



Lana Premuž^{1,2}, Vanja Varga^{1,2}, Ozana Jakšić³, Christina Khouri Matić², Dragana Marušić², Liborija Lugović-Mihić^{1,2}

Reactions to Acrylates in Dentistry and Related Factors - The First Croatian Survey Study on Reactions to Acrylates in Dentistry

Reakcije na akrilate u dentalnoj medicini i čimbenici povezani s njima – prvo hrvatsko anketno istraživanje reakcija na akrilate u stomatologiji

¹ School of Dental Medicine, University of Zagreb, 10000 Zagreb, Croatia
Sveučilište u Zagrebu Stomatološki fakultet, 10000 Zagreb, Hrvatska

² Department of Dermatovenereology, University Hospital Center Sestre Milosrdnice, 10000 Zagreb, Croatia
Klinički bolnički centar Sestre milosrdnice, Klinika za kožne i spolne bolesti, 10000 Zagreb

³ School of Medicine, University of Zagreb, 10000 Zagreb, Croatia
Sveučilište u Zagrebu Medicinski fakultet, 10000 Zagreb

Abstract

Objective: Our aim was to examine the potential impact of acrylate exposure and the influence of other associated factors on skin and mucosal changes/lesions among dental professionals and students. **Materials and Methods:** In this cross-sectional field study, we used a questionnaire to survey 136 participants—including dentists, dental technicians, nurses, assistants, and students—to assess skin conditions and the impact of acrylates on skin and mucosal disorders. **Results:** A high prevalence of self-reported work-related skin changes in dentistry was recorded, affecting 65% of dental professionals/students, with the highest frequency among dental technicians (78%) and assistants (77%), followed by students (52%) and dentists (49%). Dental technicians were significantly more frequently in daily contact with acrylates (54%) than others (students 13%, dental assistants/nurses 19%) and had a markedly higher prevalence of skin lesions after contact with acrylates (71.7%). The most common manifestations were hand eczema/fissuring (29.4%), facial/neck eczema (14.7%) and periungual dermatitis (11.8%). Those who reported acrylates as an aggravating factor had significantly more facial/neck eczema ($p=0.003$). Other significant findings: contact with contact lenses and hearing aids was a predictor of periungual dermatitis ($p=0.028$); contact with artificial eyelashes and hair extensions was a predictor of mucosal symptoms ($p=0.006$); and the contact with diabetic devices, TENS/ECG electrodes, was more frequently associated with hand eczema/fissuring ($p=0.026$). **Conclusion:** Skin lesions in dental professionals and students, particularly dental technicians, are shown to be linked to acrylate exposure in this first Croatian study. Consequently, the implementation of additional protective measures is highly recommended.

Received: February 26, 2026

Accepted: June 9, 2026

Address for correspondence

Prof. Liborija Lugović-Mihić, MD, PhD
Sestre Milosrdnice University Hospital Center,
Department of Dermatovenereology
University of Zagreb
School of Dental Medicine
Vinogradska cesta 29,
10 000 Zagreb, Croatia
liborija@sfzg.hr

MeSH Terms: Acrylic Resins; Allergic Contact Dermatitis; Occupational Dermatitis; Dental Staff; Dental Students

Author Keywords: acrylates; skin; contact dermatitis; dentistry; students; cosmetics

Lana Premuž – ORCID iD 0009-0007-2445-7645
Vanja Varga – ORCID iD 0009-0004-9019-575X
Ozana Jakšić – ORCID iD 0000-0002-2463-1494

Christina Khouri – ORCID iD 0009-0003-6082-7413
Dragana Marušić – ORCID iD: 0009-0005-0684-2967
Liborija Lugović-Mihić – ORCID iD: 0000-0001-7494-5742

Introduction

Occupational exposure in healthcare may induce a range of adverse cutaneous reactions, predominantly affecting exposed areas such as the hands (hand dermatitis or eczema), as a consequence of repeated contact with various substances, which mostly manifest as contact dermatitis: non-allergic or irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD), each with a unique underlying pathogenesis (1-5). ICD and ACD are relatively common dermatoses, with

Uvod

Profesionalna izloženost u zdravstvenoj djelatnosti može prouzročiti različite neželjene kožne reakcije koje najčešće zahvaćaju izložena područja poput šaka (dermatitis ili ekcem šaka) kao posljedicu ponavljano kontakta s različitim tvarima. Te reakcije najčešće se manifestiraju kao kontaktni dermatitis: nealergijski ili iritativni kontaktni dermatitis (IKD) te alergijski kontaktni dermatitis (AKD), pri čemu svaki ima zasebnu patogenezu (1 – 5). IKD i AKD razmjerno su česte

the irritant form being more frequent than the allergic type (1, 3, 4). Among dental professionals and students, hand lesions/eczema are especially common in those with longer professional experience, more frequent glove changes and hand washing, as well as in those with allergies and atopy (5–10). Adverse reactions to acrylates are also possible in dental professionals and students, often manifesting as eczema with erythematous, dry, scaling, cracked and vesicular lesions (sometimes accompanied by itching), predominantly on the hands and face (11,12). They can also manifest as pulpitis, nail dystrophy and sometimes even acute facial swelling. Therefore, reactions to acrylates usually include hand eczema as a manifestation of contact dermatitis (ICD and ACD), as well as nail changes (dystrophy, abnormal nail growth or discoloration such as leukoderma), periungual dermatitis, facial lesions or swelling or mucosal reactions (e.g. eyes, nasal passages or airways). Symptoms usually occur after direct contact with acrylates present in dental materials such as composite resins and denture bases. Accurate identification and diagnosis require a complete medical history and a detailed clinical examination (13).

Acrylates and methacrylates (MA) are plastic materials produced by the polymerization of monomers derived from acrylic or methacrylic acid, formed through the esterification of these acids (their reactivity varies depending on the type of acid used in the reaction) (11,13). They serve as the basis for acrylic resins and, owing to their reactive double bonds, can readily polymerize—either spontaneously at room temperature or upon activation by heat or ultraviolet (UV) light—to form stable polymeric plastic structures (12,14). The use of acrylates and methacrylates is widespread in dentistry, where they are components of denture bases, composite resins, dentin bonding agents, and glass ionomer materials (13, 15, 16). Historically, acrylate exposure occurred mainly in industrial production, specifically within the printing, painting, coating, and metallurgical sectors. However, the intensive use of acrylate and methacrylate compounds surged in the 1930s with the development of plastic materials like “organic glass,” which quickly expanded into the aviation, paint, and ink industries (12,17). Over time, other acrylates have come into use in paints, adhesives, composite resins used in dentistry, printing inks, artificial nails, and various medical devices, such as contact lenses, hearing aids, and bone cements for orthopedic endoprostheses (11).

In recent decades, an increase in reactions to (meth) acrylates has been observed within the cosmetic industry, where the primary sources of sensitization in cosmetics include artificial eyelashes, hair extensions, and artificial nails (12,18–20). Due to the widespread availability and frequent use of artificial nails based on acrylates, methacrylates, or cyanoacrylates, adverse reactions are becoming increasingly common (12,20,21). Modern long-lasting nail polishes contain photobonded acrylates (the so-called “semi-permanent”, “permanent”, or “gel” nail polishes), composed of blends of acrylate monomers that are applied to the nail plate and polymerized under fluorescent, UV or light-emitting diode (LED) lamps which have gained popularity due to their low cost and ease of application (12,18,20). All types of artificial nails contain

dermatose, pri čemu je iritativni oblik češći od alergijskoga (1, 3, 4). Među dentalnim djelatnicima i studentima lezije i ekcem šaka osobito su česti kod onih s duljim profesionalnim iskustvom, češćom promjenom rukavica i pranjem ruku te kod osoba s alergijama i atopijom (5 – 10). Neželjene reakcije na akrilate također su moguće kod stomatoloških djelatnika i studenata, a najčešće se manifestiraju kao ekcem s eritematoznim, suhim, ljuskavim, ispucalim i vezikuloznim promjenama (katkad praćenima svrbežom), pretežno na šakama i licu (11, 12). Mogu se očitovati i kao pulpitis, distrofija noktiju, a katkad se čak pojavljuju i akutne otekline na licu. Zato reakcije na akrilate obično uključuju ekcem šaka kao manifestaciju kontaktnoga dermatitisa (IKD i AKD), promjene na noktima (distrofija, abnormalni rast ili promjena boje noktiju poput leukonihije), periungvalni dermatitis, promjene ili otekline na licu te reakcije na sluznicama (npr., očiju, nosnih prolaza ili dišnih putova). Simptomi se obično pojavljuju poslije izravnoga kontakta s akrilatima u dentalnim materijalima kao što su kompozitne smole i baze proteza. Točna identifikacija i dijagnoza zahtijevaju detaljnu anamnezu i temeljiti klinički pregled (13).

Akrilati i metakrilati (MA) plastični su materijali koji nastaju polimerizacijom monomera izvedenih iz akrilne ili metakrilne kiseline, dobivenih esterifikacijom tih kiselina (njihova reaktivnost razlikuje se ovisno o vrsti kiseline korištene u reakciji) (11, 13). Oni su osnova akrilnih smola te, zahvaljujući svojim reaktivnim dvostrukim vezama, mogu lako polimerizirati – spontano na sobnoj temperaturi ili aktivacijom toplotom, odnosno ultraljubičastim (UV) svjetlom – stvarajući stabilne polimerne plastične strukture (12, 14). Primjena akrilata i metakrilata široko je rasprostranjena u dentalnoj medicini u kojoj su dio baza proteza, kompozitnih smola, dentinskih adheziva i staklenoionomernih materijala (13, 15, 16). Dok je u prošlosti izloženost akrilatima bila uglavnom povezana s industrijskom proizvodnjom, osobito u tiskarskoj, lakirerskoj, premaznoj i metalurškoj industriji, tijekom 1930-ih počela je intenzivna uporaba akrilatnih i metakrilatnih spojeva, osobito u razvoju plastičnih materijala poput tzv. *organskoga stakla* ili *plastičnoga stakla* koji su ubrzo pronašli široku primjenu u zrakoplovnoj industriji te u proizvodnji boja, premaza i tiskarskih boja (12, 17). S vremenom su se drugi akrilati počeli koristiti u bojama, ljepilima, kompozitnim smolama koje se upotrebljavaju u dentalnoj medicini, tiskarskim bojama, umjetnim noktima te različitim medicinskim pomagalicama kao što su kontaktne leće, slušna pomagala i koštani cementi za ortopedске endoproteze (11).

Posljednjih desetljeća zabilježen je porast reakcija na (met)akrilate u kozmetičkoj industriji gdje su glavni izvori senzibilizacije umjetne trepavice, ekstenzije kose i umjetni nokti (12, 18 – 20). Zbog široke dostupnosti i učestale uporabe umjetnih noktiju na bazi akrilata, metakrilata ili cijanoakrilata, neželjene reakcije sve su češće (12, 20, 21). Moderni dugotrajni lakovi za nokte sadržavaju fotopolimerizirajuće akrilate (tzv. *semi-permanentni*, *trajni* ili *gel* lakovi) sastavljene od mješavina akrilatnih monomera koji se nanose na ploču nokta i polimeriziraju pod fluorescentnim, UV ili LED svjetiljkama koje su stekle popularnost zbog niske cijene i jednostavne primjene (12, 18, 20). Sve vrste umjetnih noktiju

acrylates and can induce unwanted reactions in beauticians and their clients. Acrylates are also widely used in medical and dental applications, where adverse reactions (including allergic reactions) to acrylates present in bone cements for orthopedic endoprostheses, soft contact lenses, hearing aids, histological implant materials; wound dressings, surgical adhesives containing acrylates, etc. have been reported (12,22). Taking all this into account, the aim of this study was to investigate the impact of exposure to acrylic and other related factors on the occurrence of skin and other manifestations or complaints in dentists and dental students.

