Occupational dermatitis in New Zealand cleaners

Study report for the Department of Labour

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Background

Overseas surveillance schemes for occupational skin disease, as well as several large epidemiological surveys, have consistently shown that occupational dermatitis is frequently caused by exposure to soaps, detergents and cleaners, and wet work. Workers in the cleaning industry therefore have a particularly high risk of occupational hand dermatitis due to the combination of wet work and exposure to irritant chemicals. Frequent wet work and exposure to chemicals in cleaning agents result in epidermal barrier disruption allowing penetration of irritants which may cause occupational dermatitis. Atopic (or allergic) subjects are believed to be more susceptible. Depending on the definition of occupational dermatitis, prevalence estimates in overseas studies range from 12-43%. However, there have been no studies to address the prevalence and risk factors of occupational dermatitis in cleaners in New Zealand. It is therefore highly relevant to study these issues in the New Zealand cleaning industry, particularly since more than 30,000 New Zealand workers are employed in this industry.

In 2008 the Centre for Public health Research was awarded a Partnership Programme Research Contract for the project titled “Occupational dermatitis in New Zealand cleaners”, which was submitted in response to a 2007 RFP under the Occupational Health Research Strategy, a joint initiative in Occupational Health Research, funded by the Department of Labour and the Health Research Council of New Zealand. This report summarises the work completed under this contract.

Aims

The aims of the study were to assess: (i) the prevalence and incidence of occupational dermatitis in cleaners; (ii) which agents and work processes cause occupational dermatitis in cleaners; (iii) the relative contributions of work-related exposures; (iv) which factors increase the probability of a favourable prognosis after the diagnosis of occupational dermatitis; (v) which preventive programmes are likely to be most effective.

Study design

The relationships between cleaning and occupational dermatitis was studied using a cross sectional study design. Work-related skin symptoms were assessed in 425 cleaners involved in cleaning hospitals, tertiary education institutions, schools, commercial buildings and industry (predominantly meatworks). A standardised dermatitis questionnaire was used and we compared the outcomes in cleaners with those of an external reference group of 281 non-exposed workers (retail workers, clerical workers and bus drivers). We also made comparisons with an internal reference group consisting of those who worked in the cleaning industry, but were not exposed or had only very low exposures to wet work and/or other potential risk factors. Those subjects with suspected dermatitis had photographs taken from the affected skin areas for confirmation by dermatitis experts. We also measured trans-epidermal water loss (TEWL) as a measure of skin barrier function and atopy (or allergies) in cleaners and the external reference group.

Results

The response rates for the cleaners and comparison group were 74% and 34% respectively. Compared with the reference group the cleaners had a higher proportion of women, Māori and Pacific people. They also smoked more and were older. All analyses were therefore controlled for age, sex, ethnicity and smokers.

Cleaners had an almost two-fold increased risk of current eczema (i.e. eczema in the past three months) compared to the reference group (14.8% versus 10%; adjusted OR (aOR) = 1.92, $p<0.05$). It was also more common for cleaners to develop eczema in adult life (17.6% versus 11.4%; adjusted aOR=1.77, $P<0.05$) and to visit a doctor as an adult for hand, wrist or forearm eczema (13.4% versus 10.7%; aOR=1.50), although the latter did not reach statistical significance. Seven percent developed symptoms after they started their job as a cleaner. Thus, approximately half of all current eczema symptoms in cleaners were new-onset symptoms. Almost 15% of cleaners reported that eczema improved when being away from work which was significantly more common (aOR=2.5; $P<0.01$) than that reported by the reference group. Twelve-and-a-half percent of the cleaners had eczema which affected

their daily lives to some extent with the majority reporting the effect to be slight and 2.8% reporting the effect to be large.

In addition to current hand eczema, cleaners were also more than twice as likely to report having current (i.e. within the last three months) itchy weals (or urticaria) on their hands, wrists or forearms (11% versus 5.3%; aOR=2.37, $p<0.05$) compared to the reference group. They were also more than three times as likely to have itchy weals after the age of 18 (not statistically significant) and to see a doctor as an adult for itchy weals (8.9% versus 2.1%; aOR=3.59, $p<0.05$). For itchy weals we found that 8% developed symptoms after they started their job as a cleaner. Thus, approximately 75% of all current symptoms of itchy weals in cleaners were new-onset symptoms.

Almost one in four cleaners (24.2%) reported skin symptoms due to the use of gloves and 12% had changed glove type or stopped using gloves due to skin symptoms, compared to 6.8% and 1.8% in the reference group respectively (OR=3.87 and 6.78, $p<0.01$).

For all areas of the hand/arm that are likely to be exposed to water and cleaning agents (back of hand, top forearm and volar forearm) we found elevated trans-epidermal water loss (signalling deteriorated skin barrier function) in cleaners compared to the reference group. Measurements of the upper arm, which is typically not exposed, showed no difference between cleaners and the reference group, suggesting that the difference in TEWL measured for the other part of the hand/arm were work-related.

Cleaners and non-cleaners did not differ with regards to atopy (or allergies), and atopy was also not associated with skin symptoms.

Due to technical problems only a small proportion of photos taken of the affected skin of cleaners was sufficiently detailed which prevented a valid expert assessment of the reported symptoms. This did not affect the validity of the study results as both the questionnaire and the TEWL measurements have been developed to be interpreted without the need of confirmation by expert assessment.

In addition to showing an increased risk of skin symptoms this study also assessed the potential causal agents and work processes. For eczema the most important risk factors were: industrial/aircraft cleaning, using gloves (not significant), hands exposed to water and

chemicals without wearing gloves, and the use of “other cleaning agents” not further specified. The use of barrier cream and “other skin care products” were positively associated with eczema, but this is most likely due to reversed causation, rather than these products being a risk factor.

For itchy weals the main risk factors were: the number of years worked as a cleaner (with the highest risk for those who had worked as a cleaner for more than 3 years), cleaning in homes/schools/offices/shops/hotels (as opposed to cleaning other types of buildings), cleaning machinery, hand exposure to water and cleaning products without wearing gloves, and exposure to “other cleaning products” not further specified. A protective effect of frequent hand drying on itchy weals was observed, but no association was found with the use of skin care products.

Subsequent analyses controlling for other exposures (including exposures to cleaning products and cleaning activities at home) did not significantly change these results although confidence limits widened with some associations no longer being statistically significant.

Discussion and conclusions

Results of this study have shown a two-fold increased risk of both eczema and urticaria (itchy weals) in New Zealand cleaners. Skin barrier function of hands and forearms was also adversely affected. Half of all cleaners with current eczema developed symptoms after they started their job as a cleaner and for urticaria (itchy weals) this was the case for 75% of the cleaners. The majority of cleaners with eczema reported that their symptoms improved when away from work. Skin barrier function was adversely affected only in those areas regularly exposed to water and chemicals, but not on the upper arm which is not typically exposed to water or cleaning products. This strongly suggests that work-related factors contributed to the increased risk of skin symptoms and deteriorated skin barrier function in cleaners. Thus, although prospective studies are better suited to establish the relative contribution of new-onset work-related skin symptoms, the best possible estimate based on this study is 50% for current eczema and 75% for current urticaria, with the remainder caused by non-occupational factors. However, these percentages are upper limits as some new-onset symptoms may not be associated with work-related exposures; nonetheless, we

expect this proportion to be small and therefore consider the 50% and 75% to be realistic estimates. Controlling for exposures to cleaning products and activities in the home environment did not alter these results.

Analyses within the group of cleaners comparing “high” with “low” exposed workers identified several work-related risk factors for eczema and urticaria. For eczema the main risk factors were hand exposure to water, hand exposure to chemicals, and exposure to other “cleaning products” with risk ratios ranging from approximately 2 to 4. For “itchy weals” or urticaria the main risk factors were the number of years worked as a cleaner and hand contact with cleaning products with risk ratios ranging from 2.5 to 4.6. Atopy-mediated allergies did not contribute to the increased risk of skin symptoms in cleaners and symptoms are therefore most likely of an irritant nature which is consistent with the identified risk factors.

It is difficult to assess which factors increase the probability of a favourable diagnosis in a cross-sectional study. However, we have assessed the association between symptoms and several factors that may prevent symptoms i.e. glove use, hand drying after washing and use of skin care products. Hand drying after washing reduced the risk of current urticaria almost 5-fold and is therefore one factor that increases the probability of a favourable prognosis after the diagnosis of occupational urticaria. However, our study did not show a protective effect of using “protective” gloves as currently used by the majority of cleaners. In fact, using “protective gloves” was shown to be a *risk factor* for current eczema, although this was not statistically significant. Nonetheless, when used appropriately (which is currently not the case in the majority of cleaners) it may reduce the adverse skin effects of hand exposure to water and/or cleaning products.

The use of barrier cream and/or moisturiser was positively associated with hand eczema, but this is likely due to reversed causation (i.e. workers with symptoms are more likely to use barrier cream and moisturisers than workers without symptoms) rather than these skin care products causing skin symptoms. Also, barrier cream may not be used appropriately increasing rather than decreasing the risk of symptoms.

In conclusion, this study has shown that cleaners have an increased risk of work-related hand eczema and urticaria and identified several modifiable risk factors which are suitable

targets for prevention. In particular, preventive measures should be targeted at reducing the amount of time workers hands' are directly exposed to water and/or cleaning agents, and more appropriate use of protective gloves and hand care products. However, although consistent with the general notion that these are the most important means of reducing the risk of dermatitis in cleaners, very few studies have been able to conclusively demonstrate its effectiveness. Nonetheless, the few clinical trials on hand care products conducted to date (n=4) generally show positive results although statistical significance was not reached for any of these studies (studies were generally small and had major weaknesses).[38]

Further data collection and analyses are required (this is outside the scope of the current study) to assess the specific cleaning agents contributing to the elevated risks associated with "other cleaning products", so that high risk cleaning agents can be identified and either replaced by lower risk products or handled with appropriate protection.

Previous observational studies have shown that intervention programmes may be effective in reducing and preventing occupational dermatitis in other occupational groups, and similar types of programmes now need to be developed and evaluated for the cleaning industry.

1. Introduction

In 2008 The Centre for Public health Research was awarded a Partnership Programme Research Contract for the project titled "Occupational dermatitis in New Zealand cleaners", which was submitted in response to a 2007 RFP under the Occupational Health Research Strategy, a joint initiative in Occupational Health Research, funded by the Department of Labour and the Health Research Council of New Zealand.

The Aims of the study were to assess: (i) the prevalence and incidence of occupational dermatitis in cleaners; (ii) which agents and work processes cause occupational dermatitis in cleaners; (iii) the relative contributions of work-related exposures; (iv) which factors increase the probability of a favourable prognosis after the diagnosis of occupational dermatitis; (v) which preventive programmes are likely to be most effective.

This report summarises the work completed under this contract.

2. Cleaners and work-related dermatitis: a brief literature review

Occupational dermatitis is one of the most common work-related illnesses, and has been estimated to account for up to 40-70% of the total burden of occupational disease.[1-3] In countries such as Germany and Italy, occupational dermatitis accounts for more than 50% of workers' compensation for occupational disease.[4 5] Incidence rates estimated from disease registry data have been reported to be in the order of 0.5-1.9 cases per 1,000 workers per year, with wide variations in estimates between countries and specific occupations.[1] The true incidence is likely to be higher since occupational dermatitis is often severely underreported.[6] Factors responsible for underreporting include: 1) under-recognition of work-relatedness of the symptoms; 2) reporting discrepancies arising from distinctions between observable and compensatable skin disease; and 3) the perception that occupational dermatitis is trivial because it is not life threatening. However, despite not being life threatening, morbidity is substantial with a reported average loss of 11 work days annually in 20-25% of subjects with occupational dermatitis in the USA.[7] Others have suggested that occupational skin disease is responsible for 25% of all lost work days.[8] Also, as demonstrated in a 12 year follow-up study in Sweden, occupational dermatitis has a clear tendency to develop into a chronic condition with the majority of subjects with dermatitis still reporting symptoms 12 years later.[9] Skin atopy was shown to be the strongest unfavourable factor for the prognosis. The same study also showed that the illness had influenced the employment situation for the majority of patients (82%), and for 15% of patients it resulted in exclusion from the labour market through unemployment or disability. Similar results have been shown in other studies assessing the long-term prognosis of occupational dermatitis.[10-12] Occupational dermatitis is therefore an important occupational disease associated with work absenteeism, disability, increased use (and therefore cost) of medical care and pharmaceuticals, reduced quality of life and increased stress in individuals with these conditions. New Zealand is no exception in this regard, as indicated by the NOHSAC Burden of Occupational Disease and Injury report which estimates skin disorders to be the third highest incident occupational disease.[13] However, good prevalence and/or incidence data on occupational dermatitis are currently lacking in New

Zealand. In fact, occupational dermatitis has long been neglected in occupational medicine in New Zealand and research capacity building in this area is urgently required.

Surveillance schemes for occupational skin disease in the UK (EPIDERM and OPRA[6 14]), as well as several large epidemiological surveys internationally[1 15 16], have consistently shown that occupational dermatitis is most frequently attributed to: 1) rubber chemicals; 2) soaps, detergents and cleaners; and 3) wet work. The NOHSAC Burden of Occupational Disease and Injury report [13] also identified wet work as one of the main risk factors for occupational dermatitis (most notably irritant contact dermatitis). Although not specifically listed in the NOHSAC report as a high risk occupation, workers in the cleaning industry are believed to have a particularly high risk of occupational hand dermatitis due to the combination of wet work, exposure to irritant chemicals in cleaning agents as well as increased mechanical stress.[17] In fact, in Denmark cleaners rank highest with regard to the incidence of notified occupational skin diseases with 13.2 cases per 1,000 per year.[18] They are frequently exposed to soaps, disinfectants, scouring powders, wax removers and strippers, solvents, drain cleaners, etc. Surface-active substances used in many of these cleaning agents can dissolve the lipids of the upper skin layer resulting in impaired skin barrier function causing irritation and inflammation of the skin. This is further aggravated by frequent contact of the hands with water and the occlusion of the skin by wearing gloves. This so called “wet work” is also, in itself, a major risk factor for occupational dermatitis [1 17 19], and legal standards for the duration and frequency of wet work have been developed in Germany.[19] Thus, dermatitis in cleaners is caused by the chronic cumulative effect of multiple irritants, including frequent exposure to water.

