

Self-reported hand eczema among dental workers in Japan – a cross-sectional study

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Summary

Background. Dental workers are considered to have a high risk of developing occupational hand eczema.

Objectives. To estimate the prevalence of work-related hand eczema and associated risk factors in dental workers in Japan.

Methods. A self-administered questionnaire was sent by mail to all dental clinics of Kumamoto City, Japan. In addition, patch testing with 24 dentistry-related allergens was offered.

Results. In total, 46.4% of dental workers (n = 528; response 31.4%, based on 97 clinics) reported a lifetime history of chronic hand eczema. The 1-year prevalence was 36.2%. According to logistic regression analysis, the most important risk factors for the 1-year prevalence were a personal history of atopic dermatitis [odds ratio (OR) 4.7, 95% confidence interval (CI): 2.2–8.8], asthma and/or allergic rhinitis (OR 2.0, 95%CI: 1.3–3.0), dry skin (OR 1.7, 95%CI: 1.1–2.7), shorter duration of work (OR 2.0, 95%CI: 1.2–3.5 for up to 10 years versus >20 years), and washing hands >10 times per day (OR 1.6, 95%CI: 1.0–2.5). Fifty-four workers were patch tested. Rubber chemicals and acrylates were the most frequent occupationally relevant contact allergens.

Conclusions. Dental workers in Japan have a high prevalence of hand eczema. Health education to prevent hand eczema and more frequent patch testing are needed.

Key words: alcohol-based hand rub disinfectant; atopic dermatitis; dental workers; epidemiology; hand eczema; hand washing; occupational contact dermatitis; wet work.

Occupational contact dermatitis, often affecting the hands (occupational hand eczema), is one of the most frequent occupational diseases (1). However, it is rarely recognized officially as an occupational disease in Japan. Consequently, there are no official national statistics, and

very few epidemiological surveys on occupational hand eczema in Japan have been performed.

Dental workers are considered to have a high risk of developing occupational hand eczema, predominantly because of irritant contact dermatitis caused by wet work. They may also suffer from allergic contact dermatitis caused by dental materials such as acrylates and rubber chemicals (2). We conducted a cross-sectional survey by using a self-reporting questionnaire to estimate the prevalence of hand eczema and to investigate risk factors such as wet work, glove use or exposure to allergens in employees of dental clinics in Kumamoto City, located in southern Japan. To our knowledge, no population-based survey

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on occupational hand eczema in dental workers has been performed in Japan until now.

Methods

Study population

Dentists, hygienists, technicians, assistants and receptionists working for the 309 dental clinics organized in the Dental Association of Kumamoto City, the capital of Kumamoto Prefecture, Japan, were asked to participate voluntarily in this survey. The data collection was performed in 2011–2012.

Questionnaires

A self-administered questionnaire, partly based on the validated Nordic Occupational Skin Questionnaire 2002 (3), was sent by mail to all dental clinics, and the workers at these clinics were asked to fill in the questionnaire and send it back anonymously by mail. The questionnaire included questions about profession, duration of work, working hours per week, hand washing, the use of gloves and alcohol-based hand rub disinfectants, exposure to substances or materials used at the workplace, history of atopic diseases and metal allergy, and history of dry skin and hand eczema, including the consequences of hand eczema. Frequencies of hand washing and the use of alcohol-based hand rub disinfectants per day were categorized as 1–5, 6–10, 11–20, 21–40 and >40 times. The duration of glove use per day was categorized as no use, <0.5 h, ≥0.5 and <1 h, ≥1 and <2 h, ≥2 and <4 h, ≥4 and <6 h, and ≥6 h. Concerning dry skin, an affirmative answer to the question 'Do you think that you have dry skin?' was considered to indicate the presence of dry skin. Regarding exposure to substances or materials, all subjects were asked the following questions: 'What kinds of substances or materials are you using at your workplace?' and 'Are you handling those substances with bare hands?' For atopic disease history, the question 'Have you ever had atopic dermatitis/asthma/allergic rhinoconjunctivitis before?' was used. If the answer to this question was 'yes', we asked 'Have you consulted a doctor for the atopic diseases?' Self-reported hand eczema was considered to be present if the subjects answered 'yes' to the question 'Have you ever experienced eczema (redness, scale, fissure, vesicles, papules, oedema, exudates, itch and pain) on the hands, wrists and forearms before?' If the answer to this was 'yes', the following additional questions were asked: 'Which symptoms did you have?', 'Which area of the body was affected?', 'Did your hand eczema recur or last longer

than 3 weeks?', 'Have you had symptoms of hand eczema in the last year?', and 'Do you have symptoms of hand eczema today?'

