Assessing Indoor Air Pollution within Different Areas of Female Beauty Centers and Exploring Their Relation to Various Respiratory Symptoms

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ABSTRACT: The staff working at beauty centers are exposed to various chemical products used daily in their working environment. Both hair dressers and nail technicians are exposed to chemicals that are known to have an influence on the respiratory system. In order to evaluate such influence, this cross-sectional observational study was conducted on a randomly selected 14 beauty centers in Dammam City, Saudi Arabia. At the investigated salons, both of respiratory symptoms and the quality of air were evaluated and data were analyzed statistically. 40.5% out of the 79 subjects included in the study were hairdressers, 17.7% were nail technicians and (41.8%) were working in both of the previously mentioned areas as part of their everyday practice. The staff complained of respiratory symptoms which include dyspnea, cough, phlegm, wheeze, and shortness of breath. Both hairdressers and nail technicians developed respiratory symptoms while working in the salons. Indoor Air pollution was assessed and many data were out of the normal standard ranges which include: relative humidity (RH), volatile organic compounds (VOC), carbon dioxide (CO_2), and ammonia (NH_3). We conclude that good ventilation is required to reduce the influence of such substances on the respiratory symptoms of the staff working at salons.

Keywords: air quality, beauty centers, hairdressers, nail technicians, particulate matters, respiratory symptoms.

INTRODUCTION

Indoor air quality is recognized by the environmental protection agencies as one of the major five environmental risks to public health (Messer *et al*., 2014). Furthermore, the staff working at beauty centers are exposed to a variety of potential hazardous chemicals (Diab *et al*., 2014). Those substances are contentiously used in hairstyling and nail care techniques. The staff may provide the following services on a daily basis which includes, but not limited to, hair dying, bleaching, curling, keratin, poetics, and Praveen (Maneli *et al*., 2014). They also may apply nail polish to their customers and use disinfectants and artificial nail removers. All of the previously mentioned substances or procedures may expose the staff to dangerous levels of the following known pollutants: ammonia, volatile organic compounds (VOCs), carbon monoxide, paraformaldehyde, Titanium dioxide,

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acetone, and other particulate matters (Zhao *et al*., 2014).

Moreover, all of the previously mentioned pollutants have a significant influence on the safety of the staff working in such environments (Roelofs *et al*., 2008). Hollund *et al*. (2001) noted that hairdressers are exposed to low levels of various irritating chemicals every day. In addition, many studies attempted to assess the relationship between working in beauty centers and respiratory symptoms. Skoufi *et al*. (2013) demonstrated a worsening in the pulmonary function and the end exhaled nitrogen measurements in salons in Greece. Additionally, they have also reported an alleviation of the symptoms at home which might be an indication of their relation to an occupational exposure.

The prevalence of acute symptoms as a result of the exposure to hairdressing chemicals was addressed in the evidence. Moscato *et al*. (2005) confirmed that persulfate salts are the major agents involved in occupational asthma and occupational rhinitis in hairdressers. There were also higher frequencies of work-initiated respiratory symptoms reported which might be particularly related to a high level of exposure to bleaching powder and hair spray (Hashemi *et al*., 2010).

Brisman *et al*. (2003) evaluated the risk for three respiratory symptoms of wheeze, dry cough, and nasal blockage in hairdressers using a questionnaire to assess respiratory symptoms. The previous study concluded that Hairdressers were at high risks of developing respiratory symptoms. Hollund and Moen (1998) demonstrated the positive impact of ventilation which showed less exposure of isopropanol, ethanol, toluene, phenylendiamines, diaminotoluene, and ammonia. Thus, it might be advised to have a frequent assessment of the environmental conditions to maintain the safety of the staff. Roelofs and Do (2012) has noted the lack of adequate ventilation in his study which was of a significant concern because of the presence of potentially hazardous chemicals in the salons investigated. The health of the community and workers may be improved through the adaptation of the ventilation guidelines as well as reducing the exposure to hazardous products.

