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Indoor Air Quality of Beauty Salons in Commercial and Residential Areas of Camp, Abeokuta, Ogun State, Nigeria

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Abstract Growing increase of beauty salons and exposure to associated chemical substances present serious concern of chemical hazards and health problems. This study assessed indoor air quality (IAQ) of selected beauty salons in commercial and residential areas of Camp settlement in Abeokuta, Ogun State, Nigeria using Aeroqual GasSensing Monitor and WindMate® Weather Station. Human thermal sensation (HTS) was computed using Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD) Indices. Data collected were subjected to descriptive and inferential statistics. Findings showed TVOC exceeded permissible exposure limit (0.2 mg/m^3) in all salons and critical safe level (2500 ppm) for CO_2 was exceeded in one-third. Exceedance was observed in less than one-third of salons for $P.M_{2.5}$ and $P.M_{10}$, due to varying activities taking place per time, and location differences. Where detected, H_2S was below permissible limit (1.4 mg/m^3). HTS was above the acceptable thermal comfort levels (PMV: ±0.5; PPD: <10%) in all salons. Generally, the IAQ indicates prevalence of inadequate ventilation, and portends increased exposure risk to hazardous chemical substances associated with salon activities. Therefore, formulation of policy, stipulating minimum operating standards and enforcement, alongside enlightenment campaign are necessary to promote human safety and prevent escalation of chemical related hazards in salons.

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Globally, studies have shown the surge in beauty salon businesses, particularly in the last decade, as evidenced by increasing gainful employment of millions of people either as cosmetologists, hairdressers or stylists, with rising overall revenues by operators and governments alike (Kaikiti *et al.,* 2022). The chemical products of beauty salon include shampoos, chemical relaxers, hair dyes, hair treatment or hair conditioners, bleaching powders, hair spray, cleansing lotion etc. (Maifadi *et al.,* 2022) and contain phthalates, carbon monoxide, methacrylates, m-aminophenol, toluene-2, 5-diamine, p-benzenediamine, p-toluenediamine, potassium persulphate ethanol, ammonia volatile solvents, propellants, aerosol formaldehyde and other Volatile Organic Compounds (VOCs), which are emitted into the indoor air while being used in the salons (Baghani *et al.,* 2018). Previous studies have shown that exposure to these chemicals could cause eye and respiratory irritations, birth defects (Loius *et al.,* 2021), premature death (Adesina *et al.,* 2022), and VOCs have been linked to eye, lung and throat diseases (Liu *et al.,* 2021). Considering that this activity takes place in an enclosed environment, exposure to these aerosolized emissions suggests high risk of respiratory allergy, especially without the use of any protective material. Salon workers are susceptible to developing respiratory problems

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compared to the general population (Dalton *et al.,* 2022). Exposure to chemicals (acetone, toluene, ethyl acetate, methyl mercury and formaldehyde) and emerging airborne microplastic contaminants being emitted at the nail filing and polishing section in beauty salons could trigger respiratory, skin and eye irritations (Lamplugh *et al.,* 2019; Chen *et al.,* 2022). Chemical aerosols such as VOCs and particulate matter (Baghani *et al.,* 2018) and pathogenic biological agents such as viruses, bacteria, fungi and yeasts conveyed through bodily fluids (Mancini *et al.,* 2018) that could impact human health and trigger the development of diseases are also released from other beauty enhancing treatments. Therefore, monitoring of indoor air quality of salons is essential for the occupational safety of operators and users. Besides the highlighted potential health risk implications, indoor air quality (IAQ) of salons and associable comfort levels are important determinants of productivity (Ana *et al.,* 2019). Beauty salon operation is not a duly regulated business venture in Nigeria and as a result, any individual can decide to commence the business at will. This has paved way for a fair mix of educated and not well- educated persons in beauty salon operations, which could be responsible for the low appreciation of risk and lack of awareness of the potential health hazard associated with their job (Lamplugh *et al.*, 2019; Kezic *et al.*, 2022). Again, studies on salons' indoor air quality in developing countries such as Nigeria is limited. Therefore, the objective of this study was focused on monitoring the indoor air quality (IAQ) of selected beauty salons in commercial and residential areas of Camp settlement in Abeokuta, Ogun State, Nigeria.

