Acta Derm Venereol 2015; 95: 247–249

SHORT COMMUNICATION

Nickel Exposure When Working Out in the Gym#

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Accepted Jun 18, 2014; Epub ahead of print Jun 23, 2014

In order to decrease the burden of contact allergy, release of nickel from products intended for direct and prolonged contact with the skin has since the year 2000 been limited to 0.5 µg Ni/cm^2/week in the European Union. This is according to the former EU Nickel Directive, which is part of the EU chemicals regulation REACH since 2009 (1). The restriction has resulted in some reduction of the prevalence of nickel allergy, especially in young females (<30 years) both in the general population and in dermatitis patients. Prevalence data from North America and Western Europe show that nickel allergy is still frequent; approximately 17% of women and 3% of men in the general population are allergic to nickel (2). One reason for this might be that there are still several items on the market, including jewellery, that release nickel (3, 4). Also there are several items that come in brief and repeated contact with the skin that are not covered by the legislation. Examples are tools, keys, laptops and coins (4, 5).

The nickel legislation restricts only the amount of nickel that is released from objects and not the actual skin dose (µg Ni/cm^2) of nickel, which is the key factor for developing contact dermatitis (6). To measure the dose of nickel exposure on the skin, different methods for quantification are available such as acid wipe sampling and the finger immersion method (7, 8), requiring an advanced chemical analysis after collection of samples. A spot test, dimethylglyoxime (DMG) test, is available for quick screening of items (Fig. 1). Its sensitivity around the limit value (0.5 µg Ni/cm^2/week) is 59.3% and the specificity 97.5%, based on concentration determined by the EN 1811 reference method. It was shown that the DMG test may serve well for screening purposes (9), also to assess presence of nickel on the skin (10).

Recently, an epidemic of acute dermatitis from a fitness wristband (Force Activity-Tracking Wristband, Fitbit Inc.) was experienced in North America and the product was retracted (https://www.cpsc.gov/en/Recalls/2014/Fitbit-Recalls-Force-Activity-Tracking-Wristband/#remedy last accessed on 19 May 2014). The causative substance has, to the best of our knowledge, not yet been identified. Speculations have suggested stainless steel or a plastic chemical. Although much equipment in gyms is metallic, the potential risk of nickel exposure and dermatitis from gym training has not been discussed.

The aim of this study was to investigate if hands are contaminated by nickel when working out with DMG test positive equipment at the gym.

MATERIALS AND METHODS

Participants and selection of gyms and equipment

To evaluate if nickel is deposited on the hands by one hour of training with different equipment in the gym, we first screened 5 gyms for equipment that release nickel. The screening was performed using the DMG test, containing DMG (1.0%), ammonia (9.9%), and ethanol mixed in one bottle (Chemo Nickel Test™; Chemotechnique Diagnostics, Vellinge, Sweden). A volume of 50 µl of the test solution was applied to a white cotton-tipped stick, which was then rubbed against the test item for 30 s. If the tip turned pink, it indicated that nickel ions were released from the item (Fig. 1A). Three gyms in the Stockholm area with DMG test positive equipment were selected for the study: one work place gym and 2 commercial gyms, which belong to different nation-wide chains of gyms.

Three healthy male participants, 28, 36 and 49 years old, all right handed and with no history indicating nickel allergy, took part in the study. They had no on-going dermatitis or other skin lesion on hands or forearms. The study was approved by the

#An abstract has been accepted for oral poster presentation at the 12th Congress of the European Society of Contact Dermatitis, June 25–28, 2014

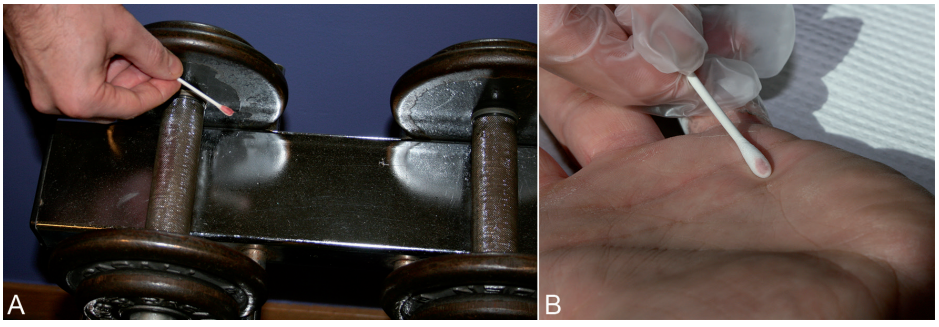

Fig. 1. Procedure to assess nickel exposure of hands in the gym. (A) Positive dimethylglyoxime test of a dumbbell. (B) Positive dimethylglyoxime test on the skin for qualitative assessment of nickel exposure.

 doi: 10.2340/00015555-1917
 ISSN 0001-5555

KI Nord ethics committee at Karolinska Hospital, Stockholm. All participants gave informed consent.

