

## INVESTIGATIVE REPORT

# Lifestyle and Nickel Allergy in a Swedish Adolescent Population: Effects of Piercing, Tattooing and Orthodontic Appliances

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**The aim of this study was to estimate the prevalence of lifestyle practices in adolescents and their association with nickel allergy. Upper secondary school pupils ( $n=4,376$ ; 15–23 years) were patch-tested for nickel allergy, following completion of a questionnaire (answered by 6,095). Almost 86% girls and 21% of boys reported piercing. More girls (6%) than boys (3%) had a tattoo. Twenty-six percent of the girls and 18% of the boys were regular smokers. Vegetarian/vegan diets were reported by 20% of girls and by 6% of boys. Piercing, female gender, and vocational programme increased the risk of nickel allergy, whereas orthodontic appliance treatment prior to piercing reduced the risk of nickel allergy. Pupils in vocational programmes had the highest prevalence of nickel allergy. Lifestyle behaviours are interconnected and cluster in subgroups of adolescents. Female sex, piercing and choice of educational programme are prominent lifestyle markers. A trend shift is observed, where more girls than boys report tattooing. *Key words: patch test; prevalence; risk; youth; questionnaire; orthodontic treatment.***

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In adolescents and young adults, previous population-based studies have indicated a prevalence of nickel allergy of 9–14% and 2–3% for girls and boys, respectively (1–4). The European Union (EU) has adopted a Nickel Directive that aims to prevent sensitization and elicitation of nickel dermatitis (5, 6).

Adolescents are prone to experimentation, and some lifestyle factors, e.g. body piercing and tattooing, have been associated with self-esteem, risk-taking and sensation-seeking behaviour (7). Lifestyle factors, such as piercing and smoking, have been associated with increased risk of nickel contact allergy (8). Dietary nickel intake is, in general, higher in vegetable than animal products, and may elicit flare-up reactions in nickel-sensitive individuals (9, 10). Orthodontic appliance treatment is mainly carried out for functional and aesthetic reasons. Recent research, including our own

results, indicate a protective effect rather than increased risk of nickel sensitization when early treatment with nickel containing orthodontic appliances precedes ear piercing (11, 12).

The aim of the present study was to estimate the prevalence of certain lifestyle factors in a general adolescent population and their association with nickel allergy.

## METHODS

### *Population and study design*

The study is a cross-sectional survey conducted amongst a sample of upper secondary schools in two municipalities in Sweden: Umeå and Örebro. The study period was from September 2000 to May 2004. A questionnaire on lifestyle, medical issues and orthodontic treatment was administered during visits to classes, at which point a patch test was also offered. In the visited school classes, 6,095 (81%) pupils aged 14.9–23.4 years (mean age 17.4 years) completed the questionnaire. Seventy percent (4,439) also consented to patch testing; however, 63 patch tests fell off and could not be evaluated. The population, study design, sampling procedure and statistical management of drop-out/non-participation have been described previously (4, 13).

### *Definitions and descriptions of terms*

Nickel allergy was defined as a positive reaction (+–+++ ) to nickel in a patch test using the TRUE Test<sup>®</sup> (Mekos Laboratories A/S, Hillerød, Denmark) (14).

*Lifestyle variables.* Piercing, tattooing, dietary and smoking habits were established with a written questionnaire, shown in Appendix S1 (available from: <http://www.medicaljournals.se/acta/content/?doi=10.2340/00015555-1305>).

Educational programmes are reported, and we hypothesized that choice of programme is associated with lifestyle. Due to a large number of educational programmes (15) we categorized the programmes into 4 major groups (social sciences, natural sciences, arts programme, and vocational education).

Atopy is a potential confounding factor. The lifetime prevalence of atopy in this study was defined by (present or past) asthma, allergic rhinitis and atopic eczema (Appendix S1).

Orthodontic appliance treatment is reported and treated as a potential confounding factor. Basic information (age at start of treatment and a description of the appliance) was obtained from the questionnaire (Appendix S1).

### *Patch-test method*

TRUE Test<sup>®</sup> panels 1 and 2 were used, containing 24 of the most common contact allergens. No testing was performed during

the summer months (June to August) (4). The test was applied to the upper back for 2 days, then removed by the participant and read once at day 4. The reactions were classified according to international guidelines (14).