MATERIALS AND METHOD

Study area: This study was conducted on 15 Beauty salons in the Alabata area of Odeda Local Government area in Abeokuta city, Ogun State, Nigeria. The neighbourhoods were stratified into two (2) main groups (commercial, residential) based on population strength and activity type as gathered during reconnaissance survey. Fifteen (15) out of the 42 beauty salons identified were selected using systematic random sampling method. The assessment was carried out within the Camp area of Odeda local government in the Abeokuta metropolis. The area was chosen based on its importance of bearing three major federal tertiaty institutions (Federal University of Agriculture, Abeokuta, Ogun-Osun River Basin Authority and the Federal College of Education Osiele) with a large chunk of budding youths, which has opened up large scale development in the area. Informed consent to voluntarily participate in the research was obtained from the owers of the beauty salons used for this study.

Abeokuta is an agelong city and the capital of Ogun State, that is located in the south-western part of Nigeria on Longitude 3°17'5" - 3°25'39" E and latitude 7°06'20" - 7°12'21" N. The city covers four of the Municipal Government Areas of Ogun State namely; Obafemi/Owode, Abeokuta north, Abeokuta south and Odeda municipal government areas. The city is located within the humid tropical region with a mean annual rainfall of 1090.5 mm (Oguntoke and Yussuf, 2008). Odeda Local Government had an estimated population of 109,449 (NBS, 2006). Traditionally, farming was the occupation of the people due to high fertile soil profile of the region, but the increasing industrial development and establishment of various tertiary institutions have led to the emergence of other forms of landuses and other artisanal activities such weldering, carpentery, hairstyling etc. Its geographical location makes it easily accessible from Lagos, the industrial capital of Nigeria and the nation's major seaport. The map of the study area is presented in Figure 1.

Table 1: Typology of beauty salons used for this study

SN	Code	Floor Space Area	Ventilation	Occupancy	Window Area
1	THC	$8.8m^2$	1 window	8	$0.8m^2$
2	BS	$5.6m^2$	1 window	5	$0.52m^2$
3	EUS	$6.4m^2$	1window	7	$0.6m^2$
4	WB	$1.9m^2$	1 window, 1 fan	5	$0.42m^2$
5	CUS	$3.3m^2$	1window, 1 fan	13	$0.8m^2$
6	SHQ	$10.1m^2$	1window	4	$0.54m^2$
7	YGB	$3.2m^2$	1window, 1fan	11	$0.76m^2$
8	CHC	$2.3m^2$	1window	7	$0.4m^2$
9	HMD	$3.6m^2$	1window	9	$0.8m^2$
10	OHB	$4.9m^2$	1 window	7	$0.42m^2$
11	DS	$10.1m^2$	1 window	9	$0.56m^2$
12	HB	$9.4m^2$	2 windows, 1 fan	14	$0.7m^2$
13	CTS	$13.3m^2$	2 windows	11	$0.4m^2$
14	SG	$6.1m^2$	1window	7	$0.4m^2$
15	NKT	$7.8m^2$	1 window	8	$0.8m^2$

