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Difference between hand and forearm transepidermal water loss and skin pH as an improved method to biomonitor occupational hand eczema: our findings in healthcare workers

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The aim of this cross-sectional field study was to establish the condition of hand and forearm skin barrier among dentists and physicians and how it may be associated with personal and work-related factors. The study consisted of an occupational questionnaire, clinical examination of skin on hands, and transepidermal water loss (TEWL) and pH measurements on hands and forearms. The participants were divided in the following groups (N=37 each, N=148 in total): physicians, medical surgeons, dentists, and dental surgeons. We calculated the difference between hand and forearm TEWL and pH (ΔTEWL and ΔpH, respectively) and divided it by the forearm values (ΔTEWL% and ΔpH%, respectively). There was a clear trend of increasing median ΔTEWL%, starting from physicians with non-surgical specialisation (56 %) to medical surgeons (65 %), dentists (104 %), and dental surgeons (108 %), with the latter two groups showing particularly worrisome signs of work-related skin barrier impairment, since they had double the TEWL on hands than on forearms. Although less prominent, the same worsening trend was noted for skin pH, with dental surgeons having on average a 0.3 points higher skin pH on hands than on forearms. These findings were mainly associated with prolonged glove use and male sex. Our findings also suggest that comparing TEWL and pH between hands and forearms can better establish occupational skin barrier impairment on hands.

KEY WORDS: contact dermatitis; dentists; physicians; skin barrier; surgeons

Healthcare professionals are at risk of developing occupational skin diseases, primarily hand eczema due to occupational skin hazards common in healthcare sector such as detergents and glove occlusion, which can lead to the impairment of the skin barrier function over time (1–6). Interestingly, using skin sanitisers and detergents alternately seem to damage the skin barrier less than washing hands with detergents alone (7). While there are global efforts to implement WHO multimodal strategy and replace the use of soap and water with alcohol-based hand sanitisers (8), hand washing with soaps still remains the preferred method of hand hygiene for both physicians and dentists (9–10). Furthermore, having a surgical specialisation is a recognised additional risk factor, as it is associated with extreme hand hygiene and prolonged glove use (11).

The main symptoms of hand eczema are dry, itchy skin that is red or darker than the surrounding unaffected skin, and the condition can progress to cracking, soreness, and bleeding. Considering that the incidence of occupational contact dermatitis, most often manifested as hand eczema, is about 16 cases per 10,000 medical doctors per year and about 11 cases per 10,000 dentists per year (12), and that work-related skin lesions among healthcare professionals usually start as early as during vocational training (3), new and reliable methods of biomonitoring are being investigated to detect the development of certain health disorders at an early stage and enable timely prevention, especially in regard to occupational health disorders (13). Speaking of contact dermatitis, one option is to biomonitor skin barrier function, mainly by measuring transepidermal water loss (TEWL) and, less often, skin pH. The rationale behind these measurements is that intact s*tratum corneum* limits excessive evaporation of water through skin, so increased TEWL may indicate its compromised integrity (14), while long-term disturbances in skin pH impair antimicrobial defence and other pH-sensitive physiological processes which can contribute to visible skin lesions over time (15).

In our previous study (1) we noted that critical skin water loss (TEWL >30 g/[m^2·h]) was present in 14 % of physicians with a non-surgical specialisation, 22 % physicians surgeons, 27 % dentists non-surgeons, and 43 % dentists surgeons. Hand skin pH was the highest among dentists with non-surgical specialisations, as 38 % of them had pH >5.5.

Although these measurements are quick, non-invasive, and therefore suitable for workplace biomonitoring, they are underused in occupational settings, mainly because in addition to skin barrier function TEWL measurements greatly depend on *stratum corneum* hydration and are highly susceptible to ambient air temperature and

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humidity (14, 16). Skin pH, in turn, seems to be more robust in field conditions but has rarely been employed in occupational settings (1, 14,17). Furthermore, both TEWL and skin pH measurements vary with personal factors such as age, sex, and atopy, which can obscure the effects of occupational skin hazards (18–21). One way to control for these confounding factors could be to compare measured values between a forearm and a hand, that is, to use a person's forearm barrier condition as a "personal baseline" (or control) for assessing the condition of the hands. However, this option has not been investigated before.

