

Original article

## Health Risk Behaviors of Formaldehyde Exposure among Salon Workers in Nakhon Si Thammarat Province, Thailand

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### Abstract

An exposure study was conducted to characterize potential formaldehyde exposure of salon workers and clients during hair treatments. We also studied knowledge, attitudes, and behaviors on chemical usage of the formaldehyde among salon workers and assessed their health risk protection behaviors. Data from a total of 55 salon workers who worked at 39 different salon beauty shops were collected. Results were analyzed based on tasked sampling and treatment sampling. Most workers were female (96.4%) with an average age of 37 years old. A majority of workers graduated from lower or upper secondary schools (56.4%), are married (52%), and earn an average income of 15,372.7 Baht per month. Most salon workers had moderate or high knowledge of formaldehyde (80%), and had high attitude towards chemical management (56.4%), and had low level of formaldehyde risk of practice (70.9%). A health risk assessment based on the average concentration of formaldehyde revealed that the risk probability of cancer ranged from  $8.34 \times 10^9$  to  $1.00 \times 10^3$ , with 30 beauticians exceeding the acceptable risk level. Cancer risk probability ranged from  $1.97 \times 10^8$  to  $1.40 \times 10^3$  based on the maximum concentration, with 31 beauticians exceeding acceptable risk level. Result of non-cancer risk assessment revealed that the risk ranged from 0.018-13.216 based on the average concentration, with 12 beauticians were exceeding the acceptable level. The results of this study show that at maximum concentration, the non-cancer risk were ranged from 0.024-18.488 and 13 salon workers professional hair treatments have the potential to produce formaldehyde concentrations that meet or exceed current occupational exposure limits according to US EPA.

**Key words:** Health Risk, Formaldehyde, Exposure

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## Introduction

Nowadays, being a beautician is an extremely popular careers. Beautician career opportunities have expanded in the large cities and even in the villages in Thailand. Based on registration data for beauty shops with the Thai Ministry of Commerce in 2004, the Thai Ministry of Public Health had announced approximately 400 hair salons or beauty shops businesses produced harmful effects on health nationwide. (Department of Health, Ministry of Public Health, 2007). In 1995, on behalf of the Ministry of Public Health, the Environmental Health Office, Department of Health conducted a survey on health and environment of hair salons and beauty shops throughout the country, including the area of Bangkok (Bureau of Environmental Health, Department of Health, Ministry of Public Health, 2013; Pollution Control Department, 1998). In 2007, it was discovered that 56.3% of beauticians of working at beauty shops or hair salons did not have annual health examinations, 60.4% of beauticians did not paid leave in case they had an illness while employed at the beauty shops, and no masks had been used in 39.5% of the beauty shops. According to the Environmental Affairs, 33.3% of the beauty shops contained the inappropriate ventilation. Additionally, according to the study authors, “it was discovered that the beauticians’ most common health problems, occurring from chemical usage, were the respiratory system symptoms,” which accounted for 49.9%. (Department of Health, Ministry of Public Health, 2007).

Beauty shops services that bring about the highest amount of income include haircut service, hair stretching service, hair dyeing service and trendy hair color business. Consequently, the entrepreneurs that provide the services listed previously support more chemical usage (Department of Health, Environmental Sanitation Division, 2011). Furthermore, hairdressing and beauty products distributors has been creating and encouraging the new styles of fashionable hairdressing, causing the chemical usage to extensively expand. Beauticians often have continuous exposure to chemical substances, which could provide them risk from chemical danger, even though the majority of chemical substance has been guaranteed to be “safe.” The concern is

that the safe amount of exposure has been identified and beauticians are exposed to extremely high levels. (Bureau of Environmental Health, Department of Health, Ministry of Public Health., 2013). The beauticians’ health risk from chemical usage includes the toxicity from chemical substances found in shampoo, hair dyes, hair color shampoo, curls shampoo and hair stretching shampoo as well as nail polish, nail polish remover, etc. (Department of Health, Ministry of Public Health, 2007). These categories of chemical substance can cause irritation, and can be absorbed into human body. The common examples of chemical substance in products, found in the beauty shops include volatile organic compounds such as: acetone, acetonitrile, formaldehyde, toluene, Phthalates etc. Usually, formaldehyde is used in leather tanning and tissue condition maintaining process. However, formaldehyde can also be found in some unstandardized brands of hair stretching shampoo, hair conditioner or shampoo during beautifying process. By using these unqualified products, the fumes from Formaldehyde can spread in the air. (Pollution Control Department, 1998). The Occupational Safety and Health Administration (OSHA) has been obtaining complaints from hairdressers, hairstyling designers, as well as the entrepreneurs of beauty shops that formaldehyde is being found in the hair styling products used on their customers. OSHA started to collect the samples of hair conditions in many hair salons during the uses of hair styling products. Formaldehyde was actually found in products even though the labels of some hair styling products claimed that no formaldehyde is used as a component. Formaldehyde was also found in some hair styling products even though it was not listed in the mixture or on the material safety data sheet. (Pollution Control Department,1998). Unfortunately, based on the research and data mentioned above beauticians are likely exposed to formaldehyde through their job and may suffering from diseases as a result, especially respiratory diseases.