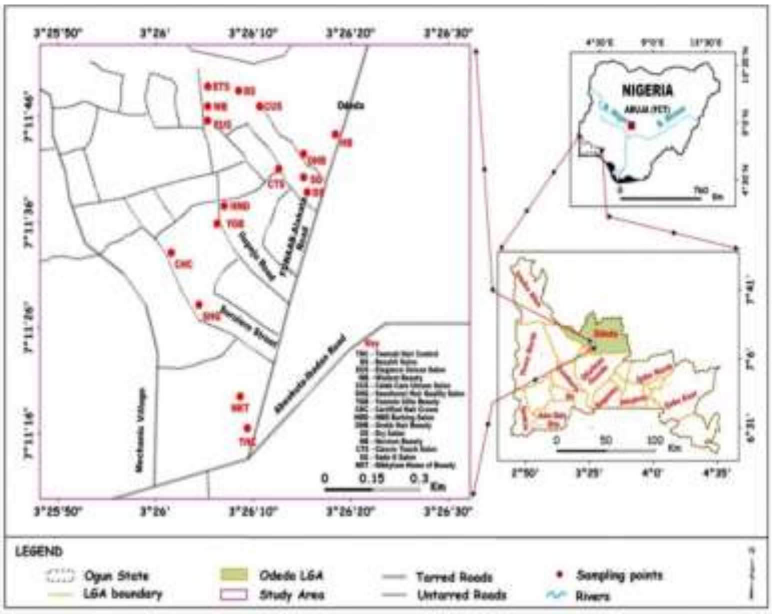

Fig 1: Map showing the Study Area

Measurement of Air Quality: Indoor air quality measurements were carried out between September and November 2019. Measurements were carried out for a period of three months, once per month. The measurements were carried out twice per time (10.00AM and 3.00PM) for representation and avoidance of underestimation of indoor air environment (WHO, 2020). The air parameters (gaseous and particulate matter) were measured with passive techniques using an Aeroqual GasSensing Monitor (Model: Series 300, Aeroqual, New Zealand), with up-to-date calibration. To minimise error, each reading was composited at four different points (cardinal directions) to arrive at a mean value for each sampling location per time, and lasted an average of 40 minutes per location. The instrument re-zeroed once it was switched off to insert another sensor head to take another measurement. Measurement of gaseous parameters were in "ppm" and converted to "mg/m^3" using equation 1, except for CO_2. Wind Mate (Model: Series WM-300, Speedtech, United State of America) was used in obtaining meteorological parameters; temperature and relative humidity, and air velocity. The Aeroqual GasSensing Monitor has a dedicated sensor per parameter. The instrument was held vertically at about 1.2 m above ground level (Oguntoke *et al.*, 2019), average height of breathing zone, above the ground level, and at the centre of the beauty salons, at least 1.5 m away from window(s) and door (WHO, 2020; Licina & Langer, 2021), to take measurements. Concentrations of gaseous parameters VOCs (mg/m^3), H_2S (mg/m^3) and CO_2 (ppm) and particulate matter ($PM_{2.5}$ and PM_{10}) (µg/m^3) were determined by interchangeably inserting sensor heads on the base monitor, and allowing the required warming time before actual measurement. Average values of the data were quantified and used. Additionally, information on types of ventilation systems and availability of Personal Protective Equipment (PPEs) in the salons were captured using a checklist. Table 2 presents the specifications of Aeroqual GasSensing Monitor and Wind Mate weather station.

Table 2: Specifications for Aeroqual sensor heads and Wind Mate weather station

Parameter	Detection range	Accuracy	Response time (s)	Resolution
VOCs	0 – 500 mg/m^3	<±5 + 10%	30	1.0
H_2S	0 – 10 mg/m^3	<±0.05 + <±10%	30	0.1
CO_2	0 – 5000 ppm	<±20 + 5%	120	1.0
$PM_{2.5}$ & PM_{10}	1 – 1000 µg/m^3	<±20 + 15%	5	1.0
Temperature	-29 – 70 ºC	±2 ºC	60	
Relative humidity	20 - 80%	±6%	60	
Air velocity	0.35 - 3.79 m/s	±3%	1	

$$Ymg/m^3 = ppm\,(MW)\frac{Xppm\,(MW)}{24.45} \quad (1)$$

Where, Y = value in mg/m^3, X = value is ppm, WM = the molecular weight of X

Table 3: Permissible guidelines for measured parameters

Parameter	PEL	Exposure time (hour)	Reference
TVOC	0.2 mg/m^3	8	U.S. EPA, 1996
CO_2	5000 ppm	8	OSHA, 2012
H_2S	1.4 mg/m^3	8	ACGIH, 2022
$P.M_{2.5}$	15 $\mu g/m^3$	24	WHO, 2022
$P.M_{10}$	45 $\mu g/m^3$	24	WHO, 2022