Our aim was therefore to address this gap by establishing differences in hand and forearm skin barrier condition in dentists and physicians. In addition, this study design gave us the opportunity to compare skin barrier condition between those specialised in surgery and non-surgical professions.

PARTICIPANTS AND METHODS

This study uses data collected in our previous cross-sectional epidemiological study set in healthcare facilities (a university hospital centre, a school of dental medicine, a university hospital, and a dental outpatient clinic) in Zagreb, Croatia in March and April 2018 (1, 2). The physicians were divided in two subgroups: non-surgeons (psychiatrists, paediatricians, dermatologists, microbiologists, naesthesiologists, and ophthalmologists; N=37) and surgeons (general surgeons, gynaecologists, and otorhinolaryngologists; N=37). Similarly, the dentists were divided in non-surgeons (N=37) and oral surgeons (N=37). Both previous studies were approved by the Ethics Committees of the participating healthcare institutions (approval Nos. EP-15006/17-3; 05-PA-26-3/2018; 3709-1/18; 100-01/19-01) and the Ethics Committee of the Institute for Medical Research and Occupational Health, Zagreb, Croatia (approval Nos. 100-21/17-6 and 100-21/20-11). All participants were adult (≥18 years old) and gave written informed consent to participation.

The study protocol conducted in participating healthcare facilities has been described in detail in previous publications (1, 2). Briefly, the participants answered a questionnaire based on the Nordic Occupational Skin Questionnaire (NOSQ) (22) expanded with questions about habits affecting skin health (hand washings and sanitising, glove use). The team's dermatovenereologist (LLM) examined the skin on the hands and marked the presence of skin lesions, namely the erythema, scaling, papules, vesicles, infiltration, or fissures.

Skin barrier function parameters, TEWL and pH, were measured on the dorsum of the hand and on the volar side of the forearm using commercially available probes (Tewameter TM 300 probe and pH probe, Courage + Khazaka electronic GmbH, Cologne, Germany) following manufacturer's instructions.

Median ambient temperature (with interquartile and total range) during measurements was 24.0 °C (23.0–25.3 °C; 19.8–27.8 °C), and median ambient relative humidity (with interquartile and total range) was 40.0 % (36.5–44.6 %; 24.2–63.7 %).

As per manufacturer's instructions, we regarded TEWL>30 g/m^2/h a critical threshold indicating a compromised skin barrier. Similarly, we took skin pH above physiological levels (>5.5) as critical.

To calculate the difference between hand and forearm values we relied on the following equations:

$$\Delta TEWL = hand\ TEWL - forearm\ TEWL$$

$$\Delta TEWL\% = \frac{hand\ TEWL - forearm\ TEWL}{forearm\ TEWL}$$

$$\Delta pH = hand\ pH - forearm\ pH$$

$$\Delta pH\% = \frac{hand\ pH - forearm\ pH}{forearm\ pH}$$

Statistical analysis

Characteristics of the participants were summarised using descriptive statistics. The significance of differences between two categorical variables was tested with the Chi-squared test or Fisher's test, if the expected subgroup frequencies were <5. Differences between continuous variables were tested with the *t*-test or Mann-Whitney *U* test (in case of non-normal distribution) and simple linear regression. Finally, associations between TEWL and pH outcomes and multiple predictors were analysed simultaneously with multiple linear regression models. Associations were considered statistically significant at P<0.05. All analyses were run on the R Studio statistical software (R Core Team, Boston, MA, USA) (23).

RESULTS

Characteristics of the participants are shown in Table 1. Surgeons, both medical and dental, were mostly men, while other groups were mostly women. Median age was around 40 years.

Tables 2 and 3 give a detailed comparison of skin barrier condition between the groups. Dental surgeons have the worst hand TEWL values, and physicians of non-surgical specialties the best. The two groups differ significantly (P=0.007, Table 2). The forearm TEWL is considerably more favourable than hand TEWL in all groups, with dentists non-surgeons having the lowest water loss and physician surgeons the highest (although still in the healthy range). Again, the difference between these two groups is significant (P=0.026, Table 2).