Although there were many published studies for the aim of assessing the respiratory symptoms influencing hairdressers around the world, such a study was not yet conducted in Saudi Arabia. This might indicate the lack of awareness about such an environmental issue. Thus, the current study will aim to assess the respiratory symptoms and the air quality of the investigated salons. It will also aim to assess the indoor air quality within multiple areas of the same salons to establish whether there will be a difference in the reported findings or not. The current study will also aim to assess and compare the frequency of respiratory symptoms present between hairdressers and nail technicians. Our null hypothesis is that there will be no difference in the severity of the reported respiratory symptoms between hairdressers and nail technicians within the beauty centers investigated.

METHODOLOGY

The study was approved by the Institutional Review Board (IRB) of University of Dammam. Upon approval, a pilot study was conducted in Al Qatif city and Al Khobar city of Saudi Arabia in February 2015, among seven beauty centers for the aim of assessing the feasibility of the study tools and the time needed for each questionnaire. There were some limitations faced during pilot study which resulted in changing the sampling technique and requesting more equipment such as chargers. The current research data collection was carried out during March 2015.

Sampling technique

This is a cross-sectional observational study which utilized a simple random

sampling technique targeting salons in Ad Dammam city, Saudi Arabia. Only beauty centers with minimal of eight workers were considered in the randomization. The reason of exclusion of the salons with less than this number was due to the limited number of hairdressers, nail technicians, treatments available, and customers as demonstrated in the pilot study findings. Additionally, the reception staff, makeup artists, tailors, and subjects with diagnosed respiratory diseases were also excluded from each beauty center. 79 subjects were included (n=79) which all were working in the day of visits. Sampling technique is summarized in Figure 1.
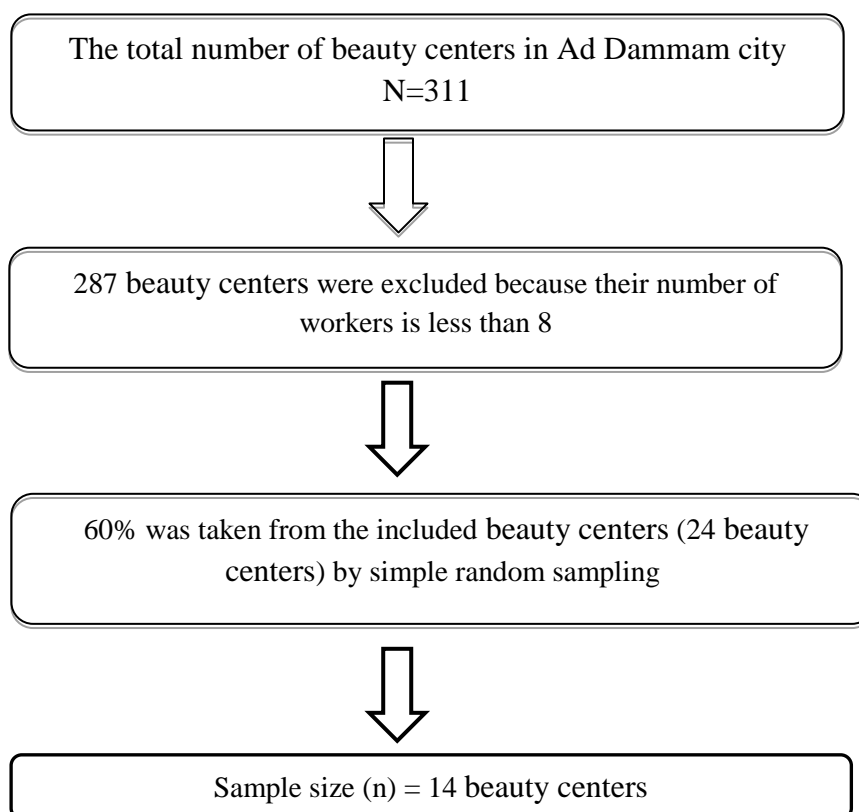
The total number of beauty centers in Ad Dammam city
N=311

