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ORIGINAL RESEARCH

Non-Combustible Source Indoor Air Pollutants Concentration in Beauty Salons and Associated Self-Reported Health Problems Among the Beauty Salon Workers

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Background: Cosmetic products emits Total Volatile Organic Compound (TVOC) and Particulate Matter with an aerodynamic diameter of 10 micrometers (PM_{10}) of different sizes and characteristics with adverse health effects. Despite the increasing need for cosmetic products, related pollutants level of concentration from beauty salon is not well understood in developing countries.

Objective: This study aims to assess indoor air pollutant concentrations in the beauty salon and self-reported health problems among the salon workers in Jimma town.

Methods: A cross-sectional study design was used on 87 beauty salons from May 13–24, 2019. The concentrations of $PM_{10,}$ TVOCs, CO_2, room temperature, and relative humidity were measured and triangulated with the survey data collected through measurements and questionnaires. A statistical software package, SPSS v.21, was used to analyze the data. A binary logistic regression was used to analyze categorical data and linear regressions to predict pollutants level and associated health outcomes.

Results: The results show that 93.1% of the respondents are females, and 85% were below 30 years old. More than 60% of the respondents were married individuals. 56.3% and 44.8% of the workers work over 10 hours per day and work the whole week. 34.6% of the workers reported as worked during pregnancy. About 70% of the workers know the harmful effects of cosmetics, benefits of ventilation, and Personal Protective Equipment (PPE) use, but only 19.4% use face masks. The majority (88.5%) reported health problems after starting work in the beauty salon. The mean volume of the beauty salon was 36.3 $m^{3,}$ with a mean PM_{10} concentration of 0.465 mg/m^3 and a mean TVOC concentration of 1034.2 $\mu g/m^3$. These air pollutants have shown a statistically significant association with self-reported health problems. Hence, urgent intervention with subsequent continuous awareness creation is needed to reduce the health consequences of a beauty salon's indoor air pollutants.

Keywords: indoor air pollutants, cosmetic products, PM_{10}, TVOCs, beauty salon, Jimma town, Ethiopia

Introduction

A beauty salon is a workplace for providing service of different cosmetology practices. The salon offers artificial nailing, hairstyling, shampooing, permanent waving, cutting, curling, coloring, highlighting, straightening, and hair.[1] These services are provided by using different cosmetic products such as solvents, glues, hardeners, hair sprays, etc. The cosmetic products may contain potentially

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hazardous chemicals like volatile organic compounds such as aromatics, esters, ketones, odorous terpenes, camphor, and ammonium.[2,3] The substances are emitted and remain in the beauty salon's indoor air environments during the services.[4,5]

The interaction of cosmetic based volatile organic compounds such as hydrocarbons, alcohols, esters, phenols, and acid with indoor particle matter increases the concentration and strength of particulate matter in the beauty salon.[6] Besides, the types and number of services offered and the application of cosmetics in beauty salons exert much more significant effects on the concentration level of indoor particulate matter, Volatile organic compounds (VOCs), and carbon dioxide (CO_2).[6,7] TVOCs are indoor air pollutants mostly produced at high concentrations in the beauty salon[2,8] with a concentration level of up to 3600 mg/m^3.[9] Indoor particulate matter of different aerodynamic sizes (PM_{10} and $PM_{2.5}$) is also one of the most harmful air pollutants with many health effects.[10,11] Particulate matter consists of liquid droplets and solid fragments smaller than 10 µm suspended in the air, whose size, chemical composition, and shape are varied.[6,12]