PEL = Permissible Exposure Limit

Predicted Mean Vote (PMV) Index: Predicted Mean Vote (PMV) Index is a concept developed by Fanger P. O. in 1970, and has since undergone numerous modifications, to determine the level of human comfort and safety with respect to human thermal sensation and satisfaction in indoor environment, using comfort equation (equation 1) (Shaw, 1972). The equation is expressed using six main parameters, four quantifiable factors (air temperature, mean radiant temperature, relative humidity and air velocity) and two assumed variables (metabolism rate and clothing insulation), to determine PMV (Han *et al.,* 2014; Alfano *et al.,* 2016). The value derived from the PMV equation is considered the thermal sensation of the target indoor environment (Gilani *et al.,* 2015). Therefore, the level of thermal sensation in relation to human comfort level is determined by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHREA) seven thermal sensation scale with the annotations cold (-3); cool (-2); slightly cool (-1); neutral (0); slightly warm (+1); warm (+2); hot (+3).

Additionally, Predicted Percentage of Dissatisfied (PPD), which denotes the acceptable range of thermal condition for human occupancy, is estimated from the relationship with PMV established by ASHREA standard 55 and International Organisation for Standardization (ISO) standard 7730. PPD is measured in percent and ranges from 5% (0 PMV) to 100% (-3 or +3 PMV). ASHREA 55 sets the thermal limit to less than <10% dissatisfied occupants, which corresponds to -0.5 to +0.5. ISO 7730 maintains the same thermal limit for new buildings and <15% thermal limit for old buildings corresponding to -0.7 to +7 (Gilani *et al.,* 2015).

$$PMV = \left(0.303 * exp^{(-0.036*M)} + 0.028\right) * (Ta - Tmrt) + 0.42 * (Va - 0.1) * (Ta + 273) - 3.96 * 10^{(-8)} * (Ta + 273)^{(4)} - fcl * \left(hc - 3.05 * 10^{(-3)} * (5733 - 6.99 * M) * (Ta - 20) - 0.42 * (Va - 0.1) * (Ta + 273)\right) - fcl * 3.05 * 10^{(-3)} * (5733 - 6.99 * M) \qquad (2)$$

Where, PMV = Predicted Mean Vote; M = metabolic rate (W/m^2) = 58.15 – air velocity – clothing insulation + sweating rate, Ta = air temperature (°C), Tmrt = mean radiant temperature (°C), Va = air velocity (m/s), Icl = clothing insulation (0.5), R.H = relative humidity (%), hc = convective heat transfer ($W/m^2.K$) = -2.0468 + 0.0367 * Ta + 1.5946 * log10(Va) + 0.03 * RH * (6.475 + 4.198 * Ta / 2 - Ta), fcl = clothing surface area factor = $Icl/(Icl + 0.1)$

Statistical Analysis: The measured parameters were entered into Excel Spread sheet, and SPSS Version 20.0 was employed for the statistical analysis. Data were analysed for mean and analysis of variance (ANOVA) to determine variations in the concentrations of parameters measured. Sources of variation among the measured parameters across the beauty salons were determined using Duncan Multiple Range Test (DMRT).