However, to our knowledge, no previous research has ever reported a health risk assessment on formaldehyde exposure for beauticians. As a result, our research team on behalf of public health researchers as well as

occupational health and safety researchers, feel a responsibility to investigate beauticians' health risk from formaldehyde exposure. Using the United States Environmental Protection Agency (US EPA) technique, which refers to the toxicity assessment in the air, this study aims to apply the risk level from the assessment to create a guideline of the beauticians' health development plans. This plan will aim to reduce the risk of diseases due to the beauticians' chemical usage. The objectives of this study are 1) to study the concentration of formaldehyde in the air of the salon workers' working space in Tha Sala District, Nakorn Si Thammarat Province and 2) to assess health risk behavior of formaldehyde exposure among beauticians in Tha Sala District, Nakorn Si Thammarat Province.

### Methods

This research was a descriptive study in which the selected population and samples are the salon workers from 39 beauty shops in Tha Sala sub-district, Tha Sala District, Nakorn Si Thammarat Province. The criteria for the samples selection was that the services of the selected beauty shops must have been continually provided for at least 6 months.

### Data Collection and Tools

We collected data using a study tool questionnaire based on a literature review and developed by the researcher and our team. The questionnaires include the following 3 parts: Part 1: General information about the questionnaires respondents, beauticians, and the beauty shops they worked at, Part 2: Information about illness and access to treatment services, and Part 3: Information about knowledge, attitudes and behaviors on prevention of chemical exposure.

We also collected data based on observing the salon workers' behaviors, activities and overall environment during their working hours. While visiting the salon shops, we collected air samples in accordance with NIOSH 3500 standard and analyzed samples for formaldehyde concentration in the laboratory. The analysis of the samples was performed by the use of Visible Absorption Spectrometry (VIS) analyzing techniques from the spectrophotometer according to NIOSH

3500 standard. The color was developed by chromo tropic acid and sulfuric acid, which absorbed light at 580-nanometer wave length. This research was approved on research ethics from Human Research Ethics Approval Committee of Walailak University, NO. 090/2014.

### Data Collection

Data from a total of 55 salon workers and 39 beauty shops were collected through questionnaires. We also collected data on the number of beauty shops in the area and conducted surveys among salon workers in order to calculate the parameter values for the formaldehyde health risk assessment, and to gather information on salon workers' knowledge, attitudes and behaviors. Formaldehyde samples were collected in the salon workers' working space, and an observation form was used by researchers to observe and record their behaviors.

### Data Analysis

The data about the exposure concentration of formaldehyde, as well as the data from questionnaires would be evaluated to assess the risk of cancer and non-cancer health problems that could be encountered by the beauticians as a result of formaldehyde. The formaldehyde exposure concentrations of beauticians at work would be compared with recommended values of USEPA. We analyzed the data to calculate the risk values of cancer and non-cancer health problems using readymade software. We also descriptive statistics including means, percentage, standard deviation and the findings of the statistical relationship of variables by Chi-square test. (Jirawatkul, et al 2009)

### Results

Among 55 salon workers, 53 (96.4%) workers were female. The majority of the samples are 31-40 years old, accounting for 45.6% of the sample (minimum=23 years old, maximum= 65 years old). Additionally, the mean age of study participants was 37 years old. The majority of the participants were married (52.7%). The highest education level of the workers distributed among primary level (21.8%), lower secondary level (21.8%), upper secondary level (34.5%), bachelor degree

(12.4%) and master degree (9.1%). Workers reported receiving 1,000-40,000 baht of monthly income, with average income equaling to 15,372 baht/month. The distribution of their monthly income corresponded to 5001-10,000 baht (36.4%), 10,001-20,000 baht (34.6%), over 20,000 baht (20%), less than 5,000 baht (9%).