The presence of a high concentration of CO_2, particulate matter, and TVOC in the indoor beauty salon affects the comfort, health, and productivity of beauty salon workers.[2,13] The concentration of these pollutants and comfort parameters in the beauty salon is affected by the type, number, and frequency of the services.[7,14,15] The Occupational health and indoor air quality problem in the beauty salon is evident because of toxic chemicals' generation to indoor air that harms workers and customers.[6,9] Some studies have reported the association of TVOC released in the beauty salons with skin problems, respiratory disorders, carcinogenicity, reproductive and genotoxic effects.[16,17] Different studies reported eye, nose, throat, lung, and skin problems from beauty salon workers.[14,18,19] It was also reported that workers in beauty salons are exposed to various physical, chemical, biological hazards, and psychosocial stresses that can affect their health.[18] The high prevalence of respiratory symptoms among nail salon workers was also reported with a likely association with nail care products.[3,13] Evidence also shows the association of particulate matter to cardiovascular and respiratory health problems[20,21] among workers working in the low ai quality beauty salon.[6,13]

Total volatile organic compounds are a total sum amount of all TVOCs in the air, and its measurement is sufficient for evaluating indoor air quality. They are essential compounds to indicate the beauty salon quality since most personal care products contain volatile organic compounds. The study shows toluene, xylene, esters and ketones, odorous terpenes, and camphor as the main volatile organic compounds in the beauty salons.[7] Workers are likely exposed to high concentrations of a mixture of volatile organic compounds at levels that can cause symptoms or discomfort. Nevertheless, TVOC's concentration level in the beauty salon can be affected by the number of services, room ventilation, the number and type of products.[2,8,18]

The health risk assessment showed that benzene, formaldehyde, and acetaldehyde represent a possible cancer risk in the beauty salons.[14] Prenatal exposure to volatile organic compounds also affects fetal development and adversely influences infants' life;[22] thus, exposure during pregnancy may affect infants' development after birth. Carbon dioxide (CO_2) is primarily a by-product of human metabolism emitted from customers and workers in the beauty salon. CO_2 does not directly cause severe health effects. Still, it indicates the salon's indoor air quality and the associated rate of air exchanges.[7,23] Hence, the salon's volume is significant to reduce the beauty salon's crowdedness with customers and workers and the level of concentration of CO_2 and other pollutants in the room.[24] Room temperature and humidity are also critical in maintaining good indoor air quality (IAQ).[25,26] Temperature and relative humidity contribute to increasing air pollutants concentrations because of holding air pollutants.[27] The release of indoor air pollutants, including TVOCs, depends on temperature and humidity's combined effects. High relative humidity (water vapor) would prevent TVOCs from absorbed by the surface of particles, dust, or residential objects. The level of adsorption and solubility of TVOCs with other particulate matter depends on the combined effects of the room temperature and relative humidity.[28]

Cosmetic products are widely used in daily life. Cosmetics are mixtures of substances placed on the human body's external parts to clean, perfume, protect, change appearance, or keep body parts in good condition. Cosmetic product uses are increasing worldwide, including in developing countries.[29,30] These products are overly promoted without providing sufficient information on their use and side effects. As a result, most users are triggered

by words and tones of promotion and use without having adequate information about its use and side effects. Lack of sufficient information affects the exposure level of people to the chemicals found in cosmetics products. Children and pregnant women are mostly at high risk of exposure due to the work's nature, mostly involving women and the presence of children with their mothers at work.[22]

Nevertheless, most of the studies on indoor air pollutant concentration in developing countries mainly focus on biomass energy-based emissions.[31,32] Cosmetic based indoor air pollutant studies are rarely available despite the increasing use of cosmetic products in developing countries. This study aims to assess the concentration of cosmetic-based indoor air pollutants and associated self-reported health problems among beauty salon workers in Jimma town. The finding is essential to control beauty salon-based air pollutant concentration and related health problems and create awareness.

Methodology

Study Area, Period, and Population

A cross-sectional study was conducted from May 13–24, 2019, on beauty salons available in Jimma town. Jimma town is located 354 km from Addis Ababa, Ethiopia. It is found at an altitude of 1700m above sea level with an average annual temperature range of 11°C and 29°C with an average relative humidity of 67%. Currently, an estimated 200,000 people are living in the town. The town has about 119 women's beauty salons, of which 87 were selected for this study. The selection of the beauty salons for the survey was made based on the locations. Accordingly, beauty salons attached or located nearer to the garage, furniture work, and other business areas with a potential TVOC emission were excluded from the study to avoid cross-pollution.

