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Emerging Trends in Gel Nail Allergies: Prevalence, Symptoms, and Occupational Hazards Associated with Acrylate Sensitization

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Abstract

Introduction and objective

Gel nail allergies have become a growing concern in recent years, as individuals experience adverse immune reactions to the chemicals present in gel nail products. The popularity of gel nails, known for their long-lasting and durable finish compared to traditional nail polishes, has increased in the beauty industry. However, specific constituents, particularly acrylate compounds used in gel nail formulations, can trigger allergic responses in susceptible individuals.

Abbreviated description of the state of knowledge

Findings from the reviewed articles indicate that allergic reactions to acrylates in gel nail products can manifest in various ways, including contact dermatitis, dermatoses, and general allergic responses. Nail technicians, due to their frequent exposure to gel nail products and other potential allergens, are particularly vulnerable to occupational hazards associated with acrylate sensitization. These insights highlight the need for preventive measures to protect the health and well-being of nail technicians and promote a safer working environment.

Summary

This literature review addresses the emerging issue of gel nail allergies and provides valuable information regarding the prevalence and characteristics of allergic reactions to acrylates. The article underscores the significance of increasing awareness, implementing preventive measures, and effectively managing gel nail allergies. By doing so, the beauty industry can ensure a safer approach to gel nail applications, benefitting both nail technicians and consumers alike.

Keywords: Gel nail allergies, Allergic contact dermatitis, Acrylates, Occupational hazards, Nail technicians, Gel nail products

1. Introduction

Allergic reactions can occur when an individual's immune system negatively responds to foreign substances present in the environment [1] . In recent years, allergic reactions to

acrylates and their derivatives found in gel nail polishes and nail adhesives have become a concerning issue.

Gel nails have gained popularity in manicures due to their long-lasting and durable finish compared to traditional nail polish [2]. Acrylates, such as methacrylates and cyanoacrylates, are essential components that create the strong and durable bond responsible for the extended longevity of gel nails. However, individuals with sensitivities may experience various allergic reactions when exposed to these chemicals, including allergic contact dermatitis, various dermatoses, and general allergic reactions [1,3–7].

Nail technicians are particularly susceptible to occupational hazards due to their daily exposure to various chemicals and tools used in nail cosmetic procedures [8]. Their profession puts them at risk of developing allergic reactions and skin conditions due to frequent contact with gel nail products and other potential allergens.

As gel nails continue to be a popular choice among consumers, it is crucial to raise awareness about the potential risks associated with acrylate allergies and the importance of proper protective measures for nail technicians to minimize the occurrence of allergic reactions and promote a safer work environment.

2. Aim of the study

The aim of this scientific study is to investigate gel nail allergies and occupational risk of beauticians in the field of nail technics. The study aims to identify the common symptoms and manifestations of gel nail allergies, with a specific focus on adverse immune responses triggered by acrylate compounds present in gel nail formulations. Additionally, the study seeks to explore preventative measures to mitigate the occurrence of allergic reactions and enhance the safety and awareness surrounding gel nail applications in the beauty industry.

3. Materials and methods

Search Strategy: A comprehensive literature search was conducted to identify relevant articles on gel nail allergies. Electronic databases, including PubMed and Google Scholar, were searched using a combination of keywords gel nail allergies, allergic contact dermatitis, acrylates, occupational hazards, nail technicians, gel nail products.

Inclusion and Exclusion Criteria: Articles were included if they focused on gel nail allergies, allergic reactions to acrylates in gel nail products, and related topics. Studies that examined allergic contact dermatitis, skin reactions, and occupational hazards among nail technicians were also considered. Articles that were not available in English, Polish, French and lacked relevant data were excluded from the review.

Data Extraction: The selected articles were carefully reviewed, and relevant data were extracted. Information on study design, sample size, study population, methods of allergen testing, identified allergens, symptoms of gel nail allergies, and preventive measures were recorded.

Data Analysis: The extracted data were analyzed to identify common themes, trends, and patterns related to gel nail allergies. Key findings from each study were summarized and compared to determine the prevalence and characteristics of gel nail allergies and associated risk factors.

Quality Assessment: The quality of each included study was assessed using established criteria, such as study design, sample representativeness, and data analysis methods. Studies with higher methodological rigor were given more weight in the review.

Synthesis of Findings: The findings from the reviewed articles were synthesized to provide a comprehensive overview of the prevalence, symptoms, and risk factors associated with gel nail allergies. Key insights and knowledge gaps were highlighted to guide future research and recommendations for preventive measures.