The difference between hand and forearm TEWL (ΔTEWL), for which we hypothesised to more accurately reflect skin changes than hand TEWL alone, also shows a worsening trend from physicians non-surgeons on one side of the spectrum to dental surgeons on the other, and the difference between these two groups is significant (Table 2).

Table 1 Personal characteristics of the participants (N=148), their habits related to skin health, and their skin condition

	Physicians, non-surgeon specialisations N=37	Physicians, surgeons N=37	Dentists, non-surgeon specialisations N=37	Dentists, surgeons N=37
Men, N (%)	5 (14)	24 (65)	11 (30)	27 (73)
Age [years] Median (IQR; total range)	41 (31–46; 27–57)	39 (32–53; 28–63)	39 (33–47; 25–63)	37 (34–43; 28–62)
History of atopic dermatitis, N (%)	2 (5)	2 (5)	8 (22)	2 (5)
One or more skin lesions on clinical examination, N (%)*	15 (41)	15 (41)	22 (59)	17 (46)
Washing hands >20 times per day, N (%)	14 (38)	10 (27)	15 (41)	17 (46)
Disinfecting hands >10 times/day, N (%)	17 (46)	13 (35)	6 (16)	16 (43)
Gloves – time worn per day, N (%)				
0–1h	25 (68)	1 (3)	0 (0)	0 (0)
1–4h	8 (22)	18 (49)	4 (11)	5 (14)
>4h/h	4 (11)	18 (49)	33 (89)	32 (86)

Data in this table were partly presented in our previous publications (1, 2). IQR – interquartile range; * erythema, infiltration, desquamation, papules, vesicles, or fissures

Table 2 Hand and forearm transepidermal water loss (TEWL) by groups of healthcare professionals (N=148)

	Physicians, non–surgeon specialisations N=37	Physicians, surgeons N=37	Dentists, non–surgeon specialisations N=37	Dentists, surgeons N=37
Hand TEWL [g/m²/h] Median (IQR; total range)	**19.73 (14.22–24.97; 8.91–57.70)[a]**	19.78 (16.08–26.99; 11.03–75.54)	20.76 (17.79–30.02; 9.55–57.87)	**25.80 (19.24–34.31; 9.91–59.95)**
Compromised skin barrier (hand TEWL >30 g/m²/h) N (%)	**5 (14)[a]**	**8 (22)[a]**	10 (27)	**16 (43)**
Forearm TEWL [g/m²/h] Median (IQR; total range)	11.45 (9.65–14.76; 5.89–57.37)	**12.08 (9.70–14.22; 4.84–57.71)[b]**	**9.86 (7.93–12.75; 5.31–45.02)**	10.48 (8.64–12.93; 6.98–45.11)
ΔTEWL* [g/m²/h] Median (IQR, total range)	**7.20 (2.73–10.67; -14.8–28.96)[a; b]**	**7.21 (4.54–16.85; -12.27–43.02)[a]**	**9.99 (4.00–19.52; 0.98–37.86)**	**13.39 (7.78–24.16; 0.41–37.91)**
ΔTEWL%** [%] Median (IQR; total range)	**56 (24–106; -34– 394)[a; b]**	**65 (42–107; -38–407)[a]**	**104 (48–189; 3–549)**	**108 (67–184; 4–383)**

IQR – interquartile range; TEWL – transepidermal water loss. Significance of difference was tested with the chi-squared test for categorical variables and *t*-test or Mann-Whitney *U* test for non-categorical variables. [a] significantly different (P<0.05) from dental surgeons; [b] significantly different (P<0.05) from dentists non-surgeons

* $\Delta TEWL = hand\ TEWL - forearm\ TEWL$

** $\Delta TEWL\ \% = \frac{hand\ TEWL - forearm\ TEWL}{forearm\ TEWL}$

Relative TEWL, that is, the percentage of difference between hand and forearm TEWL values (ΔTEWL%) with forearm value serving as baseline, shows the same trend, with increasingly worsening median values from physicians of non-surgical specialties (56 %) to the dental surgeons (108 %).

