



## ORIGINAL PAPER

DOI: <https://doi.org/10.20883/jms.357>


# Nickel-free environment – Dreams vs. Reality. Everyday utilities as a source of nickel and cobalt for patients sensitized to these metals


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### ABSTRACT

**Introduction.** Frequent occurrence of elevated nickel levels in everyday items explains why allergic contact dermatitis to nickel is the most common in the general population. In Northern America and Europe, 20% of the general population suffers from contact dermatitis while 8.6% of patients suffering from contact dermatitis are allergic to nickel.

**Material and Methods.** A group of 25 patients (24 females and 1 male) sensitized to nickel and cobalt on the basis of patch testing was analyzed during a 2-year-long period in Department of Dermatology Poznan University of Medical Sciences. Contact allergy to nickel and cobalt was confirmed with the positive result of patch test, conducted with the Polish Standard Series of chemotechnique.

**Results.** An excessive nickel release was detected in over a quarter of the tested items, respectively in 7.5% of jewellery, 57.89% of clothing accessories, 56.89% of other utility goods, such as keys, telephones or stationery. Cobalt excessive release was found in 7.3% of tested items, respectively in none of jewellery and kitchen accessories, 25% of clothing accessories, 12.5% of other utility goods (keys, pens, pendants).

**Conclusions.** In general, everyday-use items are not nickel-free and more legislation steps are necessary to provide it and prevent initial sensitization in future generations. Several articles of every-day use release nickel and cobalt above migration limits.

**Keywords:** nickel allergy, cobalt allergy, Nickel Directive.

## Introduction

Frequent occurrence of elevated nickel levels in everyday items explains why allergic contact dermatitis to nickel is the most common in the general population. In Northern America and Europe, 20% of general population suffers from contact dermatitis while 8.6% of patients suffering from contact dermatitis are allergic to nickel. Sensitization to cobalt is described as one of the most

common allergies to metals [1]. Due to a high prevalence of its occurrence, it is a health concern in the European Union [2].

The initial outbreak of sensitization to nickel is dated on early '70s (popularization of buttons and zippers of blue jeans) [3] followed by the development of ear-piercing trend in the '80s [4]. To reduce the prevalence of nickel sensitization in younger generations the Nickel Directive (currently known as nickel restriction) was estab-

lished in Denmark in 1994 [5]. In Poland, the regulation came in full force in 2005, after joining the European Union.

## Aim

According to our data research from several publications [6, 7], decrease of the prevalence of nickel allergy in younger girls in Western European countries is undeniable. As the aim of our study we took an estimation of possibility to eliminate metal items containing nickel or cobalt from the environment of sensitive patients.

The primary objective of the study was to assess whether the patients sensitive to nickel or cobalt were able to eliminate all metal items containing these elements from their daily environment, furthermore, to determine objects of everyday use with a high concentration of nickel to help patients in removing sources of sensitization. We also aimed to educate patients in regards of skin exposure avoidance and allergic reactions to nickel-containing items.

## Material and Methods

A group of 25 patients (24 females and 1 male) sensitized to nickel and cobalt on the basis of patch testing was analyzed during a 2-year-long period in Department of Dermatology Poznan University of Medical Sciences. Patients were included in the study if they had a positive reaction to patch test to nickel sulfate 5% or cobalt sulfate 5%. Contact allergy to nickel and cobalt was confirmed with the positive result of patch test conducted with the Polish Standard Series of chemotechnique. An examination of each patient consisted of extensive interview and questionnaire.

### Structure of the questionnaire

The purpose of the questionnaire was to obtain an information on patients' demographic data, age, ear-piercing, chronic conditions, medicine intake and family medical history, including allergies among family members. Moreover, we asked about the presence and characteristics of patients' allergies – duration of symptoms, time of the diagnosis, location and appearance of first skin lesions and current lesions.

Subsequently, the patients answered four questions regarding ways of elimination of sensitizing objects:

What utility goods have you eliminated from your environment after the diagnosis of allergy?

Have you taken measures to reduce skin contact to metal items, such as using plastic substitutes or painting the surface of metal items with colourless varnish?

How do you assess the effects of eliminating the above-mentioned utility goods on the course of your allergy?

Is there any metal object essential in your everyday life/ workplace which you cannot eliminate despite the allergy?

### Applied tests

The patients were asked to bring personal items or utility goods for examination. The items were supposed to be the source of nickel or cobalt allergy. A total of 229 metal items including jewellery, clothing accessories and other objects of everyday use were tested with the Chemo Nickel Test to assess nickel release. A total of 55 articles were tested with Chemo Cobalt Test to detect cobalt release. According to the producers: The Chemo Nickel Test detects free nickel down to a limit of 10 ppm (parts/million). Sensitivity threshold of most nickel allergic patients is above 11 ppm. Some strongly sensitized patients will however still react to objects releasing amounts below the threshold of the test. Chemo Nickel Test TM consists of an ammoniacal solution of Dimethylglyoxime (DMG) for the detection of nickel in various metallic objects. To perform the detection we put a few drops of the reagent solution onto the cotton tip to moisten it, and then rubbed the metal surface of the suspected object intensively for up to 1 minute. If the cotton tip changes colors into reddish-pink, this indicates the presence of nickel.