At the same time, the owners of each dental clinic were asked, by means of an additional questionnaire, what kinds of gloves they provided to the employees. The study was approved by the ethical committee of Graduate School of Kumamoto University.

Patch testing

After completing the questionnaire, all subjects were invited to be patch tested with important dental allergens. The patch test substances comprised eight different metals [nickel sulfate 2.5% pet., potassium dichromate 0.5% pet., cobalt chloride 2.0% pet., gold sodium thiosulfate 0.5% pet., mercury chloride 0.05% pet., palladium chloride 2.0% pet., copper sulfate 2.0% pet., and tin(II) chloride 2.0% pet.], four different rubber chemical mixes [thiuram mix 1.0% pet., mercapto mix 2.0% pet., *p*-phenylenediamine (PPD) (black rubber) mix 0.6% pet., and dithiocarbamate mix 2.0% pet.], 10 different (meth)acrylates (methyl methacrylate 2.0% pet., 2-hydroxyethyl methacrylate 2.0% pet., ethylene glycol dimethacrylate 2.0% pet., 2-hydroxypropyl methacrylate 2.0% pet., ethyl methacrylate 2.0% pet., bisphenol A-glycidyl methacrylate 2.0% pet., triethylene glycol dimethacrylate 2.0% pet., 1,3-butanediol dimethacrylate 2.0% pet., diurethane methacrylate 2.0% pet., and ethyl acrylate 0.2% pet.), and two plastic-related allergens (benzoyl peroxide 1.0% pet. and *N,N*-dimethyl toluidine 5.0% pet.) (Brial, Greven, Germany). A dermatologist (K.M.) visited the dental workers who agreed to be patch tested, and performed the patch tests after their informed consent had been obtained. The patch tests were applied for 2 days with Finn Chambers® on Scanpor® tape, and the reading was performed on day (D) 4. If a reading on D4 was not feasible, it was performed on D3. Patch testing was performed according to ICDRG guidelines. Weak (+), strong (++) and extreme positive (+++) reactions were considered to be allergic reactions.

Statistical analysis

Statistical analyses were performed with SPSS version 20.0. The chi-square test and analysis of variance were used for comparison of demographic and work characteristics and prevalences of hand eczema between different professions. Binary logistic regression was used to examine risk factors for hand eczema. Only risk factors with *p*-values of ≤0.2 in the univariate analyses were included in the multiple regression analyses.

Results

Subjects

Of 309 dental clinics, 97 responded (response rate of 31.4%, based on clinics), and 528 of 530 workers were available for analysis. The demographic characteristics of the 528 participating subjects of the 97 clinics are given in Table 1. Of all subjects, 80.3% were female. The mean age was 37.3 years [standard deviation (SD) 12.4 years, range 19–77 years]. The mean duration of working in dentistry ($N = 519$) was 14.5 years (SD 11.1 years, range 0.02–51 years), and the median was 12 years. The average number of working hours per week ($N = 525$) was 42.9 h (SD 12.9 h, range 8–78 h), and the median was 45 h.

Exposure to wet work and allergens

In total, 71.7% of 523 workers reported that they washed their hands at work >10 times per day, and 37.4% washed them >20 times per day. Concerning glove use, 68.8% of 525 workers reported that they used gloves, on average, for >2 h per day, and 45.3% reported that they used them for >6 h per day; 14% reported that they did not use gloves daily. Of 525 workers, 30.8% reported that they did not use alcohol-based hand-rub disinfectants. Of 489 workers, 77.7% used latex gloves, 15.1% used nitrile rubber gloves, and 13.5% used polyvinyl chloride gloves (multiple answers possible). Only 5 workers (1.0%) used inner glove liners.

