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 (PM10) 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 PM10, TVOCs, CO2, 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 m3 with a mean PM10 concentration of 0.465 mg/m3 and a mean TVOC concentration of 1034.2 µg/m3. 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, PM10, 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. These services are provided by using different cosmetic products such as solvents, glues, hardeners, hair sprays, etc. The cosmetic products may contain potentially...
hazardous chemicals like volatile organic compounds such as aromatics, esters, ketones, odororous 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 (CO₂).6,7 TVOCs are indoor air pollutants mostly produced at high concentrations in the beauty salon7,8 with a concentration level of up to 3600 mg/m³.9 Indoor particulate matter of different aerodynamic sizes (PM₁₀ and PM₂.₅) 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 CO₂, 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 problems20,21 among workers working in the low air 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, odororous 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 (CO₂) is primarily a by-product of human metabolism emitted from customers and workers in the beauty salon. CO₂ 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 CO₂ 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 Afan 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), CO₂, PM₁₀, 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 CO₂ was conducted using AEROGRAHR 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 m³/h (0.5 L/ min). The Sampler uses a photoionization detector (PID) and non-dispersive infrared (NDIR) sensor for TVOCs and CO₂, 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. PM₁₀ 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.

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 all chemicals have health effects if inappropriately used. As a result, 15 (17.2%) do not know the health effects of exposure to

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        | 66 (72.4)     |
|                   | Female      | 21 (25.7)     |
| Educational level | Less than grade 8 | 7 (8.0)     |
|                   | Grade 9–12 | 56 (66.4)     |
|                   | Above grade 12 | 24 (27.6) |
| Marital status    | Married     | 53 (60.9)     |
|                   | Unmarried   | 34 (39.1)     |

Table 2 Occupational History of the Workers at the Beauty Salon

| Description                  | Frequency | Percent | Mean ± SSD |
|------------------------------|-----------|---------|------------|
| 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 back pain 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** | **Respirator** | **Gown** | **Goggle** |
| 67(93.1) | 14(19.4) | 58(80.6) | 2(2.8) |
| | | | | |
| | | | | |

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 | Yes (%) | No (%) | Total (%) |
|-------------------------------|---------|--------|-----------|
| Skin problems                 | 71(92.2)| 6(7.8) | 77(100)   |
| Respiratory problems          | 69(89.6)| 8(10.4)| 77(100)   |
| 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 ± 299.9 mg/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/m$^3$. The salon rooms’ measured temperature varies from 20°C to over 30°C with a mean temperature of 26.359 ± 2.2°C and a mean relative humidity of 54.48 ± 5.3%.

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 |         |
| Nail care products| Nail Polish and hardeners |         |
|                   | Nail polish and glue remover |         |
| Body care and makeup | Facial cleaners, powder, cake | The services are provided in all the beauty salons |
|                   | Different body creams, lotions, and oils |         |
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 dyeing, 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.

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 m³ (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/m³ PM₁₀, 1034.18 µg/m³ TVOC and 1280.92 mg/m³ CO₂. 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 7 Beauty Salon Conditions of Ventilations

| Does the salon have ventilation? | Ventilation System | Yes (%) | No (%) |
|----------------------------------|-------------------|---------|--------|
| Artificial ventilation          | Natural ventilation | 7(8) | 50(37.5) |
|                                  |                    | 80(92) | 37(42.5) |
| Types of natural ventilation    | Cross              | 31(62) |        |
|                                  | Parallel           | 19(38) |        |
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                 | 57        | 65.5    | 0.465 ± 0.34 |
|                                         | 0.500–1.00                      | 22        | 25.3    |          |
|                                         | Above 1.00                      | 8         | 9.2     |          |
| Total volatile organic matter concentration (µg/m$^3$) | Less than 750                  | 11        | 12.6    | 1034.18 ± 299.9 |
|                                         | 750–1000.00                     | 41        | 47.1    |          |
|                                         | 1000.0–1250                     | 18        | 20.7    |          |
|                                         | Above 1250                      | 17        | 19.5    |          |
| Carbon dioxide concentration (mg/m$^3$)   | Less than 1000                  | 14        | 16.1    | 1280.92 ± 264  |
|                                         | 1000–1500                       | 58        | 66.6    |          |
|                                         | Above 1500                      | 15        | 17.2    |          |
| Room temperature (°C)                    | 20–25                           | 21        | 24.1    | 26.359 ± 2.2   |
|                                         | 25–30                           | 60        | 69.0    |          |
|                                         | Above 30                        | 6         | 6.9     |          |
| Relative humidity (%)                    | 40–50                           | 18        | 20.7    | 54.48 ± 5.3   |
|                                         | 50–60                           | 58        | 66.7    |          |
|                                         | 60–70                           | 11        | 12.6    |          |

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. Moreover, types of cosmetics products and activities in the beauty salon impact the level of pollutants’ concentration and characteristics.

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) µg/m$^3$, which is greater than the human comfort level of TVOC (200µg/m$^3$). 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). The concentration of PM$_{10}$, TVOC, and CO$_2$ in the current study is very high compared to different study findings. 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 | 1.294 | 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/m³ of PM₁₀, 1034.18 μg/m³ of TVOC, and 1280.92 mg/m³ of CO₂. 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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