RESULT AND DISCUSSION

Gaseous pollutants: The results obtained were presented in a table (Table 5), excluding hydrogen sulfide H_2S that was detected in 4 of the 15 beauty salons. Mean concentrations ranged between 30 - 5112 mg/m^3, 830 – 1663 ppm and 0.0 - 0.5 mg/m^3 for TVOC, CO_2 and H_2S respectively (Table 5). There was significant difference ($p<0.05$) in the level of TVOC recorded across the studied salons. NKT salon had the highest concentration (5112 mg/m^3) of TVOC, while the least concentration was observed at THC (30 mg/m^3). The varying scale of operations in the salons was responsible for the disparity in the obtained concentrations of TVOC. This suggests vitiation of indoor air is in connection to volume and types of activities being undertaken. In this instance, salon NKT had the most customers having different hair treatments during the assessment, which may be a reflection of the recorded concentration of TVOC. Emissions from both hair treatment and nail polishing increase the concentration of VOC and impact on the quality of indoor air (Baghani *et al.,* 2018). Indoor air environment of beauty salons is usually ladened with VOC pollutants (Lamplugh *et al.,* 2020).

The recorded TVOC concentrations were in excess of the permissible exposure limit (0.2 mg/m^3) (U.S. EPA, 1996) in all the beauty salons. This could be attributable to the ventilation types and status observed during monitoring (largely one window unit and a case of no window for a salon, with faulty mechanical ventilation systems) across the beauty salons. According to the studies conducted by Goldin et al.

(2014) and Lamplugh et al. (2020), the types of ventilation systems in beauty salons influence the quality of indoor air, which shows that ventilation plays a critical role in controlling the quality of indoor air. For instance, the beauty salon with the highest mean concentration of TVOC, NKT, had both the air conditioning system and the mechanical fan not in good working condition, with only one window unit that does not allow cross-ventilation. This obvious lack of escape may have worsened the indoor air quality. In the same vein, Ayoko & Wang (2014) and Lamplugh et al. (2019) noted that entrapment of VOCs indoor and the vitiation of indoor air is festered by poor ventilation.

Table 4: Mean and standard deviation for TVOC and CO_2 concentrations in salons

S/N	Sampling site code	VOC (mg/m^3)	CO_2 (ppm)
1	THC	30.0 ± 2.2^{d}	2321 ± 237^{a}
2	BS	574.5 ± 138.4^{cd}	2621 ± 1180^{a}
3	EUS	470.5 ± 245.5^{d}	546 ± 69^{a}
4	WB	135.5 ± 65.3^{d}	2556 ± 1227^{a}
5	CUS	138.0 ± 93.5^{d}	2108 ± 1510^{a}
6	SHQ	84.8 ± 9.1^{d}	3057 ± 1597^{a}
7	YGB	3629.0 ± 4392.5^{ab}	1841 ± 603^{a}
8	CHC	808.5 ± 284.4^{cd}	1755 ± 3114^{a}
9	HMD	2105.5 ± 1221.9^{bcd}	2987 ± 908^{a}
10	OHB	514.5 ± 143.7^{cd}	2454 ± 1347^{a}
11	DS	498.2 ± 294.7^{cd}	1755 ± 1316^{a}
12	HB	1090.2 ± 305.2^{cd}	1493 ± 503^{a}
13	CTS	2326.8 ± 1206.2^{bc}	2097 ± 694^{a}
14	SG	4895.7 ± 1172.7^{a}	1924 ± 905^{a}
15	NKT	5112.8 ± 321.4^{a}	2991 ± 1270^{a}

$^{a\text{-}d}$Means in a column without a common superscript letter differ ($p<0.05$) as analysed by one-way ANOVA and DMRT.

The emission of VOCs in beauty salons has been linked to hair spray, hair dye, conditioner and additives, permanent curls, nail polishes, glue, nail polish remover (Nayak *et al.,* 2017). Formaldehyde, xylene, toluene, ethylbenzene, benzene, 1,4-dioxane, diethylpthalate, etc. are some of the typical VOCs present in cosmetic products being used in beauty salons (Kaikiti *et al.,* 2022). Continuous exposure to these chemicals in their elevated concentrations above the permissible limit portends the onset of adverse health problems such as cancer (Manisalidis *et al.,* 2020), respiratory and cardiovascular problems (Ghaffari *et al.,* 2021), skin irritation (hand inflammation), musculoskeletal disorder among exposed subjects (de Gennaro *et al.,* 2014; Sekar *et al.,* 2019).