Data Collection and Analysis

The data involves a direct survey of beauty salon workers and indoor air pollutant concentration measurements. The survey data was obtained by using a semi-structured interview-based questionnaire prepared for this purpose. The survey questionnaires contain questions about the respondents' socio-demographic characteristics, housing condition, type of services, and perception of the workers about cosmetics, working time, and workers' experiences in the beauty salon. The questionnaire was prepared in the English language and translated to local languages Afaan Oromo and Amharic and translated back to English to ensure the consistency and clarity of the questions. The data was collected by four trained data collectors having a bachelor's degree in Environmental health. The study was conducted in accordance with the declaration of Helsinki 2013. Hence, an ethical clearance approval letter was obtained from Jimma University institute of health Institutional Review Board (IRB) and written informed consent from respondents was taken prior to data collection. In addition, the study participants have assured the confidentiality of their information and the right not to give information during data collection if they opt to do. The data was obtained from the head of the beauty salon or representative expected to work for a long time in the salon. Accordingly, the information was obtained from 87 individuals available at the salon during the data collection.

Measurement of indoor air pollutants concentration considered Total Volatile Organic Compounds (TVOC), CO_2, PM_{10}, temperature, and relative humidity. Measurements of pollutants in the beauty salons were taken at the height of 1.5 meters above floor level, a human breathing zone, and 1 meter from windows and doors based on.[14,33] Measurement of TVOC and CO_2 was conducted using AEROQUAL series 500; Aeroqual Limited, Auckland, New Zealand. The sampler is an easy-to-use with different interchangeable portable sensor for various pollutants concentration measurements. According to the manufacturer's procedure, the sampler was calibrated at a flow rate of 0.03 m^3/h (0.5 L/min). The Sampler uses a photoionization detector (PID) and non-dispersive infrared (NDIR) sensor for TVOCs and CO_2, respectively. Measurement of each pollutant was made with a 2-minutes logging interval time continuously for six minutes, and the average value within this time interval was recorded for an hour. PM_{10} measurement was made using a micro-dust aerosol monitoring system (Pro 880 nm, Casella Cel, UK) continuously for 6 minutes within a logging time of 1 second for an hour. The sampler presents maximum and average measurement values within a specified time. All measured pollutants concentration was presented as instant value uniformly expected to occur during the working hours. The instant measurements were made between 11 am and 5 pm, assumed to be peak working hours. Measurements of indoor air temperature (T) and relative humidity (Rh) were conducted by using a Thermo hygrometer (CAAL model 303C; Asun Test Ltd., Shenzhen, China). The instrument can measure

relative humidity (Rh) within the range of 10–95% and temperature (T) within −20 – 40°C. All devices used for the measurements were calibrated and checked for their correctness before actual measurements. The measurements were made by well-qualified professionals experienced in the field.

The survey data was processed and analyzed using SPSS v. 23 at a statistical significance level of 95% and the margin of error of 5%. Descriptive frequencies were used to summarize categorical variables with mean and standard deviation values. The strength of the association between dependent and independent variables with continuous nature was tested with multiple linear regression models. Variables with categorical values were tested with logistic regression by adjusting its confidence interval at 95%. The data quality was assured by conducting a pre-test of the questionnaire on 5% of the population in another town. All measurements and survey data were supervised daily by a well-qualified supervisor. All the raw data were entered into Epidata version 3.1 and transferred to SPSS for analysis.

Results

Socio-Demographic Characteristics

The socio-demographic characteristics of the study participants were described in Table 1. Accordingly, most of the respondents were females 81 (93.1%), and 74 (85%) were below the age of 30, with a mean age of 26.69 ± 6.0 years. More than 60% of the respondents were married individuals potentially at work during pregnancy or with their child. A large proportion (64.4%) of the respondents had completed secondary school education, followed by 27.6% having a college and above educational training.