Materials and Methods

This study was a cross-sectional field study conducted between January 2025 and July 2025 at the departments and teaching units of the School of Dental Medicine at the University of Zagreb. It was approved by the Ethics Committee of the School of Dental Medicine, University of Zagreb, at its 4th regular session held on January 15, 2025 (approval number: 05-PA-1-4/25). It was conducted in accordance with the principles outlined in the Declaration of Helsinki. Participation in the study was voluntary, and written informed consent was obtained from each participant before their inclusion. General objectives were to determine the prevalence of skin and mucosal lesions in relation to exposure to acrylates among dental professionals (dental technicians, dentists, and dental assistants/nurses) and dental students, and to determine the prevalence of self-reported occupationally related lesions. We also wanted to identify the associated factors that influence them (and their interrelationships), as well as the impact of acrylic nails and other acrylate-containing materials on the development of skin/mucosal lesions. Thus, the purpose of this study was to provide insight into the potential impact of acrylate exposure and other associated factors on skin and mucosal changes among dental professionals and students. This contributes to a better understanding of their interrelationship and serves as a basis for developing and implementing preventive measures.

Participants and data collection

A total of 136 participants between the ages of 20 and 61 (85% female, 15% male) were included in the study, comprising 46 dental technicians, 33 dentists, 26 dental assistants/nurses, and 31 dental students (the students had already been in contact with acrylates during their studies at the School of Dental Medicine). Participants had previously been in contact with acrylates over various periods of exposure, varying from 1 to 40 years. They provided written informed consent and met all inclusion and exclusion criteria. The inclusion criteria comprised being an adult, belonging to one of the defined target groups, expressing a voluntary willingness to participate, and signing an informed consent form. Exclusion criteria included individuals with diagnosed chronic non-eczematous skin diseases (e.g., psoriasis vulgaris) or systemic inflammatory conditions affecting the skin. Additionally, all individuals who were unable to understand the nature and purpose of the study or the content of the informed consent were excluded from participation.

ju sadržavaju akrilate i mogu izazvati neželjene reakcije kod kozmetičara i njihovih klijenata. Akrilati su također u širokoj primjeni u medicini i dentalnoj medicini, gdje su opisane neželjene reakcije (uključujući alergijske reakcije) na akrilate u koštanim cementima za ortopedske endoproteze, u mekim kontaktnim lećama, slušnim pomagalicama, histološkim implantacijskim materijalima, oblozima za rane, kirurškim ljepljivima koja sadržavaju akrilate i dr. (12, 22). Uzimajući sve navedeno u obzir, svrha ovog istraživanja bila je ispitati utjecaj izloženosti akrilatima i drugim povezanim čimbenicima na pojavu kožnih i drugih manifestacija ili tegoba kod doktora dentalne medicine i studenata dentalne medicine.

Materijali i metode

Ovo istraživanje provedeno je kao presječno terensko istraživanje između siječnja i srpnja 2025. godine u zavodima i nastavnim jedinicama Stomatološkog fakulteta Sveučilišta u Zagrebu. Odobrilo ga je Etičko povjerenstvo Stomatološkog fakulteta Sveučilišta u Zagrebu na 4. redovitoj sjednici održanoj 15. siječnja 2025. (broj odobrenja: 05-PA-1-4/25). Provedeno je u skladu s načelima navedenima u Helsinškoj deklaraciji. Sudjelovanje u istraživanju bilo je dobrovoljno i svaki je ispitanik prije uključivanja potpisao informirani pristanak. Opći ciljevi bili su ustanoviti prevalenciju kožnih i sluzničnih promjena povezanih s izloženosti akrilatima među dentalnim djelatnicima (dentalni tehničari, doktori dentalne medicine i dentalni asistenti/medicinske sestre) i studentima dentalne medicine te odrediti prevalenciju samoprijavljenih profesionalno povezanih promjena. Također smo željeli identificirati povezane čimbenike koji na njih utječu (i njihove uzajamne odnose) te utjecaj akrilnih noktiju i drugih materijala koji sadržavaju akrilate na razvoj kožnih i sluzničnih promjena. Svrha ovog istraživanja bila je pružiti uvid u mogući utjecaj izloženosti akrilatima i drugih povezanih čimbenika na promjene na koži i sluznicama među dentalnim djelatnicima i studentima te pridonijeti boljem razumijevanju njihove moguće uzajamne povezanosti, što će poslužiti kao osnova za razvoj i provedbu preventivnih mjera.

Sudionici i prikupljanje podataka

U istraživanje su bila uključena ukupno 136 ispitanika u dobi između 20 i 61 godine (85 % žena i 15 % muškaraca) – 46 dentalnih tehničara, 33 doktora dentalne medicine, 26 dentalnih asistenata / medicinskih sestara i 31 student dentalne medicine (studenti su tijekom studija na Stomatološkom fakultetu već bili u kontaktu s akrilatima). Ispitanici su prije toga bili izloženi akrilatima tijekom različitih razdoblja, u rasponu od 1 do 40 godina. Svi su ispitanici potpisali informirani pristanak i zadovoljili kriterije za uključivanje i isključivanje. Kriteriji za uključivanje obuhvaćali su punoljetnost, pripadnost jednoj od definiranih ciljnih skupina, dobrovoljno sudjelovanje te potpisivanje informiranog pristanka. Kriteriji za isključivanje bili su: osobe s dijagnosticiranim kroničnim dermatozama izvan ekcema (npr., *psoriasis vulgaris*) ili sistemskim upalnim bolestima koje zahvaćaju kožu. Iz sudjelovanja također su bile isključene sve osobe koje nisu mogle razumjeti prirodu i svrhu istraživanja, ili sadržaj informiranog pristanka.

This research includes a questionnaire that assessed factors relevant to skin condition and the impact of acrylate exposure and associated factors on skin and other symptoms among dental professionals and students (Table 1), where we considered various factors associated with the occurrence of skin and other symptoms during exposure to acrylates in dentistry (23-25). Participants were asked to participate in this study and those who agreed to it received a questionnaire that included questions regarding their exposure to acrylates, potential skin and systemic reactions they had noticed, and the perceived relationship between them. Throughout the research, we were in contact with study participants and were ready for additional questions and clarifications.

We invited participants to be tested to acrylates by patch test, and those who agreed were tested to methyl methacrylate 2.0% (MMA), 2-hydroxyethyl methacrylate 2.0% (HEMA), ethylene glycol dimethacrylate 2.0% (EGDMA), triethylene glycol dimethacrylate 2.0% (TREGDMA), and butanediol dimethacrylate 2.0% (BDDMA) by applying adhesive patches containing allergens to their upper arms. These allergens included allergen preparations and IQ Ultimate™ adhesive chambers obtained from Chemotechnique Diagnostics, Sweden. A positive reaction was defined according to the International Contact Dermatitis Research Group (ICDRG) criteria (26).

Statistical Analysis

The collected data were stored in a format suitable for further statistical processing (Excel database). For the analysis of proportions, such as the prevalence of skin lesions between occupational groups, the χ^2 test was used, with the z-test for proportions applied as a post hoc test. For the analysis of variables measured on continuous scales, such as the hand eczema severity index between occupations, the Kruskal-Wallis test was used, followed by the Mann-Whitney post hoc test and the Bonferroni correction. The Mann-Whitney test was applied when comparing continuous variables between two groups. Effect size was quantified using the formula $r = Z/\sqrt{N}$ for the Mann-Whitney test, $\epsilon^2 = (H - k + 1)/(n - k)$ for the Kruskal-Wallis test, and Cramer's V for the χ^2 test. Cohen's criteria were applied for interpretation: V = 0.25–0.3 indicated a small effect size, 0.3–0.5 a moderate effect, 0.5–0.7 a large effect, and >0.7 a very large effect. The squared value was used for interpreting ϵ^2 . All analyses were performed using the commercial software IBM SPSS Statistics, version 22.0 (IBM Corp., Armonk, NY, USA).

Results

(1) The prevalence of cutaneous/mucosal changes (work-related symptoms) in relation to exposure to acrylates and other substances

Daily contact with acrylates was significantly more frequent among dental technicians (54%) compared to students (13%) and dental assistants/nurses (19%), while no significant difference was observed when compared to dentists (36%). The frequency of reactions following acrylate exposure differed significantly between occupational groups ($p < 0.001$; $V = 0.421$). Also, a markedly higher prevalence of skin

Ovo istraživanje uključivalo je i upitnik kojim su procjenjivani čimbenici važni za stanje kože te utjecaj izloženosti akrilatima i povezanih čimbenika na kožne i druge simptome među dentalnim djelatnicima i studentima (tablica 1.). U obzir su uzeti različiti čimbenici povezani s pojavom kožnih i drugih simptoma tijekom izloženosti akrilatima u dentalnoj medicini (23 – 25). Sudionici su pozvani na sudjelovanje u istraživanju i oni koji su pristali dobili su upitnik koji je sadržavao pitanja o njihovoj izloženosti akrilatima, mogućim kožnim i sistemskim reakcijama koje su uočili te o njihovoj percepciji povezanosti između izloženosti i simptoma. Tijekom cijelog istraživanja istraživači su bili u kontaktu sa sudionicima te su bili dostupni za dodatna pitanja i objašnjenja.

Ispitanicima je ponuđeno testiranje na akrilate epikutanim (patch) testom. Oni koji su pristali testirani su, primjenom adhezivnih flastera s alergenima na nadlakticama, na metil-metakrilat 2,0 % (MMA), 2-hidroksietil-metakrilat 2,0 % (HEMA), etilen-glikol-dimetakrilat 2,0 % (EGDMA), trieten-glikol-dimetakrilat 2,0 % (TEGDMA) i butandiol-dimetakrilat 2,0 % (BDDMA). Korišteni su alergijski pripravci i IQ Ultimate™ komorice za epikutano testiranje proizvođača Chemotechnique Diagnostics iz Švedske. Pozitivna reakcija definirana je prema kriterijima Međunarodne istraživačke skupine za kontaktni dermatitis (ICDRG) (26).

Statistička analiza

Prikupljeni podatci pohranjeni su u formatu prikladnom za daljnju statističku obradu (baza podataka Excel). Za analizu udjela, poput prevalencije kožnih lezija između profesionalnih skupina, korišten je χ^2 test, a kao post hoc test primijenjen z-test za proporcije. Za analizu varijabli mjerenih na kontinuiranim ljestvicama, poput indeksa težine ekcema na šakama između zanimanja, korišten je Kruskal-Wallisov test, nakon čega su provedeni Mann-Whitneyjev post hoc test i Bonferronijeva korekcija. Mann-Whitneyev test primijenjen je u usporedbi kontinuiranih varijabli između dviju skupina. Veličina učinka kvantificirana je s pomoću formule $r = Z/\sqrt{N}$ za Mann-Whitneyjev test, $\epsilon^2 = (H - k + 1)/(n - k)$ za Kruskal-Wallisov test te Cramerov V za χ^2 test. Za interpretaciju su primijenjeni Cohenovi kriteriji: V = 0,25 – 0,3 označava mali učinak, 0,3 – 0,5 umjereni učinak, 0,5 – 0,7 veliki učinak, a > 0,7 vrlo veliki učinak. Kvadratna vrijednost korištena je za interpretaciju ϵ^2 . Sve analize obavljene su u komercijalnom softveru IBM SPSS Statistics, verzija 22.0 (IBM Corp., Armonk, NY, SAD).

