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Predictive Model for Better Health Conditions in Nail Salons Worldwide

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Abstract: ***Looking attractive with well-maintained nails has been considered a desirable trait in our society. At times, this care was done at home or in parlours with natural nail paints. Then came the idea of synthetic products, which enhanced the beauty of the nails. Attractive nails soon became associated with successful and confident individuals and were perceived as a direct reflection of someone's personality. Brittle nails or chipped nail paints soon became a thing of the past. However, the effect of nail care has not yet been examined. Personal beauty does not just mean external care, but the need to maintain our healthy body and mind is a must. Through our study, we not only direct the interest of readers towards the hazardous effects of nail salons but also predict a small solution which, if adopted right now, will be beneficial to both customers and the nail salon industry.***

Keywords: nail care, nail salons, health risks, personal grooming, beauty habits

1. Introduction

Scientists and historians around the world have emphasized the importance of physical appearance variation in developing personal and social relationships [1][2]. Many studies have revealed that physically attractive individuals are more competent, successful, and socially adept than less attractive individuals [3][4]. Nail art and Nail beauty is one of the major parts of physical appearance. The commercial cosmetic industry is among the most prevalent groups that have used ways to enhance the perceived attractiveness of women's nails. In modern society, women maintaining nails is considered a daily ritual. Many cosmetics in the market artificially modify the appearance of nails, enabling women to conform to feminine beauty standards. The nail cosmetics industry continues to expand to meet growing consumer demand. Continuous changes in fashion trends and beauty awareness have fuelled the growth of the nail care market. However, studies and observations around the world have a different story to share [5].

Health risks related to Nail salons

In Toronto, researchers established that nail salons have a ton of different things that could affect someone's health (e.g. chemicals, dust, sitting in a particular way for too long). So these researchers decided they want to find out what nail techs can do to stay safe from those factors. Then they gave nail techs a survey asking about age, gender, what they do at work and what precautions they are currently taking to stay safe. From this they found that most nail techs are women, almost everyone did mani pedis and used gloves and masks. They also found that people had pain in their necks and backs and some people had skin and breathing problems. Interestingly they found that people who worked with shellac polish were more likely to have a runny nose. This shows that even though nail techs may be using safety gear they can still face health issues and we need to educate them about the different hazards they're probably facing. Studies have shown the existence of about 29 chemicals that are found in the nail salons and are related to causing damage to the reproductive and endocrine system directly [6][7].

Another study talks about the potential health risks that come with nail care products (zooming in on the chemical ingredients used in nail polishes and their consequences on people's health). They argue that we need to be more aware of these risks and take steps to make nail care safer. It talks about how nail care is super popular and many people want to do it but people (work in nails salons or consumers) don't know about the chemicals that may be harming them. It talks about a "toxic trio" which consists of toluene, DBP and formaldehyde. All three of these are known to be harmful. It also discusses TphP (a chemical that is harmful to hormones). The problem is that many women (who are at a sort of childbearing age) are at an even higher risk because they work in nail salons or themselves use nail care products. The research author suggests that we could use safer ingredients in nail care products instead and even though some products will be labeled "3-free" (implying that this won't have the three "toxic trio" chemicals) it can still have disruptive chemicals. This article also talks about the environmental impact and how education is needed for both workers and consumers. It talks about how chemicals can spread through the air or water or soil and that's not good [8][9][10].

Another detailed study in Michigan showed that some of the common VOS'c are ethyl acetate, propyl acetate, butyl acetate, MMA, n-heptane, and toluene. These were only detected in nail salons around. MMA has many restrictions around it but it was found in most salons, sometimes at very high concentrations. This study wanted to know where these compounds are there and how good or bad the ventilation is in salons. So, what the researchers did is go to 17 salons are collect air samples to measure the VOC concentrations (in the general area and in the personal breathing zones of people receiving nail services). And then they checked the VOC composition of 35 nail products and checked ventilation (like the rate of it) by using carbon dioxide concentrations. What

they found is that MMA (restricted in USA since sometime in 1970) was found in 15 out of 17 salons. And they also found the other VOCs that I listen out above. In the breathing of personal versus general, they found that personal exposure measurements (like the breathing zone) were generally higher than area measurements, suggesting that workers and clients are exposed to higher levels of VOCs that what is measured in general salon air. Since this study was during autumn and winter, they saw that many salons had low ventilation rates (this can lead to a higher concentration of VOC's) and they noticed that some salons did not meet recommended ventilation standards. The study highlights the potential health risks that come along with prolonged exposure to these chemicals (respiratory irritation, neurological symptoms and other not good health effects). The researchers also underscore the need for better controls in nail salons (improved ventilation and restrictions on harmful chemicals) to protect the health of both workers and clients. There needs to be increased awareness and education about the risks associated with these chemicals [11] [12][13].