## Results

A total of 58 patients who presented with a positive result in Patch Testing declared participation in the study. Finally, the analyzed group consisted of 25 patients (participation rate 43.1%), 33 patients did not come to scheduled appointment.

75% of patients reported eliminating of some metal utility goods from surrounding environ-

ment (for example metal watches, jewellery, pens). 54.17% of participants took measures to reduce skin contact with metal items (mainly by exchanging metal objects, such as cutlery, to plastic ones). Among the participants who reduced skin contact or the use of metal objects, 66.67% noticed an improvement in allergy symptoms afterwards, while 16.67% found it hard to evaluate the change and 16.67% did not benefit from the elimination. 75% of the participants stated they were not able to eliminate some essential metal objects despite confirmed allergy, mostly keys, pots and cutlery.

An excessive nickel release was detected in over a quarter of the tested items (**Table 1**), respectively in 7.5% of jewellery (6 out of 80 items) (**Table 2**), 57.89% of clothing accessories (11 out of 19 items) (**Table 3**), 56.89% of other utility goods, such as keys, telephones or stationery (49 out of 86 items) (**Table 5**). None of the tested kitchen accessories (41 items, including cut-

lery, frying pans, pots and salt cellars) showed an excessive nickel release (**Table 4**).

In jewellery, the subcategory with the highest rate in detecting nickel was bracelets and watches – 21.05% (4 out of 19 items). We did not identify nickel in any earring of 24 pairs we examined. (**Table 2**) In clothing accessories, the subcategory with the highest rate in detecting nickel were belts – 83.33% (5 of 6 belts), followed by zippers and buttons of jeans- 55.56% (5 out of 9) (**Table 3**). In the category of other utility goods, the highest rate in positive nickel detection relates to keys – 78.26% (36 out of 46 keys), followed by stationery and key accessories – 40.63% (13 out of 32 items). We did not identify nickel in any examined telephone or telephone accessory (8 items) (**Table 5**).

Cobalt excessive release was found in 7.3% of tested items (4 out of 55 items), respectively in none of jewellery (23 items) and kitchen accessories (4 items), 25% of clothing accessories

**Table 1.** Detection of nickel in tested utility goods – results

Number of tested objects, (n)	Chemo nickel test – positive, % (n)	Chemo nickel test – non-diagnostic, % (n)
229	27.51% (63)	27.95% (64)

**Table 2.** Detection of nickel in tested jewellery – results

Type of jewellery	Chemo nickel test – positive % (n)	Chemo nickel test – non-diagnostic % (n)	Number of tested objects (n)
Jewellery in total	7.5% (6)	25% (20)	80
Earrings	0	25% (6)	24
Necklaces	6.25% (1)	37.5% (6)	16
Rings	5% (1)	10% (2)	20
Watches, bracelets	21.05% (4)	31.58% (6)	19
Other	0	0	1

**Table 3.** Detection of nickel in tested clothing accessories – results

Type of clothing accessories	Chemo nickel test – positive % (n)	Chemo nickel test – non-diagnostic % (n)	Number of tested objects (n)
Clothing accessories in total	57.89% (11)	15.79% (3)	19
Belts	83.33% (5)	0	6
Buttons of jeans	50% (2)	25% (1)	4
Glasses	25% (1)	0	4
Other, e.g. bag clasps, zippers	60% (3)	40% (2)	5

**Table 4.** Detection of nickel in tested kitchen accessories – results

Type of kitchen accessories	Chemo nickel test – positive % (n)	Chemo nickel test – non-diagnostic % (n)	Number of tested objects (n)
Kitchen accessories in total	0	43.90% (18)	41
Cutlery	0	46.15% (12)	26
Dishes, pots	0	40% (4)	10
Other, e.g. salt cellars, graters	0	40% (2)	5

(1 out of 4 items – a button of jeans), 12.5% of other utility goods (keys, pens, pendants – 3 out of 24 items). Among jewellery only one necklace released cobalt. We tested 13 keys and only two of them released cobalt extensively (**Table 6**).

Out of 25 research study participants, 96% were females. Apart from allergy to nickel and cobalt, almost 30% of patients were allergic to other substances, such as palladium, and cosmetic allergens (**Table 7**).

both sexes is comparable, no difference in prevalence of sensitization to nickel between genders has been observed [9].

The number of piercings and the incidence rate of nickel allergy are strongly associated among both genders, the association being higher in males [10, 11].