Little work has been done to quantify the exposure of cleaners to chemical irritants. However, some work has been conducted in assessing the frequency and duration of wet work in cleaners. In a study of 41 office workers in The Netherlands, wet work was shown to account for 50% of cleaning work, and within a typical three-hour shift an average frequency of 68 episodes of wet work was observed.[17] Wet work in this study was defined as all occupational activities that: 1) cause the skin of one or two hands to be in contact with water or watery soap solutions; 2) necessitate the wearing of protective gloves for a prolonged period of time, thus causing the hands to become moist from perspiration.

As expected, given the high exposure to irritants and wet work, high prevalences of dermatitis have been shown in hospital workers, particularly in nurses and cleaners.[20-22] However, surprisingly few studies have specifically examined occupational dermatitis in cleaners. A study by Singgih *et al* [20] in 356 hospital cleaners reported a period prevalence rate of moderate and severe dermatitis of 12% (10% in men and 19% in women). In 88%, the dermatitis had a duration of more than two years. Another study among more than 1,000 female cleaners employed at nursing homes, schools and offices found that 43% had at least one out of four skin symptoms during a one-year period.[23] Seventy percent of them reported improvements during weekends and holidays. During the two year follow-up, the risk of developing skin symptoms was greater in the group that remained working as cleaners than in the group that left their cleaning jobs. In a questionnaire survey by Gawkrodger et al,[21] it was found that 35% of women hospital cleaners reported skin disorders. A diagnosis of hand dermatitis was made in 12%, most of which was irritant in origin and related to wet work.

The prevalence/incidence estimates for occupational dermatitis vary largely between studies, even within the same or similar occupational groups. This is at least in part due to a lack of a standard definition of occupational dermatitis in population surveys.[1] Population surveys of occupational dermatitis often rely on morbidity statistics where case ascertainment usually involves hospital admissions, sick leave or referral to a specialist. This results in selection towards the more severe cases, since in a large proportion of individuals, symptoms will not result in sick leave (at least not in the early stages) and many of these subjects will not seek medical attention.[1] Other methods to ascertain cases of occupational dermatitis involve medical examinations or self-administered questionnaires or a combination of the two. Significant differences in prevalence estimates have been shown when using different methods.[24 25]

The skin serves as a barrier against penetration of irritants or allergens and prevents trans-epidermal water loss.[26] When the skin barrier function is impaired by chemical exposures and/or mechanical stress it can contribute to a decreased irritancy threshold and the development of contact dermatitis.[27] The non-invasive measurement of transepidermal

water loss (TEWL) has been established as one of the main parameters in the assessment of skin barrier function.[28] An increased TEWL can therefore indicate a defective skin barrier function in the absence of visible signs of dermatitis. This therefore provides an interesting objective and sensitive measure of skin damage which could be used to further assess exposure response associations, particularly in those workers where skin damage has not yet resulted in clear signs of dermatitis, or those whose visible signs of dermatitis have temporarily disappeared (i.e. occurrence and severity of dermatitis fluctuates over time).

Host factors such as atopy may favour the onset of occupational irritant dermatitis,[1 29] but only few epidemiological studies have conducted skin prick tests including common (non-occupational) allergens. Also, it may be that (pre-existing) intrinsic impairment of skin barrier function may favour the onset of occupational dermatitis, although currently there is no evidence to suggest that this is the case.[30 31]

Intervention studies to prevent work-related dermatitis are rare. A study in hairdressers in Germany showed that the implementation of preventive measures reduced the number of occupational skin diseases by two thirds, and the cost for insurance premiums to the government's accident insurance could be cut by 25%.[32] The authors attributed the reduction in skin diseases to the ban on glycerol monothioglycolate in perms (a well-known occupational allergen), but no direct causal link could be made. A study in dental technicians showed that the use of after-work-moisturisers reduced the frequency of irritant dermatitis.[33] Another intervention study in gut cleaners in swine slaughterhouses showed a reduction in dermatitis from 56.2% at baseline to 41.0% after the introduction of an evidence based prevention programme.[34] These and other studies[35] suggest that intervention programmes may be effective in reducing and preventing occupational dermatitis, and programmes consisting of skin protection courses are currently being introduced in Germany in health care workers, cleaners, and kitchen employees.[4]
To date there have been no studies of occupational dermatitis in cleaners in New Zealand, and prevalence and/or incidence data are therefore lacking. However, given the high exposure to irritants and wet work, occupational dermatitis in cleaners should be considered a major potential public health concern, particularly since well over 30,000 people are employed in this industry (Statistics New Zealand Census 2001), constituting a

sizeable proportion of the New Zealand workforce. It is therefore highly relevant to study the prevalence and incidence of occupational dermatitis in New Zealand cleaners, and to determine which specific exposures and/or work processes play a causal role. In addition, it is important to develop strategies to reduce exposures or change work practices and thereby prevent occupational dermatitis in New Zealand cleaners.

3. Materials and Methods

Study design

The relationship between cleaning and occupational dermatitis was studied using a cross sectional study design. Work-related dermatitis was assessed in 425 cleaners involved in cleaning hospitals, tertiary education institutions, schools and commercial buildings. A standardised dermatitis questionnaire was used (see below) and we compared the outcomes in cleaners with those of an external reference group of 281 non-exposed workers (retail workers, clerical workers and bus drivers). We also made comparisons with an internal reference group consisting of those who work in the cleaning industry, but are not exposed or have only very low exposures to wet work and/or other potential risk factors. We also measured trans-epidermal water loss (TEWL) in cleaners and the external reference group.

In those subjects with suspected dermatitis, photographs were taken from the affected skin areas for confirmation by dermatitis experts. However, despite taking photos using high resolution SLR cameras with dedicated macro lenses and ring flashes, a large proportion of the pictures were of insufficient quality to be assessed by independent experts and results will therefore not be discussed further in this report. The results presented in the report are therefore entirely based on questionnaire and TEWL data. These tools have been developed to be used independent of expert assessments and the data obtained are therefore robust and not having photos of the skin in those with symptoms therefore does not invalidate the results presented in this report.

Recruitment

Cleaners: We have recruited participants through the Service and Food Workers Union (SFWU) Nga Ringa Tota, since they cover most workers in the industry. We also recruited directly through organisations that employ or contract cleaners (see Table 1 for an overview). Recruitment took place in the greater Wellington area, Palmerston North, Whanganui, Gisborne, Auckland, Nelson/Marlborough, and Christchurch.

Once permission was obtained to contact the cleaners, an information sheet was provided and for those who were interested, a time set up to participate in the study. A small number of cleaners who worked as sole operators were also recruited by the researchers. They were found in the telephone directory or by word of mouth.
For the most part, cleaners were overwhelmingly supportive of the study. Most cleaning organisations had a 95% response rate (Table 1), and some had every cleaner take part. Often where people refused, it was because they were required urgently (for example at the hospital the cleaners would be required on short notice for urgent tasks such as mopping up biohazard spills) or they were nearing the end of their shift and had other commitments such as picking up children from school.

External reference group: The comparison group was recruited from the same geographical areas and comprised of bus drivers and retail/service workers. These included people who work on the shop floor or the storeroom in supermarkets and other retail outlets, as well as those involved in clerical duties within these organisations or in motels Members of the comparison group were invited to participate in the study by the researchers. As with the cleaners, researchers first approached the organisation and once permission was gained, the workers were contacted directly and provided with information about the study.

Identifying the study population for the bus drivers was particularly problematic. We were only able to approach bus drivers who were at the depot, however hundreds of drivers are employed by the organisation, and not all spent their break at the bus depot. In addition, drivers were coming and going to and from the depot regularly so the study population was fluid. Therefore the study population was defined as the average number of drivers who would be at the bus depot most days. From our time spent at the bus depot over a number of weeks we estimated this to be around 120. The overall response rate for the external comparison group was 34% (Table 1).

A very small number of eligible participants were excluded. One potential participant was heavily pregnant, two had colds and one worked up to six hours a week as a cleaner in addition to her retail work.

Table 1: Recruitment rates for cleaners and external comparison group

Name of organisation **Cleaners**	**Response rate** **74%**	**Number of cleaners** **425**
Bar 1	100%	1
Bar 2	100%	1
Bus depot	100%	1
Cinema	100%	2
Hospital 1	60%	32
Hospital 2	80%	16
Hospital 3	40%	12
Hospital 4	50%	4
Hospital 5	80%	3
Hospital 6	20%	2
Hospital 7	60%	11
Hospital 8	80%	16
Hospital 9	100%	1
Hospital 10	100%	2
Hospital 11	75%	3
Hospital 12	57%	13
Hospital 13	100%	1
Hotel 1	90%	11
Hotel 2	95%	12
Hotel 3	60%	6
Hotel 4	60%	6
Hotel 5	100%	6
Hotel 6	83%	5
Hotel 7	100%	1
Hotel 8	100%	2
Mall 1	90%	9
Mall 2	89%	8
Meatworks 1	93%	14
Meatworks 2	71%	24
Meatworks 3	82%	9
Meatworks 4	87%	13

Military 1	100%	16
Military 2	100%	1
Military 3	75%	9
Mine	80%	4
Motel 1	100%	2
Motel 2	100%	2
Motel 3	100%	3
Motel 4	100%	7
Motel 5	100%	1
Motel 6	100%	1
Motel 7	50%	1
Motel 8	100%	2
Motel 9	100%	1
Motel 10	100%	1
Railway Station	75%	3
Rest home 1	50%	1
Rest home 2	50%	1
Rest home 3	33%	1
Rest home 4	100%	1
Rest home 5	50%	2
School 1	100%	2
School 2	25%	1
School 3	67%	4
School 4	75%	3
Supermarket 1	100%	2
Supermarket 2	75%	3
University 1	92%	12
University 2	97%	38
University 3	50%	16
Union group 1	90%[1]	11
Union group 2	90%[1]	13
Self-employed sole operators	75%[1]	14
Reference group	**34%**	**281**
Bus drivers in Wellington and Palmerston North	49%	80

Shop 1	100%	55
Shop 2	80%	4
Shop 3	50%	2
Shop 4	14%	1
Shop 5	100%	2
Shop 6	100%	2
Shop 7	100%	2
Shop 8	100%	5
Shop 9	25%	1
Shop 10	13%	8
Shop 11	50%	2
Shop 12	3%	1
Shop 13	2%	1
Shop 14	23%	3
Shop 15	100%	1
Shop 16	33%	1
Supermarket 1	25%	31
Supermarket 2	25%	32
Supermarket 3	18%	17
Supermarket 4	23%	7
Supermarket 5	50%	11
Clerical staff from motels and comparison organisations	50%[1]	16

[1] The exact number of eligible workers was not known and response rate was estimated based on field workers' reports

Interviews

Face-to-face interviews were undertaken at the workplace for the majority of workers. Some workers were interviewed at the SFWU offices in Wellington and Auckland. The interview was based on the Nordic Occupational Skin Questionnaire (NOSQ-2002) (See appendix 1 for the complete questionnaire).[25] The questionnaire also included questions about relevant exposures including hand washing and glove usage as well as questions about protective measures taken by workers to reduce the risk of skin symptoms. In addition to questions on skin symptoms and relevant exposures we also included questions

on potential confounders including ethnicity, age, medication, smoking, etc (Appendix 1). Face-to-face interviews were recorded on paper questionnaires and then double-entered electronically and further checked and corrected in case of inconsistencies.

Trans-epidermal water loss

Skin barrier function was assessed by measuring trans-epidermal water loss (TEWL). The device used to measure TEWL was a Dermal Measurement System EDS12 (EnviroDerm Services, Evesham, UK) which consists of a cylindrical chamber, open at both sides and containing two preheated hygrometer sensors inside the cylinder situated perpendicularly above the skin surface at different fixed distances.[28] Evaporation from the skin in the area of the rounded opening of the evaporimeter probe causes a gradient of humidity inside the cylindrical chamber, which is measured by the two hygrometers. The total amount of water passing through the chamber (transepidermal water loss, TEWL) is automatically calculated from the gradient of humidity and air temperature and results are expressed in grams/meter^2/h. Measurements were taken of the back of the hand and the volar surface of the forearm according to published guidelines.[36]

In addition, we took a measurement of the upper arm which was not exposed and had no visible signs of dermatitis (dermatitis in cleaners predominantly affects the hands and forearm). This will be used as a reference estimate of the intrinsic skin barrier function not affected by occupational exposures. All measurements were conducted on the hands/arm that the subjects use to write with.

Atopy

Atopy was assessed by using skin prick tests. These were carried out after the TEWL measurements according to a well-defined protocol that has been used by our research group in many other studies.[37] The volar surface of the forearm was cleaned and solutions containing the following allergen solutions were tested by skin prick test: positive control (histamine), negative control (diluent), cat, dog, grass mix, *Alternaria*, *Cladosporium*, *Penicilium*, and house dust mite. All tests were read at 15 minutes. A positive reaction was

defined as a weal with a mean diameter of greater than or equal to 3mm, once any reaction to the negative control had been subtracted. Atopy was defined as at least one positive skin prick test to any of the common allergen extracts.

Data analyses

For all analyses involving dichotomous outcomes (yes/no) prevalence odds ratios were calculated with the Mantel-Haenszel method and logistic regression adjusting for potential confounders (e.g. smoking, age, sex, ethnicity, etc). For the continuous outcome variable (i.e. transepidermal water loss) we applied linear regression analyses adjusting for the same confounders.