287 beauty centers were excluded because their number of workers is less than 8

60% was taken from the included beauty centers (24 beauty centers) by simple random sampling

Sample size (n) = 14 beauty centers

Fig. 1. Summary of sample technique

Area description

One of the objectives of this current study was to establish whether there will be differences in the reported respiratory symptoms among the staff working in different areas within the same beauty centers. Thus, we investigated the following areas during the visits of each salon: the hair area (where hair treatments, styling, is performed), nail area (where nail arts, pedicure, and manicure are performed), and, due to the fact that they were mixed together in some beauty centers, thus, a third area was added to the investigation and was called the mixed area.

The visits of the research team were arranged alongside the inspection visits of the eastern province municipality. Their main target was to assess the availability of personal protective equipment (PPE) such as masks and gloves, general and local ventilation, vacuum ventilation, the level of cleanliness of the salon, and the expiratory dates of the products used. Their report noted the use of PEE within four beauty centers only out of the assessed fourteen. Only nine beauty centers out of the fourteen had general ventilation such as windows, which were effectively utilized, since some of them were opened during

treatments and others were not. Additionally, twelve beauty centers out of the fourteen had *local exhaust ventilation which was at use during the inspections* and that might not be considered satisfactory.

Data collection tools

A Respiratory Questionnaire adapted from the medical research council was used. The questionnaire is extensively validated by the Department of Occupational and Environmental Medicine to be a researcher driven (Cotes and Chinn, 2007).

Furthermore, three devices were used to assess indoor pollution. One was Graywalf monitor which measures Sulfer Dioxide, Nitric Oxide and Nitric dioxide, Ozone, Temperature, Oxygen, Chlorine, Ammonia, and CO_2. The other device used is called IAQ RAE which measures CO, VOC, CO_2, RH, and temperature. Thirdly, the DustTrak device which measures the particulate matter. $PM_{2.5}$ and PM_{10} were used because the availability of an evidence suggested that the particles of PM_{10} diameter and less might pass through the nose and throat, reaching the lungs, and a hazardous particulate size of $PM_{2.5}$ might penetrate into the gas exchange region of the lungs (Shoshkes *et al*., 1950)

Data analysis

Data analysis was done using SPSS software version 20. Descriptive statistics and two inferential statistical tests were used to analyze the data by means of Shapiro-Wilk test for normality and Kruskal-Wallis and chi square test to compare outcomes among more than two independent groups.

RESULTS AND DISCUSSION

Sample description

Of the 79 subjects, 40.5% were hairdressers, 17.7% were nail technicians, and 41.8% were working in both areas. There was a variety in the nationalities of the subjects. However, Filipino subjects were the majority (68.4%), 11.4% were Saudis, and 20.3% were from varieties of other nationalities. 36.7% are between the age of 15 -35 years old, while 63.3% are more than 35 years old. The majority of the subjects were married (63.3%). 62% have working experience less than 10 years, 29.1% have been working for 10-20 years, and 8.9% were with more than 20 years of experience. Smoker subjects were only 1.3%. The study sample mean age was around 39 (SD 9.79) and the mean years of experience was nine years (SD 7.13). As part of the current study, the respiratory symptoms were assessed. Figure 2 is used to demonstrate the prevalence of the respiratory symptoms among the study sample. Additionally, assessing the three categories of the sample (based on where they work in the salon) is demonstrated in Table 1.
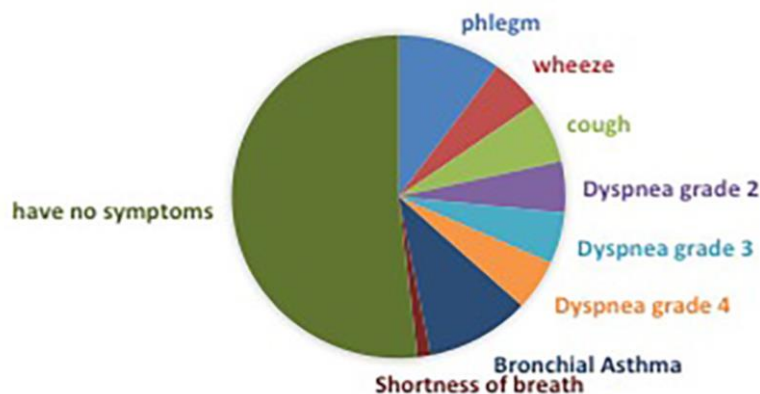