Common disorders associated with Nail salons

One group of researchers were able to find the types or kinds of chemicals in the air inside nail salons in Salt Lake County in Utah. They also checked the size of the salons and the concentration of carbon dioxide in the air. To do this, they went to 12 randomly chosen nail salons and got air samples for more than 8 hours to observe the chemicals that were present by using special instruments. Also, they checked the size of the salon and the carbon dioxide levels. Then they used math to see if there were any connections between the chemicals and the salon conditions. They found that there's a chemical called methyl methacrylate in more than half of the salons (and this chemical is banned in Utah), they also found formaldehyde was mor than the safe level for over half the salons (this chemical causes respiratory problems and can cause cancer). So, this means that the nail salon workers are inhaling these chemicals, and these chemicals are banned; therefore, the workers are at risk of diseases. So, the nail salons should have better ventilation and more PPE to make the air safer [15][16].

Another study showed that nail technicians are at high risk of developing skin problems because their daily work involves constant exposure to water, detergents, solvents, nail cosmetics, and strong chemicals such as (meth)acrylates used in acrylic and gel nails. The most common condition is hand dermatitis, which may be irritant (from repeated wet work and irritant chemicals) or allergic (from allergens in nail products, fragrances, rubber gloves, or metals). Symptoms can include dryness, itching, redness, blistering, cracking, and in chronic cases can extend to nail changes such as periungual dermatitis, onycholysis, and even nail shedding. The review also notes that workers often experience mechanical injuries (small cuts and abrasions), increased susceptibility to bacterial and fungal infections because of a compromised skin barrier, and UV-related effects from frequent use of UV-curing lamps—though the overall cancer risk from nail lamps is considered minimal. Nail salon workers are especially vulnerable due to poor ventilation, low Personal Protective Equipment (PPE) use, inadequate training, and frequent direct handling of uncured acrylics. The review recommends prevention through the use of nitrile gloves, protective clothing, safer product handling, proper ventilation, UV protection, and consistent skin-care practices such as gentle cleansers and moisturizers. Early diagnosis, avoidance of allergens or irritants, and interventions such as patch-testing and topical treatments are emphasized to manage and reduce occupational skin disease in this high-risk workforce [17].

In a cross-sectional investigation in Vietnam researchers assessed exposure to volatile organic compounds (VOCs) among 100 female nail salon workers across 15 salons and compared their health symptoms to 100 age-matched office workers from nearby workplaces. Personal air-sampling in a subset of 21 workers (using passive samplers) revealed widespread presence of VOCs- most notably acetone (detected in 97.6% of samples), along with butyl acetate, ethyl acetate, and ethyl methacrylate among others. The total concentration of VOCs was found to correlate with the number of customers serviced in a salon, CO_2 levels (a proxy for ventilation / air-exchange), and whether only general ventilation (versus local exhaust) was used. Workers reported significantly more adverse symptoms than the comparison group. Common complaints included headaches, nausea, nose and skin irritation, shortness of breath, and episodes of confusion. Statistical analysis showed increased odds for nail workers versus office workers for headache , nausea , nose irritation, skin irritation, shortness of breath, and confusion. Notably, among workers whose acetone exposure exceeded the adjusted occupational exposure limit (for their long working hours), the risk of nose irritation was markedly elevated. They suggested improving workplace conditions (better ventilation, local exhaust rather than only general ventilation) and use of personal protective equipment (such as masks, gloves, goggles) to reduce harmful exposures [18].