Multiple logistic regression models were constructed by adding one exposure variable at a time, commencing with the main exposure variables (i.e. those previously identified as risk factors in other studies) followed by the potential confounders that showed the strongest effects in univariate analyses. At each step, odds ratios were checked for signs of confounding, and standard errors were checked for signs of multicollinearity.

4. Results

Demographic characteristics

In total, we recruited 425 cleaners and 281 reference workers (Tables 1 and 2). Compared with the reference group the cleaners had a higher proportion of women, Māori and Pacific people. They also smoked more and were older (Table 2). All analyses comparing the cleaners with the reference group were therefore controlled for age, sex, ethnicity and smoking unless specified otherwise.

Table 2. Demographic characteristics for the cleaners and reference workers

	Cleaners (n=425)		**Reference workers (n=281)**	
	n	%	n	%
Sex				
Males	97	22.8	142	50.5
Females	328	77.2	139	49.5
Ethnicity				
European/Pakeha	141	33.2	189	67.3
Māori	114	26.8	38	13.5
Pacific	118	27.8	29	10.3
Other	49	11.5	24	8.5
Smoking status				
Current smoker	178	41.9	81	28.8
Ex-smoker	59	13.9	75	26.7
Non-smoker	188	44.2	124	44.1
	mean	SD	mean	SD
Age	45	12.9	40	15.1

Skin symptoms

The prevalence of eczema symptoms are presented in Table 3. Ten percent of the cleaners reported eczema at the time of the survey and 14.5% reported eczema in the past three months compared to 6.0% and 3.6% respectively in the reference group. Controlling for age, sex, ethnicity and smoking, current eczema (i.e. eczema in the past three months) was

almost twice as common in cleaners (OR=1.92, p<0.05) compared to the reference group. Cleaners were also almost twice as likely (17.6% versus 11.4%; adjusted OR (aOR) = 1.77, P<0.05) to develop eczema in adult life. Cleaners were more likely to visit a doctor as an adult for hand, wrist or forearm eczema (13.4% versus 10.7%; aOR=1.50), but this did not reach statistical significance. We asked for the year of onset of symptoms, and compared this with their work history, which allowed us to assess whether work as a cleaner was related to new-onset (or incident) dermatitis. For eczema we found that 7% developed symptoms after they started their job as a cleaner. Thus, approximately half of all current eczema symptoms (i.e. symptoms in the past three months) are new-onset symptoms.

Chemicals used at work worsened eczema in 12.5% of all cleaners compared to 8.9% in the control group (not statistically significant). Also, 9.9% of cleaners report that eczema improves when being away from work which was significantly more common (aOR=2.5; P<0.01) than that reported by the reference group. Twelve-and-a-half percent of the cleaners had eczema which affected their daily lives to some extent with the majority reporting the effect to be slight and 2.8% reporting the effect to be large. Cleaners were more likely to report their eczema to have a moderate to large effect on their daily lives, but this did not reach statistical significance (Table 3).

Table 3. Eczema in cleaners and the reference group

	Cleaners (n=418)		**Reference group (n=279)**		
Symptom	n	%	n	%	OR (95% CI)[1]
Itchy rash ever (y/n)	103	24.2	69	24.6	0.98 (0.67-1.45)
Hand eczema ever (y/n)	93	21.9	47	16.7	1.38 (0.90-2.11)
Wrist/forearm eczema ever (y/n)	52	12.2	37	13.2	0.98 (0.59-1.63)
One or more areas on the hands/arms commonly affected by eczema (y/n)	102	24.0	61	21.7	1.20 (0.80-1.79)
Frequency of eczema on hands, wrists, forearms					
Only once and for less than two weeks	11	2.6	5	1.8	1.07 (0.70-1.65)
Only once and for two weeks or more	12	2.8	4	1.4	(>once vs once or
More than once	49	11.5	38	13.5	never)
(Nearly) all the time	30	7.1	15	5.3	
Last had eczema on hands, wrists, forearms					
I have it now	43	10.1	19	6.8	1.92 (1.14-3.23)*

Not now but within the past 3 months	20	4.7	9	3.2	< 3 months vs >3
Between 3-12 months ago	14	3.3	10	3.6	months or never
More than 12 months ago	26	6.1	24	8.5	
First had eczema on hands, wrists, forearms					
Below 6 years of age	11	2.6	14	5.0	1.77 (1.09-2.88)*
Between 6 and 14 years of age	12	2.8	8	2.8	>18 yrs vs <18 or
Between 15 and 18 years of age	5	1.2	9	3.2	never
Above 18 years of age	75	17.6	32	11.4	
Visited doctor as an adult for hand, wrists or forearm eczema (y/n)	59	13.9	30	10.7	1.50 (0.89-2.51)
Chemicals at work worsen eczema (y/n)	53	12.5	25	8.9	1.58 (0.91-2.75)
Chemicals outside work worsen eczema (y/n)	34	8.0	23	8.2	0.96 (0.52-1.77)
Eczema improves when away from work					
Yes, usually	42	9.9	15	5.3	2.51(1.42-4.43)**
Yes, sometimes	20	4.7	6	2.1	Yes vs no
Eczema affects daily activities in occupation (y/n)	28	6.6	11	3.9	1.80 (0.82-3.92)
Eczema effected normal life in past 12 months					
Slight effect	28	6.6	13	4.6	1.80 (0.82-3.95)
Moderate effect	13	3.1	6	2.1	Moderate/large vs
Large effect	12	2.8	6	2.1	no/slight

[1] Adjusted for age, sex, ethnicity, smoking

* p<0.05; ** p<0.01

In addition to current hand eczema, cleaners were also more than twice as likely to report having current (i.e. within the last three months) itchy weals on their hands, wrists or forearms (11% versus 5.3%; aOR=2.37, p<0.05) compared to the reference group (Table 4). They were also more than three times as likely to have itchy weals after the age of 18 (not statistically significant) and to see a doctor as an adult for itchy weals (8.9% versus 2.1%; OR=3.59, p<0.05). For itchy weals we found that 8% developed symptoms after they started their job as a cleaner. Thus, approximately 75% of all current symptoms of itchy weals are new-onset symptoms. The prevalence of skin rash due to metal, dry skin, itchy skin due to sweat and ever been diagnosed with skin allergy were high (Table 4), but no differences were observed between cleaners and the reference group.

Almost one in four cleaners (24.2%) reported skin symptoms due to the use of gloves and 12% had changed glove type or stopped using gloves due to skin symptoms, compared to 6.8% and 1.8% in the reference group respectively (aOR=3.87 and 6.78, p<0.01; Table 4).

Table 4. Itchy weals, dry skin and skin allergy in cleaners and the reference group

	Cleaners (n=418)		Controls (n=279)		
Symptom	n	%	n	%	OR (95% CI)[1]
itchy weals on hand, wrist or forearm ever (y/n)	100	23.5	47	16.7	1.31 (0.86-2.01)
Itchy weals due to contact with fruits, vegetables, rubber gloves, animals, cleaning products etc. (y/n)	54	12.7	28	10	1.15 (0.67-1.96)
Frequency of itchy weals					
Once	26	6.1	9	3.2	1.14 (0.71-1.82)
2-5 times	27	6.4	13	4.6	>1 vs once or never
More than 5 times	47	11.1	25	8.9	
Last have itchy weals					
During the past 7 days	24	5.6	6	2.1	2.37 (1.23-4.56)**
7 days to 3 months ago	23	5.4	9	3.2	<3 months vs >3
3-12 months ago	22	5.2	12	4.3	months
Over a year ago	31	7.3	20	7.1	
First got itchy weals					
Below 6 years of age	4	0.9	7	2.5	1.68 (0.95-2.95)
Between 6 and 14 years of age	23	5.4	11	3.9	>18 yrs vs <18 yrs
Between 15 and 18 years of age	9	2.1	8	2.8	
Above 18 years of age	64	15.1	21	7.5	
Visited a doctor as an adult because of itchy weals (y/n)	38	8.9	6	2.1	3.59 (1.43-9.06)**
Rash from metal objects next to skin (y/n)	134	31.5	63	22.4	0.94 (0.63-1.40)
Dry skin (y/n)	224	52.7	135	48.0	1.02 (0.73-1.44)
Itchy skin due to sweat (y/n)	137	32.2	76	27.0	1.10 (0.76-1.60)
Ever been diagnosed with skin allergy (y/n)	62	14.6	43	15.3	0.97 (0.61-1.55)
Skin symptoms related to glove use					
Skin symptoms due to gloves (y/n)	103	24.2	19	6.8	3.87 (2.22-6.74)***
Changed glove type or stopped using gloves due to skin symptoms (y/n)	51	12.0	5	1.8	6.78 (2.57-17.88)***

[1] Adjusted for age, sex, ethnicity, smoking

* p<0.05; ** p<0.01; p<0.001

Atopy

As shown above, cleaners had a higher prevalence of current skin symptoms than the reference group. To assess whether symptoms were likely due to atopic or allergic mechanisms we conducted skin prick tests using a panel of common allergens (listed in Table 5). Comparisons between cleaners and the reference groups suggested that cleaners had a slightly reduced risk of atopy, statistically significant only for cat allergens (OR=0.54,

p<0.05). Overall, however, there was no significant difference between both groups suggesting that atopy is unlikely to play a role in the observed difference in skin symptom prevalence between cleaners and the reference group. Nonetheless we did analyse whether there was an association between atopy and skin symptoms (controlled for age, sex, ethnicity and smoking) and found no association (data not shown).

Table 5. Atopic sensitisation in cleaners and the reference group

	Cleaners (n=418)		Reference group (n=279)		
Allergen[2]	N	%	n	%	OR (95% CI)[1]
Grass mix	102	24.4	79	28.3	0.72 (0.49 - 1.06)
HD Mite	185	44.3	123	44.1	0.92 (0.65 - 1.30)
Tree Mix	46	11.0	33	11.8	0.91 (0.54 - 1.54)
Cat	44	10.5	44	15.8	0.54 (0.33 - 0.89)*
Dog	19	4.5	19	6.8	0.72 (0.35 - 1.49)
Alternaria	27	6.5	22	7.9	0.83 (0.43- 1.60)
Cladosporium	20	4.8	13	4.7	0.84 (0.38 - 1.87)
Penicilium	15	3.6	16	5.7	0.52 (0.23 - 1.17)
Atopy[3]	224	53.6	158	56.6	0.80 (0.57 - 1.13)

[1] Adjusted for age, sex, ethnicity, smoking
[2] A positive reaction is defined as a weal with a mean diameter of greater than or equal to 3mm, once any reaction to the negative control has been subtracted.
[3] Atopy is defined as at least one positive skin prick test to any of the common allergen extracts.
* P<0.05

Skin barrier function

To assess skin barrier function we measured trans-epidermal water loss (TEWL). This allows the detection of defects in the skin's protective function (to retain water and provide a barrier against microbes) even before visible skin irritation is apparent. Normal healthy skin is typically associated with lower TEWL whereas problems in skin barrier function increase TEWL. Although there is a TWEL interpretation table provided by the supplier of the TEWL instrument (see appendix 2) there are no well-established clinical criteria for defining poor skin barrier function. Therefore rather than comparing it against a pre-determined "normal" value, we have compared average levels between cleaners and the reference group, controlled for age, sex, ethnicity and smoking. For all areas of the hand/arm that are likely

to be exposed to water and cleaning agents (back of hand, top forearm and volar forearm) we found elevated trans-epidermal water loss in cleaners compared to the reference group with the most pronounced differences for the back of the hand and the volar forearm (Table 6). We also took a measurement of the upper arm which is typically not exposed and the results were highly comparable between cleaners and the reference group suggesting that the difference in TEWL measured for the other part of the hand/arm were indeed work-related.

Table 6. Trans-epidermal water loss in cleaners and the reference group

	Cleaners		**Reference group**			
	n=289		n=273		Difference[1]	
	Mean[2]	SD	Mean[2]	SD	Mean[2]	p-value
Trans-epidermal water loss						
Back of hand	7.8	3.74	6.9	2.86	1.07	0.0004
Top forearm	7.1	3.08	6.7	2.14	0.49	0.0425
Volar forearm	7.8	3.16	6.8	2.25	1.22	<0.0001
Upper arm	7.3	2.82	7.6	4.84	0.04	0.9212

[1] Adjusted for age, sex, ethnicity, smoking
[2] Unit: grams/meter^2/h

As shown above, cleaners have a significantly higher prevalence of skin symptoms and skin barrier function is adversely affected as suggested by the higher TEWL values. To assess whether there is an association between TEWL and skin symptoms we conducted regression analyses to assess the difference in TEWL for those with and without symptoms and for cleaners and the reference group separately. We have focussed the analyses on the TEWL measurements that showed the greatest difference between cleaners and reference workers i.e. the back of the hand and the volar forearm (Table 7). In the cleaners we found no significant associations between TEWL and skin symptoms. In the reference workers on the other hand, we found that eczema symptoms were associated with a significantly increased TEWL at the back of the hand with the strongest effect for current eczema. Interestingly, and against expectation, “itchy weals” was inversely associated with TEWL for both the back of the hand and the volar forearm in the reference group. The reason for not finding clearer associations in the cleaners and the reverse associations in the reference

populations may be due to the use of skin care products which are used more by those who have symptoms (see Table 11).