Regarding hand skin pH, dentists of non-surgical specialties show the highest values (Table 3), significantly higher than in any other group. Similar to TEWL, skin pH values on forearms are more favourable than those on hands in all groups and, surprisingly, the best in dental surgeons, who significantly differ from dentists non-surgeons (P=0.044, Table 3). Although the relative pH change, that is, the difference between hand and forearm pH values (ΔpH%) is small in all groups, the trend worsens slightly from physicians of non-surgical specialties (2 %) to both dentist groups (6 %), and the difference between the groups on the opposing ends is significant.

By testing the significance of associations of TEWL and pH parameters with relevant factors in the whole study sample (N=148), we noted that, overall, men had higher hand TEWL than women, while women had higher hand skin pH (Table 4). In turn, forearm TEWLs do not significantly differ between men and women (data not shown), while forearm skin pH is significantly higher in women than in men (P<0.001). Hence the higher ΔTEWL and ΔTEWL% but not ΔpH and ΔpH% in men than women (Table 4).

Age, self-reported history of atopic dermatitis, and skin lesions found on clinical examination are not significantly associated with either skin barrier parameter in our study sample.

As expected, glove use corresponds to the higher hand TEWL and pH values, but the association is significant only for ΔTEWL/ΔTEWL% and ΔpH/ΔpH% (Table 4).

Frequent hand washing is borderline associated only with higher ΔTEWL% (P=0.050); those who reported washing their hands more than 20 times a day have median ΔTEWL% of 103 % (IQR 57–166 %; total range -32–549 %), whereas those washing hands less frequently have the median ΔTEWL% of 67 % (42–131 %; -38–394 %). Although hand values alone do not differ significantly in regard to reported frequency of hand sanitising, ΔTEWL and ΔTEWL% are significantly higher in participants who reported sanitising their hand more than 10 times a day than those who reported doing it less frequently. Their respective medians (IQR; total range) are as follows: ΔTEWL 10.62 g/m^2/h (6.65–18.63; 0.41–37.86) vs 8.66 g/m^2/h (3.82–15.27; -14.80–43.02; P=0.050) and ΔTEWL% 103 % (65–166 %; 4–394 %) vs 67 % (40–133 %; -38–549 %; P=0.022). In contrast, ΔpH% is only slightly higher in those who reported sanitising their hands less than 10 times a day: 5 % (-2–13 %; -15–38 %) vs 1 % (-2–7 %; -18–22 %; P=0.047).

To identify independent variables which most affect the skin barrier, we ran multiple regression analyses with ΔTEWL, ΔTEWL%, ΔpH, and ΔpH% as outcomes and sex, age, and frequencies of hand washing, hand sanitising, and glove use as predictors. Only sex shows a significant association with ΔTEWL (regardless of their work-related habits, men had on average 7.75 g/m^2/h higher ΔTEWL (SD=1.16 g/m^2/h, P<0.001, P model <0.001, pseudo R^2=0.221) and ΔTEWL% (68 %, SD=16 %, P<0.001, P model <0.001, pseudo R^2=0.226). As for pH, lower ΔpH and ΔpH% are significantly associated with frequent hand sanitising (over 10 times a day), as follows: ΔpH -0.22 (SD=0.09, P=0.011, P model =0.007, pseudo R^2=0.176) and ΔpH% -5 % (SD=2 %, P=0.009, P model =0.005, pseudo R^2=0.138).

Table 3 Hand and forearm pH by groups of healthcare professionals (N=148)

	Physicians, non–surgeon specialisations N=37	Physicians, surgeons N=37	Dentists, non–surgeon specialisations N=37	Dentists, surgeons N=37
Hand skin pH Median (IQR, total range)	**5.25 (4.84–5.43; 4.06–6.16)[b]**	**5.07 (4.76–5.43; 4.01–6.18)[b]**	**5.33 (5.15–5.60; 4.38–6.50)[a]**	**5.22 (4.69–5.57; 4.26–6.23)**
Compromised skin acidity (hand pH >5.5) N (%)	8 (22)	9 (24)	14 (38)	12 (32)
Forearm skin pH Median (IQR, total range)	5.10 (4.65–5.53; 4.26–5.97)	4.92 (4.51–5.22; 3.74–6.31)	**5.04 (4.69–5.54; 4.16–6.33)[a]**	**4.70 (4.37–5.32; 4.01–5.88)**
ΔpH* Median (IQR; total range)	**0.12 (-0.14–0.31;-0.87–0.90)[a]**	0.16 (-0.20–0.39; -0.63–1.40)	0.30 (-0.11–0.64; -0.78–1.79)	**0.27 (0.01–0.72; -0.79–1.30)**
ΔpH%** [%] Median (IQR, total range)	**2 (-3–7; -18–19)[a]**	3 (-4–8; -12–31)	6 (-2–14; -2–38)	**6 (0–15; -15–29)**