For the control of indoor air pollutant and quality improvement of indoor air, particularly in a case where mitigation cannot be achieved by source control, adequate ventilation is considered the alternate control method (Jia *et al.,* 2019). Considering the nature of the business in beauty salons, emission of VOCs into the indoor air is inextricably linked to the activities therein, owing to the types of chemical products in use for daily operations. As a form of control, Standard 62.1 was established by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHREA) which stipulates the minimum ventilation rate for commercial buildings and strict compliance is aimed at preserving the health, safety and well-being of occupants (Persily, 2015). However, increasing ventilation has been reported in previous studies to be inconsistent on IAQ improvement, with some producing desirable outcome and some without any result (Vornanen-Winqvist *et al.,* 2018; Dutton & Fisk, 2014). The higher TVOC concentration recorded in this study could be attributed to reduced ventilation as there was no provisions for cross-ventilation in the beauty salons, and the window size is less than one-tenth of floor size for over 60 percent of the sampled salons. Measuring ventilation rate is envisaged to provide additional correlational relationship between TVOC and ventilation (Jia *et al.,* 2019) but this data was not measured. From Table 5, mean concentrations of carbon dioxide (CO_2) in the salons were below the permissible exposure limit (5000 ppm) for 8 hours time weighted average per day (OSHA, 2012). Variation across the beauty salons was not statistically significant. Concentration of CO_2 in indoor air environment can as well serve as an indicator of pollution and adequacy of ventilation (Luengas *et al.,* 2015; Bain-Reguis *et al.,* 2022, ASHRAE, 2022). Although, recorded mean concentrations suggest no compromise of indoor air quality when compared with the maximum exposure limit (5000 ppm), but they were fairly above 2500 ppm (one-third of the beauty salons) being the typical safe level for indoor CO_2 8 hours time weighted (Luengas *et al.,* 2015). This further buttresses the prevalence of inadequate ventilation within the beauty salons. Exposure to increasing concentrations of CO_2 has shown to cause fatigue and headache, nausea, respiratory irritations (Chang *et al.,* 2017). However, in a recent publication released by ASHREA (2022), the causal-effect potential of CO_2 was dispelled while reinforcing the suitability of CO_2 as a criterion for ventilation, and therefore called for further investigation. Hydrogen sulfide (H_2S) was detected in four (4) beauty salons DS (0.50 mg/m^3), NKT (0.25 mg/m^3), THC (0.13 mg/m^3) and EUS (0.05 mg/m^3). No exceedance was recorded as mean concentrations were below the maximum permissible exposure level 1.4 mg/m^3 (Table 3). Notably, emission of H_2S in beauty salons is from secondary sources, usually from the reaction of thioglycolates with disulfide bond present in human hair (Manayi & Saeidnia, 2014; Yang, 2017). Thioglycolates are depilatories used in salons for curly hairstyling and removal of unwanted hair, which then react in the process with disulfide bond present in keratin fiber to produce H_2S. This could be the reason for not being in detectable concentration in most sampled beauty salons as the use of thioglycolates may not be a routine engagement. Nonetheless, exposure to elevated concentration of H_2S portends the risk of adverse health conditions such as irritation of the eyes and respiratory track, difficulty in breading, poor memory, etc. (Kashfi, 2018).