4. Discussion

4.1. Cosmetic Nail Products

Nail cosmetic products encompass a wide range of items used to enhance the appearance and health of nails [1] . These products are popular among both professional nail salons and individuals who do their manicures and pedicures at home. Artificial nails are widely used to enhance the length, strength, and appearance of natural nails. There are several types of artificial nails, each with its unique characteristics and application methods [2,9].

4.1.1. Nail polish. Nail polish is the most well-known and widely used nail cosmetic product [2,9] . It comes in various colors and finishes, allowing individuals to express their style and

creativity. Nail polish typically consists of a combination of film-forming agents, such as alkyl esters and glycol esters, pigments, solvents, and plasticizers [10].

There are different types of nail polishes, such as regular nail polish, gel polish, and hybrid polishes like shellac [2,7,9,10]

4.1.2. A base coat is a clear or slightly tinted layer applied before the colored nail polish [10]. It helps create a smooth surface for the polish to adhere to, prevents staining of the natural nails, and enhances the longevity of the manicure. The bases contain more resin in order to increase the adhesion of the nail polish and more fixing lacquers supplemented with UV-agents to increase the resistance and protect the layer.

4.1.3. The top coat is applied on top of the colored nail polish to add shine, protect the manicure, and extend its wear [2] . Some top coats are quick-drying and provide a glossy finish, while others may have a matte or gel-like appearance.

4.1.4. Nail polish remover is used to take off old nail polish [2]. It usually contains acetone or non-acetone solvents, with acetone being more effective in removing stubborn nail polish but potentially more drying to the nails and skin.

4.1.5. Acrylic nails are one of the most popular and enduring types of artificial nails [2,8,10]. They are created by mixing a liquid monomer such as methyl-, ethyl- or isobutyl methacrylate monomer with a polymethyl or ethyl methacrylate powdered polymer to form a thick, malleable paste. Nail technicians then apply the paste onto the natural nail or a nail form (a mold) to shape and extend the nails. Acrylic nails harden when exposed to air, creating a durable and long-lasting artificial extension. They can be customized with various nail polish colors or nail art designs.

4.1.6. Gel nails are another popular option for artificial nails [2,8,9] . They are made from (meth)acrylates, which are applied over the natural nail or used to sculpt extensions. The gel is then cured or hardened using a UV or LED light. Gel nails provide a natural-looking finish with a glossy appearance. There are two main types of gel nails: hard gel, which offers added strength, and soft gel, which is more flexible and suitable for natural nail overlays.

4.1.7. Shellac nails are a hybrid nail product that combines the characteristics of gel nails and traditional nail polish [2,7] . It is a brand-specific product that involves applying a base coat,

colored polish, and a top coat, all of which are cured under a UV or LED light. Shellac nails offer a chip-resistant and glossy finish, lasting longer than regular nail polish but not as long-lasting as traditional gel nails or acrylics.

4.1.9. Press-on nails are pre-made artificial nails that come with adhesive glue already applied to the nail [7,9,10] . The surface of the nails is sanded. After disinfection, a cyano-acrylate glue fixes the fabric to the nail. This method is often used to repair damaged nails or add strength to weak nails. Once applied, the material is coated with resin or gel to create a smooth and polished surface.

4.2 Associated Allergens

Nail cosmetic procedures can lead to allergic reactions or skin irritation due to the presence of certain allergens and irritants [11] . The British Association of Dermatologists has issued warnings regarding the dangers of chemicals found in nail cosmetics. The retrospective analysis of patch testing results conducted on individuals diagnosed with contact dermatitis (CD) due to nail cosmetic ingredients revealed the most frequently occurring positive reactions to specific chemicals [3].

4.2.1 Acrylates are chemicals found in gel nail products, acrylic nails, and some nail adhesives. Hydroxyethyl Methacrylates (HEMA), Methyl Methacrylate and Ethyl Acrylate are commonly used in these products and resulted to be the most allergenic in the study (56.6%, 27.8% and 25.2%, respectively) [3] . Some individuals may develop contact dermatitis or allergic reactions to these chemicals, especially if they come into prolonged or repeated contact with the skin and are cross-reactive with one another [12].

An EECDRG (European Environmental Contact Dermatitis Research Group) study revealed 136 cases of allergic contact dermatitis (ACD) caused by nail acrylates, diagnosed through targeted testing [4] . This accounted for approximately 67% of all cases of (meth)acrylate allergy observed between the years 2013 and 2015. The study identified the main allergens responsible for these reactions, with 2-hydroxyethyl methacrylate (2-HEMA) showing a positivity rate of 91.9%, followed by hydroxypropyl methacrylate with 83.2% positivity, and ethylene glycol dimethacrylate at 69.2% positivity.