Fig. 2. Summary of the respiratory symptoms

Table 1. The prevalence of respiratory symptoms among the workers in different areas within beauty center

Work area	Hair area		Nail area		Mixed area		P value
Respiratory symptom	Freq.	Prcntg	Freq.	Prcntg	Freq.	Prcntg	
Dyspnea grade 2	4	12.5%	0	0%	0	0%	0.045
Dyspnea grade 3	3	9.3%	0	0%	1	3.03%	0.322
Dyspnea grade 4	3	9.3%	0	0%	1	3.03%	0.322
Cough	3	9.3%	0	0%	2	6.06%	0.484
Phlegm	4	12.5%	0	0%	4	12.12%	0.383
Wheeze	4	12.5%	0	0%	0	0%	0.045
Shortness of breath (SOB)	1	3.1%	0	0%	0	0%	0.475
Bronchial asthma	5	15.6%	0	0%	3	9.09%	0.262

Assessment of the respiratory symptoms

The findings of the study noted distinct differences with the prevalence of the respiratory symptoms between workers in different areas within beauty centers. The respiratory symptoms noted to be higher in the hair area workers than those working in the other areas. There were no respiratory symptoms reported in the nail area workers.

There was a significant difference in the prevalence of dyspnea grade 2 (*P* value= 0.045 < 0.05) and wheeze (*P* value= 0.045< 0.05) between the workers within different areas within beauty centers, while there was no significant difference in the other symptoms.

Assessment of the salons' quality of air

The quality of air in every area in the 14 beauty centers were assessed via Graywalf monitor, IAQ RAE, and DustTrak devices. The mean values of the following pollutants were assessed: VOC, CO_2, SO_2, NO, NO_2, O_3, NH_3, and CO, as well as the temperature and the relative humidity. It was found that VOC in the hair and nail areas of the salons exceeded the normal range (3.74, 3.1> 3), as well as the CO_2 value (1203.33, 1162.2> 1000). In addition, RH was found high in the hair area (65> 60). NH_3 pollutant was available in all of the assessed areas. Additionally, there was no statistical significant difference between their values and their presence in the hair, nail, and the mixed areas.

In this study, the prevalence of the following respiratory symptoms were investigated: cough, phlegm, wheeze, shortness of breath, bronchial asthma, and dyspnea. The results showed a high percentage of phlegm and undiagnosed Asthma (10.1%) within the whole sample of 79 subjects. While in Lysdal *et al.* (2014), other symptoms such as nasal congestion and rhinitis have been included with a questionnaire. However, because of the difficulties in identifying such symptoms within our targeted population, those symptoms could not be assessed. Additionally, our findings showed that the pollutants existing in female beauty centers were influencing the respiratory symptoms of the workers. Moreover, the prevalence of the respiratory symptoms investigated were different among the staff working in different areas within beauty centers.

Since we claim that this was a gap of knowledge which was not yet assessed by the evidence, it was interesting to reject the null hypothesis. As shown in Table 1, the hairdressers have all of the symptoms with variety of percentage (dyspnea, cough, phlegm, wheeze, SOB and bronchial asthma), while the nail technicians have not reported any symptoms. This interesting finding could be related to the difference in the time of exposure, chemicals used, treatments, and the effectiveness of ventilation between the hair area and nail area. The workers in both areas have some of the symptoms which

were dyspnea, cough, phlegm, and undiagnosed bronchial asthma, but not all of them.

