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Occupational Exposure To Nail Cosmetic Chemicals And Associated Health Risks

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I. Introduction:

Manicures have a rich cultural history dating back thousands of years. Gilded nails and henna-stained fingertips were discovered on Egyptian mummies going back to 5,000 BC. At the same period, ladies in ancient India used henna to tint their nails, and Babylonian men used kohl. Archaeologists even discovered a solid gold manicure set in southern Babylonia going back to 3,200 BC, which appeared to be part of military equipment, giving the word "war paint" a literal and historical meaning. Manicures have grown from their early origins as emblems of status, artistry, and even military readiness to a multibillion-dollar global industry, with nail salons employing millions of people across the world. The industry's outer beauty conceals a lesser-known reality: Salon staff are constantly exposed to the complex chemicals included in nail polish, gel and acrylic products, and nail hardeners. Formaldehyde, toluene, dibutyl phthalate (DBP), methacrylates, and acetone are just a few of these compounds that may be harmful to the skin, respiratory system, and, in certain situations, general health (*Hazardous Chemicals Found in Nail Salon Products*, 2024). Occupational exposure at nail salons has become a growing public health concern due to the long-term effects of recurrent and prolonged interaction with these compounds. Dermatological diseases such as allergic contact dermatitis and nail matrix damage are among the reported side effects, as are respiratory irritation, asthma-like symptoms, and sensitization. Potential systemic effects, such as neurological, reproductive, and carcinogenic hazards, are also suggested by emerging data (Huan M Tran et al., 2020). Despite the extensive use of nail cosmetic items, comprehensive study into the occupational health risks encountered by nail technicians is still scarce. As a result, the purpose of this work is to critically examine current information on chemical exposures in nail salons and their associated health outcomes, with a particular emphasis on dermatological, respiratory, and systemic impacts, in order to identify gaps that require additional scientific research.

II. Background Information:

Nail salon employees are frequently exposed to a wide range of chemical agents as a result of their daily use of nail cosmetic items. These items include polishes, acrylic and gel systems, nail hardeners, primers, removers, and disinfectants. The most often utilized compounds and their properties are: **Formaldehyde** is a preservative and nail hardener found in polishes and disinfectants. Short-term exposure can irritate the eyes, skin, throat, and respiratory tract, while long-term exposure has been related to cancer and chronic respiratory difficulties. **Toluene** is a solvent in nail polishes and adhesives that causes dizziness, headaches, nausea, and respiratory irritation and, with prolonged exposure, damage to the liver and kidneys. **Methacrylates (Methyl Methacrylate, MMA; Ethyl Methacrylate, EMA)**; acrylic nails and various gel systems rely heavily on certain components. They are sensitizers that can induce skin irritation, allergic contact dermatitis, respiratory issues such as asthma, and neurological symptoms like dizziness and exhaustion. Many countries limit or ban MMA because of its high sensitization potential. **Methacrylic acid** is used in nail primers and acrylic adhesives. Exposure can cause severe skin, eye, nose, and throat irritation, as well as burns at higher concentrations. **Acetone is a** commonly used polish remover and solvent. Short-term contact may induce headaches, dizziness, eye and skin irritation, and respiratory discomfort, particularly in poorly ventilated environments. **Butyl acetate and ethyl acetate** are solvents in polishes and removers. They can irritate the eyes, skin, respiratory tract, and mucous membranes, as well as produce headaches and nausea when inhaled repeatedly. **Acetonitrile** is occasionally found in some glue removers. Can induce breathing difficulty, nausea, weakness, and eye/nose irritation, especially in tight quarters. **Quaternary Ammonium Compounds (Quats)** are surface and tool disinfectants. They can irritate the skin and respiratory system, contributing to occupational asthma in susceptible individuals. **Dibutyl Phthalate (DBP)** is a plasticizer used to keep nail polish from peeling. Exposure can cause skin and eye irritation, respiratory difficulties, hormonal disturbance, and even reproductive consequences. **Other chemicals** such as peroxides, nail dust, and disinfectant residues can accumulate to irritate the skin, eyes, and respiratory tract, especially when protective equipment and sufficient ventilation are not employed. Occupational exposure is generally caused by

the inhalation of vapors and dust, as well as skin contact with moist goods. Employees at nail salons are more likely to experience short-term side effects like headaches, skin irritation, and respiratory discomfort as well as long-term side effects like dermatitis, asthma, reproductive disorders, neurological symptoms, and possible systemic toxicity because of their frequent and prolonged exposure to poorly ventilated environments and their inconsistent use of personal protective equipment (PPE).