Workers reported between 1 to 30 years of work experience, with the average years of experience of 8 years. They reported their average daily working hours was 9 hours, which can be classified as 2-6 hours per day (14.5%), 7-11 hours per day (72.8%) and 12-16 hours per day (12.8%). Furthermore, the number of customers per day corresponded to 1-30 people, while the average number of customers was 9 people per day. According to the additional data on customers, the daily number of customers was between 1-10 people (85.5%), 11-20 people (10.9%) and 21-30 people (3.6%). The top five products used

most frequently by the beauticians, included shampoo (96.3%), hair dye shampoo (89.1%), nails polish (89.1%), hair stretching shampoo (76.4%) and hair styling shampoo (65%).

Regarding their health condition, illness and access to health care services, workers reported that 67.3% had detected illnesses during the past 3 months of taking the questionnaire. The diseases that had been found included bronchitis (5.4%), pneumonia (2.7%), allergy (54.1%), asthma (13.5%), chronic bronchitis (2.7%), gastroesophageal reflux (2.7%), hemorrhagic fever (5.7%), cold, cough, headache and sore throat (24.3%), backache (2.7%) as well as tremor and exhaustion (2.7%). The chronic diseases were also found in 21.8% of the workers. Chronic diseases that had been detected included hypertension (5%), diabetes (5%), tuberculosis (41.7%), thyrotoxaemia (10%) and musculoskeletal pains (10%) as shown in Table 1.

**Table 1** Demographic characteristics of salon workers (n=55) and results from salon workers' health questionnaire

Population Characteristics	Number (N)	Percentage (%)
<b>Sex</b>		
Males	2	3.6
Females	53	96.4
<b>Age (years)</b>		
20-30	12	21.8
31-40	25	45.6
41-50	13	23.6
51-60	4	7.2
61+	1	1.8
Mean = 37.40, S.D = 8.75, Min = 23, Max = 65		
<b>Marital Status</b>		
Single	13	23.6
Married	29	52.7
Widow/ Divorced/ Separated	13	23.6
<b>Education Level</b>		
Primary Level	12	21.8
Lower Secondary Level	12	21.8
Upper Secondary Level	19	34.6
Higher than Upper Secondary Level	12	21.8
<b>Income (baht/month)</b>		
Less than 5,000	5	9.0
5,000-10,000	20	36.4
10,001-20,000	19	34.6
Over 20,000	11	20.0
Mean = 15,372.73, S.D = 9,495.72, Min = 1000, Max = 40,000		
<b>Years of working experience</b>		
1-6	27	49.1
7-12	18	32.8
13-20	4	7.2
20+	6	10.9
Mean = 8.22, S.D. = 6.58, Min = 1, Max = 30		
<b>Working hours (hours/day)</b>		
2-6	8	14.5
7-11	40	72.8
12-16	7	12.8
Mean = 8.98, S.D. = 2.64, Min = 2, Max = 16		

**Table 1** Demographic characteristics of salon workers (n=55) and results from salon workers' health questionnaire (cont.)

Population Characteristics	Numbers (n=55)	Percentage
Number of customers per day		
1-10	47	85.5
11-20	6	10.9
21-30	2	3.6
Mean = 8.78, S.D = 5.78, Min= 1, Max = 30		
Products used most frequently		
Shampoo	53	96.3
Hair dye shampoo	49	89.1
Nails polish/ Nails polish remover	49	89.1
Hair stretching shampoo	42	76.4
Hair styling shampoo	36	65.5
Health conditions and illness		
State of illness over the past 3 months		
No illness, occurring	18	32.7
Some illness, occurring	37	67.3
Diseases and illness, being found		
Bronchitis	2	5.4
Pneumonia	1	2.7
Allergy	20	54.1
Asthma	5	13.5
Cold, cough, headache, sore throat	9	24.3
Chronic systemic disease		
Not found	43	78.2
Found	12	21.8
Hypertension	1	5.0
Diabetes	1	5.0
Tuberculosis	5	41.7
Thyrotoxaemia	2	10.0
Myalgia	2	10.0
Other	3	7.2



Salon workers reported that they knew that adverse conditions like allergies and skin problem and musculoskeletal disorders and injuries were likely due to work chemical exposure. We assessed workers' knowledge about formaldehyde exposure through a 10-item knowledge test, in which one point would be given from one correct answer. Then, we classified the number of the knowledge points into the following 3 levels: low knowledge level (0-5 points), moderate knowledge level (6-7 points) and high knowledge level (8-10 points). According to the results of the test, we discovered that the majority of the workers' knowledge corresponded to moderate knowledge level (43.6%) and 36.4% of the workers displayed high level of the knowledge.

Regarding attitudes on the management of chemical substances, the attitudes were specifically divided into 3 levels (good, moderate, low). The results showed that the majority of the samples (56.4%) contained good attitudes towards the management of chemical substance and 43.6% had moderate attitudes towards management of chemical substances derived from 43.6% of the total samples. By combining the number of points about the knowledge about formaldehyde exposure and the attitude on the management of chemical substances, we assessed that 70.9%, of sampled workers had low risk and 23.6 % of sampled workers had low risk.