The study done in The United States examined statewide cancer registry data to determine whether women working as cosmetologists or manicurists had a higher incidence of certain cancers compared to the general female population. The researchers found that overall cancer incidence among these workers was *not significantly elevated*, but several site-specific patterns emerged. Female cosmetologists and manicurists showed moderately increased risks for cancers potentially linked to chemical exposures, including lung cancer, laryngeal cancer, and certain hematologic cancers such as multiple myeloma. Some elevated risks were observed for breast cancer and thyroid cancer, though findings were not consistent enough to establish strong associations. The study suggests that long-term, repeated exposure to chemicals in beauty and nail products—such as solvents, formaldehyde, and (meth)acrylates—may contribute to these cancer patterns, but the authors note limitations including lack of individual exposure data and potential confounding factors. They conclude that while overall cancer risk is not markedly increased, specific elevated cancer incidences warrant further investigation into occupational exposures in cosmetology and

nail-care environments [19]. A large retrospective cohort study examined 325,228 female cosmetologists and manicurists licensed in California between 1970 and 2005, linking their license records with cancer registry data to identify invasive cancer diagnoses between 1988 and 2005. Over that period, 9,044 cancer cases were recorded in the cohort. When compared with the general female population of California, the overall cancer incidence among cosmetologists and manicurists was *lower than or similar to* expected. However, when examining site-specific cancers, modestly elevated proportional incidence ratios were found for thyroid cancer among all licensees and lung cancer among manicurists specifically. Despite these observations, the authors concluded there was *no clear overall excess cancer risk* in this workforce. They did, however, caution that their findings could be influenced by limitations such as incomplete demographic data (lack of reliable race/ethnicity information, imperfect tracking of out-of-state migration), and that the workforce was relatively young- meaning many might not yet have reached ages where cancer risk peaks. As a result, they recommended further, longer-term follow-up studies to better assess potential occupational cancer risks in cosmetology and nail-care professionals [20].

2. Results and Discussion

Survey

We surveyed to examine the relationship between nail salons and the health of individuals associated with them directly or indirectly.

Our survey involved mostly the people who go to nail salons on a regular basis. This helped us understand the dynamics better and helped us understand that a conclusive result could be obtained. The chart below shows the number of times our volunteers visited the nail salons.

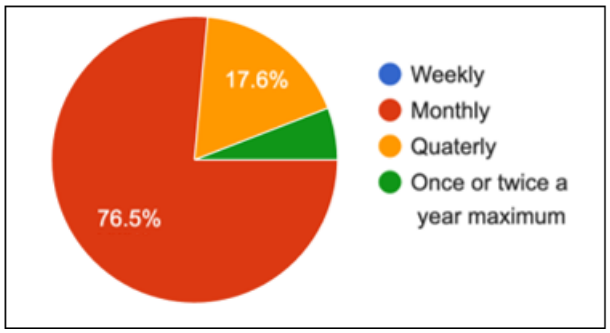

Figure 1: The Figure shows that 76.5% of the volunteers visited these salons on a monthly basis with some also doing it every quarter.

In reference to multiple reviews most of the individuals mentioned a peculiar smell that is associated with these salons. This peculiar smell could be associated with multiple particles which tend to stay in these salons permanently.

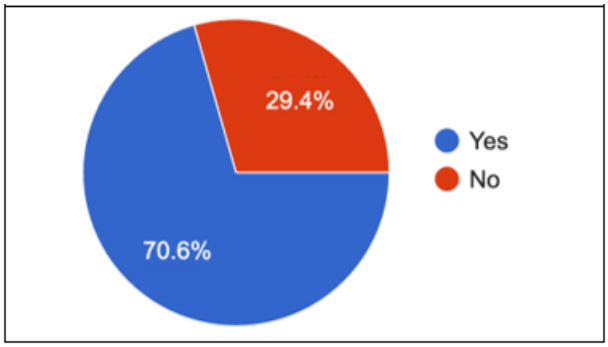

Figure 2: Most of the volunteers mentioned a smell associated with the surroundings of the nail salon

Another major observation was about the ventilation system of the salons. No enquiry about this is done and no mention about the same is ever visible in the salons either.

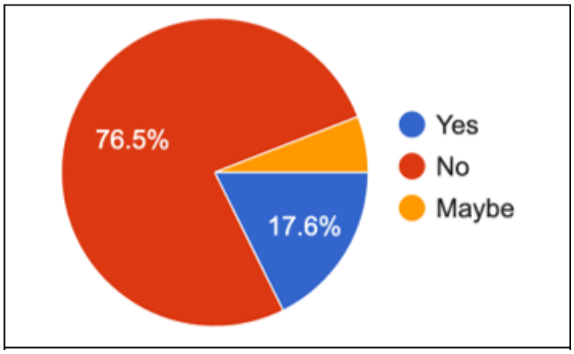

Figure 3: Most of them mentioned about no information about the ventilation system of the salon and nothing was being talked about it

Health of the individuals/ technicians is not looked into either in these salons. The survey showed that there was no enquiry about any regular check planned for these technicians either.