The monomer commonly used in nail cosmetic procedures is typically a methacrylate monomer. Initially, methyl methacrylate (MMA) was frequently employed in these products.

However, due to the occurrence of severe cases of contact dermatitis associated with MMA exposure, its use has been restricted in the United States and Europe [13]. To address safety concerns, regulations were implemented in the United States, which led to the prohibition of products with 100% MMA monomer. Additionally, in Europe, many products containing over 90% MMA monomer were recalled preventing potential adverse health effects [14].

4.2.2 Formaldehyde is a preservative and hardening agent found in some nail hardeners and nail polishes [15]. It can cause skin irritation and allergic reactions, and long-term exposure may pose health risks. There has been a decline in sensitization to tosylamide/formaldehyde resin, a common ingredient found in "classical" nail polish, while the incidence of (meth)acrylate-related allergic contact dermatitis (ACD) has been on the rise [16].

3.2.3 Parabens are preservatives used in some nail products to extend their shelf life [17]. They have been linked to skin irritation and may cause allergic reactions in sensitive individuals. They are very weak allergens with a sensitization prevalence of arounf 1% or less.

4.3. Allergic Contact Dermatitis

The most studied adverse effect of methacrylate monomers in the gel polish is allergic contact dermatitis (ACD) [18]. Recently, the incidence of allergic contact dermatitis associated with nail cosmetics has increased among beauticians and customers, particularly with the rising popularity of photo-bonded acrylic gel nails[19].

ACD caused by (meth)acrylates is commonly observed in specific occupational groups, including beauticians such as nail technicians, dental personnel (dentists and technicians), and employees working in industries involved in fiberglass, printing, glue, or paint manufacturing [1]. These professionals are at an increased risk of developing allergic reactions to (meth)acrylates due to their frequent and direct exposure to products containing these compounds in their work environments.

Gatica-Ortega et al. (2017) presented a picture of a typical patient with ACD caused by methacrylates in artificial nails as a young, non-atopic woman, who works as a nail technician and suffers from hand and face dermatisis [18]. They used MOAHFLA index, which is the acronym for male, occupational dermatitis, atopic dermatitis, hand dermatitis, leg dermatitis, face dermatitis, and age >40 years. Among the 1.82% patients with ACD of 2353 studied, the most frequently positive allergens were HPMA (positive reactions observed in almost all

patients except one), HEMA, and THFMA. Only one patient had negative patch test results for both HPMA and HEMA. Patch testing with both HPMA and THFMA would have ensured that no patients with (meth)acrylate allergies were missed.

Interestingly, these three allergens, HPMA, HEMA, and THFMA, were also the most identified (meth)acrylate compounds listed on the labels of the products used by the patients. This correlation between positive patch test results and the presence of these allergens in the products suggests the importance of identifying and labeling these compounds accurately to aid in diagnosing and managing allergic contact dermatitis caused by (meth)acrylates.

The risk of developing allergic contact dermatitis to nail cosmetics is higher in individuals who have previously been sensitized to these allergens. Sensitization can occur through repeated or prolonged exposure to these chemicals, leading the body's immune system to recognize them as harmful substances and trigger an allergic reaction upon subsequent exposure [20]. The nail technicians are under the highest risk of allergies.

The retrospective study conducted by the European Environmental Contact Dermatitis Research Group (EECDRG) revealed significant insights into acrylate-induced allergic contact dermatitis (ACD) [4].

Authors showed that an overwhelming 67% of ACD cases attributed to acrylates were caused by materials used in nail stylization. Among the affected individuals, 43% were exposed as consumers using nail cosmetic products, while 56% were exposed occupationally, primarily referring to nail technicians who handle these products regularly.

A notable finding from the study was that 65% of the cases of occupational ACD were identified within the first year of starting work. This indicates a high sensitizing potency of acrylate chemicals, as the allergic reactions were detected relatively early in the occupational exposure. It highlights the importance of recognizing the risks associated with acrylate exposure in the workplace and the need for preventative measures to protect the health of professionals working in nail stylization.

Symptoms of allergic contact dermatitis may include redness, itching, swelling, and blistering around the nail area or on the skin exposed to the nail products [4,21]. In severe cases, the reaction may spread to other parts of the body that encountered the allergen, leading to widespread dermatitis.

4.5.1. Diagnosis

Patch testing is considered the gold standard in confirming the diagnosis of allergy to acrylates [1]. During the procedure, small amounts of potential allergens, including acrylate compounds, are applied to patches that are then placed on the patient's back. The patches are left in place for a specific time, usually around 48 hours. After this period, the patches are removed, and the skin is carefully examined for any signs of allergic reactions.