The data on beauticians' practice behaviors and working spaces was derived from the beauticians' behaviors observation forms. According to the data from the observation forms on 39 beauty shops, it was discovered that for the most part, only one beautician was available in each of 34 beauty shops (or 87.2%) whereas two beauticians were involved as the entrepreneurs in four beauty shops (or 10.3%). Only one beauty shop contained three available beauticians (2.6%). The services for most customers included haircuts, hair washing and hair drying services in 32 hair salons (82.1%), hair stretching service in 25 beauty shops (64.1%) as well as hair dyeing, manicure, facial makeup and hair styling services. According to the data of general working environment in 39 beauty shops from the beauticians' behaviors observation forms, 82.1% of the beauty shops

contained sufficient lighting. Ventilation was available in 64.1% of the beauty shops. Ventilation equipment was already installed in 66.7% of the hair salons. Additionally, 48.7% of the beauty shops contained sufficient dustbins. Specific wash basins were sufficiently installed in 17.9% of the beauty shops. Clean hair wash basins were available in 79.5% of the beauty shops. In addition to the above data, clean drinking water was available for customers in 82.1% of the beauty shops. Electricity shock or electricity shot prevention system was installed in 33.3% of the hair salons. Clean and tidy management of the service facilities was established in 82.1% of the beauty shops. Moreover, chemical supplies in 35.9% of the service facilities were kept in clean and covered spaces. Correct and secure uses of the products in accordance with the announcement of the Ministry of Public Health was done for 82.1% of shops. 79.55% of the beauty shops owners had ever participated in the sanitation training for hair styling and beauty service facilities.

The concentration of formaldehyde samples from the working spaces of 19 beauty shops was higher than NIOSH standard, which specified the maximum concentration of formaldehyde of less than 0.016 ppm. Nevertheless, when comparing the sampled concentrations in our study to the formaldehyde standard from the Thai Interior Ministry Announcement on the security of working with chemical environment released in 1977 together with the information from OSHA, sampled concentrations of formaldehyde in the hair salons we visited was not excessive. The Thai Interior Ministry and OSHA specified the concentration of formaldehyde should be less than 3 ppm or 3.69 mg/m<sup>3</sup> and less than 0.75 ppm or 0.92 mg/m<sup>3</sup> World Health Organization and International Agency for Research on Cancer (2010). The increase in lung cancer, the only site for which cancer was increased in either sex, may depend on confounding from smoking. Bladder cancer was not increased among hairdressers. Hair dyes may contain a variety of chemical agents such as aromatic amines, some of which are considered proven, probable or possible human carcinogens.

## Discussion

According to the overall image of knowledge, attitudes and behaviors on the beauticians' chemical usage, 43.6% of workers had moderate levels of knowledge about formaldehyde. Additionally, 56.4% of workers had the attitudes towards management of chemical usage were positive, whereas 43.6% had the moderate attitudes. As for risk of practice, it was discovered that 70.9% of the practice contained the low level of risk, which corresponded to the study (Hakim et al.2019; Department of Health, Ministry of Public Health,2007). Furthermore, it was also found that the beauticians perceived the risk of cosmetics products very well. The majority of the beauticians frequently read the labels of cosmetics products in advance of using them. Many salon workers learned how to use personal protective equipment to reduce chemical exposure from the warnings on the labels. The beauticians' knowledge and understanding on cosmetics products labels corresponded to the very high level of knowledge. Interestingly, 97.1% of workers reported that they purchased cosmetics products purchase were based on the regular observation of labels in which a name, a manufacturer and an importer in the Thai language were included. Moreover, the perception from popular TV channels accounted for 100%. As a result, this study suggests that the government sector should support the effective access to news and information for the beauticians on chemical risks from beauty products in the Thai language, and should directly provide them knowledge about the safety of chemical usage on product labels or packaging (Amodio et al, 2009).