III. Literature Review:

Occupational exposure to toxic chemicals in nail salons has arisen as a major public health problem, particularly for nail technicians who are subjected to chronic, low-level exposure throughout long shifts. According to previous studies, nail salon workers are constantly exposed to complex chemical mixes such as volatile organic compounds (VOCs), acrylates, phthalates, aldehydes, and quaternary ammonium compounds, which have been related to a variety of acute and chronic health consequences. These toxins, included in regular salon items including nail polish, acrylic powders, gel systems, adhesives, and disinfectants, are constantly discharged into the workplace during the application, filing, and removal operations (*Worker Health in the Nail Salon Industry*, 2011). According to the literature, short-term inhalation or direct skin contact with chemical vapors during typical salon treatments can cause acute symptoms, including skin sensitization, headaches, eye and throat irritation, and dizziness. Even though they are sometimes written off as mere inconveniences, these initial symptoms are early warning signs of chemical toxicity and may get worse with time. On the other hand, long-term exposure has been associated with more severe and possibly irreversible conditions, such as occupational asthma from repeated airway sensitization, persistent dermatitis from ongoing disruption of the skin barrier, neurological impairment from the neurotoxic properties of solvents like acetone and toluene, and unfavorable reproductive outcomes like irregular menstruation and an increased risk of pregnancy complications. The length of work, daily chemical interaction, and the effectiveness of safety precautions implemented in the salon setting are all strongly correlated with the severity of these long-term impacts. However, differences in technique, demographic emphasis, and regulatory environment between studies have resulted in contradictions in risk assessment and exposure characterization (Scott et al., 2025). Government and regulatory bodies, such as OSHA and WorkSafeBC, provide evidence that many commonly used nail products contain hazardous substances such as formaldehyde, toluene, dibutyl phthalate (DBP), methacrylic acid, methyl methacrylate (MMA), ethyl methacrylate (EMA), acetone, and quaternary ammonia compounds. These organizations emphasize that these compounds cause respiratory irritation, neurological symptoms, dermatological responses, and long-term dangers such as reproductive damage and carcinogenesis. OSHA's hazard evaluations also indicate poor salon ventilation and insufficient personal protective equipment (PPE) use as important variables that increase exposure. While these studies clearly define exposure hazards, they depend heavily on hazard identification rather than direct biomonitoring or longitudinal health outcomes, which limits their capacity to demonstrate causal linkages (Marty, 2007). Epidemiological research, on the other hand, gives more in-depth information about occupational exposure patterns and their health consequences. The environmental and occupational health study of Asian nail salon workers on the East Coast of the United States found that workers had significantly higher levels of volatile organic compounds in salon air, which was strongly associated with reported symptoms such as headaches, dizziness, respiratory irritation, eye discomfort, and chronic fatigue. This study emphasizes the increased risk of immigrant workers, who frequently suffer language challenges, restricted access to safety training, and economic restrictions that limit their capacity to demand better working conditions. This social factor adds an important aspect of occupational health inequity that is generally missing from regulatory systems (Grace X Ma et al., 2019, 1168-1179). The University of Washington's occupational health study supports these findings, revealing an increased prevalence of respiratory illnesses, dermatitis, migraines, musculoskeletal discomfort, and poor reproductive outcomes among nail salon workers. Their analysis of industrial exposure studies shows that airborne dust from acrylic filing and persistent inhalation of solvent vapors both lead to respiratory dysfunction. Notably, their data indicate that musculoskeletal strain interacts with chemical exposure to increase total occupational health risk, demonstrating that nail salons are complex multi-hazard workplaces rather than chemically isolated systems (Health *Hazards in Nail Salons—Chemical Hazards | Occupational Safety and Health Administration*, 2011). The Safety of Nail Products: Health Threats in the Nail Industry (2025) examines toxicological data associating long-term exposure to methacrylates, phthalates, formaldehyde, and toluene with endocrine disruption, reproductive damage, neurological malfunction, and an increased risk of cancer. This research emphasizes the cumulative and synergistic effects of chemical combinations, rather than individual constituent toxicity, reinforcing suggestions that current occupational exposure limits may not accurately represent real-world operating circumstances. While toxicological routes are clearly defined, the review recognizes the limits of long-term cohort research, particularly in female-dominated and immigrant worker groups (*Hazardous Chemical Exposure in Nail Salons*, 2016). In conclusion, available research indicates that nail salon workers are exposed to significant amounts of occupational chemicals, which can cause both acute symptoms and long-term health problems. Future research, on the other hand, must prioritize longitudinal exposure monitoring,