Rezultati

(1) Prevalencija kožnih i sluzničnih promjena (profesionalno povezanih simptoma) u odnosu na izloženost akrilatima i drugim tvarima

Svakodnevni kontakt s akrilatima bio je značajno češći među dentalnim tehničarima (54 %) u usporedbi sa studentima (13 %) i dentalnim asistentima / medicinskim sestrama (19 %), a u usporedbi s doktorima dentalne medicine nije utvrđena značajna razlika (36 %). Učestalost reakcija poslije izloženosti akrilatima značajno se razlikovala između profesionalnih skupina ($p < 0,001$; $V = 0,421$). Također, znatno

Table 1 Survey questionnaire on reactions to acrylates among dental professionals and students.**Tablica 1.** Anketni upitnik o reakcijama na akrilate među stručnjacima dentalne medicine i studentima

Questionnaire items on acrylate exposure and associated symptoms (No.) • Stavke upitnika o izloženosti akrilatima i povezanim simptomima (Br.)	Questionnaire item • Pitanje u upitniku	Response options • Mogući odgovori
1.	Respondent's gender • Spol ispitanika	A. Male • Muški B. Female • Ženski
2.	Respondent's age • Dob ispitanika	_____ years • _____ godina
3.	Occupation • Zanimanje	A. Student • Student B. Doctor of dental medicine/dentist • Doktor dentalne medicine C. Dental assistant • Dentalni asistent D. Dental technician • Dentalni tehničar E. Nurse • Medicinska sestra F. Other _____ • Ostalo _____
4.	How many years have you worked in your current profession/performed this type of activity? • Koliko godina radite u sadašnjoj struci/obavljate ovu vrstu aktivnosti?	_____ years • _____ godina
5.	Do you notice any changes in your skin that you associate with your job? (multiple answers possible) • Uočavate li promjene na koži koje povezujete s poslom? (može se odabrati više odgovora)	A. No • Ne B. Yes, only on hands (fist and fingers) • Da, samo na rukama (šake i prsti) C. Yes, on the head (face and neck) • Da, na glavi (lice i vrat) D. Yes, on other parts of the body that are covered with clothes • Da, na ostalim neizloženim dijelovima tijela (dijelovi tijela prekriveni odjećom) E. Somewhere else, please specify where: _____ • Negdje drugdje, molimo navedite: _____
6.	Which symptoms do you have? (circle all symptoms) • Koje simptome imate? (zaokružite sve simptome)	A. I do not have any symptoms • Nemam simptome B. Occasional dryness of the skin • Povremena suhoća kože C. Occasional redness of the skin • Povremeno crvenilo kože D. More extensive changes with blisters, papules, and skin cracking • Opsežnije promjene s mjehurićima, papulama te pucanjem kože E. Some others, please specify which ones: _____ • Neke druge, navedite koje: _____
7.	How many times a year do these changes occur? • Koliko se puta na godinu pojavljuju promjene?	A. I have never noticed any changes • Do sada nisam ni jedanput primijetio/la promjene B. They used to appear before, but now I no longer notice them • Prije su se pojavljivale, a sada ih više ne primjećujem C. 1-2 times a year • 1-2 puta na godinu D. 5-10 times a year • 5-10 putana godinu E. More than 10 times a year • Više od 10 puta na godinu F. They are constantly present • Stalno su prisutne
8.	Do you observe any factors that contribute to the worsening of these changes? • Primjećujete li da neki čimbenik utječe na pogoršanje tih promjena?	A. No • Ne B. I don't know • Ne znam C. Yes, specify which: _____ • Da, navedite koji: _____
9.	How often do you use acrylic materials in your work/profession (i.e., come into contact with them)? • Koliko se često koristite akrilnim materijalima u radu/struci (tj. koliko ste u kontaktu s njima)?	A. Daily • Svaki dan B. Several times a week • Nekoliko puta na tjedan C. Several times a month • Nekoliko puta na mjesec D. Rarely • Rijetko E. Never • Nikada
10.	Have you ever experienced an adverse reaction after contact with acrylic material? • Jeste li ikada imali neželjenu reakciju poslije kontakta s akrilnim materijalom?	A. Yes • Da B. No • Ne
11.	Have you noticed any adverse reactions after exposure to acrylate-based products outside of work/profession/practice? (multiple answers possible) • Jeste li primijetili neželjene reakcije poslije izlaganja proizvodima na bazi akrilata izvan rada/struke/prakse? (može se zaokružiti više odgovora)	A. No • Ne B. After using artistic/construction materials (paints, varnishes, resins) • Nakon upotrebe umjetničkih/građevinskih materijala (boje, lakovi, smole) C. After using cosmetic products (makeup, nail glue, false eyelash glue) • Poslije upotrebe kozmetičkih proizvoda (šminka, ljepilo za nokte, ljepilo za umjetne trepavice) D. After the application of artificial nails (acrylate nails, gel nails, permanent nail polish) • Poslije umjetnih noktiju (akrilatni nokti, gel nokti, trajni lak)
12.	If you have noticed any adverse reactions after exposure to acrylate-based products, please circle all symptoms that apply. • Ako ste primijetili neželjene reakcije poslije izlaganja proizvodima na bazi akrilata, zaokružite sve uočene simptome.	A. No symptoms • Bez simptoma B. Occasional dryness • Povremena suhoća C. Itching • Svrbež D. More extensive changes with blisters, papules, and skin cracking • Opsežnije promjene s mjehurićima, papulama te pucanjem kože E. Some others, specify which ones: _____ • Neke druge, navedite koje: _____
13.	Have you ever sought treatment for these changes? If yes, please specify the type of treatment. • Jeste li se dosad liječili zbog tih promjena? Ako jeste, navedite terapiju.	A. No • Ne B. Yes, self-treated: _____ • Da, samostalno: _____ C. Yes, treated by a general practitioner: _____ • Da, kod liječnika obiteljske medicine: _____ D. Yes, treated by a dermatologist: _____ • Da, kod dermatologa: _____ E. Yes, allergy testing was performed (please specify): _____ and the test was positive / negative • Testiran/la sam se na alergije (navedite koje _____) i test je bio pozitivan/negativan

14.	Do you engage in leisure-time activities that involve prolonged hand contact with liquids or substances/allergens that may cause adverse reactions? • Bavite li se u slobodno vrijeme aktivnostima koje uključuju dugotrajni kontakt ruku s nekim drugim tekućinama ili tvarima/alergenima koji mogu izazvati neželjene reakcije?	A. Yes, specify which: _____ • Da, navedite koje: _____ B. No • Ne
15.	Are you frequently exposed to any of the following substances? If yes, please circle all that apply. • Jeste li često u kontaktu s nekom od navedenih tvari? Ako jeste, zaokružite te tvari.	A. Paints, adhesives, coatings, and printing inks • Boje, ljepila, premazi, tiskarske tinte B. Dental composite resins and bonding agents • Dentalne kompozitne smole i veziva C. Artificial nails and long-lasting nail polish (e.g., semi-permanent nail polish, permanent nail polish, or gel nail polish) • Umjetni nokti i trajni lak za nokte (npr., polutrajni lak za nokte, trajni lak za nokte ili gel lak za nokte) D. Artificial eyelashes, hair extensions • Umjetne trepavice, ekstenzije kose E. Cosmetics containing acrylates • Kozmetika koja sadržava akrilate F. Floor waxes and coatings • Podni voskovi i premazi G. Leather, textile, and paper products • Kožni, tekstilni i papirnati proizvodi H. Soft contact lenses, hearing aids • Mekane kontaktne leće, slušni aparati I. Wound dressings, surgical adhesives, histological preparations • Zavoji za rane, kirurška ljepila, histološki preparati J. Medical devices for people with diabetes, electrodes for transcutaneous electrical nerve stimulation (TENS), electrocardiogram (adhesive layer of electrodes) • Medicinski uređaji za dijabetičare, elektrode za transkutanu električnu živčanu stimulaciju (TENS), elektrokardiogram (ljepljivi sloj elektroda) K. Intradermal filler injections • Intradermalne injekcije filera L. Production of plastic glass • Proizvodnja plastičnoga stakla M. Bone cement for orthopedic endoprostheses • Koštani cement za ortopedске endoproteze
16.	Have you ever experienced, or are you currently experiencing, any symptoms potentially related to acrylate exposure? If so, please circle all that apply. • Jeste li ikada imali/trenutačno imate neke od manifestacija potencijalno povezane s akrilatima? Ako jeste, zaokružite ih.	A. Hand skin inflammation with dryness (<i>eczema</i>), cracking of the fingertip skin (pulpitis), especially the first three fingers • Upala i suhoća kože na šakama (<i>ekcem</i>), pucanje kože na jagodicama prstiju (pulpitis), osobito prva tri prsta B. Skin inflammation (<i>dermatitis</i>) around the nails (periungual) • Upala kože (<i>dermatitis</i>) oko noktiju (periungvalni) C. Appearance of whitish depigmentation (<i>leukoderma</i>) on the fingertips • Pojava bjelkastih depigmentacija (<i>leukoderma</i>) na jagodicama prstiju D. Changes/damage (<i>dystrophy</i>) of the nails • Promjene/oštećenje (<i>distrofija</i>) noktiju E. Skin inflammation with dryness (<i>eczema</i>): skin changes, rash of the face, neck, and eyelids • Upala kože sa suhoćom (<i>ekcem</i>): promjene na koži, osip na licu, vratu i vjedama F. Generalized skin inflammation (<i>dermatitis</i>) • Generalizirana upala kože (<i>dermatitis</i>) G. Mucosal symptoms (ocular, nasal, and respiratory) due to exposure to acrylates (e.g., methacrylates), including airway inflammation and impaired lung function • Sluznični simptomi (očni, nazalni i dišni) zbog izloženosti akrilatima (npr., metakrilatima), uključujući upalu dišnih puteva i poremećenu funkciju pluća H. Breathing problems, e.g., difficulty breathing, asthma, frequent respiratory tract infections, or rhinoconjunctivitis • Problemi s disanjem, npr., teško disanje, astma, česte upale dišnih puteva ili rinokonjunktivitis I. Allergic contact stomatitis • Alergijski kontaktni stomatitis

lesions after contact with acrylates was observed in dental technicians (71.7%) compared to dental assistants (38.5%), dentists (24.2%), and students (25.8%). No significant differences were found among the latter three groups. Among the reported manifestations affecting the skin and other organ systems, only hand eczema and fingertip fissuring were significantly more common in dental technicians (50%) than in dentists (6%) ($p < 0.001$; $V = 0.246$). No association was found between the occurrence of skin lesions and the frequency of acrylate contact.

The prevalence of self-reported occupationally related skin lesions was 65%, and this difference was significant across occupations, with a small effect size ($p = 0.009$, $V = -0.235$). Dental technicians reported skin lesions significantly more frequently than dentists (78% vs. 49%), while no significant differences were observed compared with dental assistants (77%) and students (52%). The frequency of skin lesions on specific body sites is presented in Table 2.

veća prevalencija kožnih lezija poslije kontakta s akrilatima zabilježena je kod dentalnih tehničara (71,7 %) u usporedbi s dentalnim asistentima (38,5 %), doktorima dentalne medicine (24,2 %) i studentima (25,8 %). Među tim posljednjim skupinama nisu utvrđene značajne razlike. Među prijavljenim manifestacijama na koži i drugim organskim sustavima jedino su ekcem šaka i raspukline kože na jagodicama prstiju bile značajno češće kod dentalnih tehničara (50 %), nego kod doktora dentalne medicine (6 %) ($p < 0,001$; $V = 0,246$). Nije ustanovljena povezanost između pojave kožnih lezija i učestalosti kontakta s akrilatima.

Prevalencija samoprijavljenih profesionalno povezanih kožnih lezija iznosila je 65 %, a razlika među zanimanjima bila je statistički značajna uz mali efekt ($p = 0,009$; $V = -0,235$). Dentalni tehničari prijavljivali su kožne lezije znatno češće nego doktori dentalne medicine (78 % prema 49 %), a znatne razlike nisu utvrđene u usporedbi s dentalnim asistentima (77 %) i studentima (52 %).