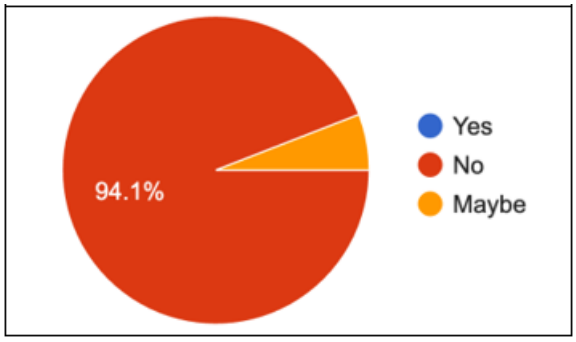

Figure 4: Showing that no information about technician health or upkeep is provided or visible in the salon.

Model for the room

Keeping in mind the harmful effects of irritants used in nail salons and recognizing how their circulation and accumulation over time can contribute to respiratory symptoms, musculoskeletal strain, and long-term occupational health issues, we developed a model that can serve as a benchmark for establishing safer and more responsible salon environments. Nail salons commonly contain airborne

particles from filing, buffing, and acrylic application, as well as volatile organic compounds (VOCs) from solvents and polishes. When these pollutants are not properly ventilated or filtered, they tend to settle on surfaces and linger in the air, increasing the risk of inhalation for both technicians and customers. Over time, this exposure can lead to chronic coughing, nose and throat irritation, eye discomfort, headaches, and, in more severe cases, asthma-like symptoms or allergic reactions. Additionally, poor workstation design often forces technicians into awkward positions, contributing to musculoskeletal problems such as back, shoulder, neck, and wrist pain.

To address these overlapping concerns, our model integrates multiple engineering and ergonomic controls to form a comprehensive safety system. The layout begins with the installation of a HEPA filter or an air curtain at the salon's entry point. This feature ensures that dust particles, polluted air, and external contaminants are not allowed to circulate freely within the workspace. A HEPA filter helps trap fine particles that are often invisible to the naked eye, while an air curtain creates a protective barrier that maintains a clean indoor environment by preventing outside air from flowing inward.

Inside the salon, the model incorporates two wall-mounted fans, represented by circles in the design. These fans are strategically positioned to ensure continuous air circulation, preventing the deposition of dust, acrylic particles, and chemical fumes in stagnant zones of the salon. Proper air movement helps reduce localized pollutant accumulation and supports the functioning of other ventilation devices. To further enhance airflow, two square windows positioned on opposite walls create a natural cross-ventilation system. This ensures a steady exchange of indoor and outdoor air, diluting chemical concentrations and providing a healthier breathing environment for everyone in the salon.

A critical feature of the model is the installation of fitted exhaust units on each working table. These localized exhaust systems directly capture nail dust, fumes, and vapors at the source, minimizing their spread throughout the room. Because most chemical exposures occur in the technician's immediate breathing zone, source-capture ventilation is one of the most effective ways to reduce occupational risk.

Finally, the model recommends the use of a working table equipped with transparent fiber sheets placed vertically between the technician and the client. These sheets contain openings only for the customer's and technician's hands, ensuring that particles generated during filing or drilling are prevented from dispersing freely. This barrier not only limits direct exposure but also adds an additional layer of hygiene and protection.

Collectively, these integrated features form a practical, efficient, and adaptable blueprint that nail salons can adopt to significantly reduce harmful exposures, improve working conditions, and promote long-term health for both workers and clients.