#### Data handling and statistical analysis

A  $\chi^2$ -test was used for comparison of proportions. Statistical significance was defined as  $p < 0.05$ . Associations between nickel allergy and risk indicators were analysed with logistic regression. When estimating the prevalence in the target population (weighted prevalence) and summarizing the risks of nickel allergy in regression analyses, we used district- and sex-stratified weights based on the actual number in each educational programme. All statistical analyses were performed using the SPSS 15.0 statistical software package.

#### Ethical approval

The study was approved by the ethics committee of the Faculty of Medicine and Odontology, Umeå University.

## RESULTS

### Prevalence

All prevalence figures are given as weighted percentages in Tables I, II and SI–SII (available from: <http://www.medicaljournals.se/acta/content/?doi=10.2340/00015555-1305>).

Piercing was reported by girls more often than boys (Table SI). The mean age for piercing was 10 years for girls and 11 years for boys, and in >9 out of 10 cases the piercings were in the ears.

Multiple piercings ( $\geq 2$ ) was more frequent in girls than boys. Among the pierced adolescents, the most common parts of the body to be pierced were the ear, navel, nose and eyebrow, with some gender differences. Body piercing (ear piercing not included) was practiced by almost 10 times more girls than boys.

Tattooing was reported by approximately 1 out of 20 pupils. More girls than boys had a tattoo and the mean age at tattooing was 16 and 17 years, respectively. Among tattooed females, the most common parts of the body to be tattooed were: arm (46%), posterior

Table I. Distribution of lifestyle variables (in weighted percentages) stratified for educational programmes and sex

Variable	Piercing, %		Tattooing, %	Vegetarian/vegan diet, %	Smoking (ever), %
	Multiple	Single			
<b>Girls</b>					
Natural sciences	15.1	62.4	3.5	21.2	18.6
Social sciences	20.7	61.8	5.0	21.9	30.4
Arts	24.0	60.2	5.3	39.1	34.1
Vocational	30.5	60.4	8.3	13.9	45.4
<b>Boys</b>					
Natural sciences	1.3	11.7	2.0	5.0	13.9
Social sciences	3.1	15.2	3.0	9.4	24.1
Arts	2.6	15.6	4.0	23.7	37.7
Vocational	3.9	20.3	4.0	4.2	34.5

Table II. Risk of nickel allergy in relation to lifestyle factors and potential confounding factors, summarized in a multivariate logistic regression model. Risk is expressed as odds ratio (OR) with 95% confidence interval (95% CI)<sup>a</sup>

Variable	OR	95% CI	
		Lower bound	Upper bound
<b>Number of piercings</b>			
Multiple $\geq 2$	<b>1.6</b>	<b>1.2</b>	<b>2.0</b>
Single (ref)			
<b>Smoking</b>			
Ever	1.2	0.9	1.5
Never (ref)			
<b>Tattooing</b>			
Yes	1.3	0.9	1.8
No (ref)			
<b>Vegetarian diet</b>			
Yes	1.0	0.7	1.3
No (ref)			
<b>Sex</b>			
Girl	<b>3.0</b>	<b>2.0</b>	<b>4.5</b>
Boy (ref)			
<b>Atopy</b>			
Yes	1.0	0.8	1.2
No (ref)			
<b>Educational programme</b>			
Natural sciences (ref)			
Social sciences	1.3	0.9	1.9
Arts	0.9	0.5	1.6
Vocational	<b>1.8</b>	<b>1.2</b>	<b>2.6</b>
<b>Orthodontic appliance</b>			
Before piercing	<b>0.4</b>	<b>0.3</b>	<b>0.7</b>
After piercing (ref)			

<sup>a</sup>(ref) indicates the variable category chosen as reference in analysis. Bold text indicates a statistically significant effect.

trunk (21%), leg (15%), and buttocks (10%). For boys the corresponding localizations were: arm (73%), posterior trunk (13%), anterior trunk (7%), and leg/buttocks (3%).

Approximately 3 times more girls than boys reported following vegetarian or vegan diets. In both sexes, the mean age at the start of the vegetarian diet was 14 years, with a mean duration (age at start until end/quitting of habit, or the longest, until completing the questionnaire) of 2 years.

One out of 5 pupils were regular smokers (occasional or daily smoking) and almost twice as many girls as boys reported regular smoking. The mean start age for smoking for both sexes was 14 years, with a mean duration of 2 years.