Table 7. Trans-epidermal water loss in cleaners

	Trans-epidermal water loss			
	Back of hand		Volar forearm	
	Difference[1]			
Symptoms (y/n) for Cleaners	mean	p-value	mean	p-value
Eczema in the past 3 months	0.53	0.39	-0.32	0.54
Eczema above 18 yrs of age	0.29	0.62	-0.44	0.36
Visited doctor for eczema as adult	0.06	0.92	-0.24	0.66
Itchy weals in the past 3 months	-0.88	0.23	-0.07	0.91
Itchy weals above 18 yrs of age	-0.59	0.34	-0.92	0.07
Visited Doctor for itchy weals as adult	-0.64	0.43	-0.19	0.78
Symptoms (y/n) for reference group				
Eczema in the past 3 months	1.66	0.004**	0.64	0.15
Eczema above 18 yrs of age	1.04	0.05*	0.08	0.85
Visited doctor for eczema as adult	0.69	0.21	0.26	0.54
Itchy weals in the past 3 months	-0.72	0.34	-0.12	0.84
Itchy weals above 18 yrs of age	-0.78	0.23	-1.02	0.04*
Visited doctor for itchy weals as adult	-2.45	0.04*	-1.76	0.05*

[1] Adjusted for age, sex, ethnicity, smoking

* p<0.05; ** p<0.01; p<0.001

Job details and cleaning activities

Cleaners worked 8.5 years on average in their current job with an average work week of 33 hours (Table 8). However, there was substantial variance around the mean with some cleaners having been in the job for only a few months and some having worked as a cleaner for 20 years or more. Similarly, the number of hours worked per week ranged widely for the cleaners. The reference group had worked in their current occupation for an average of six years and, as was the case for the cleaners, the number of years worked in their current occupation ranged widely.

The majority of cleaners conducted their cleaning work in homes, schools, offices, shops and hotels (77.2%). The remainder worked in hospitals and pharmacies (32.5%), café, restaurant

or kitchens (14.8%) and industrial settings (17.6%) or outside (4.6%). Of those who indicated to be involved in cleaning in an industrial setting, the majority were cleaners in meatworks, but there were also two cleaners from a steel processing plant and some hospital (n=3), university (n=1) and army cleaners (n=1) also reported cleaning activities in an industrial setting. The most common cleaning activities among cleaners were dusting/sweeping/vacuuming, mopping/wet cleaning/damp wiping, cleaning toilets, and cleaning windows and mirrors. Cleaning activities not very frequently conducted included washing clothes/linen by hand and/or machine. Although almost 50% of the reference workers reported to be involved in cleaning activities the frequency of these activities was (as expected) relatively low and considerably less than those reported by the cleaners.

Table 8. Job details and cleaning activities for cleaners and the reference group

	Cleaners n=425		**Reference group** n=281	
	Mean	SD	Mean	SD
Years worked in current job (yrs)	8.5	8.61	6.2	7.13
Number of hours/week worked as a cleaner	33.8	12.08	-	-
	n	%	n	%
Involved in cleaning activities in current job (y/n)	425	100.0	134	47.7
Type of cleaning work				
Homes/schools/offices/shops/hotels	328	77.2	-	-
Hospitals/pharmacies	138	32.5	-	-
Café/Restaurant/Kitchens	63	14.8	-	-
Industrial	75	17.6	-	-
Outside	21	4.9	-	-
Dusting, sweeping, vacuuming				
Never	48	11.3	180	64.1
<1 day/week	11	2.6	16	5.7
1-3 days/week	64	15.1	55	19.6
4-7 days/week	302	71.1	30	10.7
Mopping, wet cleaning, damp wiping				
Never	16	3.8	174	61.9
<1 day/week	12	2.8	21	7.5
1-3 days/week	53	12.5	37	13.2
4-7 days/week	342	80.5	49	17.4
Cleaning the toilet				
Never	85	20.0	254	90.4
<1 day/week	15	3.5	18	6.4
1-3 days/week	35	8.2	7	2.5
4-7 days/week	288	67.8	2	0.7

Polishing, waxing, shampooing				
Never	289	68.0	272	96.8
<1 day/week	40	9.4	1	0.4
1-3 days/week	54	12.7	8	2.8
4-7 days/week	41	9.6	0	0.0
Cleaning windows and mirrors				
Never	68	16.0	230	81.9
<1 day/week	37	8.7	21	7.5
1-3 days/week	77	18.1	15	5.3
4-7 days/week	243	57.2	15	5.3
Cleaning the kitchen				
Never	170	40.0	220	78.3
<1 day/week	12	2.8	12	4.3
1-3 days/week	36	8.5	29	10.3
4-7 days/week	207	48.7	20	7.1
Washing/soaking clothes/linen by hand				
Never	393	92.5	277	98.6
<1 day/week	5	1.2	2	0.7
1-3 days/week	6	1.4	2	0.7
4-7 days/week	21	4.9	0	0.0
Washing clothes by machine				
Never	353	83.1	271	96.4
<1 day/week	12	2.8	2	0.7
1-3 days/week	21	4.9	5	1.8
4-7 days/week	37	8.7	3	1.1
Cleaning machinery in industrial setting				
Never	359	84.5	265	94.3
<1 day/week	7	1.6	2	0.7
1-3 days/week	1	0.2	4	1.4
4-7 days/week	56	13.2	10	3.6

"-" not applicable to the reference workers

Glove usage, wet work, use of barrier creams and moisturisers and exposure to cleaning agents

Occupational dermatitis is most frequently attributed to the use of (latex) gloves, wet work, soaps, detergent and other cleaning agents. The use of moisturisers and barrier creams may reduce the risk of dermatitis. In this section we will briefly describe the occurrence of these exposures and the use of protective creams. In subsequent sections we will describe the analyses assessing any potential associations between these factors and skin symptoms and TEWL.

Of the cleaners 88% currently used protective gloves at work (Table 10). They also reported frequent hand washing, with 17% washing their hands more than 20 times per day. The majority of them almost always dried their hands after washing. Approximately 25% of the cleaners had their hands exposed to water and/or cleaning products for more than 30 minutes a day (Table 9). Unexpectedly, although fewer workers in the reference group were exposed to gloves and/or had frequent hand contact with water, there was still a sizable group who were exposed.

Moisturisers were commonly used by both cleaners (59.3%) and the reference workers (48%), but barrier cream was used by only 5.2% of the cleaners and 2.5% of the reference group. A relatively large proportion of the cleaners and reference workers used no skin care products (30.1% and 43.1% respectively).

Table 9. Hand contact with water, glove usage and skin care products

	Cleaners n=425		**Reference group** n=281	
	N	%	n	%
Using protective gloves at work (y/n)				
Yes, at present	375	88.2	76	27.0
Yes, but not at present	29	6.8	49	17.4
Frequency of hand washing				
0-5 times per day	122	28.7	85	30.2
6-10 times per day	137	32.2	134	47.7
11-20 times per day	92	21.6	46	16.4
More than 20 times per day	74	17.4	15	5.3
Frequency of hand drying after washing				
Almost always	381	89.6	255	90.7
Often	22	5.2	14	5.0
Sometimes	15	3.5	7	2.5
Occasionally	3	0.7	4	1.4
Almost never	3	0.7	0	0.0
Hands exposed to water without gloves				
Not at all	162	38.1	175	62.3
Less than 1/2 hour per day	149	35.1	85	30.2
1/2 hour - 2 hours per day	61	14.4	14	5.0
2-5 hours per day	35	8.2	5	1.8
More than 5 hours a day	18	4.2	1	0.4
Hands exposed to cleaning products without gloves				
Not at all	220	51.8	144	51.2
Less than 1/2 hour per day	103	24.2	113	40.2

1/2 hour - 2 hours per day	56	13.2	20	7.1
2-5 hours per day	32	7.5	3	1.1
More than 5 hours a day	14	3.3	0	0.0
Use of skin care products				
Moisturiser	252	59.3	135	48.0
Barrier cream	40	9.4	17	6.0
Other	41	9.6	25	8.9
No products	128	30.1	121	43.1

Table 10 summarises the cleaning agents that cleaners and the reference group were exposed to. Due to workers being exposed to more than one agent the percentages to not add up to 100%. The most common cleaning agents used by cleaners included detergents/washing powders, polishes/waxes, liquid multi-use cleaning products, bleach, and "other cleaning products" (cleaners were often not aware what cleaning agents they used and for that reason they often reported "other cleaning products"). The average duration for using each of these cleaning agents ranged from about 10 minutes to an hour per day (Table 10). The most commonly used cleaning products by the reference group were detergents/washing powders and liquid multi-use cleaning products. We did not assess the time spent using these cleaning products by the reference group.

Table 10. Use and duration of specific cleaning agents for cleaners and the reference group

	Cleaners n=425			**Reference group** n=281	
Cleaning agents	n	%	Duration in hrs/day mean (SD)	n	%
Detergents/washing powders (y/n)	179	42.1	1.1 (2.1)	44	15.7
Polishes, waxes (y/n)	82	19.3	0.5 (1.5)	8	2.8
Liquid multi-use cleaning products (y/n)	142	33.4	1.0 (2.03)	68	24.2
Bleach (Janola, Domestos, Cholorsan) (y/n)	163	38.4	1.0 (2.12)	27	9.6
Ammonia (Mr Muscle amoniated floor & general purpose) (y/n)	58	13.6	0.3 (1.23)	19	6.8
Decalcifiers, acids (liquid scale removers) (y/n)	26	6.1	0.3 (1.40)	4	1.4

Solvents, stain removers (y/n)	26	6.1	0.2 (1.08)	18	6.4
Other cleaning products (y/n)	366	86.1	4.4 (4.55)	25	8.9

Work-related factors and skin symptoms

For preventive measures to be developed it is important to establish which specific exposures and/or work practices contribute to the increased risk of eczema and itchy weals. We first assessed the associations between exposure and symptoms controlling for age, sex, ethnicity and smoking, but no other potential confounders (Table 11). To assess whether the effects observed for single exposures were not due to confounding we conducted the same analyses with further adjustments for other exposures (Table 12). For the analyses presented in Table 12 we selected only those exposures and/or work practices which showed borderline statistically significant ($p<0.10$) associations in the previous analyses and/or had a substantial effect even if it was not statistically significant.

The initial analyses (not controlling for other exposures) showed that risk factors were not always the same for eczema and itch weals (Table 11). For eczema the most important risk factors were industrial/aircraft cleaning, washing clothes/linen by hand (not significant), using gloves (not significant), hands exposed to water and chemicals without wearing gloves, and the use of "other cleaning products". "Other cleaning products" represented all cleaning products not specifically asked for in the questionnaire. However, it also included cleaning products where the specific composition was not known by the cleaners. As a result this category may, in addition to "other" cleaning products, also include specific cleaning agents such as bleach, multi-use cleaning products (i.e. many of the products used by the cleaners did not have specific information on the package as to what was in it). We were not able to obtain this information from the employers as this was outside the scope of the current study.

Using the average time that cleaning products were used for, rather than whether the product was used or not, did not significantly change the results (data not shown). The use of barrier cream and "other skin care products" were positively associated with eczema, but this is most likely due to reversed causation, rather than these products being a risk factor.

For itchy weals the main risk factors were the number of years worked as a cleaner with the highest risk for those who had worked as a cleaner for more than 3 years (Table 11). Cleaners involved in cleaning homes/schools/offices/shops/hotels had a significantly greater risk than those who were involved in industrial/aircraft cleaning. Other risk factors included cleaning machinery, hand exposure to water and cleaning products without wearing gloves, and exposure to “other cleaning products”. Using the average time that cleaning products were used for, rather than whether the product was used or not, did not significantly change the results (data not shown). A protective effect of frequent hand drying on itchy weals was observed, but no association was found with the use of skin care products.

Similar analyses were conducted for TEWL, but no clear associations were observed (data not shown).

Table 11. The association between exposures and skin symptoms (n=425)

Exposure	Eczema in past 3 months	Eczema >18 yrs	Itchy weals in past 3 months	Itchy weals >18 yrs
	OR (95% CI)[1]			
Years worked as a cleaner				
< 3 years (n=134)	Ref	Ref	Ref	Ref
3-10 years (n=141)	0.86 (0.41-1.78)	0.76 (0.39-1.48)	2.35 (1.03-5.34)*	1.96 (0.93-4.12)#
>10 years (n=150)	1.36 (0.62-3.00)	0.91 (0.45-1.85)	1.46 (0.55-3.90)	2.05 (0.89-4.73)
Type of cleaner				
Homes/schools/offices/shops/hotels (n=175)	Ref	Ref	Ref	Ref
Hospital (n=126)	0.75 (0.37-1.53)	0.41 (0.20-0.87)	0.77 (0.37-1.58)	0.83 (0.44-1.58)
Café/restaurant/kitchen (n=32)	1.27 (0.47-3.43)	1.61 (0.66-3.94)	0.81 (0.26-2.53)	1.09 (0.41-2.91)
Industrial/Aircraft (n=67)	0.87 (0.37-2.04)	2.03 (0.98-4.21)*	0.19 (0.04-0.85)**	0.22 (0.06-0.79)**
Outside (n=21)	1.08 (0.33-3.55)	1.88 (0.65-5.40)	0.30 (0.04-2.38)	1.08 (0.33-3.55)
Dusting, sweeping, vacuuming				
<1 day/week (n=59)	Ref	Ref	Ref	Ref
1-7 days/week (n=366)	0.95 (0.42-2.15)	1.15 (0.55-2.40)	0.29 (0.07-1.28)	1.12 (0.48-2.63)
Mopping, wet cleaning, damp wiping				
<1 day/week (n=30)	Ref	Ref	Ref	Ref
1-7 days/week (n=395)	0.61 (0.17-2.11)	1.16 (0.45-3.00)	0.64 (0.14-2.79)	2.13 (0.85-5.34)
Cleaning the toilet				
<1 day/week (n=102)	Ref	Ref	Ref	Ref
1-7 days/week (n=323)	0.71 (0.35-1.45)	1.16 (0.62-2.15)	0.62(0.25-1.51)	0.71 (0.34-1.48)
Polishing, waxing, shampooing				
<1 day/week (n=330)	Ref	Ref	Ref	Ref
1-7 days/week (n=95)	0.55 (0.29-1.02)	0.68 (0.38-1.23)	0.66 (0.33-1.34)	0.52 (0.29-0.96)*
Cleaning windows and mirrors				
<1 day/week (n=105)	Ref	Ref	Ref	Ref
1-7 days/week (n=320)	0.74 (0.37-1.46)	0.93 (0.51-1.71)	0.81 (0.37-1.79)	0.86 (0.44-1.69)