Table 1 Socio-Demographic Characteristics of the Respondents (N=87)

Category	Description	Frequency (%)
Age	Less than 20	7 (8)
	21–25	40(46)
	26–30	27(31)
	31–35	9(10.3)
	Above 35	4(4.6)
Sex	Male	6(6.9)
	Female	81(93.1)
Educational level	Less than grade 8	7(8.0)
	Grade 9–12	56(64.4)
	Above grade 12	24(27.6)
Marital status	Married	53 (60.9)
	Unmarried	34 (39.1)

The Occupational History of the Beauty Salon Workers

Work experiences of the beauty salon workers are presented in Table 2. As shown in the results, the majority (56.3%) of the workers work over 10 hours per day, followed by 25 (28.7%) working between 8–10 hours with a mean of 10.47 ± 1.8 hours per day. With these long working hours, 39 (44.8%) work the whole week without rest, followed by 40 (46%) workers working six days per week. Moreover, 28 (34.6%) workers worked during pregnancy, of which 23 (82.2%) of them had used the whole pregnancy time.

Knowledge and Practice of the Workers Towards the Use of Cosmetics

The level of exposure of workers and customers to cosmetic-based indoor air pollutants is affected by several factors. Workers' perception and subsequent practice on cosmetics' uses determine the level of pollutant concentration and exposure. When workers are aware of their health, they open windows and doors to ventilate the room or use any ventilation mechanism to refresh the room. However, about 44 (50.6%) of the workers do not know as all chemicals have health effects if inappropriately used. As a result, 15 (17.2%) do not know the health effects of exposure to

Table 2 Occupational History of the Workers at the Beauty Salon

	Description	Frequency	Percent	Mean ±SD
Working hours per day	Less than 8 hours	13	14.9	10.47 ± 1.8
	8–10 hours	25	28.7	
	Above 10 hours	49	56.3	
Working days per week	5 days	8	9.2	6.36 ± 0.65
	6 days	40	46.0	
	7 days	39	44.8	
Work experiences	1–3 years	47	54.0	3.68 ± 2.17
	3–6 years	30	34.5	
	Above six years	10	11.5	
Did you work during pregnancy?	Yes	28	34.6	
	No	53	65.4	
How long did you work during pregnancy?	Second trimester	5	17.8	
	Third trimester	23	82.2	
Did you keep your child with you during working?		15	17.2	

cosmetics products on pregnant women and children. This implies that they likely work during pregnancy and keep their child at the salon during working. The knowledge of workers towards cosmetics use and related health effects are presented in Table 3. As shown in the results, on average, about 70% of the workers know the harmful effects of cosmetics, benefits of ventilation, and PPE use. For instance, 81 (93.1%) and 76 (87.4%) know about the dilution effects of ventilation on cosmetics and the importance of PPE use to prevent exposure.

Moreover, 72 (82.8%) of the workers use personal protective equipment (Table 4). However, most of the PPE used by the workers are gloves and gowns, which are less important to prevent entrances of the pollutants into the body. Only 14 (19.4%) of the workers reported PPE to use respirators or face masks.

Self-Reported Health Problems

The self-reported health problems of the beauty salon workers are presented in Table 5. Accordingly, 77 (88.5%) of the respondents reported health problems after starting work in a beauty salon. Most workers (92.2%) reported skin problems, followed by respiratory problems by 89.6%. Eye problems, headache, fatigue, nausea, kidney problems, loss of appetite, and backpain are also among the significant health problems reported by beauty salon workers.

Personal Care Services Provided in the Studied Beauty Salons

Beauty salon services are provided based on the requests from the customers. The demand from the customers has been attributed to the need for personal care services. In most cases, customers request complete services such as hair, body, nail services, or specific services. Each service is provided with different cosmetics products. Cosmetic products used for various services in the studied beauty salons are presented in Table 6. The cosmetics products used in the beauty salons ranges from 5–14 different types of cosmetics products. The survey identified about 14 different cosmetics products available for hair care services, followed by 12 different body care products. All the cosmetics products have specific chemical, physical character, and function to provide specific intended services.