If a patient is allergic to acrylates, the patch test will reveal a positive reaction in the form of redness, swelling, or rash at the site of exposure to the acrylate allergen. This positive result confirms the diagnosis of acrylate allergy and helps the healthcare provider to identify the specific acrylate compounds to which the patient is sensitive.

Acrylate allergies can sometimes be polyvalent, meaning patients may exhibit positive patch test reactions to multiple acrylate compounds even if they have not been directly exposed to all those substances individually [20]. This phenomenon is often attributed to cross-reactions between different acrylic monomers and concomitant allergies.

4.4. Additional Risk

Allergies to gel nail chemicals are more likely to occur if gel polish isn't accurately or sufficiently cured under a UV or LED lamp during the manicure, leading to skin sensitization [2]. The British Association of Dermatologists has urged caution with at-home gel nail kits, as improper curing and exposure to acrylates can cause allergic reactions [22–24].

Acrylates are not only present in nail cosmetics but have a wide application in various medical purposes, such as dental ligatures, soft contact lenses, endoprostheses, hearing aids and medical devices for diabetes patients [25–28].

As a result, individuals who have previously developed allergic contact dermatitis (ACD) to acrylates from artificial nails may experience allergic reactions upon re-exposure to acrylates in these other materials. Moreover, cross-reactions with other acrylic monomers may occur, leading to additional allergic responses [20].

For individuals with ACD to acrylates in artificial nails, it is essential to exercise caution when using other products that contain acrylates. However, it has been reported that those

who are not allergic to ethyl cyanoacrylate, which is present in all nail glues, can safely use silk wrap nails as an alternative [5]. This option provides a potentially safer choice for nail enhancements without the risk of triggering allergic reactions caused by acrylates in artificial nails.

4.5. Adverse effects of artificial nails

4.5.1. Localized paronychia

Paronychia is a common condition characterized by inflammation of the skin around the nails, usually affecting the fingers more than the toes [7]. It can be caused by various factors, including bacterial or fungal infections, trauma, or irritants.

When it comes to gel nails, paronychia can sometimes occur as a result of improper nail preparation, application, or maintenance [6]. If the natural nail surface is not adequately cleaned, sanitized, and dehydrated before gel application, bacteria and fungi may thrive, leading to an infection around the nail. If the gel product is not applied evenly or if there are air pockets or gaps between the gel and the natural nail, it can create a space where bacteria or fungi can accumulate. Frequent and prolonged use of gel nails without sufficient breaks can weaken the natural nail and make it more susceptible to infections. If the gel nails are not removed properly, the nail bed may be damaged, leaving it vulnerable to infection.

4.5.2. Nail dystrophy

Nail dystrophy and pseudo-psoriatic nails have been observed in individuals who wear acrylic nails [29]. The clinical features of this condition, such as onycholysis (nail detachment from the nail bed) and severe subungual hyperkeratosis (excessive thickening of the nail bed), can closely resemble those seen in psoriatic nails. This resemblance has led to misdiagnoses and incorrect treatments, with some cases being treated with topical or intralesional corticosteroids or even immunosuppressants, especially if there is coincident joint pain. The authors have observed that the origin of pseudo-psoriatic nails was prior to the removal of acrylic nails. Patch testing in these patients revealed positive reactions to methylmethacrylate, indicating that sensitization to acrylates may be responsible for this clinical phenotype.

Heller's canaliform dystrophy is a longitudinal, median channel or temporary crack, splitting the free edge of the nail [10]. The lesion usually is localized on the thumbs. The origin is

usually traumatic removal of firmly attached artificial nails, triggering the phenomenon of Koebnerization. Partial transverse occur more likely than total section of the distal end of the nail.

4.5.3. Onycholysis

Onycholysis is a condition where the nail plate separates or lifts from the nail bed, leading to a visible gap between the two [2]. This separation occurs at the distal or lateral edges of the nail and can progress proximally. Onycholysis can be caused by various factors, including trauma, fungal infections, psoriasis, thyroid disorders, and the use of certain medications.

When it comes to gel nails, onycholysis can be a potential concern if the gel nail application is not done correctly or if proper aftercare is not followed [7].

Gel nails are a type of artificial nail enhancement that involves the application of a gel-based product to the natural nail, which is then cured under a UV or LED lamp to harden and create a durable and glossy finish. Improper gel nail application or excessive filing during the process can damage the nail plate and cause onycholysis. If the gel product is not applied evenly or if air is trapped between the gel and the natural nail, it can lead to lifting and separation of the gel layer from the nail bed.