Particulate Matter ($PM_{2.5}$ and PM_{10}): The mean concentrations of fine ($PM_{2.5}$) and coarse (PM_{10}) particulate matter ranged between 2.7-25.0 µg/m^3 and 3.0-50.8 µg/m^3 respectively. Elevated PM values were observed in salons HMD (25.0; 50.8 µg/m^3) and YGB (22.3; 47.0 µg/m^3) respectively for $PM_{2.5}$ and PM_{10} (Figure 2), above the World Health Organization (WHO) permissible exposure limits (PEL) for $PM_{2.5}$ (15 µg/m^3- 24 hours) and PM_{10} (45 µg/m^3- 24 hours). Value of $PM_{2.5}$ in salon DS (13.5 µg/m^3) was fairly below the WHO permissible exposure limit (Figure 2). The pattern of PM values is a reflection of activities being implemented in the beauty salons. Particularly, nail dressing alongside other activities were observed in the salons with elevated PM values (HMD, YGB & DS) during the measurements, which could be responsible for the spike in PM pollution load in the indoor air environment (Chen *et al.,* 2022). There was no significant variation in the values of PM across the salons.

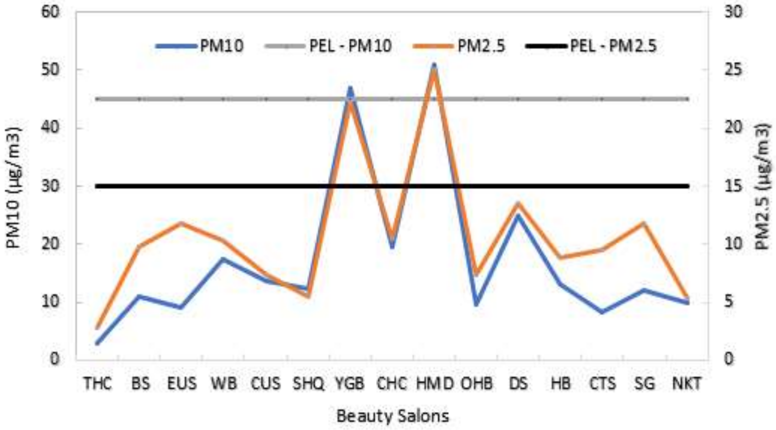

Fig 2: Mean concentrations for $PM_{2.5}$ and PM_{10} in salons

Although, low values of PM were observed in twelve (12) of the fifteen (15) beauty salons (Figure 2), they are as well at the brink of witnessing elevated pollution of PM when nail dressing and any other PM emitting activities are implemented, considering the prevailing lack of cross-ventilation (largely one window, with no ventilation equipment), liable to entrapment of emitted PM (Evtyugina *et al.,* 2021; Kaikiti *et al.,* 2022). This exceedance above the WHO PEL portends serious health risk to operators and users. Notably, indoor air limits for $PM_{2.5}$ and PM_{10} was revised by WHO in 2021 from 25 to 15 µg/m^3 (24 hours) and 50 to 45 µg/m^3 (24 hours), respectively (WHO, 2021). This further emphasized the growing concern for the health risk associated with exposure to elevated PM. Users and operators in beauty salons where exceedance was indicated may experience respiratory and allergic symptoms as a result of exposure to PM (Taiwo *et al.,* 2015; Manisalidis *et al.,* 2020). Abulude et al. (2021) noted that the presence of particulate matter in high concentration in the environment is considered one of the factors of increased morbidity and mortality cases among human population, particularly among the vulnerable population groups. Also, PM (fine) can get into the blood through the lung and cause organic damage (U. S EPA, 2022). Moreover, 80% of the salons had no Personal Protective Equipment (PPE) in place while the remaining 20% rarely use the PPE, which could increase risk of exposure to PM and other work-related airborne pollutants.

Thermal Comfort: Thermal comfort performance of the beauty salons is presented in Figure 3. Quantification of thermal sensation was determined with PMV index equation and subsequent estimation of PPD, which informed the relatable indoor air thermal sensation after comparison with ASHREA 55 and ISO 7730 Standards. From Figure 3, it shows all the salons fall outside the maximum criteria set by ASHREA 55 and ISO 7730. Although, zero PMV value corresponds with approximately 5% PPD, which translates to improbable attainment of 100% thermal comfort satisfaction for all occupants due to varying individual thermal feeling and conception (Gilani *et al.,* 2015), the estimated PPD values (%) of dissatisfied occupants in the salons was observed to be overly higher than the maximum set standard of < 10%.