Abbreviations: IQR, interquartile range. Significance of difference was tested with the chi-squared test for categorical variables and *t*-test or Mann–Whitney *U* test for non-categorical variables. [a] significantly different (P<0.05) from dental surgeons; [b] significantly different (P<0.05) from dentists non-surgeons

* $\Delta pH = hand\ pH - forearm\ pH$

** $\Delta pH\ [\%] = \frac{hand\ pH - forearm\ pH}{forearm\ pH}$

DISCUSSION

Our study shows a clear trend of increasing difference between hand and forearm skin barrier condition in the following order (from lowest to highest): physicians with non-surgical specialisation, medical surgeons, dentists, and dental surgeons, with the latter two groups showing particularly worrisome signs of work-related skin barrier impairment, since they had double the TEWL on hands than on forearms. Although less prominent, the same worsening trend is observed for hand skin pH, with dental surgeons having on average a 0.3 points higher hand than forearm skin pH (ΔpH). These observations are in line with the increasing demand for hand hygiene across these professions (2).

Considering that we found no significant association between hand TEWL and increased glove use but did find a significant trend of worsening of relative parameters ΔTEWL, ΔTEWL%, ΔpH, and ΔpH%, our study has confirmed the hypothesised utility of using the forearm as a personal baseline when investigating skin health on hands exposed to occupational hazards. Surprisingly, frequent hand sanitising is significantly associated with high ΔTEWL, which implies that frequent hand sanitising does not replace hand washing in our sample but complements it, thus increasing the risk of hand skin damage. Furthermore, our cut-offs for what is "frequent" (20 times a day for washing and 10 times a day for sanitising), based on NOSQ (22) and our experience in previous occupational studies] may be too crude for the healthcare sector, especially for surgeons who may be washing and/or sanitising their hands dozens of times a day. A more nuanced questionnaire on exposure or even a diary-based approach could help overcome these challenges in the future studies.

Interestingly, we found a more favourable (0.2 points lower) ΔpH among those who reported sanitising their hands more than 10 times a day independent of other personal or work-related factors, which is in line with the literature data suggesting that hand sanitising disrupts the skin barrier less than washing with soaps (8, 19). But since frequent hand sanitising is also associated with higher relative TEWL in this study, another explanation could be that alcohol-based hand rubs simply lower the pH, as alcohol dehydrogenase present in the skin metabolises rub ingredients to acidic products (24). Furthermore, hand sanitisers with high ethanol concentrations are associated with increased scaliness, presumably because volatile alcohols take water along as they evaporate (25).

Besides work-related factors, we have noted significant associations between sex and skin barrier condition. Men have higher hand TEWL than women, while the forearm TEWL does not significantly differ between the sexes. Consequently, the difference between hand and forearm condition (ΔTEWL) in men is double the difference in women (median ΔTEWL 14.94 vs 7.95 g/m^2/h, respectively, or expressed as percentage: median ΔTEWL% 113 % vs 63 %). Although even men without damaged hand skin seem to have higher TEWL than women (16, 26), we cannot exclude the possibility that sex in our study sample is a proxy for the overall burden of hand hygiene and glove use, which is most notable in surgeons, who, in turn, are predominately men in our sample. The case in point is our finding that, regardless of their work-related habits, men have about 7 g/m^2/h higher ΔTEWL than women (ΔTEWL% 68 %). In contrast, women in our study sample have higher pH values for both hand and forearm skin pH. This may stem from sex differences in the sebum content and sweat production, but the influence of sex on skin pH is still inconclusive. Some earlier studies have found the same association as we have (26, 27), but there are also those having found no (28) or even the opposite association (lower skin pH in women) (29). Nevertheless, judging by the results of our previous occupational studies over the years, women in our southern European Caucasian population have higher hand pH values than men (1, 17, 30), and this study only confirms them.