4.5.4. Worn down nails

Worn-down nail syndrome is characterized by a triangular area of significant nail thinning, with the base located at the free edge of the nail [30] . The main reason is chemical or mechanical trauma. Dermoscopy of affected nails may reveal pinpoint hemorrhages and dilated capillaries. Recently, Wu et al. identified a new cause of worn-down nail syndrome resulting from trauma caused by nail filing to remove acrylic nails [30].

Treatment for this condition primarily involves discontinuing the behavior responsible for the repetitive trauma to the nail plate. By avoiding further nail filing and minimizing any additional damage to the nail, the condition can improve and the nail may gradually recover.

4.6. Skin lesions associated with UV nail lamps

Skin lesions induced by UV nail lamps have been a subject of concern in the beauty and nail salon industry [31]. UV nail lamps are used in gel nail applications to cure and harden the gel

polish, providing a long-lasting and glossy finish. However, there have been reports of potential skin damage associated with the use of these lamps [32]. The main concern is the exposure to UV radiation emitted by these lamps. UV radiation can cause various skin issues, including photodamage, skin cancer risk and allergic reactions [33].

4.6.1. Photodamage: Prolonged exposure to UV radiation from nail lamps can lead to photodamage, which includes premature aging of the skin, wrinkles, and age spots [34].

4.6.2. Skin Cancer Risk: UV radiation is a known risk factor for skin cancer, including squamous cell carcinoma and melanoma. Three cases of squamous cell carcinoma (SCC) have been reported in association with UV nail lamp exposure [33,35]. In these cases, there was a considerable delay between UV exposure and the diagnosis of SCC, ranging from 11 to 15 years. Frequent and prolonged exposure to UV rays from nail lamps may increase the risk of developing skin cancer, especially in individuals with a history of sun sensitivity or previous skin cancer.

4.6.3. Allergic Reactions: Some individuals may experience allergic reactions to UV radiation, leading to redness, itching, and swelling around the nails and surrounding skin [36].

4.7. Occupational Hazard

In the past, the most common exposures to (meth)acrylates were associated with various manufacturing industries, including printing, painting, coating, metallurgical industries, and dentistry [1,25,28,37]. These compounds were found in floor waxes, floor coatings, and surface treatments of leather, textiles, and paper products.

Occupational allergies to (meth)acrylates have been frequently observed among dental personnel since 1990s [1,25]. Dental staff are exposed to numerous materials that can act as potential contact allergens, such as uncured plastic resins, particularly acrylic monomers like acrylates, methacrylates, urethane acrylates, and epoxy acrylates. These substances are commonly used in dentistry for prostheses, dentin bonding materials, and glass ionomers [25,38].

Nail technicians face several occupational hazards due to their daily exposure to various chemicals and tools used in nail cosmetic procedures. Studies have shown that nail technicians may be more susceptible to sensitization compared to customers [8]. Sensitization

to compounds found in nail polishes, gels, acrylics, and adhesives can occur through accidental skin contact or long-term ambient exposure [20,25,38].

The typical features of methacrylate allergy are allergic contact dermatitis, skin irritation, respiratory issues. When filing and shaping nails, fine dust and fumes can be generated, which technicians can inhale. Air quality in nail salons has been analyzed, and it has been found that volatile organic compounds, like formaldehyde and (meth)acrylates, can exceed recommended exposure limits [39]. In certain cases, acrylates can cause involvement of the face and eyelids when airborne particles of these substances encounter the skin. Additionally, allergens can be transported through contaminated tools or hands, leading to skin reactions on the face and eyelids [18,24].

Respiratory hypersensitivity can be triggered by acrylates, resulting in symptoms such as wheezing, asthma, or rhinoconjunctivitis [40]. Inhaling acrylate particles or fumes can irritate the respiratory system, leading to respiratory allergies and discomfort in affected individuals. Neurocognitive and neurosensory deficits have also been observed, possibly due to exposure to neurotoxic substances like methacrylates [41].

4.8. Occupational prevention

To mitigate occupational hazards, it is essential for nail technicians and salon owners to take appropriate measures, such as increased ventilation, regular air content analysis, and careful inspection of nail product ingredients [8,39,42].