The owners of 81 clinics contributed information on the kinds of gloves that they were providing to their employees. These were most often powder-free latex gloves (64.2%), followed by powdered latex (39.5%), non-powdered nitrile (21.0%), non-powdered plastic (17.3%), powdered plastic (13.6%), and powdered nitrile (7.4%) gloves. Only in one clinic were inner cotton gloves available.

The self-reported exposures to different materials at the workplace are shown in Table 2. Twenty-four percent of 525 workers reported that they were handling uncured resin with bare hands.

Prevalence of hand eczema and its characteristics and consequences

The prevalence of self-reported hand eczema is shown in Table 3. In total, 55.9% of 528 workers had suffered from hand eczema at least once in their lifetime. The highest prevalence was found in hygienists and assistants, and the lowest in dentists. The 1-year prevalence and point prevalence were 39.6% and 18.4%, respectively. Of those with

a lifetime history of hand eczema, 43.8% reported that the symptoms had recurred, and 30.7% claimed that the symptoms had lasted for >3 weeks. The lifetime history, 1-year prevalence and point prevalence of chronic hand eczema (defined by symptoms that were either recurrent or lasted for >3 weeks) were 46.4%, 36.1%, and 17.6%, respectively.

The skin symptoms and the locations of the lesions of hand eczema reported by subjects with a lifetime history of chronic hand eczema are shown in Table 4. Itch, erythema, scales and fissures were reported most frequently. The fingertips and dorsa were the most frequently affected sites on the hands. If chronic hand eczema was more conservatively defined as the presence of at least two symptoms, the lifetime history, 1-year prevalence and point prevalence decreased to 36.6%, 28.2%, and 13.8%, respectively.

The characteristics and consequences of a lifetime history of chronic hand eczema are shown in Table 5. Of 241 workers with a lifetime history of chronic hand eczema, 58.0% reported that the symptoms of their hand eczema did not affect their life very much, 33% reported that the symptoms of their hand eczema affected their life to some extent, and 6.2% reported that the symptoms of their hand eczema affected their life very much. Only 3 (1.2%) reported having been on sick leave because of hand eczema; 1 of the 3 workers reported that she was diagnosed with latex allergy. Of the 245 workers with a lifetime history of chronic hand eczema, 49.8% had consulted a dermatologist, but skin tests and blood tests, respectively, had been performed in only 5.3%. Of 240 workers, 70.6% reported having used hand creams or emollients to treat their hand eczema, and 47.4% reported that their symptoms were always or sometimes improved after days off. Of 242 workers, 40.9% reported that the symptoms were not related to the season, but 49.5% reported that their symptoms worsened in winter. The causative exposures that workers with a lifetime history of chronic hand eczema ($n = 245$) most often considered as a cause of their hand eczema were soap use for hand washing, glove powder, gloves, alcohol-based hand rub disinfectant, and detergents used for tools (Table 6).

History of atopic diseases, dry skin, and metal allergy

The lifetime prevalences of self-reported atopic dermatitis, asthma and allergic rhinoconjunctivitis were 15.8%, 9.9% and 47.1% of 526 workers, respectively. The lifetime prevalences of those who had consulted a doctor for atopic dermatitis, asthma and allergic rhinoconjunctivitis were 12.9%, 7.2%, and 32.1%, respectively. Workers with a lifetime history of chronic hand eczema were

Table 1. Demographic and work characteristics of the 528 dental workers

	Dentist	Hygienist	Technician	Assistant	Receptionist	Total	<i>p</i> -Value
Number	n = 103	n = 266	n = 21	n = 75	n = 63	N = 528	–
Mean age (years)	48.9	32.9	46.0	36.7	34.3	37.3	<0.001 ^a
% of females	19.4	100.0	14.3	98.7	96.8	80.3	<0.001 ^b
Mean duration of work (years)	23.1	12.5	23.0	11.7	8.9	14.5 ^c	<0.001 ^a
Mean working hours per week	44.9	44.1	50.3	40.8	43.7	42.9 ^d	<0.01 ^a

^aAnalysis of variance.^bChi-square test.^cN = 519; values for 8 subjects were missing.^dN = 525; values for 3 subjects were missing.**Table 2.** Self-reported exposure to different substances at the workplace