Cleaning the kitchen				
<1 day/week (n=182)	Ref	Ref	Ref	Ref
1-7 days/week (n=243)	0.75 (0.42-1.34)	0.76 (0.45-1.31)	1.30 (0.69-2.45)	1.23 (0.70-2.15)
Washing clothes/linen by hand				
<1 day/week (n=398)	Ref	Ref	Ref	Ref
1-7 days/week (n=27)	2.57 (0.58-11.31)	3.18 (0.73-13.84)	0.72 (0.23-2.22)	1.15 (0.38-3.51)
Washing clothes by machine				
<1 day/week (n=367)	Ref	Ref	Ref	Ref
1-7 days/week (n=58)	1.32 (0.55-3.19)	1.01 (0.47-2.17)	0.74 (0.32-1.70)	0.64 (0.30-1.34)
Cleaning industrial machinery				
<1 day/week (n=368)	Ref	Ref	Ref	Ref
1-7 days/week (n=57)	1.21 (0.50-2.91)	0.57 (0.27-1.18)	7.56 (0.98-58.18)#	5.22 (1.19-22.84)*
Using protective gloves at work (y/n)	3.24 (0.42-25.13)	4.39 (0.57-33.77)	0.52 (0.16-1.69)	0.65 (0.20-2.07)
Frequency of hand washing				
0-5 times per day (n=122)	Ref	Ref	Ref	Ref
6-10 times per day (n=137)	1.45 (0.72-2.93)	1.03 (0.55-1.94)	0.41 (0.18-0.95)*	0.65 (0.32-1.31)
11-20 times per day (n=92)	1.44 (0.65-3.19)	0.92 (0.45-1.92)	0.45 (0.18-1.13)	0.73 (0.34-1.57)
More than 20 times per day (n=74)	0.88 (0.35-2.25)	0.57 (0.24-1.35)	0.94 (0.40-2.21)	0.69 (0.30-1.57)
Hand drying after washing				
Sometimes/Occasionally/never (n=403)	Ref	Ref	Ref	Ref
Almost always/often (n=22)	0.88 (0.28-2.77)	1.01 (0.33-3.12)	0.29 (0.10-0.80)**	0.73 (0.23-2.28)
Hands exposed to water without gloves				
Not at all	Ref	Ref	Ref	Ref
Less than 1/2 hour per day	2.30 (1.14-4.62)*	1.93 (1.05-3.54)*	1.33 (0.64-2.74)	1.56 (0.83-2.92)
1/2 hour - 2 hours per day	2.67 (1.14-6.22)*	1.48 (0.66-3.31)	0.87 (0.30-2.52)	0.77 (0.29-2.02)
2-5 hours per day	1.85 (0.64-5.34)	1.34 (0.49-3.66)	0.83 (0.22-3.09)	0.85 (0.27-2.69)
More than 5 hours a day	2.59 (0.73-9.19)	1.81 (0.53-6.15)	3.40 (1.04-11.14)*	2.12 (0.67-6.72)
Hands exposed to cleaning products w/o gloves				
Not at all (n=162)	Ref	Ref	Ref	Ref
Less than 1/2 hour per day (n=149)	1.92 (1.02-3.61)*	1.78 (0.99-3.20)#	1.91 (0.89-4.09)	1.97 (1.02-3.78)*

1/2 hour - 2 hours per day (n=61)	1.61 (0.72-3.60)	1.05 (0.47-2.36)	1.49 (0.55-4.05)	1.03 (0.40-2.69)
2-5 hours per day (n=35)	0.46 (0.10-2.07)	0.38 (0.09-1.67)	2.66 (0.94-7.51)	2.69 (1.07-6.74)*
More than 5 hours a day (n=18)	1.08 (0.22-5.27)	3.23 (1.00-10.47)*	6.46 (1.90-22.02)**	5.51 (1.73-17.59)**
Use of skin care products				
No products (n=128)	Ref	Ref	Ref	Ref
Moisturiser (n=234)	0.85 (0.43-1.69)	0.65 (0.35-1.20)	0.79 (0.38-1.68)	0.85 (0.45-1.61)
Barrier cream (n=40)	2.73 (1.13-6.64)*	2.37 (1.07-5.26)*	1.79 (0.65-4.92)	1.22 (0.46-1.41)
Other (n=23)	3.49 (1.24-9.87)**	1.42 (0.50-4.07)	1.58 (0.45-5.50)	1.35 (0.43-4.19)
Detergents/washing powders (y/n) (n=179)	0.87 (0.49-1.53)	0.95 (0.57-1.59)	0.68 (0.36-1.30)	0.81 (0.46-1.41)
Polishes, waxes (y/n) (n=82)	1.36 (0.70-2.65)	1.31 (0.71-2.41)	0.38 (0.13-1.10)	0.89 (0.44-1.81)
Liquid multi-use products (y/n) (n=142)	1.28 (0.73-2.26)	1.55 (0.92-2.61)	0.59 (0.29-1.19)	1.44 (0.84-2.48)
Bleach (y/n) (n=163)	1.03 (0.59-1.80)	0.78 (0.46-1.32)	0.81 (0.42-1.53)	1.44 (0.84-2.48)
Ammonia (y/n) (n=58)	1.07 (0.49-2.33)	1.25 (0.62-2.52)	0.90 (0.36-2.24)	1.27 (0.60-2.68)
Decalcifiers, acids (y/n) (n=26)	0.74 (0.21-2.60)	1.12 (0.40-3.10)	0.35 (0.05-2.66)	0.22 (0.03-1.67)
Solvents, stain removers (y/n) (n=26)	1.53 (0.55-4.28)	0.58 (0.17-2.01)	1.67 (0.54-5.15)	0.50 (0.11-2.18)
Other cleaning products (y/n) (n=366)	4.26 (1.26-14.43)**	2.77 (1.05-7.29)*	7.80 (1.04-58.26)*	2.41 (0.83-6.97)

[1] Adjusted for age, sex, ethnicity, smoking

Ref = reference; #p<0.10; *p<0.05; **p<0.01

We found very similar results when we repeated the analyses for a selected number of exposures and/or cleaning activities previously identified as being significant or otherwise important and mutually controlling for all exposures/cleaning activities (Table 12). However, confidence limits generally widened due to reduced power as a consequence of controlling for multiple exposures/cleaning activities and the often small numbers for some subgroups.

For eczema the main risk factors remained hand exposure to water, hand exposure to chemicals, and exposure to "other cleaning products". Risk ratios ranged from 2 to 4 and a dose- response relationship was found for hand exposure to water and "eczema in the past three months" (Table 12). Although not statistically significant, washing clothes/linen by hand, and using protective gloves at work were also associated with hand eczema. No association was found with the number of years employed as a cleaner.

For "itchy weals" or urticaria the main risk factors remained years worked as a cleaner and hand contact with cleaning products with risk ratios ranging from 2.5 to 4.6 (Table 12). Cleaning machinery and exposure to "other cleaning products" were also associated, but these did not reach statistical significance. Hand drying after washing significantly reduced the risk of current itchy weals by almost 5-fold (Table 12), but no other factors increasing the probability of a favourable diagnosis were identified, in part due to the cross-sectional design of the study which is not ideally suited to study this (see also the Discussion section).

We also repeated the same analyses controlling for exposures to cleaning products and cleaning activities at home (data not shown). This did not alter the results indicating that these exposures are unlikely to explain the increased risks associated with work-related exposures.

Table 12. The independent association between exposures and skin symptoms (n=425)

Exposure	Eczema in past 3 months	Eczema >18 yrs	Itchy weals in past 3 months	Itchy weals >18 yrs
	OR (95% CI)[1]			
Years worked as a cleaner				
< 3 years (n=134)	Ref	Ref	Ref	Ref
3-10 years (n=141)	0.78 (0.36-1.68)	0.69 (0.34-1.37)	2.51 (1.04-6.06)*	2.00 (0.92-4.38)
>10 years (n=150)	1.14 (0.50-2.60)	0.70 (0.33-1.46)	1.42 (0.50-4.05)	1.85 (0.77-4.47)
Type of cleaner				
Homes/schools/offices/shops/hotels (n=175)	Ref	Ref	Ref	Ref
Hospital (n=126)	0.48 (0.22-1.05)	0.30(0.13-0.66)	0.95 (0.42-2.14)	0.90 (0.45-1.83)
Café/restaurant/kitchen (n=32)	1.05 (0.38-2.96)	1.49 (0.58-3.81)	0.69 (0.21-2.26)	1.01 (0.37-2.78)
Industrial/Aircraft (n=67)	1.02 (0.23-4.53)	2.51 (0.71-8.89)	0.35 (0.04-2.84)	0.35 (0.06-2.05)
Outside (n=21)	0.86 (0.24-3.16)	1.85 (0.60-5.70)	0.42 (0.05-3.44)	1.31 (0.38-4.49)
Polishing, waxing, shampooing				
<1 day/week ((n=330)	Ref	Ref	Ref	Ref
1-7 days/week (n=95)	0.56 (0.29-1.08)	0.61 (0.32-1.13)	0.71 (0.34-1.49)	0.60 (0.32-1.12)
Washing clothes/linen by hand				
<1 day/week (n=398)	Ref	Ref	Ref	Ref
1-7 days/week (n=27)	3.16 (0.67-14.96)	2.74 (0.60-12.43)	1.16 (0.32-4.17)	1.45 (0.45-4.73)
Cleaning industrial machinery				
<1 day/week(n=368)	Ref	Ref	Ref	Ref
1-7 days/week (n=57)	1.16 (0.38-3.58)	0.67 (0.26-1.70)	5.12 (0.53-49.09)	4.10 (0.82-20.58)
Using protective gloves at work (y/n) (n=404)	4.55 (0.54-38.58)	6.49 (0.79-53.36)	0.72 (0.18-2.82)	0.76 (0.21-2.76)
Hand drying after washing				
Sometimes/Occasionally/never (n=403)	Ref	Ref	Ref	Ref
Almost always/often (n=22)	0.91 (0.26-3.15)	1.31 (0.40-4.31)	0.22 (0.07-0.72)**	0.62 (0.18-2.19)
Hands exposed to water without gloves				
Not at all (n=162)	Ref	Ref	Ref	Ref

Less than 1/2 hour per day (n=149)	2.52 (1.22-5.23)**	1.93 (1.02-3.66)*	1.12 (0.51-2.45)	1.32 (0.68-2.59)
1/2 hour - 2 hours per day (n=61)	2.76 (1.10-6.93)*	1.29 (0.53-3.10)	0.51 (0.16-1.63)	0.45 (0.16-1.29)
2-5 hours per day (n=35)	3.07 (0.89-10.62)	1.68 (0.52-5.45)	0.38 (0.08-1.68)	0.41 (0.11-1.55)
More than 5 hours a day (n=18)	3.79 (0.91-15.71)	2.20 (0.56-8.66)	1.10 (0.26-4.66)	0.76 (0.20-2.94)
Hands exposed to cleaning products w/o gloves				
Not at all (n=220)	Ref	Ref	Ref	Ref
Less than 1/2 hour per day (n=103)	1.77 (0.90-3.47)	2.03 (1.07-3.82)*	1.85 (0.82-4.17)	1.93 (0.97-3.86)
1/2 hour - 2 hours per day (n=56)	1.06 (0.41-2.74)	0.92 (0.36-2.39)	1.24 (0.39-3.92)	0.91 (0.31-2.66)
2-5 hours per day (n=32)	0.25 (0.05-1.32)	0.39 (0.08-1.89)	2.01 (0.58-6.99)	2.60 (0.88-7.69)
More than 5 hours a day (n=14)	0.41 (0.07-2.46)	3.26 (0.83-12.83)	3.84 (0.91-16.25)	4.65 (1.20-18.00)**
Use of skin care products				
No products (n=128)	Ref	Ref	Ref	Ref
Moisturiser (n=234)	0.83 (0.40-1.71)	0.67 (0.35-1.27)	0.81 (0.37-1.76)	0.85 (0.44-1.66)
Barrier cream (n=40)	2.08 (0.80-5.37)	2.07 (0.88-4.84)	2.00 (0.68-5.83)	1.08 (0.39-3.00)
Other (n=23)	3.70 (1.23-11.10)**	1.49 (0.49-4.49)	1.44 (0.39-5.32)	1.12 (0.34-3.68)
Other cleaning products (y/n) (n=366)	4.02 (1.17-13.80)**	2.81 (1.05-7.50)*	6.74 (0.89-51.21)	2.26 (0.76-6.71)

[1] Adjusted for age, sex, ethnicity, smoking and all other exposure variables in the table

Ref = reference; *p<0.05; **p<0.01

5. Stakeholder engagement

As well as engaging with study participants, the research team have built good relationships with unions and employers who have been connected with the study. In particular, the Service and Food Workers Union (SFWU) Nga Ringa Tota have been extremely supportive of the study and they have invited us on several occasions to speak to their members regarding the risks of occupational dermatitis. The SFWU is a union of 24,000 members and represents cleaners in hospitals, tertiary education institutions, schools and commercial buildings. They have a long history of campaigns to improve the working conditions of cleaners and have built up strong relationships with the communities that their members come from. The SFWU provided assistance in the recruitment of cleaners for the study including use of their facilities and introduction to their network of workplace delegates.