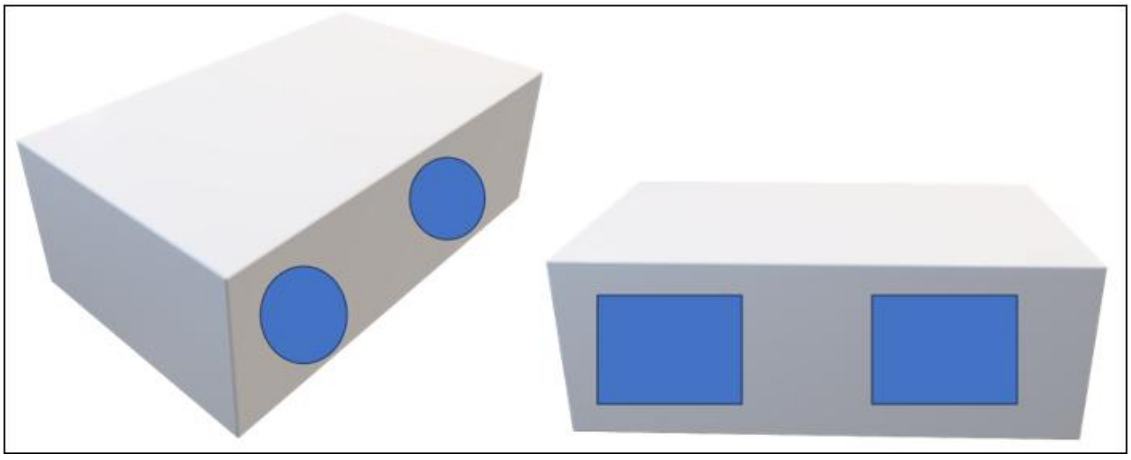

Figure 5: Arrangement of windows and fan area.

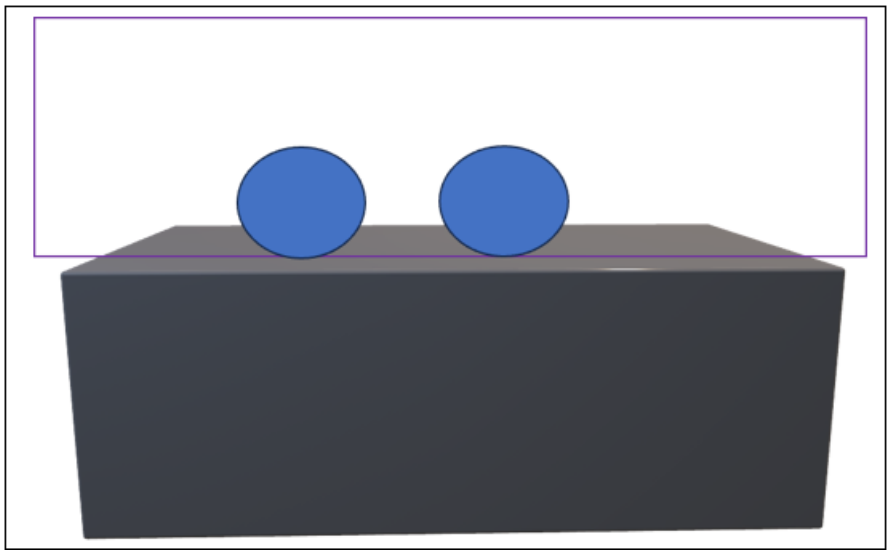

Figure 6: Arrangement of the work bench with a fibre glass for both sides and holes indicate the place to move the hands inside.

3. Conclusion

In conclusion, the survey conducted on nail salons reveals a concerning link between salon environments and various health problems experienced by both workers and clients. The data collected supports the idea that prolonged exposure to chemicals commonly used in nail treatments- such as formaldehyde, toluene, and acetone—can contribute to respiratory issues, skin irritation, headaches, and other health complications [3] [5].

To address these challenges, the model we developed offers a practical and effective solution that benefits both clients and technicians. By integrating the mentioned changes, the model not only raises awareness of potential hazards but also promotes a healthier and safer salon environment. Moreover, the model encourages continuous monitoring of indoor air quality and routine evaluation of chemical usage, helping salons adapt to emerging health standards. It also supports the adoption of training modules that equip staff with the knowledge to identify early signs of chemical sensitivity or exposure-related illness. By promoting a culture of health consciousness and accountability, the model ensures that safety becomes an integral part of daily salon operations rather than an afterthought [11] [14] [16] [21].

Although additional testing, refinement, and long-term monitoring will strengthen its effectiveness, the model already demonstrates significant potential to mitigate occupational hazards within the beauty industry. With broader adoption—especially if supported by training programs, policy guidelines, or regulatory incentives—it could transform standard salon practices, leading to meaningful improvements in worker safety, consumer confidence, and overall public health. Ultimately, the model provides a pathway toward a healthier, more sustainable, and more responsible nail-care industry. These small modifications not only protect today's technicians, who often spend long hours exposed to fumes and fine particulates, but also safeguard future generations by promoting cleaner indoor air and reducing overall chemical burden in communities. When salons adopt safer practices, they set a standard for the beauty industry, encouraging others to follow. As awareness grows, even minor adjustments can create a ripple effect- leading to healthier workplaces, empowered workers, informed customers, and a more sustainable future.

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