Girls in vocational programmes reported a significantly higher prevalence of multiple piercings, tattooing, and smoking than other programmes (Table SII). Similarly, boys in vocational programmes reported the highest, or nearly highest frequency of piercing, tattooing, and smoking habits. In comparison, girls and boys attending natural science programmes reported the lowest prevalence of piercing, tattooing, and smoking. Vegetarian/vegan diets were reported least amongst pupils in the vocational programmes, and most frequently in arts programmes, which also had most boys

reporting (ever) smoking. Thus, within programmes, girls and boys appear to share similar preferences with regards to youth lifestyle practices. Girls were observed to report higher prevalences for all lifestyle practices under investigation.

Furthermore, pierced individuals, both girls and boys, reported a significant (up to seven-fold) increased prevalence of tattooing, smoking and vegetarian dietary habits compared with non-pierced adolescents.

Approximately one out of 7 (14.5%) pupils reporting body piercing (excluding earrings) showed concomitant tattooing practices, and significantly more boys (25.4%) than girls (13.7%) were affiliated with both of these "body modification" practices.

Atopic pupils did not significantly differ from non-atopic pupils in terms of prevalence of reported piercing or tattooing practices.

Orthodontic appliance treatment, or dental braces, was reported by almost half of the population and significantly more often in girls than in boys (50.2% vs. 37.1%). The reported mean age at fitting of dental braces for girls and boys was 12 and 13 years, respectively. No difference in the reported use of dental braces was found among tattooed/non-tattooed pupils, ever-/non-smokers, or between educational programmes. A new variable was created to characterize the time sequence of orthodontic appliance treatment and piercing.

#### *Nickel allergy in relation to lifestyle, educational programme, atopy and orthodontic appliances (adjusted data analysis (Table SII))*

Nickel allergy was found in significantly more girls than boys.

Piercing was significantly associated with a higher frequency of nickel allergy among girls, whereas no such association was observed among boys. An almost two-fold risk increase, and even higher in boys (four-fold), was shown in multiple-pierced adolescents compared with those with single piercings. The age at piercing (as categorized in Table SII) was associated with increased risk of nickel allergy in younger, albeit not the youngest, age group.

In comparison with their non-tattooed peers, tattooed boys showed a three-fold, and girls an almost two-fold risk increase in nickel allergy by patch test.

No clear association was found between vegetarian/vegan diet and nickel allergy.

Daily smoking was associated with a two-fold increased risk of nickel allergy in adolescents compared with non-smoking adolescents. Moreover, the effect seemed to increase in a dose-dependent way. This effect was valid for girls, but not for boys.

The highest frequency of nickel allergy was found in pupils attending the vocational programmes with a significant, two-fold risk increase of a positive patch

test compared with the referent programme, i.e. natural sciences. No such effect, however, could be observed in boys.

Exposure to orthodontic appliances decreased the risk of nickel allergy. Comparing individuals exposed to orthodontic appliances before, as well as after, piercing, these results also indicated a protective effect from exposure to orthodontic appliances when preceding the piercing event.

There was no significant difference in prevalence or estimated risk of nickel allergy between pupils categorized as atopics compared with non-atopics.

#### *Association between nickel allergy and lifestyle in a multivariate model (Table II)*

Multiple piercings, female sex, and attending vocational programmes were all found to be associated with nickel allergy. A three-fold increased risk of nickel allergy was estimated for girls compared with boys. In this analysis, exposure to tattooing, vegetarian/vegan diet or atopy was not significantly associated with nickel allergy. The exposure to orthodontic appliance treatment before piercing, however, indicated a reduced risk of having a positive patch test (odds ratio (OR) 0.4, 95% confidence interval (CI) 0.3–0.7).

## DISCUSSION

The present study is the first to provide figures for the prevalence of piercings at different bodily locations in a general Swedish adolescent population. In tattooing practices, a shift compared with previous national data (16) was observed, where more young girls than boys of the same age reported tattooing. At a group level, a clear association was observed between pupils' educational programmes and their lifestyle practices, such as piercing, tattooing, vegetarianism and smoking. Number of piercings, female gender, choice of educational programme, and smoking were associated with an increased risk of nickel allergy verified by patch tests. Multiple piercings, tattooing, vegetarian/vegan diets and smoking were all more common amongst girls than boys.

There are few existing population-based studies in youths (7, 17) that can be compared with the present study.