Nail technicians should wear gloves made of nitrile or neoprene to protect their skin from chemical exposure. Morgado et al. (2019) recommended a specific protocol for the use of nitrile gloves in situations involving exposure to methacrylates [43]. According to their suggestion, technicians should use nitrile gloves for a maximum of 30 minutes during a procedure, and if the procedure is not completed, they should change their gloves. They observed that during prolonged exposure to (meth)acrylates, these chemical compounds have the potential to diffuse from the nail gel. This diffusion may lead to an increased risk of developing dermatitis or other allergic reactions on the skin, particularly in those who are sensitive or prone to (meth)acrylate allergies.

Masks and goggles can also help reduce inhalation of dust and fumes [21]. Salons should have proper ventilation systems to minimize exposure to airborne particles and fumes. Nail

technicians should receive training on proper handling of chemicals, equipment, and hygiene practices to reduce the risk of accidents and exposure. Good hygiene practices should be maintained, including regular handwashing and disinfection of tools and work surfaces.

To reduce the risk of skin lesions induced by UV nail lamps, nail salons and users can consider using LED lamps, wearing UV-protective gloves, limiting exposure time, applying SPF creams and controlling skin regularly [44,45] . LED lamps emit less UV radiation compared to traditional UV nail lamps, making them a safer option for gel nail applications. Nail technicians and clients can wear special UV-protective gloves during gel nail applications to shield the hands and skin from UV exposure. Reducing the exposure time under the UV lamp during gel nail applications can help minimize the risk of UV-related skin damage. Applying sunscreen with broad-spectrum protection to the hands and surrounding skin before gel nail applications can provide additional protection against UV radiation [45]. Individuals who frequently undergo gel nail treatments should be vigilant about monitoring their skin for any changes and seek medical attention if they notice any unusual skin lesions or signs of damage.

5. Conclusions

Gel nail allergies present a significant concern in the beauty industry, considering the increasing popularity of gel nails and the potential for adverse immune responses to acrylate compounds. This study has shed light on the common symptoms and manifestations of gel nail allergies, with a focus on allergic contact dermatitis. The implementation of preventative measures, such as patch testing and using hypoallergenic alternatives, is crucial to ensure safer and more informed gel nail applications.

Furthermore, limiting prolonged exposure to gel nail products and UV nail lamps can contribute to enhancing the safety and awareness surrounding gel nail applications. By adopting these practices, nail technicians and clients can enjoy gel nails without compromising nail health and overall well-being. Continued research and awareness are essential to improve the safety and efficiency of gel nail procedures, ultimately benefiting both the beauty industry and consumers.

Authors’s contribution

Conceptualization, PZ, and JZ; methodology, JZ; software, RZ; check, PZ, JZ and DA; formal analysis, IŁ; investigation, PZ, JZ, RZ, DA, EG; resources, RZ and DA; data curation, PZ; writing - rough preparation, PZ and JZ; writing - review and editing, PZ, JZ, RZ, DA, IŁ, EG. All authors have read and agreed with the published version of the manuscript.

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References
1. Kucharczyk M, Słowik-Rylska M, Cyran-Stemplewska S, Gieroń M, Nowak-Starz G, Kręcisz B. Acrylates as a significant causes of allergic contact dermatitis – new sources of exposure. Advances in Dermatology and Allergology 2021;38:555–60. https://doi.org/10.5114/ada.2020.95848.
2. Dinani N, George S. Nail cosmetics: a dermatological perspective. Clin Exp Dermatol 2019;44:599–605. https://doi.org/10.1111/ced.13929.
3. Warshaw EM, Voller LM, Silverberg JI, DeKoven JG, Atwater AR. Contact Dermatitis Associated With Nail Care Products: Retrospective Analysis of North American Contact Dermatitis Group Data, 2001–2016. Dermatitis 2020;30:191–201.
4. Gonçalo M, Pinho A, Agner T, Andersen KE, Bruze M, Diepgen T, et al. Allergic contact dermatitis caused by nail acrylates in Europe. An EECDRG study. Contact Dermatitis 2018;78:254–60. https://doi.org/10.1111/cod.12942.