policy assessment, and socioeconomic variables in order to establish complete, evidence-based protective frameworks for this workforce.

IV. Results:

The evaluated research consistently reveals that nail salon workers suffer a wide range of negative health impacts as a result of recurrent occupational exposure to toxic compounds found in nail care products. These effects mostly affect the respiratory system, skin, nervous system, and reproductive health. (*Health Hazards in Nail Salons—Chemical Hazards | Occupational Safety and Health Administration*, 2026)

Respiratory Effects

Respiratory difficulties are among the most commonly reported health issues in nail salon workers. Volatile organic compounds (VOCs) such as formaldehyde, toluene, acetone, and methacrylates first come into contact with the mucous membranes of the nasal cavity and upper airways, triggering localized inflammatory responses such as mucosal irritation, increased mucus secretion, and ciliary dysfunction. The cilia that line the respiratory epithelium, which are normally responsible for trapping and expelling particulate matter and harmful substances, become compromised after repeated chemical exposure, impairing the mucociliary clearance mechanism and making the airways more vulnerable to further damage. As these chemicals travel along the respiratory system, they enter the bronchial and bronchiolar epithelium, causing airway hyperresponsiveness and smooth muscle constriction. Formaldehyde, a recognized respiratory sensitizer, binds to proteins inside the airway mucosa, triggering an immune-mediated hypersensitivity response that presents clinically as occupational (*Hazardous Chemical Exposure in Nail Salons*, 2016).

Dermatological Effects

Skin-related diseases are common among nail technicians due to their constant close contact with nail supplies. Common dermatological conditions include allergic contact dermatitis, eczema, chronic dryness, skin cracking, and nail matrix damage. Frequent exposure to acrylates, solvents, and disinfectants causes skin sensitization, raising the risk of long-term allergic reactions. Workers who do not wear protective gloves or who frequently handle wet materials have a greater incidence of dermatitis and chronic skin irritation (Scott et al., 2025).

Neurological Effects

Nail salon workers who have been exposed to organic solvents frequently experience neurological issues. Short-term side effects include headaches, dizziness, nausea, lethargy, and difficulties concentrating. Workers who have been exposed for an extended period of time may have chronic headaches, decreased memory, a shorter attention span, and persistent fatigue. These effects are mostly related to the inhalation of toluene, acetone, and other solvent vapors, especially in situations with insufficient air circulation (*Common Chemicals Found in Beauty Salons & Their Possible Dangers | VODEX Ltd.*, 2019).

Reproductive and Systemic Effects

Several studies have identified potential reproductive health hazards connected with long-term occupational exposure to nail shop chemicals. Substances like phthalates and toluene have been associated with hormonal disturbance, menstrual irregularities, decreased fertility, and increased risks during pregnancy, including low birth weight and developmental issues in children. Additionally, persistent formaldehyde exposure has been linked to an increased risk of certain malignancies, notably those affecting the respiratory system. Although epidemiological information is lacking, current findings raise serious concerns about long-term systemic health impacts in nail salon workers (*Worker Health in the Nail Salon Industry*, 2011; *Hazardous Chemical Exposure in Nail Salons*, 2016).

Factors influencing exposure:

The severity of health consequences is heavily impacted by working conditions. Poor ventilation, a lack of local exhaust systems, frequent customer turnover, long working hours, and insufficient usage of personal protective equipment all contribute to increased chemical exposure. Workers in small, enclosed salon areas have significantly greater airborne concentrations of hazardous vapors, increasing occupational health concerns.