Table 4 Use of Personal Protective Equipment Among Beauty Salon Workers

Do You Use PPE?		Yes (%)	No (%)	Total (%)
		72(82.8)	15(17.2)	87(100)
Types of PPE	Glove	67(93.1)	5(6.9)	72(100)
	Respirator	14(19.4)	58(80.6)	
	Gown	58(80.6)	14(19.4)	
	Goggle	2(2.8)	70(97.2)	

The Characteristics of the Beauty Salon

The beauty salons' volume varies widely from less than 20 to above 80 $m^{3,}$ with a majority (41.4%) in the range of 20–40 m^3 (Figure 1). The mean volume of the salon was 36.3 ± 28.5 m^3. The majority (57.5%) of the beauty salons used natural ventilation like windows and doors, and only 7 (8%) used artificial ventilation systems like air conditioners. Among all salons using natural ventilation, 31 (62%) use cross-ventilation, 19 (38%) use a parallel ventilation approach. Nevertheless, 37 (42.5%) of the beauty salon did not have any ventilation system. In general, 31 (35.6%) of the beauty salon has a cross-ventilation that can permit good entrance and outdoor air movement (Table 7).

Air Pollutants Concentration in the Beauty Salons

Instant pollutant concentration measurements were shown in Table 8. Accordingly, the instant concentration of the PM_{10} µm aerodynamic diameter ranges from less than 0.25 mg/m^3 to

Table 3 Knowledge of Beauty Salon Workers Towards Cosmetics Use and Related Health Effects (N=87)

	Knowledge Questions	Yes (%)	No (%)
1	All chemicals have human health effects	43(49.4)	44(50.6)
2	The use of cosmetics in the presence of children have health effects	72(82.8)	15(17.2)
3	The use of cosmetics has a health effect on pregnancy	72(82.8)	15(17.2)
4	Ventilation has a dilution effect on the concentration of pollutants	81(93.1)	6(6.9)
5	Use of PPE prevent exposure to cosmetics-based pollutants	76(87.4)	11(12.6)
6	All cosmetics contain chemicals that can harm human health	59(67.8)	28(32.2)
7	Applying cosmetics in an indoor environment affects human health	72(82.7)	15(17.3)

Table 5 Self-Reported Health Problems Among Beauty Salon Workers

		Yes (%)	No (%)	Total (%)
Are there any health problems during working?		77(88.5)	10(11.5)	87(100)
Self-reported health problems	Skin problems	71(92.2)	6(7.8)	77(100)
	Respiratory problems	69(89.6)	8(10.4)	
	Eye problem	64(83.1)	13(16.9)	
	Headache	67(87)	10(13)	
	Fatigue	51(66.2)	26(33.8)	
	Nausea	37(48)	40(52)	
	Kidney problems	43(58.8)	34(44.2)	
	Nail problems	45(58.4)	32(41.6)	
	Back pain	66(85.7)	11(14.3)	
	Loss of appetite	46(59.7)	31(40.3)	

over 1.25 mg/m^3 with a mean level of concentration of 0.465 ± 0.34 mg/m^3. Total volatile organic matter concentration varies from less than 750 mg/m^3 to over 1500 mg/m^3 with a mean value of 1034.18 ± 299.9mg/m^3. The beauty salon's carbon dioxide concentration varies from 750–2000 mg/m^3 with a mean value of 1280.92 ± 264 mg/m3. The salon rooms' measured temperature varies from 20 °C to over 30 °C with a mean temperature of 26.359 ± 2.2 ºC and a mean relative humidity of 54.48 ± 5.3%.