Our population-based survey was conducted using a young sample group who were yet to begin their working life, and were of an age at which they were susceptible to lifestyle changes. The results indicate 14–15 years to be the critical age at which both smoking habits and specific dietary practices begin. The fact that more girls than boys exhibit these practices is in accordance with previous national data (18, 19). Strengths of our study are the large population sample, high response rate and a low internal dropout rate (1–1.5%),

and importantly, nickel allergy was assessed by a patch test. Internal validity was assured by a missing-value analysis and has been reported previously (4). Thus, the data obtained may provide significant up-to-date information for future studies on lifestyle and nickel allergy in Sweden, and on the possible impact of the Nickel Directive (5, 6), which was implemented at the start of the present study.

The cross-sectional study design, however, does not allow for causality assessment. For practical reasons, reading of the patch test was carried out on day 4, which is recommended when only one reading is performed. Approximately 10% of patch-test reactions can be lost due to late-appearing reactions (20) and consequently, may introduce misclassification in patch-test results.

The prevalence of ear piercing appears to have remained virtually unchanged over the last 20 years, having compared our results with those reported by Larsson-Stymne & Widström (1) and also with comparable Norwegian and Danish data (21, 22). Body piercing was reported at similar prevalence levels to Preti and colleagues (17) in their study of Italian adolescents, but at lower levels compared with recent German data (7).

There are few recent population-based studies that deal with tattooing practices in Sweden. Tattooing is considerably more prevalent (6%) than reported in 50-year-old Swedish data (<1%) (16) and prevalence among girls is approximately two-fold that of boys, which suggests a shift in this lifestyle practice.

A new observation was that pierced individuals were found to practice tattooing, smoking and vegetarian/vegan dietary habits more often than non-pierced individuals. Similarly, pupils from certain educational programmes, such as vocational and arts programmes, were more likely to have multiple piercings, tattoos and to smoke. Thus, educational programme and piercing are both considered to be important lifestyle markers. In practice, this implies that, when future surveys among young populations or school environments are planned, thorough consideration of sample distribution and size, and educational programme, is warranted. No previous study has reported this important covariance.

Age at piercing has typically been considered to reflect the duration of nickel exposure, and thus influence the risk of development of nickel allergy. We also found a risk of nickel allergy in the younger, but not the youngest, age group (1–8 years) compared with those aged 12 years or more. This finding may be explained by: (i) a less responsive/allergen-sensitive immune system; or (ii) differences in cultural/ethnic origin in those being pierced at a very early age, suggesting a tradition of use of solid gold or non-nickel-releasing piercing items/jewellery (1), compared with individuals pierced later in life.

Furthermore, female gender, multiple piercings and being a pupil in a vocational programme were found

with an increased risk of nickel allergy in the multivariate regression analysis. A reasonable explanation of the risk increase among girls, although adjusted for background variables, may be due to differences in nickel exposures between boys and girls. Girls may be pierced earlier in life and use a higher quantity of, and more frequent, nickel-releasing piercing items than young boys (1, 23). Piercing practices were found to increase the risk of nickel allergy by a factor of three, but up to a factor of 5 in girls, compared with non-pierced pupils. In agreement with a Danish study (22), piercing was not associated with nickel allergy in boys. In common with previous studies (24, 25), we found a significantly increased risk of nickel allergy in pupils with multiple piercings. The almost two-fold increased risk of nickel allergy among pupils in vocational programmes could be explained by higher exposure to nickel from the more prevalent practice of multiple piercings, tattooing and smoking.

Atopics may have a different lifestyle, resulting in possible conscious avoidance of piercing and tattooing practices during adolescence due to parental and own awareness of allergy and risks, thus acting as a confounder in analyses. Interestingly, in the present study atopic pupils did not seem to avoid piercing or tattooing practices more than their non-atopic peers.

Smoking was found to be a risk factor in nickel allergy, although the effect was lost in the final multivariate model (Table II). Such a risk may be an effect from smoking as a confounder, if smoking was associated with the use of non-precious metals in contact with skin. Hence, an explanation could be that girls who smoke use non-precious metals to a greater extent than boys. In addition, smoking has immunomodulatory effects, plausibly favouring Th1-mediated immune responses, and is a well-known risk factor for some autoimmune diseases and psoriasis (26–28).

### Conclusion

Piercing is still the most important risk factor in nickel allergy, dependent on the number of piercings as well as exposure time (duration). Dietary habits do not play a significant role in nickel allergy. Different lifestyle behaviours, here indicated by piercing, tattooing, vegetarian/vegan diet and smoking, are connected. The pupil's choice of educational programme is an important lifestyle marker. Girls and boys choosing the same educational programme also show similarities in lifestyle preferences. A significant change in tattooing prevalence between the sexes is observed.

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