The highest rate in nickel detecting in every day utilities was observed in keys, however, according to the definition of prolonged contact

**Table 5.** Detection of nickel in other tested utility goods – results

Type of utility goods	Chemo nickel test – positive, % (n)	Chemo nickel test – non-diagnostic, % (n)	Number of tested objects, (n)
Utility goods in total	56.98% (49)	17.44% (15)	86
Keys	78.26% (36)	17.39% (8)	46
Key sheaths, key rings	40% (2)	60% (3)	5
Telephones, telephone accessories	0	25% (2)	8
Other, e.g. stationery, clips, pens	40.74% (11)	7.41% (2)	27

**Table 6.** Detection of cobalt in tested utility goods – results

Type of utility goods	Chemo cobalt test – positive, % (n)	Chemo nickel test – non-diagnostic, % (n)	Number of tested objects, (n)
Utility goods in total	7.27% (4)	7.27% (4)	55
Jewellery	0	4.35% (1)	23
Clothing accessories	25% (1)	0	4
Kitchen accessories	0	0	4
Other	12.5% (3)	12.5% (3)	24

**Table 7.** Characteristics of research study participants

Property	Characteristics of research study participants, (n)
Gender	95% Females (24), 5% males (1)
Average age	47 Years
Ear-piercing	68% (17)
Monovalent allergy to nickel	72% (18)
Allergy to nickel and cobalt	24% (6)
Other allergies	28% (7)

## Discussion

Contact dermatitis is manifested by an itchy rash appearing a few hours after skin contact with the allergen [8], so it is essential to avoid skin contact with nickel or cobalt containing metals.

The disproportion between genders observed in the study (24 female patients:1 male) is most likely associated to the difference in exposure to jewellery between men and women in our culture.

On the contrary – in Nigeria, where men and women wear jewellery equally and piercing rate in

with the skin it may be rather unlikely to cause allergic contact dermatitis.

Moreover, metal clothing items were identified as a significant source of nickel in our study. It was released by 57.89% of them, including belts, buttons, zippers, etc. Cheong et al. support our findings in their study; they revealed presence of nickel in 76.3% of metal clothing items from Korean markets. They also examined jewellery as a potential source of nickel, with positive results in 42.3% of them. In our study only 7.5% of jewellery was associated with nickel release. The difference may be associated with less effective

regulations regarding the release of nickel from metal products in Korea. Cobalt release was presented in 7.27% of all items in our study and in 6% of all items in Korean study. In both studies, all items releasing cobalt were also positive in the nickel releasing test [12].

According to the meeting of Nickel Institute Association in Brussels in 2017 the main reason of nickel sensitization persistence in European society are: sensitization before regulation was indicated (older individuals), the regulation might be too weak (necessity to decrease migration limits), violation of the regulation, lack of control by authorities, new items causing nickel allergy – e.g. laptops, phones and other sources not covered by regulation: toys, medical devices, coins, occupational.

The legislation stipulates that items intended to come into direct and prolonged contact with the skin are not allowed to release nickel above “migration limits”, which is more than 0.5 ug/cm<sup>2</sup>/week and 0.2 ug/cm<sup>2</sup>/week for items intended to be inserted into human body (pierced ears or other body parts).

In 2014 European Chemical Agency defined “prolonged contact with the skin” as potentially more than 10 minutes on three or more occasions within two weeks and more than 30 minutes on one or more occasions within two weeks [13].

The implementation of the EU Nickel Directive caused a decrease in sensitization rate to nickel, especially among young women [14]. The median age of women participating in our study was 48 years, which may confirm that the nickel registration is sufficient because there was only one female participant under 25 years (4.17%). Other study shows that women ear pierced after 1990 were less likely to develop nickel allergy and dermatitis than women pierced before the introduction of regulations [15]. However, the incidence rate is still high and amounts to 8–18% of the general population [16] and 10% of young women being nickel allergic [15] (12.3% of 15-year-old females in a Polish study [17]). Higher nickel allergy prevalence rate is observed in southern than in northern EU countries [14].

The weakness of the present study is the human factor. Our aim was to assess whether patients sensitive to nickel or cobalt were able to eliminate metal items containing that elements from their environment, although some patients

did not show any motivation in this process. For example, for some participants it was hard to part ways with favorite trousers despite the rash appearing on stomach near zipper area appearing few hours after skin contact. Some of the participants claimed to forget to put layers of nail polish on earrings which used to cause dermatitis because it was not important enough for them to prevent skin dermatitis. Other weakness of our study is a number of tested patients, which was relatively small.

## Conclusions

Our investigation shows that patients who are strongly motivated are able to remove most sources of nickel or cobalt contact dermatitis from their environment. In general, every day-use items are not nickel-free and more legislation steps are necessary to provide it and prevent initial sensitization in future generations. Several articles of every-day use release nickel above migration limits. More common items need to be covered by the nickel regulations, especially keys, zippers and pendants. Some subgroups of every day use items, for example, cooking tools and earnings were found by us as nickel-free which is satisfactory and brings hope for sensitive patients to extend that profile to all items in the future.

## Acknowledgements

### Conflict of interest statement

The authors declare no conflict of interest.

### Funding sources

There are no sources of funding to declare.

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Acceptance for editing: 2019-07-23  
Acceptance for publication: 2019-09-15

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