5. Conde-Salazar L, Díaz Martínez B, Valks R, Elena Gatica M. Dermatitis alérgica de contacto profesional por uñas artificiales. Piel 2004;19:261–4. https://doi.org/10.1016/S0213-9251(04)72848-8. [Spanish]
6. Iorizzo M, Pasch MC. Bacterial and viral infections of the nail unit: Tips for diagnosis and management. Hand Surg Rehabil 2022. https://doi.org/10.1016/j.hansur.2022.11.006.
7. Reinecke JK, Hinshaw MA. Nail health in women. Int J Womens Dermatol 2020;6:73–9. https://doi.org/10.1016/j.ijwd.2020.01.006.
8. Arora H, Tosti A. Safety and Efficacy of Nail Products. Cosmetics 2017;4:24. https://doi.org/10.3390/cosmetics4030024.
9. Madnani NA, Khan KJ. Nail cosmetics. Indian J Dermatol Venereol Leprol 2012;78:309–17.
10. Baran R, Goettmann S, André J. Cosmétiques unguéaux. Ann Dermatol Venereol 2016;143:389–96. https://doi.org/10.1016/j.annder.2016.01.005. [French]
11. Sainio E-L, Engström K, Henriks-Eckerman M-L, Kanerva L. Allergenic ingredients in nail polishes. Contact Dermatitis 1997;37:155–62. https://doi.org/10.1111/j.1600-0536.1997.tb00189.x.
12. Lee H, Pokorny C, Law S, Pratt M, Sasseville D, Storrs F. Cross-reactivity among epoxy acrylates and bisphenol F epoxy resins in patients with bisphenol A epoxy resin sensitivity. American Journal of Contact Dermatitis 2002;13:108–15. https://doi.org/10.1053/ajcd.2002.34595.
13. FDA: Silver Spring. Methacrylate Monomers in Artificial Nails (“Acrylics”). US Food and Drug Administration, USA: 2016.
14. Insight into Cosmetics Recalls Since EU Cosmetic Regulation Implementation. SGS (Société Générale de Surveillance), Geneva, Switzerland: 2014.
15. Linauskiene K, Isaksson M. Allergic contact dermatitis from formaldehyde mimicking impetigo and initiating rosacea. Contact Dermatitis 2018;78:359–61. https://doi.org/10.1111/cod.12944.
16. Lee S, Maor D, Palmer A, Nixon RL. Declining prevalence of allergic contact dermatitis caused by toslyamide/formaldehyde in nail polish. Contact Dermatitis 2018;79:184–5. https://doi.org/10.1111/cod.13020.
17. Fransway AF, Fransway PJ, Belsito D V., Warshaw EM, Sasseville D, Fowler JF, et al. Parabens. Dermatitis 2019;30:3–31. https://doi.org/10.1097/DER.0000000000000429.
18. Gatica-Ortega M-E, Pastor-Nieto M-A, Mercader-García P, Silvestre-Salvador J-F. Allergic contact dermatitis caused by (meth)acrylates in long-lasting nail polish - are we

facing a new epidemic in the beauty industry? Contact Dermatitis 2017;77:360–6. https://doi.org/10.1111/cod.12827.
19. Le Q, Cahill J, Palmer-Le A, Nixon R. The rising trend in allergic contact dermatitis to acrylic nail products. Australasian Journal of Dermatology 2015;56:221–3. https://doi.org/10.1111/ajd.12311.
20. Lazarov A. Sensitization to acrylates is a common adverse reaction to artificial fingernails. Journal of the European Academy of Dermatology and Venereology 2007;21. https://doi.org/10.1111/j.1468-3083.2006.01883.x.
21. Kieć-Świerczyńska M, Świerczyńska-Machura D, Chomiczewska-Skóra D, Kręcisz B, Walusiak-Skorupa J. Screening survey of ocular, nasal, respiratory and skin symptoms in manicurists in Poland. Int J Occup Med Environ Health 2017. https://doi.org/10.13075/ijomeh.1896.00961.
22. https://www.bad.org.uk/dermatologists-reiterate-artificial-nails-warning-and-risk-of-at-home-kits/ n.d.
23. https://www.bad.org.uk/dermatologists-issue-warning-about-uk-artificial-nail-allergy-epidemic/ n.d.
24. Gatica-Ortega M-E, Pastor-Nieto M-A, Gil-Redondo R, Martínez-Lorenzo E-R, Schöendorff-Ortega C. Non-occupational allergic contact dermatitis caused by long-lasting nail polish kits for home use: 'the tip of the iceberg.' Contact Dermatitis 2018;78:261–5. https://doi.org/10.1111/cod.12948.
25. Heratizadeh A, Werfel T, Schubert S, Geier J. Contact sensitization in dental technicians with occupational contact dermatitis. Data of the Information Network of Departments of Dermatology (IVDK) 2001-2015. Contact Dermatitis 2018;78:266–73. https://doi.org/10.1111/cod.12943.
26. Sidhu S, Shaw S. Allergic contact dermatitis to acrylates in disposable blue diathermy pads. Ann R Coll Surg Engl 1999;81:187–90.
27. Herman A, de Montjoye L, Tromme I, Goossens A, Baeck M. Allergic contact dermatitis caused by medical devices for diabetes patients: A review. Contact Dermatitis 2018;79:331–5. https://doi.org/10.1111/cod.13120.
28. PiirilÄ, Kanerva, Keskinen, Estlander, HytÖnen, Tuppurainen, et al. Occupational respiratory hypersensitivity caused by preparations containing acrylates in dental personnel. Clinical & Experimental Allergy 1998;28:1404–11. https://doi.org/10.1046/j.1365-2222.1998.00400.x.