Substances	N	Yes (%)	With bare hands (%)
Metal dust	523	70.5	16.4
Metal tools	523	88.9	31.2
Resin, uncured, as powder	523	83.4	24.9
Resin, uncured, as liquid	525	82.7	24.0
Cured resin, dust	522	85.7	26.1
Plaster	525	76.2	32.8
Plaster, hardened	522	72.3	30.8
Wax	522	75.5	27.8
Polishing powder/cream	520	67.9	18.7
Detergent for tools	522	79.7	20.3
Disinfectant for tools (glutalaldehyde)	517	58.2	7.0
Disinfectant for tools (benzalkonium chloride)	518	63.9	12.2
Disinfectant for the oral cavity (iodine glycerine)	521	65.8	12.3
Ointments with antibiotics	517	60.9	12.2
Local anaesthetics	510	58.0	11.4

more affected by the disease if they had a self-reported history of atopic dermatitis than if there was no history of atopic dermatitis (60.8% versus 35.8% of workers reported sick leave or being affected very much or to some extent; $p < 0.01$, $n = 241$). Furthermore, workers with a self-reported history of atopic dermatitis had consulted a dermatologist for their hand eczema more often than those without (90.2% versus 38.7%; $p < 0.001$, $n = 245$). Moreover, 64.8% of 526 workers reported that they had dry skin, and 12.6% of 525 workers indicated they were allergic to metal.

Risk factors for chronic hand eczema

In Table 7, risk factors for chronic hand eczema (lifetime prevalence, 1-year prevalence, and point prevalence) are shown as odd ratios (ORs) in relation to sex, profession,

self-reported atopic disease history of those who had consulted a doctor, dry skin, metal allergy, working hours per week, duration of work, frequency of hand washing, and use of gloves and of alcohol-based hand rub disinfectants. According to logistic regression analyses, atopic disease history was the most significant risk factor for a lifetime history of chronic hand eczema ($p < 0.001$). Atopic dermatitis [OR 4.1, 95% confidence interval (CI): 2.1–7.7] was more strongly associated with a lifetime history of chronic hand eczema than only asthma and/or allergic rhinoconjunctivitis (OR 1.9, 95%CI: 1.2–2.9). In addition, dry skin was associated with a lifetime history of chronic hand eczema (OR 1.9, 95%CI: 1.2–2.9; $p < 0.01$).

Regarding the 1-year prevalence of chronic hand eczema, significant risk factors included a personal history of atopic diseases (OR 2.2, 95%CI: 1.2–3.9 for atopic dermatitis; OR 1.4, 95%CI: 0.9–2.2 for only asthma and/or allergic rhinoconjunctivitis; $p < 0.05$), dry skin (OR 1.7, 95%CI: 1.1–2.7; $p < 0.05$), shorter duration of work (OR 2.0, 95%CI: 1.2–3.5 for up to 10 years; OR 1.7, 95%CI: 1.0–3.1 for >10 years, up to 20 years; $p < 0.05$), and washing hands >10 times per day (OR 1.6, 95%CI: 1.0–2.6; $p < 0.05$).

Concerning current hand eczema (point prevalence), the associations with a personal history of atopic diseases ($p < 0.05$) and shorter duration of work ($p < 0.01$) were still significant, but the strongest risk factor was not using alcohol-based hand rub disinfectants (OR 2.4, 95%CI: 1.5–4.0; $p < 0.001$).

Results of patch testing

Only 54 workers (6 dentists, 39 hygienists, 2 technicians, 5 assistants, and 2 receptionists), including 37 subjects with a lifetime history of hand eczema, agreed to be patch tested. Of the patch tested workers, 47 (87.0%) were females, and the mean age was 36.3 years (SD 11.5 years). No significant differences were found regarding age and sex distribution between the patch tested

Table 3. Lifetime history, 1-year and point prevalence (95% confidence interval) of hand eczema and chronic hand eczema among dental workers