Table 2 Prevalence of skin and other manifestations reported by dental professionals and students.
Tablica 2. Prevalencija kožnih i drugih manifestacija koje su prijavili stručnjaci dentalne medicine i studenti

Variable (manifestation) • Varijabla (manifestacija)	Occupation • Zanimanje				Total • Ukupno N=136	p	V
	Student • Student N=31	Doctor of dental medicine • Doktor dentalne medicine N=33	Dental assistant/nurse • Dentalni asistent / medicinska sestra N=26	Dental technician • Dentalni tehničar N=46			
Hand skin inflammation with dryness (<i>eczema</i>); fissuring of the skin on the fingers • Upala i suhoća kože na šakama (<i>ekcem</i>), pucanje kožena prstima	8 (25,8%) ^{a, b}	2 (6,1%) ^b	7 (26,9%) ^{a, b}	23 (50%) ^a	40 (29,4%)	<0,001	0,246
Skin inflammation (<i>dermatitis</i>) around the nails (periungual) • Upala kože (<i>dermatitis</i>) oko noktiju (periungvalno)	3 (9,7%)	2 (6,%)	5 (19,2%)	6 (13%)	16 (11,8%)	0,452	0,064
Depigmented patches on the skin on the fingertips (<i>leukoderma</i>) • Depigmentirana područja kože na jagodicama prstiju (<i>leukoderma</i>)	0	0	1 (3,8%)	5 (10,9%)	6 (4,4%)	0,057	0,203
Nail dystrophy • Distrofija noktiju	0	1 (3,0%)	3 (11,5%)	6 (13%)	10 (7,4%)	0,101	0,189
Skin inflammation with dryness (<i>eczema</i>) of the face, neck, and eyelids • Upala i suhoća kože (<i>ekcem</i>) na licu, vratu i vjeđama	5 (16,1%)	4 (12,1%)	3 (11,5%)	8 (17,4%)	20 (14,7%)	0,874	0,021
Generalized skin inflammation (<i>dermatitis</i>) with dryness • Generalizirana upala kože (<i>dermatitis</i>) praćena suhoćom	1 (3,2%)	2 (6,1%)	3 (11,5%)	3 (6,5%)	9 (6,6%)	0,656	0,049
Mucosal symptoms (eyes, nose, respiratory tract) • Sluznični simptomi (oči, nos, dišni sustav)	1 (3,2%)	1 (3%)	2 (7,7%)	5 (10,9%)	9 (6,6%)	0,447	0,122
Allergic contact stomatitis • Alergijski kontaktni stomatitis	0	0	2 (7,7%)	3 (6,5%)	5 (3,7%)	0,197	0,145

p – level of significance based on the χ^2 test; V – effect size. Groups sharing the same superscript letter do not differ significantly according to the z-test for proportions. • p – stupanj značajnosti temeljem χ^2 testa, V – veličina efekta. Grupe koje dijele ista slova u eksponentu ne razlikuju se statistički značajno temeljem z-testa za proporcije.

The overall prevalence of skin lesions was 63%, and it varied significantly between occupational groups ($p = 0.006$, $V = -0.263$), being markedly higher among technicians (80%) compared with students (48%) and dentists (49%). Table 3 presents the prevalence of self-reported work-related skin lesions (localization, manifestations) by occupation in dental professionals and students.

Among the 53 participants tested by patch test to acrylates, two individuals were positive to MMA, two to HEMA, and two to EGDMA.

(2) The most common manifestations of cutaneous and mucosal changes among participants and associated factors that influence them and their interrelationships

The most frequent manifestations were hand eczema and fingertip fissuring (29.4%), followed by eczema of the face, neck, and eyelids (14.7%) and periungual dermatitis (11.8%). The rarest manifestations included allergic contact stomatitis (3.7%) and leukoderma on the fingertips, as well as eczematous lesions around the nails (4.4%). The frequency of self-reported skin and mucosal changes among dental professionals and students is presented in Figures 1-3. Among our examinees, three participants reported frequent contact with acrylates as a factor exacerbating their skin lesions and all of them presented with eczema of the face, neck, and eyelids ($p = 0.003$; $V = 0.362$). No association was found between the oc-

Ukupna prevalencija kožnih lezija iznosila je 63 % te je značajno varirala između skupina ($p = 0.006$; $V = -0.263$), pri čemu je bila znatno viša kod tehničara (80 %) nego kod studenata (48 %) i doktora dentalne medicine (49 %). Tablica 3. prikazuje prevalenciju samoprijavljenih profesionalno povezanih kožnih lezija (lokalizacija i manifestacije) prema zanimanjima.

Od 53 ispitanika testiranih epikutanim testom na akrilate, dvije osobe bile su pozitivne na MMA-u, dvije na HEMA-u te dvije na EGDMA-u.

(2) Najčešće manifestacije kožnih i sluzničnih promjena te povezani čimbenici i njihove uzajamne povezanosti

Najčešće manifestacije bile su ekcem na šakama i raskupline na jagodicama prstiju (29,4 %), zatim ekcem na licu, vratu i vjeđama (14,7 %) te periungvalni dermatitis (11,8 %). Najrjeđe manifestacije uključivale su alergijski kontaktni stomatitis (3,7 %) te leukodermu jagodica prstiju i erimatozne promjene oko noktiju (4,4 %). Učestalost samoprijavljenih kožnih i sluzničnih promjena među dentalnim djelatnicima i studentima prikazana je na slikama od 1. do 3. Među ispitanicima tri su osobe navele česti kontakt s akrilatima kao čimbenik pogoršanja, a sve su imale ekcem na licu, vratu i vjeđama ($p = 0,003$; $V = 0,362$). Nije utvrđena povezanost između učestalosti kontakta s akrilatima i pojave kožnih ili sluzničnih promjena. Također tri ispitanika navela su često pranje

Table 3 Prevalence of self-reported, occupationally related skin lesions (localization and symptoms) in dental professionals and students.
Tablica 3. Prevalencija samoprijavljenih kožnih lezija povezanih sa zanimanjem (lokalizacija i simptomi) među stručnjacima dentalne medicine i studentima

	Variable • Varijabla	Occupation • Zanimanje				Total • Ukupno N=136	p	V
		Student • Student N=31	Doctor of dental medicine • Doktor dentalne medicine N=33	Dental assistant/nurse • Dentalni asistent / medicinska sestra N=26	Dental technician • Dentalni tehničar N=46			
Localization of skin changes • Lokalizacija kožnih promjena	Reported work-related localization of skin changes • Prijavljena lokalizacija kožnih promjena povezanih sa zanimanjem	16 (51,6%) ^{a, b}	16 (48,5%) ^b	20 (76,9%) ^{a, b}	36 (78,3%) ^a	88 (64,7%)	0,009	0,235
	- skin changes on hands (palms and fingers) • kožne promjene na šakama (dlanovi i prsti)	14 (45,1%) ^a	15 (45,5%) ^a	17 (65,4%) ^a	34 (73,9%) ^a	80 (58,8%)	0,022	0,232
	- skin changes on head (face, neck) • kožne promjene na glavi (lice i vrat)	2 (6,5%) ^a	2 (6,1%) ^a	7 (26,9%) ^a	11 (23,9%) ^a	22 (16,2%)	0,031	0,199
	- skin changes on non-exposed body areas • kožne promjene na neizloženim dijelovima tijela	1 (3,2%)	1 (3%)	0	3 (6,55%)	5 (3,7%)	0,525	0,059
Symptoms and manifestations • Simptomi i manifestacije	Reported work-related symptoms • Prijavljeni simptomi povezani sa zanimanjem	15 (48,4%) ^a	16 (48,5%) ^a	18 (69,2%) ^{a, b}	37 (80,4%) ^b	86 (63,2%)	0,006	-0,263
	- occasional dryness • povremena suhoća	11 (35,5%)	13 (39,4%)	11 (42,3%)	29 (63%)	64 (47,1%)	0,060	0,2
	- occasional redness • povremeno crvenilo	13 (41,9%) ^{a, b}	11 (33,3%) ^b	11 (42,3%) ^{a, b}	30 (65,2%) ^a	65 (47,8%)	0,028	0,193
	- observed vesicles, papules, skin fissuring • opaženi mjehurići, papule, pucanje kože	4 (12,9%)	6 (18,2%)	7 (26,9%)	15 (32,6%)	32 (23,5%)	0,192	0,17

p – level of significance based on the χ^2 test; V – effect size. Groups sharing the same superscript letter do not differ significantly according to the z-test for proportions. • p – stupanj značajnosti temeljem χ^2 testa, V – veličina efekta. Grupe koje dijele ista slova u eksponentu ne razlikuju se statistički značajno temeljem z-testa za proporcije.

currence of skin or mucosal changes and the frequency of acrylate contact. In addition, three participants identified frequent hand washing as an aggravating factor; however, hand washing was not associated with any specific manifestation.

Of other recorded factors, cold exposure was reported as an aggravating factor in 3 out of 136 participants (2%), disinfectants in 6 participants (4%), and protective gloves in 4 participants (3%) (cold exposure was not significantly associated with skin/mucosal changes, except in one participant who presented with eczema on the hands). Disinfectants were associated with leukoderma or eczema: 2/6 participants (33%) with these manifestations reported disinfectants as an aggravating factor, compared with 4/130 (3%) without such manifestations (half of them who cited disinfectants as an aggravating factor had hand eczema), and only one participant each reported a relationship with periungual dermatitis, nail dystrophy, or generalized dermatitis. Protective gloves use was mentioned as an aggravating factor for hand eczema by only one participant (no other manifestations were observed among those who cited gloves as an aggravating factor). Statistically, when all frequency categories were considered, the frequency of self-reported skin and mucosal changes did not differ significantly among dental professionals and students. However, when frequency was dichotomized into “rare” (<2 times per year) and “frequent” (>5 times per year), these changes were significantly more common among dental technicians and assistants than among students ($p = 0.001$; $V = 0.337$).

ruku kao čimbenik pogoršanja, no ono nije bilo povezano s određenom manifestacijom.

Od ostalih čimbenika, izloženost hladnoći kao pogoršavajućem čimbeniku, prijavilo je 3 od 136 ispitanika (2 %), dezinficijense je prijavilo 6 ispitanika (4 %), a zaštitne rukavice njih 4 (3 %). Hladnoća nije bila značajno povezana s kožnim/sluzničnim promjenama, osim kod jednog ispitanika koji je imao ekcem šaka.

Dezinficijensi su bili povezani s leukodermom ili ekcemom: 2/6 ispitanika (33 %) s tim manifestacijama navelo je dezinficijense kao čimbenik pogoršanja, u usporedbi s 4/130 (3 %) bez tih manifestacija. Polovina ispitanika koji su naveli dezinficijense imala je ekcem šaka, a po jedan ispitanik povezo je izloženost s periungvalnim dermatitisom, distrofijom noktiju ili generaliziranim dermatitisom.

Korištenje zaštitnih rukavica kao čimbenik pogoršanja naveo je samo jedan ispitanik (bez drugih manifestacija u toj skupini).

Statistički, kada su sve kategorije učestalosti uzete u obzir, učestalost kožnih i sluzničnih promjena nije se značajno razlikovala među skupinama. No kada je učestalost podijeljena na rijetku (< 2 puta na godinu) i čestu (> 5 puta na godinu), te su promjene bile značajno češće kod dentalnih tehničara i asistenata nego kod studenata ($p = 0.001$; $V = 0.337$).

Table 4 Frequency of self-reported skin and mucosal changes among dental professionals and students.**Tablica 4.** Učestalost samoprijavljenih promjena na koži i sluznicama među stručnjacima dentalne medicine i studentima

Frequency of skin and mucosal changes • Učestalost promjena na koži i sluznicama	Occupation • Zanimanje				Total • Ukupno N=136	p	V
	Student • Student N=31	Doctor of dental medicine • Doktor dentalne medicine N=33	Dental assistant/ nurse • Dentalni asistent/ medicinska sestra N=26	Dental technician • Dentalni tehničar N=46			
No changes observed so far • Dosad nije bilo promjena	14 (45,2%)	14 (42,4%)	6 (23,1%)	10 (21,7%)	44 (32,4%)		
Previously present, now absent • Prije su se pojavljivale, sada ih nema	3 (9,7%)	2 (6,1%)	1 (3,8%)	4 (8,7%)	10 (7,4%)		
1-2 times per year • 1-2 puta na godinu	8 (25,8%)	4 (12,1%)	5 (19,2%)	3 (6,5%)	20 (14,7%)		
5-10 times per year • 5-10 puta na godinu	2 (6,5%)	2 (6,1%)	4 (15,4%)	8 (17,4%)	16 (11,8%)		
Persistently present • Stalno prisutne	4 (12,9%)	11 (33,3%)	10 (38,5)	21 (45,7%)	46 (33,8%)	0,063	0,223
Dichotomous • Dihotomno ≤2 times per year • ≤2 puta na godinu	25 (80,6%)	20 (60,6%)	12 (46,2 %)	17 (37%)	74 (54,4%)		
≥5 times per year • ≥5 puta na godinu	6 (19,4%) ^a	13 (39,4%) ^{ab}	14 (53,8%) ^b	29 (63%) ^b	62 (45,6%)	0,001	0,337

p – level of significance based on the χ^2 test; V – effect size. Groups sharing the same superscript letter do not differ significantly according to the z-test for proportions. • p – stupanj značajnosti temeljem χ^2 testa, V – veličina efekta. Grupe koje dijele ista slova u eksponentu ne razlikuju se statistički značajno temeljem z-testa za proporcije.