Only two symptoms were showing a significant difference in their prevalence between the three assessed areas of the salons; dyspnea and wheeze. The results in our study was somehow similar to another cross-sectional study conducted in Palestine which assessed some respiratory symptoms (wheezing, chest tightness, shortness of breath, cough, chest phlegm, asthma (diagnosed by a doctor) among female hairdressers. They found that the hairdressers reported more chest tightness, shortness of breath, and phlegm compared to the controls. In the same study, they have excluded smokers unlike our study which revealed that there were three smokers among the 79 subject. However, this finding might be doubtful since one of the identified limitations of the used questionnaire is that it must be research driven and some staff might deny smoking as a result.

The quality of the indoor air was assessed within the fourteen beauty centers investigated. There were values which fall outside of the normal accepted ranges; which were (VOCs, CO_2, RH, and NH_3). The VOCs in hair area concentration mean was 3.74, which was more than the reported mean in the nail area (3.10) and the mix area had the least concentration (1.55). This finding might not necessarily suggest advocating for mixing both areas together since it could be due to the increase space available or the improved ventilating conditions. In addition, VOCs concentrations showed great variance depending on ventilation (Goldin *et al*., 2014; Tsigonia *et al*., 2010).

In our findings, the CO_2 was also outside the normal range and higher in the hairdressing areas of the salons. This might also be related to ventilation within the investigated beauty centers. Turanjanin *et al*. (2014) mentioned in his study that the high level of CO_2 concentration points to

insufficient ventilation of indoor space. The level of indoor CO_2 has become widely used as an indicator of indoor air quality and surrogate for the ventilation rate. For the relative humidity values, all of the three areas in the assessed salons had values out of the normal range. Markowicz and Larsson (2014) research findings demonstrate an increased level of VOCs which was found to be associated with the increased RH levels. So improving ventilation and reducing RH was found to be valuable.

The values of the NH_3 were found high in all of the three areas of the salons which was found to cause nose and throat irritation, in addition to cough, shortness of breath, and tightness of the chest (Nemer *et al*., 2015; Sexton *et al*., 2004). The Environmental Protection Agency (EPA) guideline notes that VOCs may cause dyspnea and irritation for the nose and throat while CO_2 causes tachypnea and fatigue (EPA, 2012). Additionally, the National Center for Biotechnology Information documented that relative humidity affects the incidence of respiratory infections and allergies (NCBI, 1986).

There was no significant difference reported between the pollutants levels that were outside the normal ranges within the three areas of the salons. However, the mix area showed better results which might suggest that it has better ventilation than the hair or the nail areas alone. Although effective general ventilation will alleviate the effects of the air pollutants, it could not completely solve the problem (Leino, 1999). Therefore, local exhaust ventilation is recommended at all areas of the salons equally.

CONCLUSION

There is a significant difference in the prevalence of some respiratory symptoms (wheeze and dyspnea) between the hairdressers and nail technicians who work in beauty centers. Some of the pollutants

measured in this study were outside the slandered normal range; they were CO_2, VOC, RH%, and ammonia. The pollutants were not significantly different between the assessed areas of the salons. The previous findings might suggest that poor ventilation was probably the reason. Furthermore, it was also noted that the degree of the indoor pollution was found to be equal despite the usage of different beauty products.

Based on our findings, the separation between hair area, nail area, and mixed area is not required but good ventilation and using personal protective equipment is essential to lower the risks of developing respiratory symptoms in hairdressers and nail technicians. Additionally, the development of a self-administered questionnaire rather than a researcher-administered one is recommended hence the subjects will be more comfortable to answer the questionnaire honestly.

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