	Dentist (n = 103)	Hygienist (n = 266)	Technician (n = 21)	Assistant (n = 75)	Receptionist (n = 63)	Total (N = 528)	p-Value ^a
Lifetime prevalence (%)							
Hand eczema	39.8 (30.4–49.3)	64.3 (58.5–70.0)	42.9 (21.7–84.0)	56.0 (44.8–67.2)	50.8 (38.4–63.1)	55.9 (51.6–60.1)	<0.001
Chronic hand eczema ^b	34.0 (24.8–43.1)	51.9 (45.9–57.8)	28.6 (9.2–47.9)	46.7 (35.4–58.0)	49.2 (36.9–61.6)	46.4 (42.1–50.7)	<0.05
One-year prevalence (%)							
Hand eczema	25.2 (16.9–33.6)	45.1 (39.1–51.1)	38.1 (17.3–58.9)	40.0 (28.9–51.1)	39.7 (27.6–51.8)	39.6 (35.4–43.8)	<0.05
Chronic hand eczema ^b	23.3 (15.1–31.5)	40.6 (34.7–46.5)	28.6 (9.2–47.9)	37.3 (26.4–48.3)	39.7 (27.6–51.8)	36.2 (32.1–40.3)	<0.05
Point prevalence (%)							
Hand eczema	14.6 (7.8–21.4)	20.7 (15.8–25.5)	23.8 (5.6–42.0)	13.3 (5.6–21.0)	19.0 (9.4–28.7)	18.4 (15.1–21.7)	NS
Chronic hand eczema ^b	12.6 (6.2–19.0)	20.3 (15.5–25.1)	19.0 (2.3–35.8)	13.3 (5.6–21.0)	19.0 (9.4–28.7)	17.6 (14.4–20.9)	NS

NS, not significant.

^aChi-square test.^bChronic hand eczema was defined as recurring hand eczema or hand eczema that persists for > 3 weeks.**Table 4.** Skin symptoms and localizations of the lesions of subjects reporting a lifetime history of chronic hand eczema (multiple answers)

Symptoms	n (N = 245)	%	Lesions	n (N = 243)	%
Itch	181	73.9	Fingertips	120	49.4
Redness	136	55.5	Dorsa of hands	104	42.8
Scale	112	45.7	Wrists and forearms	65	26.7
Fissures	89	36.3	Palms	60	24.7
Pain	61	24.9	Lateral sides of fingers	59	24.3
Vesicles	52	21.2	Extensors of fingers	52	21.4
Exudates	45	18.4	Interdigital web spaces	45	18.5
Oedema	24	9.8	Flexors of fingers	39	16.0
Papules	18	7.3	Neck	39	16.0
			Face	36	14.8

workers and those who were not patch tested. Of all subjects, 53.7% showed at least one positive reaction to the 24 allergens patch tested. Sensitization to nickel (n = 14) was the most common metal sensitization, followed by sensitization to chromium (n = 12). Among 37 subjects with a history of hand eczema, 6 reacted positively to either thiuram mix or PPD (black rubber) mix, and 2 reacted positively to several (meth)acrylates. One reacted positively both to PPD (black rubber) mix and to several (meth)acrylates. Those positive results were considered to be occupationally relevant, except for PPD (black rubber) mix, which is not a common allergen in rubber gloves. Therefore, 7 of 37 workers with hand eczema were diagnosed with occupational allergic contact dermatitis.

Discussion

In the present study, the 1-year prevalence of hand eczema in Japanese dental workers was 39.6%, which was slightly higher than that found in studies using

the same method for hand eczema case ascertainment. The 1-year prevalence of self-reported hand eczema in Swedish dentists (n = 3082), 2208 Danish dentists and 799 Finnish dental nurses was reported to be 13.5% (4), 21.4% (5), and 30% (6), respectively. In the present study, the self-reported prevalence of hand eczema was assessed (3). Other questionnaire studies on hand eczema have used a set of questions addressing symptoms of hand eczema, and their duration and recurrence (7). With the use of symptom-based questions, the 1-year prevalence among 192 Danish dental technicians, 527 Swedish dental personnel, 1252 dentists in New Zealand and 285 dentists in Australia was reported to be 43% (8), 13.6% (9), 32.8% (10), and 29.1% (11), respectively. The symptom-based hand eczema prevalence tends to be an overestimate of the true prevalence (12), whereas the prevalence of self-reported hand eczema tends to be an underestimate of the true prevalence (13). These two methods of ascertaining hand eczema with the Japanese self-administered questionnaires should be further