Association of Self-Reported Health Problems with PPE and Indoor Air Pollutants Concentrations

The results on the association of self-reported health problems and Personal Protective Equipment (PPE) use are presented in Table 9. The results show that those who are not using PPE are more likely exposed to respiratory issues about five times, skin problems more than four times, and eye and nail problems more than six times than those using PPE. The results also presented the statistically significant association of self-reported health problems with the concentration of indoor air pollutants and related working conditions (Table 10). Respiratory and eye problems were shown a statistically significant association with the concentration of indoor air pollutants. Besides, fatigue and back pain have shown a statistically significant association with long working hours and days.

Discussion

This study assessed the beauty salon's indoor air pollutants concentration and workers' working and health conditions. As shown in the results, over 90% of the workers are females and less than 35 years (Table 1). They are in the reproductive age group expected to be pregnant and have children; thus, exposing them and their fetuses to indoor air pollutants will have significant health consequences. As women are in charge of all household activities and child-care, they likely keep their children with them. It has been shown in the results that 28 (34.6%) of the women reported as they work during pregnancy, of which 23 (82.2%) of them worked during the whole pregnancy time (Table 2). Exposing a fetus and child to these toxic pollutants at an early age can significantly affect their development and survival. A handful of literature reported the health effects of cosmetics-based indoor air pollutants on mothers and children.[24,34–36]

Moreover, 49 (56.3%) of the respondents reported over 10 hours of working per day. Besides, 39 (44.8%) of the respondents work the whole week without any rest. Longer working hours and days can have substantial health consequences. This is also evident with the results shown in Table 4. Over 60% of the respondents reported fatigue, headache, nausea, back pain, and appetite loss, which could be associated with longer working hours

Table 6 Type of Services Provided and Cosmetics Products Used in Beauty Salons (N=87)

Types of Services	Types of Cosmetic Products	Remarks
Hairdressing	Different hair treatments Hair spray, glues, oil, and dye Hair coloring, lotion, and gel	The services are provided in all the beauty salons
Nail care products	Nail Polish and hardeners Nail polish and glue remover	
Body care and makeup	Facial cleaners, powder, cake Different body creams, lotions, and oils	

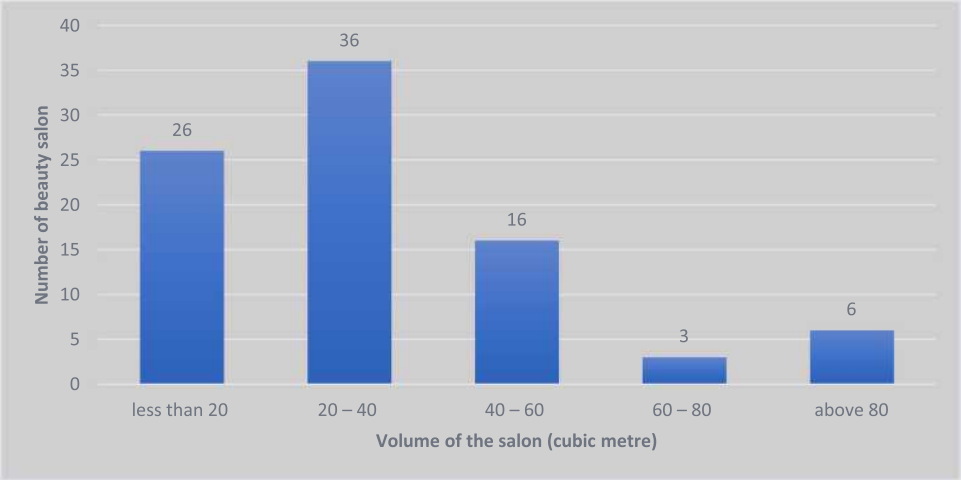

Figure 1 Volume of the beauty salons.

and days. This was further proved with the statistically significant association presented in Table 9, where weekly working days likely increased fatigue and back pain occurrence over two times.