In addition, a number of large employers showed a high level of enthusiasm and support for the study, as well as many smaller organisations that employ cleaners and retail/service workers. The research team have had ongoing communication with employers and unions, keeping them up to date with study progress, and results will be reported back through written reports and hui. Once the current report has been approved by the HRC/DoL we will send a summary of the study results to each participant.

Over the duration of the study, regular PROHM meetings (Practitioners and Researcher Occupational Health) have been held which have, among other relevant occupational health issues, focussed on both occupational dermatitis and occupational asthma (in cleaners and other relevant occupational groups). Since the start of PROHM, which is a CPHR-led platform for stakeholder engagement, a total of 5 meetings have been held (listed below).

PROHM meetings

1st PROHM meeting: 21 April 2009

2nd PROHM meeting: 20 November 2009

3rd PROHM meeting: 14 October 2010

4th PROHM meeting: 10 May 2011

5th PROHM meeting: 16 November 2011

The PROHM meetings are full-day meetings organized by CPHR and in first instance attended by CPHR and DoL staff, and are now also attended by ACC staff, employers and occupational health physicians.

Also, in November 2008 we organised a two day “Symposium on Occupational Health in New Zealand: Challenges and Opportunities”. One of the sessions was devoted to occupational dermatitis and the current study was presented as part of this session. The Symposium was attended by 150 delegated including occupational physicians and nurses, occupational hygienists, DoL staff, ACC, researchers from various universities, union representatives, private practitioners, etc. We are organising a similar symposium for 2 and 3 April this year (2012). The results of the current study will be presented and there will be an opportunity to discuss the results with the audience (we expect 150 delegates of a similar make up as the previous conference held in 2008).

6. Discussion and conclusions

Results of this study have shown a two-fold increased risk of both eczema and urticaria (itchy weals) in New Zealand cleaners. Skin barrier function of hands and forearms was also adversely affected. Half of all cleaners with current eczema developed symptoms after they started their job as a cleaner and for urticaria (itchy weals) this was the case for 75% of the cleaners. The majority of cleaners with eczema reported that their symptoms improved when away from work. Skin barrier function was adversely affected only in those areas regularly exposed to water and chemicals, but not on the upper arm which is not typically exposed to water or cleaning products. This strongly suggests that work-related factors contributed to the increased risk of skin symptoms and deteriorated skin barrier function in cleaners. Analyses within the group of cleaners comparing “high” with “low” exposed workers and activities at home further confirmed this conclusion. Controlling the analyses for exposures to cleaning products and cleaning activities at home did not alter these results.

In addition to showing an increased risk of skin symptoms this study also assessed the potential causal agents and work processes. For eczema the main risk factors were hand exposure to water, hand exposure to chemicals, and exposure to other “cleaning products” with risk ratios ranging from 2 to 4. For “itchy weals” or urticaria the main risk factors were the number of years worked as a cleaner and hand contact with cleaning products with risk ratios ranging from 2.5 to 4.6. Due to cleaners often not being aware what cleaning products they used we were not able to fully identify the risks associated with specific cleaning agents and further data collection is required to obtain this information from the employers (which is outside the scope of this study; see also below).

The prevalence of atopy did not differ between cleaners and non-cleaners and atopy was also not associated with skin symptoms suggesting that atopy-mediated allergies do not contribute to the increased risk of skin symptoms in cleaners. Occupational skin symptoms are therefore most likely of an irritant nature which is consistent with the identified risk factors.

It is difficult to assess which factors increase the probability of a favourable diagnosis in a cross-sectional study (these issues are typically studied in longitudinal studies). However, we have assessed the association between symptoms and several factors that may prevent symptoms i.e. glove use, hand drying after washing and use of skin care products. Hand drying after washing reduced the risk of current urticaria almost five-fold and is therefore one factor that increases the probability of a favourable prognosis after the diagnosis of occupational urticaria. However, our study did not show a protective effect of using "protective" gloves. In fact, using "protective gloves" was a *risk factor* for current eczema, although this was not statistically significant. Nonetheless, when used appropriately (which is currently not the case in the majority of cleaners) it may reduce the adverse skin effects of hand exposure to water and/or cleaning products. The use of barrier cream and/or moisturiser was positively associated with hand eczema, but this is likely due to reversed causation (i.e. workers with symptoms are more likely to use barrier cream and moisturisers than workers without symptoms) rather than these skin care products causing skin symptoms. Also, barrier cream may not be used appropriately increasing rather than decreasing the risk of symptoms. Thus, although appropriate use of gloves and skin care products are likely to favour a better outcome, we were not able to demonstrate this in this cross sectional study. Prospective studies allowing separating the potentially protective effects of appropriate use from the adverse effects associated with inappropriate use are required to address this issue in more detail.

The low response rate in the reference workers may have led to non-response bias. However, generally responders have a higher prevalence of the disease under study than non-responders. Therefore non-response bias is unlikely to explain the *increased* risk of the skin symptoms as non-response in the reference group would have led to an overestimation of the symptom prevalence in that population and consequently in a reduction of the observed effect. Therefore, the comparisons with the external reference group may have underestimated the true effect. Also, the reference workers still had some exposure to wet work and cleaning and this may have led to a further underestimation of the true effect. There were also significant differences in sex, age, ethnicity and smoking habits between cleaners and the reference workers, but these were appropriately controlled for in the analyses.

The potential issues with the reference group may have affected the risk estimates to some degree (most likely resulting in an underestimation of the effect). However, the results were highly consistent with previous international studies of occupational dermatitis in cleaners (see literature review) suggesting that our results are robust and valid. Also, our results on risk factors are based on "internal analyses" involving comparisons *within* the group of cleaners (not including the external reference group) and this significantly reduces the risk of major biases. In particular, internal comparisons limit the potential for bias due to differences in sex, ethnicity, age, social economic position, lifestyle factors etc. Also, the response rate for cleaners was reasonable (74%) limiting the potential for significant bias due to non-response.

Although we found a consistent difference in skin barrier function between the cleaners and the reference category we did not find clear associations between risk factors and skin barrier function within the group of cleaners. It is not clear why this is the case, and more detailed analyses are required (which are outside the scope of this contract) to determine the specific relationship between skin barrier function, symptoms and risk factors.

This study has provided consistent and robust findings for modifiable risk factors of dermatitis in New Zealand cleaners, several of which constitute ideal targets for intervention. A reduction of hand contact with water, appropriate use of barrier creams and gloves combined with adequate skin care are generally regarded as the most important means of prevention for occupational hand dermatitis and the results of the current study confirm this.

However, apart from observational studies such as the current study, few clinical trials have been conducted and direct evidence of the effectiveness of any of these measures is therefore limited. A 2010 Cochrane review assessed the effectiveness of interventions on the primary prevention of occupational irritant dermatitis.[38] They identified four clinical trials which were eligible for review, one of which[39] involved a study in 111 cleaners and kitchen workers. The interventions tested were the use of barrier creams or moisturisers. The findings of the overall review showed that the use of barrier creams and moisturisers were generally associated with fewer cases of incident dermatitis, but no statistical significance was reached. This was likely attributable to small study size and poor quality of

the studies.[38] The study in cleaners and kitchen workers showed that while using a moisturiser none of the participants developed dermatitis whereas during the control period (a cross-over design was used) 20.4% developed dermatitis.[39] There is also some experimental evidence suggesting that barrier creams and moisturisers may prevent or significantly reduce detergent and solvent-induced dermatitis.[38] These results therefore suggest that the use of barrier creams and moisturisers may be effective in preventing/reducing the development of dermatitis . However, as noted in the Cochrane report the evidence is weak (due to the lack of good quality clinical trials). Also, no clinical trials have been conducted testing multiple preventive options. Our study also suggests that specific cleaning agents may be an additional risk factor. However, further data collection and analyses are required (this is outside the scope of the current study) to assess the specific cleaning agents contributing to the elevated risk associated with "other cleaning products", so that high risk cleaning agents can be identified and either be replaced by lower risk products or be handled with (more) appropriate protection.

In addition to clinical trials and experimental evidence there is are also observational studies showing that intervention programmes may be effective in reducing and preventing occupational dermatitis, but these studies have been conducted in other occupational groups (see literature review), and similar types of programmes are now required to be developed for the cleaning industry.

It is difficult to predict the efficacy of such an intervention programme, but the limited current evidence is positive. The results of our study strengthen this conclusion and, as noted above, these provide a solid basis to guide the development of an evidence-based cleaners-specific intervention programme. However, further studies are required to establish the efficacy of such an intervention.

In conclusion, this study has shown that cleaners have an increased risk of work-related hand eczema and urticaria. Although prospective studies are better suited to establish the relative contribution of new-onset work-related skin symptoms, we estimate that 50% of current eczema and 75% of current urticaria may be caused by occupational exposures with the remainder caused by other (non-occupational) factors. These percentages represent upper limits as some new-onset symptoms may not be associated with work-related

exposures; nonetheless, we expect this proportion to be small and therefore consider the 50% and 75% to be realistic estimates. The study has also identified several modifiable risk factors which are consistent with previous international studies (see above) and these represent feasible targets for prevention even if the precise efficacy is not currently known.

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Appendix 1: Questionnaire

Respiratory and skin health in New Zealand cleaners and retail workers

Questionnaire for **Cleaners**

Employer:

Workplace:

Department:

First I am going to ask some questions about your demographic details and your health.

Name:

Today's date: Day Month Year

Date of Birth: Day Month Year

Sex: Male Female

To which ethnic group(s) do you belong? European/ Pakeha Maori Pacific Island Other

Specify

Questions about respiratory health and allergies

1. Have you had wheezing or whistling in your chest at any time in the past 12 months?

- ☐ Yes
- ☐ No **IF YOU HAVE ANSWERED '*NO*' PLEASE GO TO QUESTION 5**

2. Have you been at all breathless when the wheezing noise was present?

- ☐ Yes
- ☐ No

3. Have you had this wheezing or whistling in the chest when you did not have a cold?

- ☐ Yes
- ☐ No

4. How many attacks of wheezing or whistling have you had in the past 12 months?

- ☐ None
- ☐ 1-3 times
- ☐ 4-12 times
- ☐ More than 12 times

5. Have you woken up with a feeling of tightness in your chest at any time in the past 12 months?

☐ Yes

☐ No

6. Have you been woken by an attack of shortness of breath at any time in the past 12 months?

☐ Yes

☐ No

7. Have you been woken by an attack of coughing at any time in the past 12 months?

☐ Yes

☐ No

8. Have you ever had asthma?

☐ Yes

☐ No **IF YOU HAVE ANSWERED '*NO*' PLEASE GO TO QUESTION 14**

9. Was the diagnosis confirmed by a doctor?

☐ Yes

☐ No

10. How old were you when you had your first attack of asthma?

☐ Years

11. How old were you when you had your last attack of asthma?

☐ Years

12. Have you had an attack of asthma in the past 12 months?

☐ Yes

☐ No

13. Are you currently taking any medicine (including inhalers, aerosols or tablets) for asthma?

☐ Yes

☐ No

14. Do you have any nasal allergies including hay fever?

☐ Yes

☐ No **IF YOU HAVE ANSWERED '*NO*' PLEASE GO TO QUESTION 17**

15. How old were you when you first had hay fever or nasal allergy?

☐ Years

16. How old were you when you had hay fever or nasal allergy for the last time?

☐ Years

17. Do you cough almost daily for at least part of the year?

☐ Yes

☐ No **IF YOU HAVE ANSWERED '*NO*' PLEASE GO TO QUESTION 25**

18. How many month(s) a year do you have this cough?

☐ Month(s) a year

19. How many consecutive years have you had this cough?

☐ Years

20. Do you usually have this cough in winter?

☐ Yes

☐ No

21. Do you cough up phlegm almost daily for at least part of the year?

☐ Yes

☐ No **IF YOU HAVE ANSWERED '*NO*' PLEASE GO TO QUESTION 25**

22. How many months a year do you have this cough (with phlegm)?

☐ Month(s) a year

23. How many consecutive years have you had this cough (with phlegm)?

☐ Years

24. Do you usually have this cough (with phlegm) in winter?

☐ Yes

☐ No

25. In the past 12 months, how often have you been unable to work because of respiratory symptoms ie cough, phlegm, wheezing/whistling or shortness of breath?

☐ Never

☐ 1-7 days

☐ 8-30 days

☐ At least 31 days

☐ Don’t know

26. How often, during the past 12 months (or if you had this job for less than a year, how often since you started), have you had one or more of the following symptoms?

☞ *(Please indicate whether symptoms lessen or disappear during weekends and holidays)*

Symptoms	How often?				Lessen or disappear during weekends and holidays?	
	Daily/ almost daily	1-2 times per week	1-2 times per month	Never/ Seldom	No	Yes
Dry cough	☐	☐	☐	☐	☐	☐
Cough with phlegm	☐	☐	☐	☐	☐	☐
Wheezing in the chest	☐	☐	☐	☐	☐	☐
Breathlessness with wheezing	☐	☐	☐	☐	☐	☐
Shortness of breath	☐	☐	☐	☐	☐	☐
Chest tightness	☐	☐	☐	☐	☐	☐

Questions about your skin

27. Have you ever had an itchy rash that has been coming and going for at least 6 months and at some time has affected skin creases?