Based on the result of the measurement and the analysis of formaldehyde concentration in the air of the beauticians' working spaces from 39 beauty shops, it was discovered that the concentration of formaldehyde from 19 beauty shops equaled to 0.00002-0.5710 ppm or 0.0002-0.7010 mg/m<sup>3</sup>, which was considered higher than NIOSH standard. The NIOSH standard specified the concentration of formaldehyde in the working environment should be less than less than 0.016 ppm. In our study. the concentration of formaldehyde was not detected in 6 beauty

shops. This finding corresponded to previous research (Naddafi et al.2019; Leino, 1999; Bureau of Environmental Health, Department of Health, Ministry of Public Health, 2013; Pollution Control Department,1998). In addition, it was also found that formaldehyde was included in some unstandardized brands of hair stretching shampoo, hair conditioner, and shampoo that were used in the beautifying process. OSHA received complaints from the beauticians and the hair stylists as well as the barbers that beauty product labels had no identification of formaldehyde, yet the products still contained formaldehyde as a component. Or in some cases products had formaldehyde but did not list formaldehyde in the mixture or on the material safety data sheet. By collecting the air samples from the beauty shops during the use of hair styling shampoo, it was discovered that formaldehyde in the air was actually detected, indicating that information on warning labels on the products didn't correspond to the list of real components. This inconsistency could lead to the occurrence of danger and health risk for beauticians handling products with formaldehyde. (Leaung-amphorn, et al.2014; Pak et al, 2013).

In our study, the formaldehyde residue was found in collected air samples. In our sample data, we discovered that 6 of 7 salon workers (85.7%) with 11-15 years of experience were exposed to formaldehyde levels that could pose cancer risk. This result corresponded to the previous study, which found that the illness from allergy and eczematous dermatitis, encountered by 5.9% of the salon worker was mostly resulted from hair curling shampoo. These types of illness were likely to be found from the beauticians with 6-10 years of experience. Furthermore, the samples from 11 closed beauty shops, where the ventilation systems were not installed, contained the highest formaldehyde air concentrations. Thus, these 11 closed beauty shops had the highest opportunity of cancer risk. Additionally, the samples from 4 closed beauty shops that did not have air conditioners installed had high formaldehyde concentrations. Thus, cancer risk due to formaldehyde exposure may possibly emerge in all 4 of these beauty shops due to the inappropriate ventilation. The connection



between inappropriate ventilation and increased cancer risk corresponded to the study by the Environmental Health Office, Department of Health, Ministry of Public Health. (Department of Health, Ministry of Public Health 2007). This study conducted by the Environmental Affairs Office showed that the ventilation in 33.3% of the how many) beauty shops was not appropriate. The Environmental Affairs Office recommended that beauty shop management should install a standard ventilation system and modify the beauty shop workplace to build up safety for both beauticians and customers. However, according the management, the compact spaces of beauty shops, the fact that the beauty shops often share space with other businesses, and the close proximity of beauty shops to other nearby community location and trade areas make it difficult to expand and manage the workplace to maximize safety in the workplace. In this case, closed ventilation system is needed to solve the problems, and this design may affect the adjacent buildings. Nonetheless, continuing to strengthen regulations, offerings safety and mitigation knowledge, and continuous follow-up of public health and safety officials with beauty salon workers and owners will build up understanding and increase awareness on the health risks that could happen with formaldehyde exposure. (Wonglakorn, 2013; Department of Health, Ministry of Public Health, 2007). We also assessed non-cancer risk of formaldehyde exposure using standard (Department of Health, Ministry of Public Health, 2007). It was discovered that the non-cancer risk due to formaldehyde exposure encountered by the total samples of the beauticians (n=55), equaled to between 0.00-18.5. Formaldehyde air samples from 13 beauty shops contained the risk value of over 1, which indicates the insecurity, which remained unacceptable for the samples to be handled. According to the sample data from

beauty shops in the interior of the municipal area, 11 beauty shops had the risk value was more than 1. In comparison, among samples from the exterior of the municipal area, the range of risk values were from 0.00-1.79 and only 2 samples had risk value of more than 1 was involved. The majority of the beauty shops were located in the municipal area, corresponding with the research by PhornKeaw Leung-amphorn and her team. (Leung-amphorn, et al.2014)

According to this study, it was found that sex, education level, chronic disease, sufficiency of income, experience of danger from chemical substance, business sizes and the management of chemical danger prevention were significantly and statistically different with the p-value of less than 0.05. The above result was in agreement with the study of Jitniran Wonglakorn,(Wonglakorn, 2013). Indicating that the low level of the beauticians' environmental health knowledge was apparent.

Overall, our study provides support that there should be more training on basic toxicology and product safety specifically for the beauticians that applies directly to their working procedure in the real practice. (Bureau of Environmental Health, Department of Health, Ministry of Public Health., 2013). We should support beauty salon management to design and manage working spaces so that they have the appropriate ventilation system. In the future, a prospective cohort study should be conducted to study workers that use beauty products with little or none of these toxic ingredients in their products compared to the usual products used in practice. To improve health conditions in beauty salons, air quality guidelines or a mandatory occupational regulatory framework is needed.

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