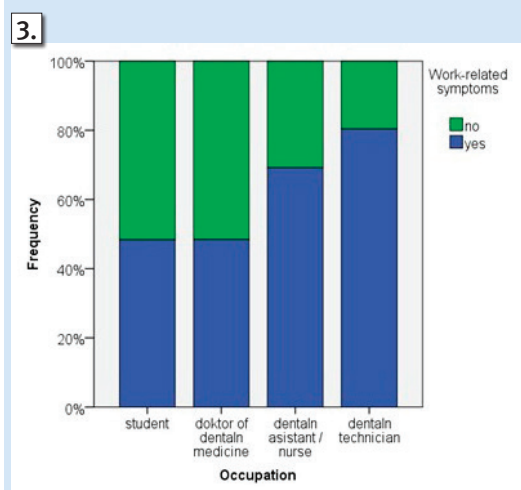
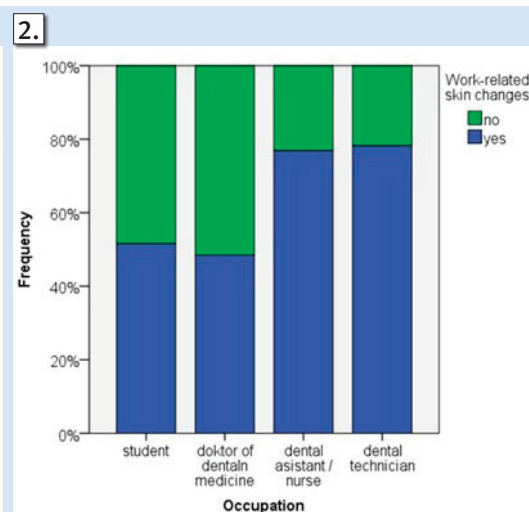
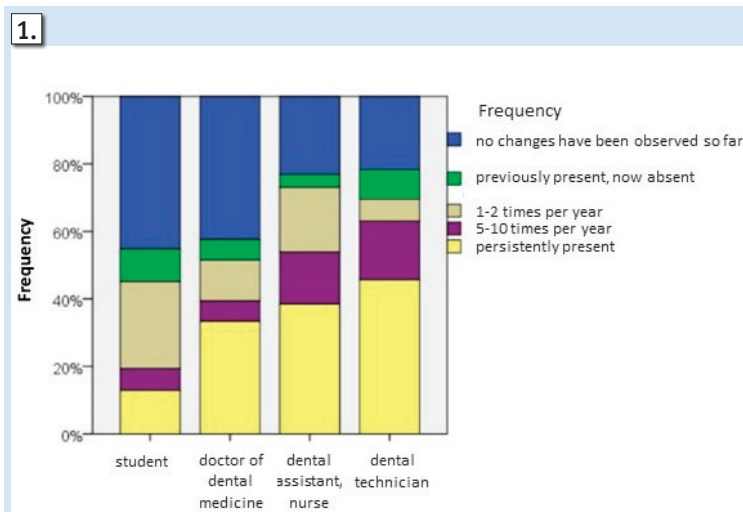
**Figure 1** Frequency (temporal) of self-reported skin/mucosal changes among dental professionals and students.**Slika 1.** Učestalost pojave samoprijavljenih kožnih i sluzničnih promjena među stručnjacima dentalne medicine i studentima**Figure 2** Frequency (occurrence) of self-reported work-related skin changes among dental professionals and students.**Slika 2.** Učestalost samoprijavljenih kožnih promjena povezanih s poslom među stručnjacima dentalne medicine i studentima**Figure 3** Frequency of self-reported work-related skin symptoms among dental professionals and students.**Slika 3.** Učestalost samoprijavljenih kožnih simptoma povezanih s poslom među stručnjacima dentalne medicine i studentima

Table 5 Frequency of contact with acrylates (from various sources) and exposure to them among dental professionals and students.
Tablica 5. Učestalost kontakta i izloženosti akrilatima (iz različitih izvora) među stručnjacima dentalne medicine i studentima

Variable • Varijabla	Occupation • Zanimanje				Total • Ukupno (N=136)	p	V
	Student • Student (N=31)	Doctor of dental medicine • Doktor dentalne medicine (N=33)	Dental assistant/nurse • dentalni asistent/ medicinska sestra (N=26)	Dental technician • Dentalni tehničar (N=46)			
Frequent exposure to paints, adhesives, and inks • Česta izloženost bojama, ljepilima i tintama	2 (6,5%)	3 (9,1%)	4 (15,4%)	5 (10,9%)	14 (10,3%)	0,731	0,098
Frequent exposure to composite resins and dental bonding agents • Česta izloženost kompozitnim smolama i dentalnim vezivima	24 (77,4%) ^a	26 (78,8%) ^a	11 (42,3%) ^b	15 (32,6%) ^b	76 (55,9%)	<0,001	0,428
Frequent exposure to artificial nails and permanent nail polish • Česta izloženost umjetnim noktima i trajnom laku	8 (25,8%)	10 (30,3%)	10 (38,5%)	9 (19,6%)	37 (27,2%)	0,36	0,154
Frequent exposure to artificial eyelashes or hair extensions • Česta izloženost umjetnim trepavicama ili ekstenzijama kose	0	1 (3%)	1 (3,8%)	3 (6,5%)	5 (3,7%)	0,517	0,129
Frequent exposure to cosmetics containing acrylates • Česta izloženost kozmetici koja sadržava akrilate	3 (9,7%)	1 (3%)	3 (11%)	2 (4,3%)	9 (6,6%)	0,465	0,137
Frequent exposure to floor waxes and coatings • Česta izloženost podnim voskovima i premazima	0	0	1 (3,8%)	2 (4,3%)	3 (2,2%)	0,432	0,142
Frequent exposure to leather, textile, and paper products • Česta izloženost koži, tekstilu i papirnatim proizvodima	3 (9,7%)	3 (9,1%)	5 (19,2%)	6 (13%)	17 (12,5%)	0,645	0,111
Frequent exposure to soft contact lenses and hearing aids • Česta izloženost mekanim kontaktnim lećama i slušnim pomagalicama	5 (16,1%)	4 (12,1%)	4 (15,4%)	2 (4,3%)	15 (11%)	0,326	0,159
Frequent exposure to bandages, surgical adhesives, and histological specimens • Česta izloženost zavojima za rane, kirurškom ljepilu, histološkim preparatima	0	2 (6,1%)	3 (11,5%)	0	5 (3,7%)	0,046	0,243
Frequent exposure to medical devices for diabetics, TENS units, and electrocardiographic equipment • Česta izloženost medicinskim uređajima za dijabetičare, TENS uređajima i elektrokardiografskoj opremi	1 (3,2%)	0	3 (11,5%)	1 (2,2%)	5 (3,7%)	0,106	0,212
Frequent exposure to intradermal fillers • Česta izloženost intradermalnim filerima	0	2 (6,1%)	0	0	2 (1,5%)	0,096	0,216
Frequent exposure in plastic glass manufacturing • Česta izloženost proizvodnji plastičnoga stakla	0	0	0	0	0		
Frequent exposure to bone cement used in orthopedic endoprostheses • Česta izloženost koštanom cementu za ortopedске endoproteze	0	1 (3%)	0	0	1 (0,7%)	0,37	0,152

(3) Assessment of the influence of acrylic nails and other acrylate-containing materials on the development of skin lesions among dental professionals and students

Participants most frequently reported contact with dental composite resins, as well as with artificial nails and permanent nail polish (Table 5). When analyzed by occupation, the only statistically significant difference was observed for contact with composite resins and adhesives, which was

(3) Utjecaj umjetnih noktiju i drugih materijala koji sadržavaju akrilate na razvoj kožnih promjena

Isplanici su najčešće prijavljivali kontakt s dentalnim kompozitnim smolama te s umjetnim noktima i trajnim lakovima za nokte (tablica 5.). Prema zanimanju, jedina statistički značajna razlika uočena je za kontakt s kompozitnim smolama i adhezivima koji je bio češći kod doktora dentalne medicine i studenata (79 % i 77 %) u usporedbi s dentalnim tehničarima i dentalnim asistentima/medicinskim sestrama

more common among dentists and students (79% and 77%, respectively) than among dental technicians and dental assistants/nurses (33% and 42% $p < 0.001$).

In the analysis of the association between exposures and manifestations, hand eczema and fingertip fissuring were significantly more frequent among participants who reported contact with diabetic devices, TENS, or ECG electrodes than among those without such contact (10% vs. 1%; $p = 0.026$; $V = 0.217$). Mucosal symptoms (eyes, nose, respiratory tract) were more common in participants who had contact with artificial eyelashes and hair extensions compared to those who did not (22.2% vs. 2.4%; $p = 0.035$; $V = 0.262$). No significant associations were observed between other exposures and manifestations. Statistically, when controlling for the simultaneous effect of all exposures in multiple logistic regression analyses, wearing contact lenses and hearing aids was a significant predictor of periungual dermatitis, conferring a 5.3-fold higher likelihood of dermatitis (OR 5.3; 95% CI 1.2–23.2; $p = 0.028$). Contact with artificial eyelashes and hair extensions was a significant predictor of mucosal symptoms (eyes, nose, respiratory tract), conferring a 107.1-fold higher likelihood of such symptoms (OR 107.1; 95% CI 3.9–2936.3; $p = 0.006$). No significant predictors were identified for other manifestations.

Discussion

Our assessment of the prevalence of skin lesions and its association with acrylate exposure has revealed a significantly higher prevalence among dental technicians than other dental staff and students, where this relationship depends on multiple factors (frequent contact with acrylates, frequent hand washing, and exposure to cold, etc.). Thus, a markedly higher prevalence of skin lesions after contact with acrylates was recorded in dental technicians (71.7%) compared to dental assistants (38.5%), dentists (24.2%), and students (25.8%). Also, among our examinees, three participants reported frequent contacts with acrylates as a factor exacerbating their skin lesions, with an observed association between acrylates exposure and facial/neck/eyelid eczema. Consequently, the high prevalence of work-related skin lesions among our dental professionals and students (65%) underscores the clinical significance of occupational exposure to acrylates. Although the rate among dental students and dentists specifically was lower (49%–52%), it remains substantial. The most frequently reported manifestations in our examinees were hand eczema and cracking on finger skin (29.4%), eczema of the face/neck (14.7%) and periungual dermatitis (11.8%), which is generally in accordance with literature data.

The high incidence of adverse skin changes reported in dental staff and students exposed to acrylates aligns with data showing these materials are not entirely safe. For instance, components of acrylic resin used in denture bases can be released and absorbed through the oral mucosa, skin, gastrointestinal, or respiratory systems (27). The specific absorption mechanism would depend on the nature/chemical properties of the released elements. Adverse effects on skin and internal

(33 % i 42 %) ($p < 0,001$).

U analizi povezanosti izloženosti i manifestacija, ekcem šaka i raskupline kože na jagodicama prstiju bili su značajno češći kod ispitanika koji su prijavili kontakt s dijabetičkim uređajima, elektrodama TENS ili EKG, nego kod onih bez takvog kontakta (10 % prema 1 %; $p = 0,026$; $V = 0,217$).

Sluznični simptomi (oči, nos, dišni sustav) bili su češći kod ispitanika koji su imali doticaj s umjetnim trepavicama i ekstenzijama kose u usporedbi s onima koji nisu (22,2 % prema 2,4 %; $p = 0,035$; $V = 0,262$).

Nisu ustanovljene značajne povezanosti između ostalih izloženosti i manifestacija.

U multivarijantnoj logističkoj regresiji, uz kontrolu istodobnog učinka svih izloženosti, kontakt s kontaktnim lećama i slušnim pomagalicama bio je značajan prediktor periungvalnoga dermatitisa, uz 5,3 puta veću vjerojatnost za pojavu (OR 5,3; 95 % CI 1,2–23,2; $p = 0,028$).

Kontakt s umjetnim trepavicama i ekstenzijama kose bio je značajan prediktor sluzničnih simptoma (oči, nos, dišni sustav), uz 107,1 puta veću vjerojatnost (OR 107,1; 95 % CI 3,9–2936,3; $p = 0,006$).