The studied beauty salons provide hairdressing, hair dying, body and nail care services. These services are provided with different cosmetics products of varying chemical and physical compositions. Most of these cosmetic products contain aromatic and volatile compounds efficiently emitted to the environment or absorbed into the skin during use. Personal care products are mostly applied to human skin, eyes, lips, mucus, and hairs, increasing human systemic exposure. Although different studies reported the shortage of evidence of these personal care products' carcinogenicity and reproductive toxicity, they still emphasized the need for safety concerns.[37,38]

Further carcinogenic risk reduction measures involving the use of gloves by pregnant women, working no more than 35 hours per week, and avoidance of standing for a prolonged time and adequate ventilation was recommended.[38] However, only 82.8% of the respondents use PPE, of which respiratory risk reduction PPE use only accounts for 19.4% (Table 4). This means that over 80% of the respondents, including working pregnant women, are under systemic exposure risk.

Table 7 Beauty Salon Conditions of Ventilations

	Ventilation System	Yes (%)	No (%)
Does the salon have ventilation?	Artificial ventilation Natural ventilation	7(8) 50(57.5)	80(92) 37(42.5)
Types of natural ventilation	Cross Parallel	31(62) 19(38)	

Moreover, the characteristics of the beauty salon and the workers' perception are the main determinants affecting the concentration of indoor air pollutants resulting from personal care products. The results show that 41.4% of the salon has a volume ranging between 20–40 m^3 (Figure 1). However, 42.5% of the beauty salon did not have any ventilation system, and only 35.6% of the salons have cross ventilation that permits good entrance and movement of outdoor air (Table 2). Moreover, on average, over 30% of the respondents did not have sufficient knowledge of the health effects of personal care products and the importance of appropriate ventilation to reduce the risk of exposure (Table 3). Lack of sufficient space and ventilation in the salon, and insufficient knowledge can increase indoor air pollutant concentration. This study reported a mean concentration 0.465 mg/m^3 PM_{10}, 1034.18 $\mu g/m^3$ TVOC and 1280.92 mg/m^3 CO_2. Most workers are exposed to these pollutants for over 10 hours per day and seven days per week. Studies reported that exposure to TVOC and Particulate matter has significant respiratory health problems.[19,39,40] The association of TVOC exposure to kidney dysfunction was also reported.[41]

The absence of sufficient ventilators could contribute to the increase of indoor air pollutants. The study reports the effect of inadequate ventilation in the beauty salon on the level of pollutants' concentration.[8] They reported that salons with adequate ventilation have a low concentration of TVOC and vice versa. The concentration of carbon

Table 8 Levels of the Indoor Air Pollutants Concentrations of the Beauty Salon (N=87)

Pollutants	Category	Frequency	Percent	Mean +SD
Average concentration of PM_{10} (mg/m^3)	Less than 0.500 0.500–1.00 Above 1.00	57 22 8	65.5 25.3 9.2	0.465 ± 0.34
Total volatile organic matter concentration ($\mu g/m^3$)	Less than 750 750–1000.00 1000.0–1250 Above 1250	11 41 18 17	12.6 47.1 20.7 19.5	1034.18 ± 299.9
Carbon dioxide concentration (mg/m^3)	Less than 1000 1000–1500 Above 1500	14 58 15	16.1 66.6 17.2	1280.92 ± 264
Room temperature (°C)	20–25 25–30 Above 30	21 60 6	24.1 69.0 6.9	26.359 ± 2.2
Relative humidity (%)	40–50 50–60 60–70	18 58 11	20.7 66.7 12.6	54.48 ± 5.3

dioxide and relative humidity also serves as indicators of indoor air quality. Increased carbon dioxide concentration is associated with the level of room crowding and low ventilation system.