29. Adigun C, Shoaf H. Psoriasiform Onychodystrophy Induced by Photobonded Acrylic Nails. J Clin Aesthet Dermatol 2020;13:18–20.
30. Wu TP, Morrison BW, Tosti A. Worn down nails after acrylic nail removal. Dermatol Online J 2015;21. https://doi.org/10.5070/D3211025449.
31. Basta-Arciszewska K, Arciszewski K, Borowik J, Brodowski W, Swora A, Sygacz O, et al. Health effects of UV nail lamps - is there a risk of cancer? Journal of Education, Health and Sport 2022;12:891–904. https://doi.org/10.12775/JEHS.2022.12.09.103.
32. Litaiem N, Baklouti M, Zeglaoui F. Side effects of gel nail polish: A systematic review. Clin Dermatol 2022;40:706–15. https://doi.org/10.1016/j.clindermatol.2022.07.008.
33. Diffey BL. The risk of squamous cell carcinoma in women from exposure to UVA lamps used in cosmetic nail treatment. British Journal of Dermatology 2012;167:1175–8. https://doi.org/10.1111/j.1365-2133.2012.11107.x.
34. Gromkowska-Kępka KJ, Puścion-Jakubik A, Markiewicz-Żukowska R, Socha K. The impact of ultraviolet radiation on skin photoaging — review of in vitro studies. J Cosmet Dermatol 2021;20:3427–31. https://doi.org/10.1111/jocd.14033.
35. Freeman C, Hull C, Sontheimer R, Curtis J. Squamous cell carcinoma of the dorsal hands and feet after repeated exposure to ultraviolet nail lamps. Dermatol Online J 2020;26. https://doi.org/10.5070/D3263047974.
36. Matsumura Y, Ananthaswamy HN. Toxic effects of ultraviolet radiation on the skin. Toxicol Appl Pharmacol 2004;195:298–308. https://doi.org/10.1016/j.taap.2003.08.019.
37. Spencer A, Gazzani P, Thompson DA. Acrylate and methacrylate contact allergy and allergic contact disease: a 13-year review. Contact Dermatitis 2016;75:157–64. https://doi.org/10.1111/cod.12647.
38. Minamoto K. Allergic Contact Dermatitis from Two-component Acrylic Resin in a Manicurist and a Dental Hygienist. J Occup Health 2014;56:229–34. https://doi.org/10.1539/joh.13-0244-CS.
39. Quach T, Gunier R, Tran A, Von Behren J, Doan-Billings P-A, Nguyen K-D, et al. Characterizing Workplace Exposures in Vietnamese Women Working in California Nail Salons. Am J Public Health 2011;101:S271–6. https://doi.org/10.2105/AJPH.2010.300099.
40. Savonius B, Keskinen H, Tuppurainen M, Kanerva L. Occupational respiratory disease caused by acrylates. Clinical Experimental Allergy 1993;23:416–24. https://doi.org/10.1111/j.1365-2222.1993.tb00348.x.
41. Neurocognitive sequelae of exposure to organic solvents and (meth)acrylates among nail-studio technicians. Neuropsychiatry Neuropsychol Behav Neurol 2002;15:44–55.

42. Ursberg A-M, Bergendorff O, Thorsson A-C, Isaksson M. Is there a good in vivo method to show whether gloves are sufficiently protective when a nail technician is exposed to (meth)acrylates? An in vivo pilot study. Contact Dermatitis 2016;75:62–5. https://doi.org/10.1111/cod.12573.

43. Morgado F, Batista M, Gonçalo M. Short exposures and glove protection against (meth)acrylates in nail beauticians—Thoughts on a rising concern. Contact Dermatitis 2019;81:62–3. https://doi.org/10.1111/cod.13222.

44. Shihab N, Lim HW. Potential cutaneous carcinogenic risk of exposure to UV nail lamp: A review. Photodermatol Photoimmunol Photomed 2018;34:362–5. https://doi.org/10.1111/phpp.12398.

45. Wilson J, Maraka J. Need for sun cream with your manicure? Dangers of UV nail dryers. Journal of Plastic, Reconstructive & Aesthetic Surgery 2016;69:871. https://doi.org/10.1016/j.bjps.2016.03.011.