☞ *(By <u>skin creases we mean</u> folds of elbows, behind the knees, fronts of ankles, under buttocks, around the neck, ears or eyes)*

☐ Yes

☐ No

☐ Don't know

28. Have you ever had hand eczema?

☐ Yes

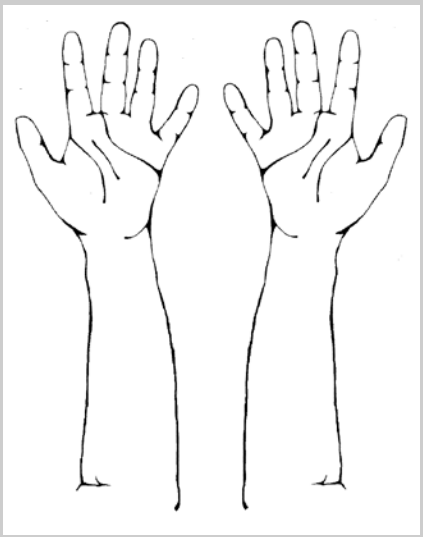
☐ No

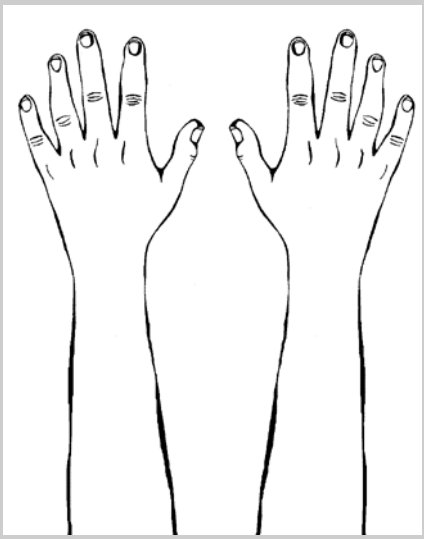
29. Have you ever had eczema on your wrists or forearms (excluding fronts of elbows)?

☐ Yes

☐ No **IF YOU HAVE ALSO ANSWERED '*NO*' TO QUESTION 28, PLEASE GO TO QUESTION 46**

30. Shade areas on the hands or forearms where you commonly have eczema
☞ *(One or more areas)*





31. How often have you had eczema on your hands, wrists or forearms?

☞ *(One answer in each column if applicable)*

	Hand eczema	Wrist/ Forearm eczema
Only once and for less than two weeks	☐	☐
Only once but for two weeks or more	☐	☐
More than once	☐	☐
(Nearly) all the time	☐	☐

32. When did you last have eczema on your hands, wrists or forearms?

☞ *(One answer in each column if applicable)*

	Hand eczema	Wrist/ Forearm eczema
I have it now	☐	☐
Not now but within the past 3 months	☐	☐
Between 3-12 months ago	☐	☐
More than 12 months ago	☐	☐
When was the last time? *(Make your best estimate)*	_____ (Year)	_____ (Year)

33. When did you first get eczema on your hands, wrists or forearms?

☞ *(One answer in each column if applicable, make your best estimate)*

	Hand eczema	Wrist/ Forearm eczema
Below 6 years of age	☐	☐
Between 6 and 14 years of age	☐	☐
Between 15 and 18 years of age	☐	☐
Above 18 years of age	☐	☐
In which year did it start? *(Make your best estimate)*	_____ (Year)	_____ (Year)

IF THE HAND/FOREARM ECZEMA STARTED <u>BEFORE 18 YEARS OF AGE</u> GO TO QUESTION 37

34. What do you think was the <u>cause</u> of the eczema on your hands, wrists or forearms when it started?

	Hand eczema	Wrist/Forearm eczema
Cause	_____	_____
	_____	_____
	_____	_____
	_____	_____
Don't know the cause	☐	☐

35. What was your occupation when the eczema started?

	Hand eczema	Wrist/Forearm eczema
Occupation	_____	_____

36. What were your major activites at work when the eczema started?

	Hand eczema	Wrist/Forearm eczema
Activity	_____	_____
	_____	_____

37. Have you visited a doctor as an adult for your hand or wrist/forearm eczema?

	Hand eczema	Wrist/ Forearm eczema
Yes	☐	☐
No	☐	☐
When was the last time? *(Make your best estimate)*	_____ (Year)	_____ (Year)

38. During which season do you have most problems with hand or wrist/forearm eczema?

☞ *(One answer in each column if applicable)*

	Hand eczema	Wrist/ Forearm eczema
No seasonal differences	☐	☐
Winter	☐	☐
Spring	☐	☐
Summer	☐	☐
Autumn	☐	☐

39. How would you grade your eczema on a scale of 0-10?

☞ *(Put a mark on the line corresponding to the severity of the eczema)*

Today

0 ——— 10

No eczema — Extremely bad eczema

At worst

0 ——— 10

No eczema — Extremely bad eczema

40. Have you noticed that contact with certain materials, chemicals or anything else <u>in your work</u> makes your eczema worse?

☞ *(One answer in each column if applicable)*

	Hand eczema	Wrist/ Forearm eczema
Yes	☐	☐
No	☐	☐
Don't know	☐	☐

	Hand eczema	Wrist/Forearm eczema
Please specify what you think makes your eczema worse:	_____	_____
	_____	_____
	_____	_____
	_____	_____

41. Have you noticed that contact with certain materials, chemicals or anything else <u>outside your work</u> makes your eczema worse?

☞ *(One answer in each column if applicable)*

	Hand eczema	Wrist/ Forearm eczema
Yes	☐	☐
No	☐	☐
Don't know	☐	☐

IF YOU ANSWERED "NO" OR "DON'T KNOW" IN <u>BOTH</u> COLUMNS GO TO QUESTION 43

42. What do you consider as the most important things outside the workplace that worsen your eczema?

☞ *(Mark **no more than 5** things in each column)*

	Hand eczema	Wrist/ Forearm eczema
Soap, liquid soap, shampoo and other personal hygiene products	☐	☐
Detergents and other household cleaning and laundry products	☐	☐
Handling of food	☐	☐
Work with wet hands	☐	☐
Frequent hand washing	☐	☐
Protective gloves	☐	☐
Machine maintenance (eg cars), handling oils	☐	☐
Construction work, painting, wall-papering, renovation and decoration	☐	☐
Gardening, handling plants, soil, vegetables, berries, fruits etc	☐	☐
Infections (colds, flu or fever)	☐	☐
Mood, stress	☐	☐
Menstrual periods or other hormonal factors	☐	☐
Other *(Please specify)* _____	☐	☐
_____	☐	☐
_____	☐	☐

43. Does your eczema improve when you are away from your normal work (eg weekends or holidays)?

☞ *(One answer in each column if applicable)*

	Hand eczema	Wrist/ Forearm eczema
Yes, usually	☐	☐
Yes, sometimes	☐	☐
No	☐	☐
Don't know	☐	☐

44. Has eczema on your hands, wrists or forearms affected your daily activites in your occupation in any way?

☞ *(Mark any that are applicable)*

Yes ☐

Not at all ☐

IF YOU HAVE ANSWERED '*NOT AT ALL*'' PLEASE GO TO QUESTION 45

Which of the following statements are true?

☞ *(Mark any that are applicable)*

Because of my eczema ...

... I have to use protective gloves ☐

... My work tasks have been changed ☐

... I have changed jobs ☐

... I have had difficulties in getting a job ☐

... My work mates or employer(s) have a negative attitude towards me ☐

... My choice of job or occupation has been affected ☐

... My income has decreased ☐

... I have been on sick leave or otherwise off work ☐

For how long during the past 12 months have you been on sick leave or otherwise off work due to eczema?

_____
(Weeks)

... I have lost a job ☐

Other consequences *(please specify)* _____

_____

45. How has your eczema affected your life during the past 12 months?

☞ *(One answer in each line)*

	No effect	Slight effect	Moderate effect	Large effect	Not relevant
Occupational work	☐	☐	☐	☐	☐
Housework, daily activities	☐	☐	☐	☐	☐
Sport and similar activities	☐	☐	☐	☐	☐
Other hobbies or activities	☐	☐	☐	☐	☐
Sleep	☐	☐	☐	☐	☐
Getting about, travel	☐	☐	☐	☐	☐
Social activities	☐	☐	☐	☐	☐
Close personal relations	☐	☐	☐	☐	☐
Mood	☐	☐	☐	☐	☐

46. Have you ever had itchy wheals (round, itchy spots) appearing and disappearing rapidly (within hours) on your hands, wrists or forearms (urticaria or nettle rash)?

☐ Yes

☐ No **IF YOU HAVE ANSWERED '*NO*' PLEASE GO TO QUESTION 55**

47. Have these itchy wheals (urticaria) on your hands, wrists or forearms been caused by skin contact with fruits, vegetables, rubber gloves, animals, cleaning products etc?

☞ *(Wheals appearing in minutes after contact)*

☐ Yes — After skin contact with what?

_____

_____

_____

☐ No

☐ Don't Know

48. How often have you had these itchy wheals (urticaria) on your hands, wrists or forearms?

☞ *(Only one answer)*

☐ Once

☐ 2-5 times

☐ More than 5 times

49. When did you last have these itchy wheals (urticaria) on your hands, wrists or forearms?
☞ *(Only one answer)*

- ☐ During the past 7 days
- ☐ 7 days to 3 months ago
- ☐ 3-12 months ago
- ☐ Over a year ago

In which year? *(Make your best estimate)* _____ (Year)

50. When did you first get these itchy wheals (urticaria) on your hands, wrists or forearms?
☞ *(Only one answer)*

- ☐ Below 6 years of age
- ☐ Between 6 and 14 years of age
- ☐ Between 15 and 18 years of age
- ☐ Above 18 years of age

In which year did it start? *(Make your best estimate)* _____ (Year)

IF YOU STARTED HAVING THESE ITCHY WHEALS (URTICARIA) BEFORE 18 YEARS OF AGE GO TO QUESTION 53

51. What was your occupation when you started having the itchy wheals (urticaria)?

_____

52. What was your major activity at work when you started having the itchy wheals (urticaria)?

_____

_____

53. Have you visited a doctor as an adult because of the itchy wheals (urticaria)?

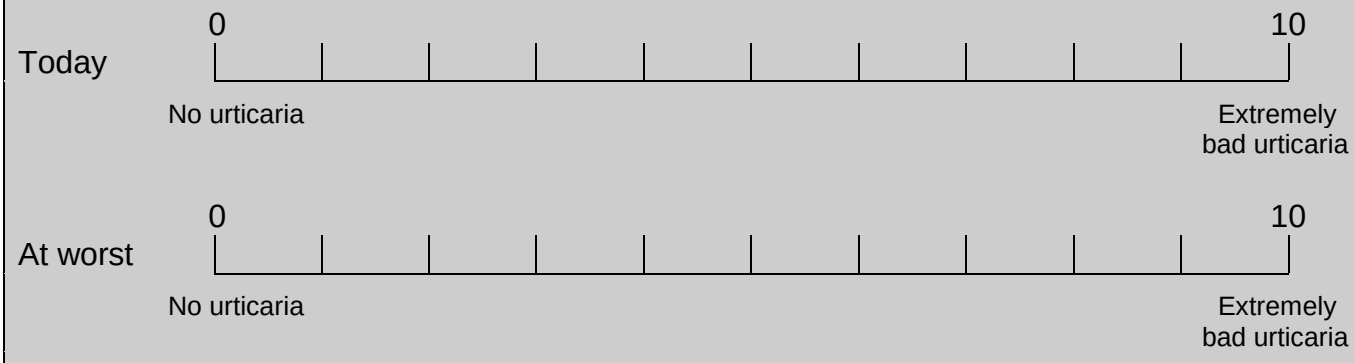
☐ Yes

When was the last time? *(Make your best estimate)* _____ (Year)

☐ No

54. How do you grade the itchy wheals (urticaria) on a scale from 0-10??

☞ *(Put a mark on the line corresponding to the severity of the urticaria)*



55. Have you had any of the following symptoms on your hands or wrist/forearms during the past 12 months?

☞ *(Mark in each column any that are applicable)*

	Hands	Wrists/ Forearms
Redness	☐	☐
Dry skin with scaling/flaking	☐	☐
Fissures or cracks	☐	☐
Weeping or crusts	☐	☐
Tiny water blisters (vesicles)	☐	☐
Papules (small, solid, rounded bumps on the skin)	☐	☐
Rapidly appearing itchy wheals/welts (urticaria)	☐	☐
Itching	☐	☐
Burning, prickling or stinging	☐	☐
Tenderness	☐	☐
Aching or pain	☐	☐
Something else *(Please specify)* _____	☐	☐
No symptoms during the past 12 months	☐	☐

56. Do you get a rash from metal buttons, metal fasteners, metal costume jewelery (eg earrings) or other metal object next to your skin?