Exposure by workout exercise and assessment by DMG test and acid wipe sampling (See Appendix SI[1])

RESULTS

The DMG test of the left hand was positive at all exposed test areas and negative at all non-exposed reference areas (Fig. 1B).

The range of nickel concentration on the exposed areas of all 3 participants was between 0.28 μg/cm^2 and 1.7 μg/cm^2 after one hour of workout on DMG test positive equipment (Table I). The highest skin dose of nickel (1.7 μg/cm^2) was found on the palm of participant A at gym I. The lowest skin dose of nickel (0.28 μg/cm^2) on exposed skin was found on the finger of participant C at gym III. Nickel could be detected on all reference surfaces (little fingers) but at a much lower concentration (mean value: 0.031 μg/cm^2). The limit of detection was 0.4 μg/l for the analytical instrument, corresponding to 0.005 μg/cm^2.

The total duration of contact with DMG test positive equipment varied between the participants (17, 20, and 29 min), as measured during one workout session for each participant (Table SI[1]). The nickel skin doses corresponding to one hour of continuous contact with DMG test positive equipment were calculated (Table SI[1]). The highest calculated one-hour dose for the finger was 2.9 μg/cm^2 and for the palm 2.1 μg/cm^2. The values between the participants are not directly comparable since they used different equipment.

DISCUSSION

This is the first study concerning nickel exposure to the hands from training at the gym. Using 2 different methods, the DMG test and acid wipe sampling, we were able to show that the use of nickel releasing equipment in gyms may result in relatively high nickel doses on the skin.

All exposed test areas on the hands were DMG test positive and all reference areas were negative. Comparing with the results of acid wipe sampling, the DMG test was positive at an amount of 0.28 μg Ni/cm^2, equivalent to the amount of nickel found on the middle finger of participant C at gym III. We have previously shown that the DMG test on skin will detect as low concentrations as 0.13 μg/cm^2 in laboratory settings (10).

What can be noticed is that nickel is deposited onto the skin in amounts that have been shown capable of eliciting allergic contact dermatitis in previously sensitised subjects by using the repeated open application test (6, 11). In gym III the majority of the dumbbells were DMG test negative at the day of workout, but the bars of weight machines were strongly DMG test positive. It is not known how much the final value of the acid wipe sampling was affected by working out on DMG negative dumbbells in gym III.

It is well-known that release of metal ions from metal surfaces (alloys or platings) is not directly related to the metal content (5, 12, 13). We know that human sweat influences the release of nickel metal ions.

The amount of nickel deposited on skin during one hour of gym training with weight machines and dumbbells is in the same range as the amount of nickel deposited on skin of metal workers and locksmiths during one hour, but higher than for example cashiers, carpenters and dressmakers (14, 15).

The number of participants and gym equipment in the study were few, and the workout technique varied which could be regarded as limitations. However the duration of exposure sessions was equal and the method for quantitative skin exposure assessment is sensitive, well defined and validated.

We suggest that dermatologists should encourage their nickel allergic patients to use the DMG test to identify nickel-releasing items in gyms, and avoid skin contact with these.

[1]http://www.medicaljournals.se/acta/content/?doi=10.2340/00015555-1917

Table I. *The amount of nickel deposited onto the hands of 3 participants during one-hour workout with nickel-releasing equipment. Sampling of the skin was performed by acid wipe sampling and chemical analysis with atomic absorption spectrometry (GF-AAS). The reference surface is the little finger*

		Nickel on skin (μg/cm^2) in participants		
Gym	Sampling area	A	B	C
I	Middle finger	1.2	0.64	0.93
	Palm	1.7	0.59	0.47
	Reference	0.065	0.046	0.036
II	Middle finger	0.32	0.46	0.48
	Palm	0.50	0.30	0.65
	Reference	0.052	0.0085	0.010
III	Middle finger	0.68	0.48	0.28
	Palm	0.99	0.33	0.80
	Reference	0.013	0.0046	0.043

ACKNOWLEDGEMENTS

The study was financed by a grant from the Swedish Research Council for Health, Working Life and Welfare, and by Centre for Occupational and Environmental Medicine, Stockholm County Council, Stockholm, Sweden.

The authors declare no conflicts of interest.

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