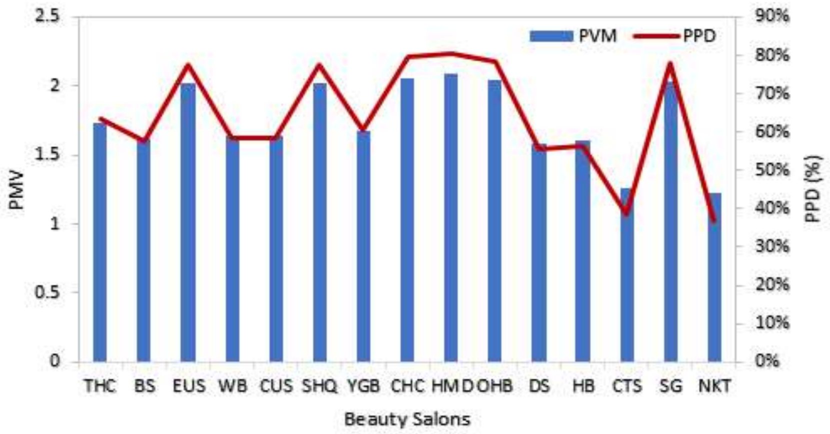

Fig 3: Thermal variability of beauty salons from PMV and PDD values

Six of the salons were within the warm and hot regions (+2 and +3) with the lowest PPD 77.5% (EUS and SHQ), and seven tended towards the warm (> +1.5) with the lowest PPD 55.5% (DS) while the remaining two were above slightly warm (> +1), with corresponding PPD 38.3% and 36.7% for salons CTS and NKT, respectively. Overall, all the salons were not in thermal acceptable condition. Largely, this signals the risk of heat stress related conditions (heat exhaustion, heat stroke) among the operators and users of these beauty salons. Generally, thermal comfort performance in the beauty salons is poor and this may be as a result of inadequate ventilation, congestion and building component materials. Findings in this study are in agreement with Mukhopadhyay et al. (2021) which established the link between severe heat stress and congestion and poor ventilation. Adequate ventilation (natural or/and mechanical) ensures improved thermal comfort and indoor air quality (Marcel & Villot, 2021; Dharmasastha *et al.*, 2022). Although, the human body can adapt to different temperatures in an indoor environment, based on distinguishing uniqueness of body shape, metabolism, etc., to suit individual preferences (Zune *et al.*, 2020), efforts should be made to legislate and enforce compliance with ASHREA 62.1 ventilation criteria and acceptable thermal condition set by ASHREA 55 and ISO 7730 standards in order to prevent associable adverse health risks such as diabetes complications and cardiovascular problem (Uejio *et al.*, 2022), and the onset of respiratory diseases (Niu *et al.*, 2022).

Policy Implication: Findings suggest that beauty salon activities create hazardous indoor work environment, where exposure to chemical substances (gaseous and particulate) can result to adverse health conditions. This exposure may affect the health of operators and users of beauty salons and contribute to serious disease burden countrywide (Liu *et al.*, 2020) and as well affect productivity (Huang *et al.*, 2016), which may be exacerbated without any form of regulation. Therefore, development of policy, stipulating minimum standard requirements, for beauty salon operations (hairstylists and outlets), and enforcement are imperative to public health promotion, which would as well harness the economic potential of the growing business.

Conclusion: The use of cosmetic products for hairstyling operations vitiates the indoor air and exposes humans to danger of chemical poisoning, which undermines good health and productivity. Results revealed ventilation inadequacy, indicating possible high human exposure to discomfort and potentially hazardous chemical substances being used in the salons. The risk of exposure to pollutants by salon operators and users was established. Therefore, regulation of beauty salon operations in terms of design of operating outlet, certification of hairstylists (operators), and enlightenment campaign are recommended.

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