Rasprava

Naša procjena prevalencije promjena na koži i njihove povezanosti s izloženosti akrilatima pokazala je njihovu značajno veću prevalenciju među dentalnim tehničarima u odnosu prema ostalom dentalnom osoblju i studentima, pri čemu ta povezanost ovisi o više čimbenika (učestali kontakt s akrilatima, učestalo pranje ruku, izloženost hladnoći i dr.). Tako je značajno veća prevalencija promjena na koži poslije kontakta s akrilatima zabilježena kod dentalnih tehničara (71,7 %) u usporedbi s dentalnim asistentima (38,5 %), stomatolozima (24,2 %) i studentima (25,8 %). Također, među našim ispitanicima tri su sudionika navela učestali kontakt s akrilatima kao čimbenik koji pogoršava njihove promjene na koži, pri čemu je uočena povezanost između izloženosti akrilatima i ekcema na licu/vratu/vjeđama. Ta visoka prevalencija profesionalno povezanih promjena na koži među našim dentalnim djelatnicima i studentima (65 %) upućuje na veliko kliničko značenje profesionalne izloženosti akrilatima. Iako je prevalencija među studentima dentalne medicine i stomatolozima bila zamjetno niža (49 % – 52 %), i dalje je značajna. Najčešće prijavljene manifestacije među našim ispitanicima bile su ekcem na šakama i pucanje kože na prstima (29,4 %), ekcem na licu/vratu (14,7 %) te periungvalni dermatitis (11,8 %), što je uglavnom u skladu s podacima iz literature.

Velika učestalost neželjenih promjena na koži prijavljenih među dentalnim osobljem i studentima izloženima akrilatima može se objasniti općepoznatim činjenicama da akrilati nisu potpuno sigurni materijali. Primjerice, sastojci akrilatnih smola koje se koriste za bazu proteza mogu se oslobađati i apsorbirati kroz oralnu sluznicu, kožu te probavni ili dišni sustav (27). Specifični mehanizam apsorpcije ovisi o prirodi/kemijskim svojstvima oslobođenih sastavnica. Štetni učin-

tissues may be caused by both toxic and immunological reactions. According to research data, the unbound MMA may be both an allergen and tissue irritant, e.g., certain amounts of residual MMA have been found in dentures that had been worn for decades. By hydrolyzing MMA, methacrylic acid, which is cytotoxic, is formed. According to previous research results, potentially toxic effects of acrylic materials, including those in dentistry, are associated with butylene glycol dimethacrylate (BuMA), EGDMA and urethane dimethacrylate (UDMA), as well as with the co-monomer crosslinker ethylene glycol dimethacrylate (EGDM) (27,28). Also, isobornyl-acrylate (IBOA), which can be present in dental materials such as dental resins (composite fillings and adhesives), may trigger both contact allergic or irritant reactions and was named 2020 contact allergen of the year responsible for many adverse skin reactions.

Thus, recommendations have been proposed to decrease the amount of residual monomer in acrylate polymerization, such as additional initiation or immersion in an aqueous water bath before application (27). Also, according to the ISO standard recommendations, the maximum allowed amount of residual MMA for hot polymerized acrylate is 2.2%, and for cold polymerized acrylate it is 4.5% (29). However, acrylates have become an integral part of dentistry and many industries (30). Despite their great practical value, frequent exposure carries the risk of adverse skin reactions, especially ICD and, less commonly, ACD. In general, allergic reactions to acrylates are rare, which aligns with our research, in which only 6 positive reactions were recorded out of 53 participants tested. However, a patch test could potentially be performed to check for a contact allergy to acrylates (30). Despite rarely recorded allergic reactions in our research, our participants often had persistent skin/mucosal changes, recorded among 55.7% dental technicians, 38.5% dental assistant/nurse 33.3% dentists, and 12.9% students. So, prevention and education are vital in protecting the health of dental professionals and students.

In addition to the side effects of acrylates in dentistry, other sources of acrylates can be identified. Thus, we recorded that contact with diabetic devices, TENS and ECG electrodes were significantly more frequently associated with hand eczema/fissuring, while contact with lenses or hearing aids was a significant predictor of periungual dermatitis. This confirms our data that individuals in frequent contact with devices containing acrylates (diabetic devices, TENS and ECG) also had more frequent manifestations, such as hand eczema and cracking finger skin, than those who did not have such contact. Also, contact with lenses and hearing aids was a significant predictor of periungual dermatitis, creating a 5.3x greater likelihood of dermatitis, and contact with false eyelashes and hair extensions was a predictor of mucosal symptoms, with a 107.1x greater likelihood. In addition, mucosal symptoms (eyes, nose, and respiratory system) were more common in examinees working in/studying dentistry that also had contact with false eyelashes and hair extensions than in those who did not; for the other tested products containing acrylate, there was no significant association with manifestations.

ci na kožu i druga tkiva mogu biti posljedica i toksičnih i imunosnih reakcija. Prema dostupnim istraživanjima, nevezana MMA može djelovati i kao alergen i kao tkivni iritans; primjerice, određene količine rezidualne MMA-e pronađene su u protezama koje su se nosile desetljećima. Hidrolizom MMA-e nastaje citotoksična metakrilna kiselina. Prema dosadašnjim istraživanjima, potencijalni toksični učinak akrilatnih materijala, uključujući one koji se koriste u dentalnoj medicini, povezan je s butilen-glikol dimetakrilatom (BuMA), EGDMA-om i uretan dimetakrilatom (UDMA) te s umrežavajućim komonomerom etilen-glikol dimetakrilatom (EGDM) (27, 28). Također, izobornil-akrilat (IBOA), koji se može nalaziti u dentalnim materijalima poput dentalnih smola (kompozitnih ispuna i adheziva), može izazvati alergijske ili iritativne kontaktne reakcije te je proglašen kontaktnim alergenom 2020. godine zbog mnogobrojnih prijavljenih neželjenih reakcija na koži.

Zbog navedenoga, predložene su preporuke za smanjenje količine rezidualnog monomera tijekom polimerizacije akrilata, primjerice, dodatnom kompenzacijom ili uranjanjem materijala u vodene otopine u vodenoj kupelji prije primjene (27). Također, prema preporukama ISO standarda, maksimalno dopuštena količina rezidualne MMA-e iznosi 2,2 % za toplinski polimerizirane akrilate, odnosno 4,5 % za hladno polimerizirane akrilate (29). Međutim, akrilati su integrirani u dentalnu medicinu te u mnogobrojne druge industrije (30). Unatoč njihovoj velikoj praktičnoj vrijednosti, učestala izloženost rizična je zbog neželjenih reakcija na koži, osobito iritativnoga kontaktnog dermatitisa (ICD), a rjeđe alergijskoga kontaktnoga dermatitisa (ACD). Općenito su alergijske reakcije na akrilate rijetke, što je u skladu s našim istraživanjem u kojemu je među 53 testirana ispitanika zabilježeno samo šest pozitivnih reakcija. Epikutano testiranje može se koristiti za provjeru kontaktne alergije na akrilate (30). Unatoč rijetko zabilježenim alergijskim reakcijama u našem istraživanju, naši su ispitanici često imali perzistentne promjene na koži i/ili sluznicama koje su zabilježene kod 55,7 % dentalnih tehničara, 38,5 % dentalnih asistenata / medicinskih sestara, 33,3 % stomatologa i 12,9 % studenata. Stoga, prevencija i kontinuirana edukacija ključne su za zaštitu zdravlja dentalnih djelatnika i studenata.

Osim nuspojava akrilata u dentalnoj medicini, mogu se prepoznati i drugi izvori izloženosti akrilatima. Tako smo zabilježili da su kontakti s dijabetičkim uređajima, TENS uređajima i EKG elektrodama, bili značajno češće povezani s ekcemom na šakama i pucanjem kože na prstima, a kontakt s kontaktnim lećama ili slušnim pomagalicama bio je značajan prediktor periungvalnoga dermatitisa. To potvrđuje naš podatak da su osobe koje su češće bile u kontaktu s uređajima koji sadržavaju akrilate (dijabetički uređaji, TENS uređaji i EKG elektrode) također češće imale manifestacije poput ekcema na šakama i pucanja kože na prstima u usporedbi s osobama bez takvog kontakta. Također, kontakt s kontaktnim lećama i slušnim pomagalicama bio je značajan prediktor periungvalnoga dermatitisa, uz 5,3 puta veću vjerojatnost za njegov razvoj, a kontakt s umjetnim trepavicama i ekstenzijama za kosu bio je prediktor simptoma na sluznicama, uz 107,1 puta veću vjerojatnost za njihovu pojavu. Nadalje, simptomi

Caution and awareness of different types of exposure are required when working with acrylates. Reactions can occur from both skin and airborne exposure and can cause even systemic reactions. Sometimes, manifestations can occur on parts of the body not directly exposed, such as the thighs or genitals (12). In beauticians, studies have recorded symptoms affecting the eyes and nasal and respiratory mucosa. Other studies have shown that nail salon workers' contact with (meth) acrylates affected breathing, both the lungs and the airway (31). Such findings support the fact that acrylates can be strong irritants. According to one research survey conducted on females interested in applying manicures using gel nail polish, the majority reported side effects associated with using gel nail polish, including those that occur during wearing the manicure (21.2%) and after removing it (75.2%) (32). Also, skin lesions were reported by 3.1% examinees (hands, lip oedema, widespread), while 52.9% reported subjective symptoms like itching, a burning sensation or pain during wearing the gel nail polish (15.53%) and after removing it (6.99%). One Italian study has recently shown an increasing ACD prevalence related to 2-HEMA (33). The authors suggest that this increase is mainly caused by increased nail product use and a lack of regulation around 2-HEMA (33). Although 2-HEMA use in the workplace is currently restricted under EU regulations, these regulations do not prevent the cross-reaction of 2-HEMA with other acrylates in nail cosmetics that are still readily available to the general public. The growing exposure from nail products requires further research, greater public awareness about the risks of exposure, as well as stronger government action to monitor acrylate use (33,34).

When considering potential preventive measures, health-care professionals should identify potential occupational hazards in dentistry and implement measures to avoid skin lesions or contact dermatitis, including the correct use of personal protective equipment such as protective gloves, goggles, masks and disposable aprons (13, 35). To avoid skin exposure to chemicals, non-contact techniques are important. It is also of great importance that product labels of dental acrylic materials display all contained acrylic compounds, even acrylic monomers/impurities at concentrations lower than 1%, which could help in selecting products that a sensitized person could use. Also, when selecting protective gloves, it should be taken into account that nitrile rubber gloves offer better protection against MA penetration for shorter exposures of 15–20 minutes. They are considered more effective than latex gloves, providing greater penetration resistance and lower monomer penetration rates (12). Frequent glove changes have also been emphasized, e.g., some authors suggest using nitrile gloves for a maximum period of 30 minutes, after which they should be changed if the procedure is not completed (36). It has also been observed that during long-term exposures, acrylates could diffuse from nail gel and cause skin changes. In addition, general skin care, especially of the hands, including moisturizing and the use of alcohol-free disinfectants, is needed to maintain a strong skin barrier or restore a damaged epidermal layer. Implementing such measures prevents flare-ups. It is also

na sluznicama (oči, nos i dišni sustav) bili su češći među ispitanicima koji rade ili studiraju dentalnu medicinu, a također su bili u kontaktu s umjetnim trepavicama i ekstenzijama za kosu, nego među onima bez takvog kontakta. Za ostale ispitivane proizvode koji sadržavaju akrilate nije ustanovljena značajna povezanost s manifestacijama.