V. Discussion:

Nail salons have a unique set of chemical, physical, and behavioral dangers that affect worker health. Nail technicians, unlike clients, are constantly exposed to a complicated mixture of solvents, plasticizers, and disinfectants, leaving them susceptible to cumulative health impacts. The study's findings highlight that these hazards are not isolated instances but rather inherent in the regular operations of salons with poor ventilation and

inadequate protective measures. One crucial finding is that health threats are multifaceted. Adverse outcomes in workers are determined not just by the toxicity of particular chemicals, but also by exposure frequency and duration, chemical interactions, and ambient circumstances such as cramped salon spaces and a lack of ventilation. For example, respiratory irritation and dermatitis get worse when workers handle wet acrylics for several hours without gloves or masks, implying that exposure prevention is just as important as product choice. Another major finding is that occupational exposure goes beyond the acute pain. While short-term consequences like eye irritation or headaches are prevalent, long-term exposure can lead to chronic illnesses such as respiratory problems, skin sensitivity, neurological weariness, and even reproductive hazards. This cumulative impact is consistent with the larger occupational health literature, which shows that chronic low-level exposure to volatile organic chemicals and sensitizers frequently results in long-term systemic and dermatological disorders. The study also identifies a gap between knowledge and practice. While there are requirements for ventilation, PPE usage, and safer chemical handling, many salons follow them inconsistently. This shows that employee education, training, and enforceable workplace safety standards are critical for risk reduction. Furthermore, current research frequently focuses on self-reported symptoms and small sample numbers, leaving issues concerning the quantitative link between exposure levels and specific health consequences unaddressed. In summary, nail salon employees encounter complex, cumulative, and systemic occupational hazards. Both structural and behavioral interventions are necessary for the effective mitigation of occupational health risks in nail salons. The most efficient way to reduce airborne chemical exposure before vapors can spread throughout the salon is to install local exhaust ventilation (LEV) systems, which are units placed directly at the nail table and actively draw away chemical fumes at the point of production. Chemical levels in the workplace can be further decreased by using high-quality air filtration systems in conjunction with routine ventilation equipment maintenance when structural changes are not practical. Occupational health authorities must enforce revised exposure limits, conduct routine workplace inspections, and adopt systematic health monitoring programs to detect work-related illness early. Continued study is needed to better understand the long-term cumulative consequences of chemical exposure in this workforce, as well as to ensure that preventative interventions are evidence-based and successful.

VI. Future Research:

In order to reliably measure chemical exposure levels inside salon environments, future research should prioritize direct air and biological monitoring, going beyond the self-reported data that currently predominates in the literature. In order to better understand exposure-response interactions and ascertain the actual long-term health effects of repetitive chemical contact, longitudinal studies that track nail technicians over longer periods of employment would be very beneficial. The comparability and reliability of results would also be significantly increased by standardizing outcome measures across research using objective clinical evaluations such as pulmonary function testing, skin patch tests, and neurological exams. Furthermore, studies should methodically assess how well safety precautions like PPE, ventilation systems, and low-chemical product substitutes reduce health hazards. The generalizability of the results would be further strengthened by broadening the research populations to include other nations, salon sizes, and working methods. This would guarantee that the conclusions reached are representative of the many circumstances in which nail technicians operate around the world.

VII. Conclusion:

Nail salon workers suffer serious occupational health hazards as a result of repetitive exposure to chemical agents included in nail cosmetic items such as formaldehyde, toluene, dibutyl phthalate, methacrylates, acetone, and quaternary ammonium compounds. Chronic inhalation and cutaneous contact can result in a variety of negative health effects, including respiratory, dermatological, neurological, and reproductive issues. These effects are frequently cumulative, aggravated by inadequate ventilation, lengthy working hours, and inconsistent use of personal protective equipment. This study emphasizes the need for using preventative techniques to reduce occupational dangers. Proper PPE usage, the use of safer goods, proper ventilation, and worker education on chemical hazards may dramatically minimize both short-term and long-term health consequences. Despite current information, there are still gaps in the quantitative evaluation of exposure, long-term systemic effects, and reproductive hazards. Future research should include longitudinal designs, air and biological monitoring, and standardized clinical evaluations to better understand the long-term effects of chronic chemical exposure. To summarize, protecting nail salon workers necessitates a mix of workplace interventions, evidence-based safety procedures, and ongoing scientific research to ensure both worker well-being and the survival of the nail care sector.

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