☞ *(Apart from under rings)*

☐ Yes

☐ No

57. Do you have dry skin?

☐ Yes

☐ No

58. Does your skin itch when you sweat?

☐ Yes

☐ No

59. Has a doctor ever diagnosed you with a skin allergy?

☐ Yes

☐ No

☐ Don't Know

IF YOU HAVE ANSWERED '*NO*' OR '*DON'T KNOW*' PLEASE GO TO QUESTION 61

60. Was the allergy/were the allergies diagnosed with…

☞ *(Mark any that are applicable)*

Patch–tests *(test are normally taped onto the upper back and removed after 1-2 days)* ☐

Skin-prick-tests *(test drops are normally placed on the forearm and pricked through with lancets or needles. The results are read after 15-30 minutes)* ☐

Blood test *(eg RAST test)* ☐

Other *(please specify)* _____ ☐

_____

Don't know ☐

61. Have you ever used protective gloves in your work?

☐ Yes, at present

How many hours per day on average? _____ (Hours)

☐ Yes, but not at present

☐ No

IF YOU HAVE ANSWERED '*NO*' PLEASE GO TO QUESTION 68

62. What type of gloves do you (or did you) use in your work?

☞ *(Mark any that are applicable in each column)*

	At present	Only previously
Natural rubber/latex **(POWDERED)**	☐	☐
Natural rubber/latex **(NOT POWDERED)**	☐	☐
Synthetic rubber (eg nitrile, neoprene etc)	☐	☐
Plastic (eg vinyl, PVC, polyethene)	☐	☐
Cotton gloves underneath rubber or plastic gloves	☐	☐
Leather	☐	☐
Cloth	☐	☐
Other *(Please specify)* _____	☐	☐
Don't know	☐	☐

63. On an average day how many times do you (or did you) change gloves in your work?

☐ Times/day

64. How long do you (or did you) usually wear your gloves before changing them?

☐ Hours ☐ Minutes

65. During which of the following activities do you (or did you) wear gloves?
☞ *(Mark any that are applicable)*

Wet work ☐

Dry work ☐

Cleaning of toilets ☐

When using cleaning products ☐

Other *(please specify)* _____ ☐

_____

66. Have you had skin symptoms as a result of wearing protective gloves?

☐ Yes — From what type of gloves? *(Mark any that are applicable)*

- Natural rubber/latex **(POWDERED)** ☐
- Natural rubber/latex **(NOT POWDERED)** ☐
- Synthetic rubber ☐
- Plastic ☐
- Leather ☐
- Other *(please specify)* ☐

_____

- Any gloves ☐
- Don't know ☐

☐ No — **IF YOU HAVE ANSWERED '*NO*' PLEASE GO TO QUESTION 68**

67. Have you changed glove type or stopped using gloves because of skin symptoms?

☐ Yes

When? _____ (Year)

☐ No

68. How many times do you wash your hands during a usual working day?

- ☐ 0-5 times per day
- ☐ 6-10 times per day
- ☐ 11-20 times per day
- ☐ More than 20 times per day

69. How often do you usually dry your hands after you have washed them?

- ☐ Almost always
- ☐ Often
- ☐ Sometimes
- ☐ Occasionally
- ☐ Almost never

70. At work are your hands exposed to water without protective gloves?

- ☐ Not at all
- ☐ Less than ½ hour per day
- ☐ ½ hour – 2 hours per day
- ☐ 2-5 hours per day
- ☐ More than 5 hours a day

71. At work are your hands exposed to cleaning products without protective gloves?

- ☐ Not at all
- ☐ Less than ½ hour per day
- ☐ ½ hour – 2 hours per day
- ☐ 2-5 hours per day
- ☐ More than 5 hours a day

72. Do you use any skin care products for your hands, wrists or forearms?
☞ *(Mark any that are applicable)*

- ☐ Yes, I use a moisturiser
- ☐ Yes, I use a barrier cream
- ☐ Yes, I use *(Please specify)*

_____

- ☐ No

IF YOU HAVE ANSWERED '*NO*'
PLEASE GO TO QUESTION 75

73. How often do you use these skin care products on a usual work day?

- ☐ Times

74. When do you apply these skin care products?
☞ *(Mark any that are applicable)*

☐ Before work

☐ During work

☐ After work

YOUR WORK AS A CLEANER

75. How many years have you worked as a cleaner?

☐ Years

76. How many hours per week do you work as a cleaner?
☞ *(On average)*

☐ Hours/week

77. What are your regular work hours (ie 9 - 5)?

_____

78. In addition to your work as a cleaner, do you have another job at present?

☐ Yes *(Please specify)*

_____

☐ No

79. During the past 5 years what was your main job or what has been your main job activity?

Cleaner ☐

Office work/health professional ☐

Labor/factory work/mining/building ☐

Farming ☐

Forestry ☐

House keeping ☐

At home looking after children ☐

Unemployed ☐

Pensioner ☐

Other ☐

(Please specify)

In the last 12 months:

80. What/where did you clean?

	No	Yes	On average, how many hours per week?
Private homes	☐	☐	☐
Schools	☐	☐	☐
Offices	☐	☐	☐
Hospitals, pharmacies	☐	☐	☐
Shops	☐	☐	☐
Cafés, restaurants	☐	☐	☐
Kitchens	☐	☐	☐
Factories (production sites)	☐	☐	☐
Outside	☐	☐	☐
Bedrooms/accommodation	☐	☐	☐

In the last 12 months:

81. How many days a week did you perform the following cleaning tasks?

	Never	<1 day/wk	1-3 days/wk	4-7 days/wk	On average how many hours per day?
Dusting, sweeping, vacuuming	☐	☐	☐	☐	☐

What do you use for this task?

☞ *(Mark any that are applicable)*

Polishes, waxes	Other cleaning products	
☐	☐	_____
		_____

81. (a) How many days a week did you perform the following cleaning tasks?

	Never	<1 day/wk	1-3 days/wk	4-7 days/wk	On average how many hours per day?
Mopping, wet cleaning, damp wiping	☐	☐	☐	☐	☐

What do you use for this task?

☞ *(Mark any that are applicable)*

Detergents/ washing powders	Polishes, waxes	Liquid multi-use cleaning products	Bleach (Janola, Domestos, Cholorsan)	Ammonia (Mr Muscle amoniated floor & general purpose)	Decalcifiers, acids (liquid scale removers)	Solvents, stain removers	Other cleaning products
☐	☐	☐	☐	☐	☐	☐	☐

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81. (b) How many days a week did you perform the following cleaning tasks?

	Never	<1 day/wk	1-3 days/wk	4-7 days/wk	On average how many hours per day?
Cleaning the toilet bowl	☐	☐	☐	☐	☐

What do you use for this task?

☞ *(Mark any that are applicable)*

Detergents/ washing powders	Liquid multi-use cleaning products	Bleach (Janola, Domestos, Cholorsan)	Ammonia (Mr Muscle amoniated floor & general purpose)	Decalcifiers, acids (liquid scale removers)	Solvents, stain removers	Other cleaning products
☐	☐	☐	☐	☐	☐	☐

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81. (c) How many days a week did you perform the following cleaning tasks?

	Never	<1 day/wk	1-3 days/wk	4-7 days/wk	On average how many hours per day?
Polishing, waxing, shampooing	☐	☐	☐	☐	☐

What do you use for this task?

☞ *(Mark any that are applicable)*

Polishes, waxes	Other cleaning products	
☐	☐	_____
		_____

81. (d) How many days a week did you perform the following cleaning tasks?

	Never	<1 day/wk	1-3 days/wk	4-7 days/wk	On average how many hours per day?
Cleaning windows or mirrors	☐	☐	☐	☐	☐

What do you use for this task?

☞ *(Mark any that are applicable)*

Detergents/ washing powders	Liquid multi-use cleaning products	Bleach (Janola, Domestos, Cholorsan)	Ammonia (Mr Muscle amoniated floor & general purpose)	Decalcifiers, acids (liquid scale removers)	Solvents, stain removers	Other cleaning products
☐	☐	☐	☐	☐	☐	☐

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81. (e) How many days a week did you perform the following cleaning tasks?

	Never	<1 day/wk	1-3 days/wk	4-7 days/wk	On average how many hours per day?
Cleaning the kitchen	☐	☐	☐	☐	☐

What do you use for this task?

☞ *(Mark any that are applicable)*

Detergents/ washing powders	Polishes, waxes	Liquid multi-use cleaning products	Bleach (Janola, Domestos, Cholorsan)	Ammonia (Mr Muscle amoniated floor & general purpose)	Decalcifiers, acids (liquid scale removers)	Solvents, stain removers	Other cleaning products
☐	☐	☐	☐	☐	☐	☐	☐

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81. (f) How many days a week did you perform the following cleaning tasks?

	Never	<1 day/wk	1-3 days/wk	4-7 days/wk	On average how many hours per day?
Washing or soaking clothes/linen by hand	☐	☐	☐	☐	☐

What do you use for this task?

☞ *(Mark any that are applicable)*

Detergents/ washing powders	Bleach (Janola, Domestos, Cholorsan)	Ammonia (Mr Muscle amoniated floor & general purpose)	Solvents, stain removers	Other cleaning products
☐	☐	☐	☐	☐

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81. (g) How many days a week did you perform the following cleaning tasks?

	Never	<1 day/wk	1-3 days/wk	4-7 days/wk	On average how many hours per day?
Washing clothes by machine	☐	☐	☐	☐	☐

What do you use for this task?

☞ *(Mark any that are applicable)*

Detergents/ washing powders	Bleach (Janola, Domestos, Cholorsan)	Ammonia (Mr Muscle amoniated floor & general purpose)	Solvents, stain removers	Other cleaning products
☐	☐	☐	☐	☐

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81. (h) How many days a week did you perform the following cleaning tasks?

	Never	<1 day/wk	1-3 days/wk	4-7 days/wk	On average how many hours per day?
Cleaning machinery in an industrial setting	☐	☐	☐	☐	☐

What do you use for this task?

☞ *(Mark any that are applicable)*

Detergents/ washing powders	Polishes, waxes	Liquid multi-use cleaning products	Bleach (Janola, Domestos, Cholorsan)	Ammonia (Mr Muscle amoniated floor & general purpose)	Decalcifiers, acids (liquid scale removers)	Solvents, stain removers	Other cleaning products
☐	☐	☐	☐	☐	☐	☐	☐

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In the last 12 months:

82. How many days a week did you use the following sprays?

	Never	<1 day/wk	1-3 days/wk	4-7 days/wk	On average how many hours per day?
Furniture sprays					
Glass cleaning sprays (windows, mirrors)					
Sprays for carpets, rugs or curtains					
Sprays for mopping the floor					
Oven sprays					
Ironing sprays					
Air refreshing sprays					
Multi-purpose antibacterial cleaning sprays					
Other sprays -					

(Please specify)

In the last 12 months:

83. How many days a week did you wear a mask or other respiratory protection during cleaning work?

- ☐ Never
- ☐ <1 day/week
- ☐ 1-3 days/week
- ☐ 4-7 days/week

Now I am going to ask some questions about your exposure to cleaning products – at home

CLEANING/WASHING IN THE HOME

In the last 12 months:

84. How often did you perform the following tasks at home?

	Never/ Occasionally	Monthly	Weekly	Daily
Cleaning the house	☐	☐	☐	☐
Washing clothes by hand	☐	☐	☐	☐
Washing clothes by machine	☐	☐	☐	☐
Cooking	☐	☐	☐	☐
Caring for children under 4 years	☐	☐	☐	☐

In the last 12 months:

85. How often did you perform the following cleaning tasks at home?

	Never/ Occasionally	Monthly	Weekly	Daily
Dusting, sweeping, vacuuming	☐	☐	☐	☐
Mopping, wet cleaning, damp wiping	☐	☐	☐	☐
Cleaning the toilet bowl	☐	☐	☐	☐
Polishing, waxing, shampooing	☐	☐	☐	☐
Cleaning windows or mirrors	☐	☐	☐	☐
Cleaning the kitchen *(Not including dish-washing)*	☐	☐	☐	☐

In the last 12 months:

86. How often did you use the following cleaning products at home?

	Never/ Occasionally	Monthly	Weekly	Daily
Washing powders (detergents)	☐	☐	☐	☐
Liquid multi-use cleaning products	☐	☐	☐	☐
Polishes, waxes (floor, furniture)	☐	☐	☐	☐
Bleach (Janola, Domestos, Chlorasan)	☐	☐	☐	☐
Ammonia (Mr Muscle, ammoniated floor and general purpose, Handy Andy)	☐	☐	☐	☐
Decalcifiers, acids (liquid scale removers)	☐	☐	☐	☐
Solvents, stain removers	☐	☐	☐	☐
Other cleaning products -	☐	☐	☐	☐

(Please specify) →

In the last 12 months:

87. How often did you use the following sprays at home?

	Never/ Occasionally	Monthly	Weekly	Daily
Furniture sprays	☐	☐	☐	☐
Glass cleaning sprays (windows, mirrors)	☐	☐	☐	☐
Sprays for carpets, rugs or curtains	☐	☐	☐	☐
Sprays for mopping the floor	☐	☐	☐	☐
Oven sprays	☐	☐	☐	☐
Ironing sprays	☐	☐	☐	☐
Air refreshing sprays	☐	☐	☐	☐
Multi-purpose antibacterial cleaning sprays	☐	☐	☐	☐
Other sprays -	☐	☐	☐	☐

(Please specify) →

SMOKING

88. Have you smoked more than 5 packs of cigarettes in total in your whole life?

☐ Yes

☐ No **IF YOU HAVE ANSWERED '*NO*' PLEASE GO TO THE END OF THE QUESTIONNAIRE**

89. Do you still smoke?

☐ Yes

☐ No → At what age did you quit smoking? ☐ Years

90. How many cigarettes per day do you or did you smoke?

☐ Cigarettes per day

91. At what age did you start smoking?

☐ Years

Thank you for your time answering this questionnaire. Do you have anything you would like to add or any comments?

Appendix 2: Skin trans-epidermal water loss measurements

Protocol for skin trans-epidermal water loss measurements

In all subjects measurements will be taken of:

- the back of the hand
- the volar surface of the forearm (the under part of the forearm)
- the top of the forearm
- the upper arm which is not exposed and has no visible signs of dermatitis

Measurements will be taken at approximately the midpoint of these sites.

1. Setup

The dermal measurement system EDS12 is **turned on by depressing the end of the probe**. The machine has a small LCD display and switches off by itself after a short time.

2. Measurements

The individual we wish to make measurements on **needs to become acclimatised** to the ambient conditions where the measurement is being made. The skin on which we will take measurements from will be **cleaned** with plain wipes with water. All measurements will be conducted on the hands/arm that will not be used for skin prick tests.

The skin will be allowed to dry and acclimatise for at least 15 minutes. During this time, we will conduct the questionnaire.

TEWL measurements are taken at least once.



TEWL measurement

3. Recording results

All skin measurement values will be recorded on the field forms. The values produced by the machine are whole numbers i.e. 1, 2, 3, 4, 5, 6, etc.

TWEL interpretation table

TEWL value	**Interpretation**
0-4	Indicates very healthy skin barrier function; no action required
5-9	Indicates healthy skin barrier function; no action required
10-12	Indicates normal skin barrier function; no action required
13-16	Indicates strained skin barrier function; requires investigation into possible causes of damage to skin barrier
17-20	Indicates critical skin barrier function; requires urgent investigation into causes of damage to skin barrier