Oprez i svijest o različitim vrstama izloženosti potrebni su pri radu s akrilatima. Reakcije se mogu pojaviti i poslije izloženosti kože i inhalacijske izloženosti te mogu prouzročiti čak i sistavne reakcije. Katkad se manifestacije mogu pojaviti na dijelovima tijela koji nisu izravno izloženi, kao što su bedra ili genitalije (12). Kod kozmetičarki u studijama zabilježeni su simptomi koji zahvaćaju oči te sluznicu nosa i respiratornu sluznicu. U drugim studijama istaknuto je da kontakt djelatnika u salonima za nokte s (met)akrilatima utječe na disanje, uključujući pluća i dišni sustav (31). Takvi nalazi podupiru činjenicu da akrilati mogu biti jaki iritansi. Prema jednom anketnom istraživanju provedenom među ženama zainteresiranim za primjenu manikura s gel lakom za nokte, većina je prijavila nuspojave povezane s uporabom toga laka, uključujući one tijekom nošenja laka (21,2 %) i poslije uklanjanja (75,2 %) (32). Također, promjene na koži prijavilo je 3,1 % ispitanika (šake, edem usana, generalizirane promjene), a 52,9 % istaknulo je subjektivne simptome poput svrbeža, osjećaja pečenja ili boli tijekom nošenja gel laka (15,53 %) i poslije uklanjanja (6,99 %). U jednoj talijanskoj studiji istaknut je porast prevalencije ACD-a povezanoga s 2-HEMA-om (33). Autori sugeriraju da je porast uglavnom posljedica povećane uporabe proizvoda za nokte i nedostatka regulacije 2-HEMA-e (33). Iako je uporaba 2-HEMA-e na radnome mjestu trenutačno ograničena EU regulativama, te regulative ne sprječavaju križnu reakciju 2-HEMA-e s drugim akrilatima u kozmetici za nokte koja je i dalje lako dostupna općoj populaciji. Sve veća izloženost klijenata alergenima iz proizvoda za nokte zahtijeva daljnja istraživanja, veću javnu svijest o rizicima izloženosti te snažnije vladine mjere za nadzor uporabe akrilata (33, 34).

Pri razmatranju mogućih preventivnih mjera, zdravstveni djelatnici trebaju identificirati potencijalne profesionalne opasnosti u dentalnoj medicini i provesti mjere za izbjegavanje promjena na koži ili kontaktnog dermatitisa, što obuhvaća pravilnu uporabu osobne zaštitne opreme kao što su zaštitne rukavice, naočale, maske i jednokratne pregače (13, 35). Za izbjegavanje izloženosti kože kemikalijama važne su tehnike bez kontakta. Također je iznimno važno da su u deklaracijama dentalnih akrilatnih materijala sadržani svi akrilatni spojevi, čak i akrilatni monomeri/nečistoće u koncentracijama manjim od 1 %, što bi moglo pomoći u odabiru proizvoda kojima se senzibilizirana osoba može koristiti. Također, pri odabiru zaštitnih rukavica treba uzeti u obzir da nitrilne gumene rukavice bolje štite od penetracije MA-e za kraće izloženosti od 15 do 20 minuta. Smatraju se učinkovitijima od lateks rukavica, jer imaju veću otpornost na penetraciju i nižu stopu prolaska monomera (12). Također je istaknuta česta promjena rukavica, primjerice, neki autori predlažu korištenje nitrilnih rukavica najviše 30 minuta, a zatim ih treba promijeniti ako postupak nije završen (36). Također je uočeno da tijekom dugotrajne izloženosti akrilati mogu difundirati iz ge-

important to wear a mask and protective eyewear to prevent inhalation and eye irritation. Also, it is very important to control the environment (working in a well-ventilated area or use ventilated manicure tables), as well as to keep acrylates away from other products and work areas to avoid contamination. These measures are especially important for dental technicians who were most common group in prevalence of unwanted reactions to acrylates among dental professionals. In addition, environmental controls such as good ventilation, proper curing, and chemical analysis methods (e.g., gas chromatography for airborne exposure and tape-stripping techniques for dermal exposure) serve as very useful measures for their protection. Concerning measures related to professional nail care procedures, it is useful to change protective coverings on manicure stations after each customer, ensure proper product handling and curing (avoiding touching uncured polish, ensuring all nails are properly cured under the lamp for the required time) and to not use tools, such as nail files, from acrylate procedures for conventional manicures to avoid cross-contamination (37). Taken together, applying these basic precautions is effective in preventing new cases of eczema and contact dermatitis, thereby reducing an individual's need to change their occupation (13). Given that awareness of the sensitizing properties of acrylates has increased in recent years, and due to the more frequent use of personal protection, as well as the popularity of non-contact techniques, the number of dental personnel allergic to methacrylates has decreased (12).

However, a limitation of our research is the relatively small sample size. Furthermore, the results relied predominantly on self-reported data regarding skin and mucosal changes; these symptoms may not be uniquely attributable to acrylate exposure but could also stem from other preexisting dermatological conditions. Additionally, potential confounding factors outside the occupational or academic environment exist. Consequently, larger, multicenter studies are recommended to enable a more precise determination of the frequency of adverse reactions to acrylates resulting from occupational exposure.

Conclusion

The most common work-related skin changes were confirmed in dental professionals and students in dentistry (in more than half of dental professionals and students, especially in technicians) and their association with acrylates highlights the clinical significance of occupational exposure, especially among dental technicians. Acrylics have become an integral part of dentistry and many industries and are widely used in medical and cosmetic products that come into close

la za nokte i prouzročiti promjene na koži. Uz to, potrebna je opća njega kože, posebice šaka, uključujući ovlaživanje/hidrataciju i uporabu dezinficijensa bez alkohola kako bi se sačuvao integritet kožne barijere ili obnovio oštećeni epidermalni sloj. Razlog za primjenu tih mjera jest sprječavanje egzacerbacije. Također je važno nositi masku i zaštitne naočale kako bi se spriječila inhalacija i iritacija očiju. Potrebno je kontrolirati okolišne uvjete (rad u dobro prozračenom prostoru ili korištenje ventiliranih stolova za manikuru) te držati akrilate podalje od drugih proizvoda i radnih površina da bi se izbjegla kontaminacija. Navedene mjere posebno su važne za tehničare koji su bili najčešća skupina u prevalenciji neželjenih reakcija na akrilate među dentalnim osobljem. Uz to, kontrola radnoga okruženja dobrom ventilacijom i pravilnim stvrdnjavanjem (polimerizacijom) materijala te potencijalna primjena metoda kemijske analize (npr., plinska kromatografija za procjenu izloženosti putem zraka te tehnike uklanjanja slojeva kože ljepljivom vrpcom za procjenu dermalne izloženosti), vrlo su korisne mjere zaštite. Kad je riječ o mjerama povezanim s profesionalnim postupcima njege noktiju, korisno je mijenjati zaštitne podloge na manikirnim radnim površinama poslije svakog klijenta, osigurati pravilno rukovanje proizvodima i njihovo odgovarajuće stvrdnjavanje (izbjegavati dodirivanje nestvrdnutoga laka te osigurati da su svi nokti dovoljno dugo izloženi svjetiljki kako bi se pravilno stvrdnuli) te ne upotrebljavati alate poput turpija za nokte koji su korišteni u postupcima s akrilatima za klasičnu manikuru kako bi se izbjegla križna kontaminacija (37). Primjena osnovnih preventivnih mjera korisna je u sprječavanju novih slučajeva ekcema i kontaktnoga dermatitisa te, posljedično, može smanjiti potrebu pojedinca za promjenom zanimanja (13). S obzirom na to da je posljednjih godina porasla svijest o senzibilizirajućim svojstvima akrilata te zbog češće uporabe osobne zaštitne opreme i popularnosti tehnika bez izravnoga kontakta, smanjio se broj stomatoloških djelatnika alergičnih na metakrilate (12).

No ograničenje našeg istraživanja jest razmjerno mali broj ispitanika. Rezultati su se također temeljili pretežno na samoprijavljenim podacima o promjenama na koži i/ili sluznicama koje su ispitanici sami zabilježili, a nisu mogle biti isključivo posljedica izloženosti akrilatima, nego su mogle biti povezane i s drugim dermatološkim ili već postojećim zdravstvenim stanjima. Uz to, možda su djelovali i drugi čimbenici izvan radnoga ili obrazovnoga okruženja koji su mogli negativno utjecati na rezultate. Zbog toga se preporučuju veća, multicentrična istraživanja koja bi omogućila preciznije utvrđivanje učestalosti nuspojava povezanih s profesionalnom izloženošću akrilatima.

Zaključak

Uobičajene promjene na koži povezane s radom potvrđene su kod osoblja i studenata u dentalnoj medicini (kod više od polovine dentalnih djelatnika i studenata, osobito tehničara) i njihova povezanost s akrilatima ističe kliničko značenje profesionalne izloženosti, osobito među dentalnim tehničarima. Akrilati su postali sastavni dio dentalne medicine i mnogobrojnih drugih industrija i često se koriste u medicinskim i kozmetičkim proizvodima koji dolaze u bliski kontakt

contact with the skin and mucous membranes, and despite the benefits of their use, there is a risk of adverse health reactions (46). Frequent exposure can cause adverse skin reactions, especially irritant changes or lesions on exposed skin such as the hands and face. Despite the above-mentioned limitations, this study confirms that dental technicians—those most frequently exposed to acrylates—report the highest prevalence of skin problems. Our findings highlight the importance of preventive measures, protective equipment, improved work techniques, better skin care and continuing education, and prevention and education are key to protecting the health of dental professionals and students. Future studies should be multicentric and should explore other dermatologic conditions that may coexist with acrylate-related changes. With a larger sample size and broader demographic representation, it could be possible to provide deeper insights into susceptibility patterns. Thus, continued research and interdisciplinary collaboration is encouraged so that diagnostic accuracy can improve and that clinical work can offer greater benefits to patients.

Statement: AI was used during the final stage of preparing this manuscript to check grammar and spelling.

Funding: This research received no external funding. Informed consent: Informed consent was signed by all subjects involved in the study.

Conflict of interest: The authors declare no conflicts of interest regarding this manuscript.

Ethics approval and consent to participate: The study protocol was approved by the Ethics Committee of the School of Dental Medicine, University of Zagreb, at its 4th regular session held on January 15, 2025 (approval number: 05-PA-1-4/25).

Acknowledgement: The parts of this research were presented at the School of Dental Medicine, University of Zagreb Zagreb, September, 17, 2025 (A Rector's Award for research)

Author's contribution: V.V. - contributed to conception, design, analysis and interpretation; L.P. - contributed to conception, design, analysis and interpretation; O.J. - contributed to conception, design and critically revised the manuscript; C.K. - contributed to design and critically revised the manuscript; D.M. - contributed to design, and critically revised the manuscript. L.L.-M. - contributed to conception, design, analysis and interpretation, drafted and critically revised the manuscript. All authors gave their final approval and agreed to be accountable for all aspects of the work.

s kožom i sluznicama te, unatoč koristima od njihove primjene, postoji rizik od štetnih reakcija na koži. Učestala izloženost može prouzročiti štetne reakcije na koži, osobito iritativne promjene, većinom na izloženoj koži poput kože šaka i lica. Unatoč navedenim ograničenjima, ova studija potvrđuje da dentalni tehničari — oni koji su najčešće izloženi akrilatima — imaju najveću prevalenciju promjena na koži. Naši rezultati ističu važnost preventivnih mjera, korištenja zaštitne opreme, poboljšanih radnih tehnika, adekvatnije njege kože i kontinuirane edukacije, a prevencija i edukacija ključne su za zaštitu zdravlja dentalnih djelatnika i studenata. Buduća istraživanja trebala bi biti multicentrična te obuhvatiti druge dermatološke bolesti i stanja koja mogu koegzistirati s promjenama povezanim s izloženosti akrilatima. Veći uzorak ispitanika i šira demografska zastupljenost omogućili bi dublji uvid u obrasce osjetljivosti na razvoj takvih promjena. Zato se potiču daljnja istraživanja i interdisciplinarna suradnja kako bi se unaprijedila dijagnostička točnost te omogućila veća korist za pacijente u kliničkoj praksi.

Izjava: Alat umjetne inteligencije (UI) korišten je tijekom završne faze u pripremi ovog rukopisa za provjeru gramatike i pravopisa.

Financiranje: Ovo istraživanje nije imalo vanjsko financiranje.

Informirani pristanak: Informirani pristanak potpisali su svi ispitanici uključeni u studiju.

Sukob interesa: Autori nisu bili u sukobu interesa.

Etičko odobrenje i pristanak za sudjelovanje: Protokol studije odobrilo je Etičko povjerenstvo Stomatološkog fakulteta Sveučilišta u Zagrebu na 4. redovitoj sjednici održanoj 15. siječnja 2025. (broj odobrenja: 05-PA-1-4/25).

