ever got into your eyes?	Yes		No	Uncertain	
10. Have you received Occupational Health and Safety training regarding your job as a nail technician?			Yes	No	
11. If yes, how long ago was the training given?					
12. Have you received any form of training on the health effects of these products?	Yes		No		
13. If yes, how long was the training given?					
14. Do you use any protection during the nail application procedure to prevent exposure?		Yes		No	
15. If yes, why?					
16. If yes, what type of protection do you use?					
17. If no, why not?					
18. Do you disinfect your workspace when attending to clients?	Yes		No		
19. If yes, how often?					
20. If no, why not?					
21. Do you sterilize your work equipment?	Yes		No		

22. If yes, how do you sterilize the equipment?		
23. If yes, how often?		
24. If no, why not?		
25. Do you sanitize your clients' hands?	Yes	No
26. If yes, how often?		
27. Do you sanitize your clients' feet?	Yes	No
28. Did you participate in the previous study?	Yes	No
29. Did the study improve your knowledge?	Yes	No
30. If yes, please elaborate further		
31. Did the study influence your practice?	Yes	No
32. If yes, please elaborate further		



ANNEXURE 2: INFORMATION LEAFLET

Good day my name is Frengy Mmamogopodi, and I am a Master of Science in Medicine (field of Exposure Science) student at the University of the Witwatersrand, Johannesburg. As part of my studies, I must undertake a research project, under the supervision of Dr Goitsemang Keretetse and Professor Gill Nelson. The title of my chosen research project is to assess the knowledge, attitudes, and practices among informal nail technicians regarding risks associated with exposure to nail product chemicals in Braamfontein, South Africa.

As part of this project, I would like to invite you to answer some questions about demographic information, knowledge, symptoms, and practices. This will take around 30 minutes.

There will be no personal costs to you if you participate in this project, you will not receive any direct benefits, but there are no disadvantages or penalties if you do not choose to participate or if you withdraw from the study after agreeing to participate. You may withdraw at any time or not answer any question if you do not want to. The administration of the questionnaire will be completely confidential and anonymous as I will not be asking for your name or any identifying information. The information you give to me will be held securely and not disclosed to anyone else. I will be using a participant number to represent your participation in my research. The data collected from this research project will be stored in a secure area within the university. With your permission, the data collected from this research project may be used by other researchers in an anonymized format.

If you experience any distress or discomfort at any point in this process, I will stop administering the questionnaire or resume another time. If you have any questions during or after this research, feel free to contact me, using the details listed below.

This study will be written as a research report which will be available online through the university library website. If you wish to receive a summary of this report, I will be happy to send it to you.

If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Medical) chair through his secretary, Ms Zanele Ndlovu.
Email: zanele.ndlovu@wits.ac.za or 011 717 1252/2700.

Yours sincerely,
Researcher: Frengy Mmamogopodi
frengyoratile@gmail.com
Supervisors:
Dr Goitsemang Keretetse
Email: goitsemang.keretetse@wits.ac.za
Prof. Gill Nelson
Email:Gill.Nelson@wits.ac.za



ANNEXURE 3: CONSENT FORM

PARTICIPANT:

I have read this consent form and have been given the chance to ask questions. I agree to participate in this research described above, titled:

Knowledge and practices associated with exposure among the informal nail technicians in Braamfontein, Johannesburg, South Africa.

- I have also received, read, and understood the Information Leaflet.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the University of the Witwatersrand, or on their behalf.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) consent to participate in this study.

Participant:

Signature / Mark or Thumbprint	**Date and Time**

Researcher:

Signature / Mark or Thumbprint	**Date and Time**

WITS UNIVERSITY

ANNEXURE 4: ETHICAL CLEARANCE



UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Mrs Frengy Mmamogopodi

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M240116 M240606-B-0001

NAME: (Principal Investigator)	Mrs Frengy Mmamogopodi **DEGREE:** MSc
DEPARTMENT:	Faculty of Health Sciences Occupational Health Division
TITLE:	*Knowledge and practices associated with exposure to nail products among informal nail technicians in Braamfontein, South Africa*
DATE CONSIDERED:	26/01/2024
DECISION:	Approved unconditionally
CONDITIONS:	
NOTE:	HREC (Medical) Application Number: MED23-05-018
SUPERVISOR:	Prof G. Nelson and Dr G. Keretetse
APPROVED BY:	Mrs M. Van Niekerk, Co-Chairperson, HREC (Medical)
DATE OF APPROVAL:	06/06/2024 **EXPIRY DATE:** 06/06/2029

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATOR(S)

I/we fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report** in the month date of convened meeting each year until study is closed. Failure to submit annual report will result in ethics clearance certificate suspension. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. Unreported changes to the application may invalidate the clearance given by the HREC (Medical). Login to upload signed copy of this ethics clearance certificate prior to commencing with the study https://www.witsethics.co.za/login.aspx. Email a signed copy of ethics clearance certificate to HREC-Medical.ResearchOffice@wits.ac.za.

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

WITS UNIVERSITY

ANNEXURE 5: TURNITIN REPORT

1497230:Frengy_mmamogopodi_Msc_Protocol_draft_1497230_.

ORIGINALITY REPORT

Supervisor: Goitsemang Keretetse

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