The main strength of this study is that it supports a new approach to skin biomonitoring in an occupational setting. While there were occupational studies exploring workers' hand and forearm barrier condition separately, putting these two anatomical sites in relation has not been attempted before. For example, although TEWL and skin pH were found to be higher on hands than forearms of newspaper print workers in Germany, the study did not further analyse the difference in regard to workplace skin hazards or visible skin lesions on hands (31). Similarly, an Italian study assessing the effectiveness of a training course for the prevention of occupational contact dermatitis (32) and a study set in a fish processing plant (33) did not consider the difference in TEWL between hand and forearm skin. In addition, although there are clinical trials comparing different hand hygiene protocols for healthcare workers (25, 34, 35), studies investigating the influence of their usual practices on skin health are rare.

Our current study therefore builds on our previous findings of adverse effects of glove use on hand TEWL and pH by looking into hand TEWL and pH parameters relative to forearm only to find more significant associations with hand sanitising.

The main limitation of our study is a small sample size (N=148 in total, N=37 in each group). It would also have benefitted from a more detailed questionnaire to identify the most harmful work-related factors, specific for each study group, that would better inform future preventive strategies. Instead, we aimed for a short and simple questionnaire based on the NOSQ (22) to accommodate field-study time limitations. We only included questions regarding hand exposure and missed the opportunity to collect data on surgical preparation. Since there are no quantitative literature data on the exact influence of hand and forearm surgical scrubbing on skin barrier function, this could be an interesting focus for future studies.

The limitations of our study may have obscured the associations of ΔTEWL and ΔpH with visible skin lesions. However, the fact that the incidence of visible hand skin lesions (41 % among physicians of either surgical or non-surgical specialisations, 59 % in dentists with non-surgical specialisation, and 46 % in dental surgeons) reported earlier (1, 2) do not coincide with increased

Table 4 Hand and forearm transepidermal water loss (TEWL) among healthcare professionals by sex and glove use (N=148)

	Sex		Glove use (h)		
	Men N=67	**Women N=81**	**0–1 h N=26**	**1–4 h N=35**	**>4 h N=87**
Hand TEWL [g/m²/h] Median (IQR; total range)	**26.99 (19.21–36.56; 9.55–75.54)[a]**	**18.70 (14.63–24.53; 8.91–46.77)**	17.98 (13.88–24.97; 8.91–57.70)	19.79 (16.11–29.71; 11.67–75.54)	21.77 (17.00–32.41; 9.55–59.95)
Compromised skin barrier (hand TEWL >30 g/m²/h) N (%)	**30 (45)[a]**	**9 (11)**	3 (12)	9 (26)	27 (31)
ΔTEWL* Median (IQR, total range)	**14.94 (7.09–23.65; -12.27–43.02)[a]**	**7.95 (3.78–11.23; -14.80–29.03)**	**6.58 (1.85–10.65; -14.80–28.96)[b]**	**7.99 (5.23–14.02; -12.27–37.91)[b]**	**10.95 (5.70–19.57; -6.17–43.02)[b]**
ΔTEWL%** [%] Median (IQR, total range)	**113 % (65–234; -38 –549)[a]**	**63 % (41–106; -34–311)**	**62 % (17–109; -32–394)[b]**	**64 % (49–109; -38–336)[b]**	**104 % (50–183; -34–549)[b]**
Hand skin pH Median (IQR, total range)	**5.01 (4.59–5.37; 4.01–6.50)[a]**	**5.36 (5.14–5.63; 4.06–6.39)**	5.21 (4.82–5.40; 4.09–6.16)	5.07 (4.74–5.57; 4.01–6.18)	5.25 (5.01–5.59; 4.23–6.50)
Compromised skin acidity (hand pH >5.5) N (%)	**13 (19)[a]**	**30 (37)**	4 (15)	10 (29)	29 (33)
ΔpH*** Median (IQR, total range)	0.23 (-0.02–0.48; -0.47–1.79)	0.11 (-0.22–0.59; -0.87–1.39)	**0.06 (-0.22–0.31; -0.51–0.74)[b]**	**0.16 (-0.16–0.35; -0.87–1.40)[b]**	**0.27 (-0.02–0.66; -0.79–1.79)[b]**
ΔpH%** [%] Median (IQR, total range)	5 % (0–11; -10–38)	2 % (-4–12; -18–29)	**1 % (-5–6; -8–17)[b]**	**3 % (-3–8; -18–31)[b]**	**5 % (0–14; -15–38)[b]**