Zahvala: Dijelovi ovog istraživanja predstavljani su na Stomatološkom fakultetu Sveučilišta u Zagrebu, 17. rujna 2025. (kao istraživanje nagrađeno Rektorovom nagradom).

Doprinos autora: V. V., L. P. – koncepcija, izgled rada, analiza i interpretacija; O. J. – koncepcija, izgled rada i kritičko revidiranje teksta; C. K., D. M. – izgled rada i kritičko revidiranje teksta; L. L. M. – koncepcija, izgled rada, analiza i interpretacija, kritičko revidiranje teksta. Svi autori dali su konačno odobrenje i slažu se da su odgovorni za sve aspekte rada.

Sažetak

Cilj: Cilj ovog istraživanja bio je ispitati mogući utjecaj izloženosti akrilatima te utjecaj drugih povezanih čimbenika na promjene kože i sluznice među stomatološkim djelatnicima i studentima. **Materijali i metode:** U ovom presječnom terenskom istraživanju ukupno je 136 ispitanika (dentalni tehničari, doktori dentalne medicine, dentalni asistenti/medicinske sestre te studenti) ispunilo upitnik o čimbenicima koji utječu na stanje kože te o učinku akrilata i povezanih čimbenika na kožne i sluznične promjene. **Rezultati:** Zabilježena je visoka prevalencija samoprijavljenih profesionalno povezanih promjena na koži u dentalnoj medicini koje su zahvaćale 65 % dentalnih djelatnika i studenata. Najveća učestalost ustanovljena je među dentalnim tehničarima (78 %) i asistentima (77 %), a zatim slijede studenti (52 %) i doktori dentalne medicine (49 %). Dentalni tehničari bili su znatno češće svakodnevno izloženi akrilatima (54 %) u odnosu prema ostalim skupinama (studenti 13 %, dentalni asistenti/medicinske sestre 19 %) te su imali i znatno veću prevalenciju kožnih lezija poslije kontakta s akrilatima (71,7 %). Najčešće manifestacije bile su ekcem i raspukline kože na šakama (29,4 %), ekcem na licu i vratu (14,7 %) te periungvalni dermatitis (11,8 %). Ispitanici koji su naveli akrilate kao čimbenike pogoršanja imali su znatno češće ekceme na licu i vratu ($p = 0,003$). Ostali značajni nalazi obuhvaćaju kontakt s kontaktnim lećama i slušnim pomagalicama kao prediktorima periungvalnoga dermatitisa ($p = 0,028$), kontakt s umjetnim trepavicama i ekstenzijama kose kao prediktorima simptoma na sluznicama ($p = 0,006$) te kontakt s dijabetičkim pomagalicama i elektrodama TENS/ECG koji je bio češće povezan s ekcemom i raspuklinama na šakama ($p = 0,026$). **Zaključak:** Prema rezultatima ovoga prvog hrvatskog istraživanja o akrilatima, oni mogu pridonijeti nastanku kožnih lezija kod dentalnih djelatnika i studenata, a osobito dentalnih tehničara među kojima je zabilježen značajan udio kožnih reakcija povezanih s akrilatima. Ti nalazi pokazuju da su potrebne dodatne zaštitne mjere.

Zaprimljen: 26. veljače 2026.

Prihvaćen: 9. lipnja 2026.

Adresa za dopisivanje

prof. dr. sc. Liborija Lugović-Mihić
Klinika Sestre milosrdnice
Zavod za dermatovenerologiju
Sveučilište u Zagrebu Medicinski
fakultet
Vinogradska cesta 29, 10 000 Zagreb,
Hrvatska
liborija@sfz.hr

MeSH pojmovi: akrilne smole; alergijski kontaktni dermatitis; profesionalni dermatitis; stomatološko osoblje
Autorske ključne riječi: akrilati, koža, kontaktni dermatitis, dentalna medicina, studenti, kozmetika

References

1. Quaade AS, Simonsen AB, Halling AS, Thyssen JP, Johansen JD. Prevalence, incidence, and severity of hand eczema in the general population—a systematic review and meta-analysis. *Contact Dermatitis*. 2021 May;84(5):361-74.
2. Bains SN, Nash P, Fonacier L. Irritant contact dermatitis. *Clin Rev Allergy Immunol*. 2019 Feb;56(1):99-109.
3. Dickel H, Bauer A, Brehler R, Mahler V, Merk HF, Neustädter I, et al. S1 guideline: contact dermatitis. *J Dtsch Dermatol Ges*. 2022 May;20(5):712-34.
4. Lugović-Mihić L, Novak-Bilić G, Vučić M, Japundžić I, Bukvić I. CD44 expression in human skin: high expression in irritant and allergic contact dermatitis and moderate expression in psoriasis lesions in comparison with healthy controls. *Contact Dermatitis*. 2020 May;82(5):297-306.
5. Japundžić I, Bembić M, Špiljak B, Parać E, Macan J, Lugović-Mihić L. Work-related hand eczema in healthcare workers: etiopathogenic factors, clinical features, and skin care. *Cosmetics*. 2023 Oct;10(5):134.
6. Căminșteanu F, Vorovenci A, Perieanu VȘ, Petri SA, Burlibașa L, David M, et al. Occupational diseases among dental personnel: a scoping review. *J Med Life*. 2025 Jun;18(6):526-35.
7. Wiechens B, Meyer-Marcotty P, Buhl T, Werfel T, Bauer A, Apfelbacher C, et al. Hand eczema symptoms, exposures and skin care in orthodontics: a national, cross-sectional questionnaire-based survey. *J Orofac Orthop*. 2025 Sep;86(5):327-36.
8. Japundžić I, Vodanović M, Lugović-Mihić L. An analysis of skin prick tests to latex and patch tests to rubber additives and other causative factors among dental professionals and students with contact dermatoses. *Int Arch Allergy Immunol*. 2018 Nov;177(3):238-44.
9. Japundžić-Rapić I, Macan J, Babić Ž, Vodanović M, Salarić I, Prpić-Mehićić G, et al. Work-related and personal predictors of hand eczema in physicians and dentists: results from a field study. *Dermatitis*. 2024 Jan;35(1):101-5.
10. Warshaw EM, Ruggiero JL, Atwater AR, DeKoven JG, Zug KA, Reeder MJ, et al. Occupational contact dermatitis in dental personnel: a retrospective analysis of the North American Contact Dermatitis Group data, 2001 to 2018. *Dermatitis*. 2022 Jan;33(1):80-90.
11. Sasseville D. Acrylates in contact dermatitis. *Dermatitis*. 2012 Jan;23(1):6-16.
12. Kucharczyk M, Słowik-Rylska M, Cyran-Stemplewska S, Gieroń M, Nowak-Starz G, Kręćisz B. Acrylates as a significant cause of allergic contact dermatitis: new sources of exposure. *Postepy Dermatol Alergol*. 2021 Aug;38(4):555-60.
13. Cameli N, Silvestri M, Mariano M, Messina C, Nisticò SP, Cristaudo A. Allergic contact dermatitis, an important skin reaction in diabetes device users: a systematic review. *Dermatitis*. 2022 Mar;33(2):110-5.
14. Lyapina M, Dencheva M, Krasteva A, Tzekova M, Kisselova-Yaneva A. Concomitant contact allergy to formaldehyde and methacrylic monomers in students of dental medicine and dental patients. *Int J Occup Med Environ Health*. 2014 Oct;27(5):797-807.
15. Luo S, Liu F, He J. Preparation of low shrinkage stress dental composite with synthesized dimethacrylate oligomers. *J Mech Behav Biomed Mater*. 2019 Jun;94:222-8.
16. Rodrigues SB, Petzhöld CL, Gamba D, Leitune VCB, Collares FM. Acrylamides and methacrylamides as alternative monomers for dental adhesives. *Dent Mater*. 2018 Nov;34(11):1634-44.
17. Spencer A, Gazzani P, Thompson DA. Acrylate and methacrylate contact allergy and allergic contact disease: a 13-year review. *Contact Dermatitis*. 2016 Sep;75(3):157-64.
18. Gatica-Ortega ME, Pastor-Nieto MA, Mercader-García P, Silvestre-Salvador J. 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 Dec;77(6):360-6.
19. Lin Y, Tsai S, Yang C, Tseng Y, Chu C. Allergic contact dermatitis caused by acrylates in nail cosmetic products: case reports and review of the literature. *Dermatol Sin*. 2018 Dec;36(4):218-21.
20. 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 Apr;78(4):254-60.
21. Splete H. Dermatologists name isobornyl acrylate contact allergen of the year [Internet]. *MDedge Dermatology*; 2019 [cited 2024 Jun 6]. Available from: <https://www.mdedge.com/dermatology/article/195656>
22. 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 Dec;79(6):331-5.
23. Rustemeyer T, Elsner P, John SM, Maibach HI, editors. *Kanerva's occupational dermatology*. 2nd ed. Cham: Springer; 2018. doi:10.1007/978-3-319-40221-5.
24. Minamoto K, Watanabe T, Diepgen TL. Self-reported hand eczema among dental workers in Japan—a cross-sectional study. *Contact Dermatitis*. 2016 Oct;75(4):230-9.
25. Lugović-Mihić L, Ferček I, Duvancić T, Bulat V, Ježovita J, Novak-Bilić G, et al. Occupational contact dermatitis amongst dentists and dental technicians. *Acta Clin Croat*. 2016 Jun;55(2):293-300.
26. Johansen JD, Aalto-Korte K, Agner T, Andersen KE, Bircher A, Bruze M, et al. European Society of Contact Dermatitis guideline for diagnostic patch testing—recommendations on best practice. *Contact Dermatitis*. 2015 Oct;73(4):195-221.
27. Kostić M, Pejčić A, Igic M, Gligorijević N. Adverse reactions to denture resin materials. *Eur Rev Med Pharmacol Sci*. 2017 Dec;21(23):5298-305.
28. Gawkrödger DJ. Investigation of reactions to dental materials. *Br J Dermatol*. 2005 Sep;153(3):479-85.
29. Rieder EA, Tosti A. Cosmetically induced disorders of the nail with update on contemporary nail manicures. *J Clin Aesthet Dermatol*. 2016 Apr;9(4):39-44.
30. Lugović-Mihić L, Filija E, Varga V, Premuž L, Parać E, Tomašević R, et al. Unwanted skin reactions to acrylates: an update. *Cosmetics*. 2024 Aug;11(4):127.
31. Reutman SR, Rohs AM, Clark JC, Johnson BC, Sammons DL, Toennis CA, et al. A pilot respiratory health assessment of nail technicians: symptoms, lung function, and airway inflammation. *Am J Ind Med*. 2009 Nov;52(11):865-75.
32. Putek J, Przybyla T, Szepietowski JC, Baran W, Batycka-Baran A. Side-effects associated with gel nail polish: a self-questionnaire study of 2,118 respondents. *Acta Derm Venereol*. 2020 Nov;100(18):adv00325.
33. Caroppo ES, Casciola G, Hansel K, Guglielmo A, Ferrucci SM, Guarneri F, et al. The Italian trend of contact allergy to 2-hydroxyethyl methacrylate: is the current European legislation working? *Contact Dermatitis*. 2025 Sep;93(3):224-33.
34. Wilkinson SM, Aerts O, Agner T, Bruze M, Brans R, Foti C, et al. Contact allergy to methacrylate-containing nail products: lack of impact of EU legislation. An audit on behalf of the European Environmental Contact Dermatitis Research Group (EECDRG). *Contact Dermatitis*. 2025 Apr;92(4):283-90.
35. Japundžić I, Novak D, Kuna M, Novak-Bilić G, Lugović-Mihić L. Analysis of dental professionals' and dental students' care for their skin. *Acta Stomatol Croat*. 2018 Mar;52(1):46-52.
36. Morgado F, Batista M, Gonçalo M. Short exposures and glove protection against (meth)acrylates in nail beauticians—thoughts on arising concern. *Contact Dermatitis*. 2019 Jul;81(1):62-3.
37. Mieręga I, Grigale-Sorocina Z, Birks I. The chemistry behind UV-curable nail polishes. *Polymers (Basel)*. 2025 May;17(9):1166.