Moreover, high humidity relates to high pollutant concentration due to the probability of pollutant adsorption by dense air. The study shows a positive correlation between PM_{10} concentration and TVOC with relative humidity.[13,42] Moreover, types of cosmetics products and activities in the beauty salon impact the level of pollutants' concentration and characteristics.[6]

TVOC is a known type of pollutant due to the variety of cosmetics products used in the salon, which contains volatile compounds. The mean concentration of average TVOC in this study was 1034.18 ± 299 (Mean ± SD) $\mu g/m^3$, which is greater than the human comfort level of TVOC ($200\mu g/m^3$).[43,44] All the measured indoor pollutants concentrations (PM_{10}, TVOC, and CO_2) in this study are above the recommended Indoor Air Quality (IAQ) standards of different countries and World Health Organizations (WHO).[45] The concentration of PM_{10}, TVOC, and CO_2 in the current study is very high compared to different study findings.[13,17] Lack of adequate ventilation and salon size could significantly contribute to the presence of a high concentration of indoor air pollutants having significant health consequences on the workers and customers. This is also evident with the current results that self-reported respiratory problems and eye problems have shown statistically significant association with the concentration of particulate matter, TVOC, and carbon dioxide (Table 10).

Table 9 Association of PPE Use with Self-Reported Health Problems of the Salon Workers

PPE Use	B	Sig.	Exp(B)	95% C.I. for Exp(B)	
				Lower	Upper
Respiratory	1.579	0.010	4.852	1.461	16.118
Skin problems	1.419	0.024	4.133	1.208	14.143
Eye problems	1.827	0.003	6.214	1.897	20.355
Nail problems	1.723	0.012	5.600	1.453	21.583

Table 10 Association of Indoor Air Pollutants Concentration with Self-Reported Health Problems

Health Problems	Predictors	Unstandardized B	Sig.
Respiratory problems	TVOC	1.245	0.000
	PM_{10}	1.128	0.000
	CO_2	1.400	0.000
	RH	1.222	0.009
Eye problems	TVOC	1.294	0.000
	PM_{10}	1.199	0.000
	CO_2	1.281	0.000
Fatigue on workers	Weekly working days	2.444	0.000
	Daily working hours	1.02	0.003
	Relative humidity	1.534	0.007
	Room temperature	1.529	0.021
Back pain	Weekly working days	2.211	0.000

Exposing women in the reproductive age group and pregnant women to such toxic indoor air pollutants have many policy implications. One of the sustainable development goals (SDG 3) is to ensure healthy lives and promote well-being for all ages.[46] Moreover, this goal has given due emphasis to achieve a significant reduction in mother and child death. It also targets the reduction of deaths and illnesses related to exposure to hazardous chemicals in the air. Without reducing the concentration of indoor air pollutants and preventing their exposure, achieving these targets cannot be possible. The promotion of productive employment and safe and secure working environments is also one of the goals (SDG 8) to be achieved by 2030. Hence, improving their working environment and working time is crucial to improving their livelihood and productivity. Because in this study, participants reported that they were forced to work more than 10 hours per day and more than six days per week (Table 2).

Conclusion

Beauty salons are one of the potential areas for non-combustible sources of indoor air pollutant emission. Beauty salons use different cosmetic products to meet the cosmetic needs of the customers. The cosmetic products contain various volatile organic compounds with a potential adverse health effect. This study determined a mean concentration of 0.465 mg/m^3 of PM_{10}, 1034.18 µg/m^3 of TVOC, and 1280.92 mg/m^3 of CO_2. All these concentrations are above the IAQ standards, which could have adverse human health effects. Self-reported health problems reported in this study include respiratory, skin, eyes, and other health problems.

Moreover, the beauty salon services are mostly provided by women of the reproductive age groups. All of the current study respondents are in early reproductive age groups, and some worked during pregnancy. The majority of these workers do not have adequate knowledge and do not use personal protective equipment at work. These groups are exposed to high concentration TVOC for more than 10 hours per day and six days per week. Moreover, the results show a statistically significant association of self-reported health problems with indoor air pollutants concentration and PPE use. Hence, urgent intervention with subsequent continuous awareness creation is needed to reduce the health consequences of beauty salon-based indoor air pollutants.

Disclosure

The authors report no conflicts of interest for this work.

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