IQR – interquartile range; TEWL – transepidermal water loss. Significance of difference was tested with the chi-squared test for categorical variables and *t*-test or Mann–Whitney *U* test for noncategorical variables. [a] significantly different (P<0.05) from men; [b] significantly different (P<0.05) across the three ordinal categories of glove use

* $\Delta TEWL = hand\ TEWL - forearm\ TEWL$

** $\Delta TEWL\ \% = \frac{hand\ TEWL - forearm\ TEWL}{forearm\ TEWL}$

*** $\Delta pH = hand\ pH - forearm\ pH$

**** $\Delta pH\ [\%] = \frac{hand\ pH - forearm\ pH}{forearm\ pH}$

occupational skin hazards across these professions may point to the healthy worker effect. If so, then our results emphasise the need for regular skin barrier biomonitoring, which, along with understanding the toxicological aspects of skin damage could help alleviate the burden of professional skin diseases for both workers and employers (36–42).

To conclude, our findings justify the proposed new approach of using forearm skin barrier condition as a personal baseline and call for larger studies that would put it to use in various occupational settings and with a more detailed exposure assessment.

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Razlika između transepidermalnoga gubitka vode (TEWL) i pH kože šaka i podlaktica kao alat za biomonitoring profesionalnog ekcema šaka – model zdravstvenih radnika

Cilj ove presječne epidemiološke terenske studije bio je istražiti razliku između stanja kožne barijere šaka i podlaktica među zdravstvenim radnicima te povezanosti s osobnim i radnim čimbenicima. Studija je uključivala upitnik o radnoj izloženosti, klinički pregled kože šaka i mjerenje transepidermalnoga gubitka vode (TEWL) i pH kože šaka i podlaktica. Sudionici su bili sljedeći zdravstveni djelatnici (N=37 u svakoj skupini): liječnici-nekirurzi, liječnici-kirurzi, stomatolozi-nekirurzi i stomatolozi-kirurzi. ΔTEWL i ΔpH izračunani su kao razlika vrijednosti na šaci i podlaktici, a ΔTEWL% i ΔpH% kao ta razlika podijeljena s vrijednošću na podlaktici. Uočili smo jasan trend povećanja razlika između stanja kožne barijere šake u odnosu na podlakticu, počevši od liječnika-nekirurga s medijanom ΔTEWL% od 56 %, do liječnika-kirurga (65 %), stomatologa-nekirurga (104 %) i stomatologa-kirurga (108 %). TEWL vrijednosti na šakama u objema skupinama stomatologa u prosjeku su bile dvostruko veće od onih na podlaktici, što je posebno zabrinjavajući pokazatelj oštećenja kožne barijere. Iako manje izražen, isti trend pogoršanja primijećen je za pH kože, pri čemu su kirurzi u prosjeku imali 0,3 viši pH kože šaka nego podlaktica. Dugotrajna uporaba rukavica bila je glavni radni čimbenik povezan s oštećenjem kožne barijere vidljivim u većoj razlici vrijednosti TEWL i pH kože šake i podlaktice, a muški je spol bio osobni čimbenik značajno povezan s višim TEWL-om i nižim pH kože. Naši rezultati upućuju na bolju diferencijaciju oštećenja kožne barijere na rukama zbog profesionalne izloženosti kožnim štetnostima usporedbom rezultata mjerenja na šaci s rezultatom na podlaktici.

KLJUČNE RIJEČI: kirurzi; kontaktni dermatitis; kožna barijera; liječnici; stomatolozi