Table 5. Severity and characteristics of a lifetime history of chronic hand eczema

	n	%
Did your hand eczema affect your daily life? (N = 241)		
Yes, forced to take sick leave	3	1.2
Yes, very much	15	6.2
Yes, to some extent	81	33.0
No, not affected very much	142	58.0
Have you consulted a dermatologist or physician for treatment? (Multiple answers) (N = 245)		
Yes	122	49.8
If so, what was done?		
Prescription of ointments	115	46.9
Prescription of oral medications	54	22.0
Skin tests (patch and/or prick test)	13	5.3
Blood examinations	13	5.3
What did you do to abate your hand eczema except consulting a dermatologist or physician? (multiple answers) (N = 245)		
Ointment purchased from pharmacy	53	21.6
Hand cream or emollients	173	70.6
Starting wearing gloves	28	11.4
Changing materials of gloves	29	11.8
Did days off abate your hand eczema? (N = 240)		
Yes, always	55	22.9
Yes, sometimes	60	24.5
No	39	15.9
Don't know	86	35.8
In which seasons is your hand eczema worsened? (Multiple answers) (N = 242)		
Not related to seasons	99	40.9
Related to seasons (multiple answers)		
Spring	13	5.4
Summer	21	8.7
Autumn	19	7.9
Winter	124	51.2

evaluated, for example by comparison with the results of standardized dermatological examinations.

In Japan, two studies on the prevalence of hand eczema using the symptom-based hand eczema questions in nurses have been published, but there has been no study in dental workers. The 1-year prevalence of chronic hand eczema with two or more symptoms determined by the use of self-administered questionnaires was found to be 35% in nurses of a teaching hospital (n = 305) (14) and 53.3% in nurses (n = 860) (15). In Japan, hand eczema is rarely recognized as an occupational disease. Almost all patients with hand eczema are treated under official medical insurance that requires patients to cover 30% of the consultation and treatment cost. In a study of 176 Japanese outpatients with hand eczema, 42% of cases were considered to be work-related, and it was shown that the treatment cost per person was only one-tenth of the cost incurred by a German patient, and that most of the patients consulted a physician only once in 6 months (16). In our study, only 3 workers regarded their symptoms as being severe enough to ask for sick leave, and only half of the workers with a lifetime history of chronic hand eczema

had consulted a doctor. However, 58% of the workers reported that their symptoms had not affected their life very much.

Exposure to irritants was found to be common in Japanese dental workers. Well-known irritants are water, soap, disinfectants, detergents, plaster, and occlusive gloves (2). In our study, 72% of dental workers reported washing their hands >10 times per day, and 38% reported washing their hands >20 times per day. Nearly 70% of all workers wore gloves for >2 h per day. These results are very similar to those obtained in two Swedish studies in dentists (17, 18). Seventy-three per cent of the investigated Swedish dentists (n = 3083) reported wearing gloves for >2 h per day, and 48% reported wearing gloves for >6 h per day (17); 64% (according to the calculation by the author) of the Swedish dentists (n = 303) reported washing their hands >16 times per day (18).

Logistic regression analysis showed that a history of atopic disease was a strong predictor of chronic hand eczema, with a much stronger association with atopic dermatitis than with only respiratory and mucocutaneous atopy. In Swedish dentists, a history of childhood eczema,

Table 6. What kinds of substance do you think cause your hand eczema? (N = 245 with a lifetime history of chronic hand eczema)

Causative materials	n	%
Gloves	59	24.1
Glove powder	72	29.4
Hand soap	83	33.9
Alcohol-based hand rub disinfectant	71	29.0
Metal fumes	3	1.2
Metal dust	11	4.5
Metal tools	4	1.6
Resin, uncured, powder	16	7.8
Resin, uncured, liquid	23	9.4
Cured resin, dust	14	5.7
Plaster	25	10.2
Plaster, hardened	13	5.3
Wax	3	1.2
Polishing powder/cream	3	1.2
Detergent for tools	45	18.4
Disinfectant for tools (glutalaldehyde)	26	10.6
Disinfectant for tools (benzalkonium chloride)	20	8.2
Disinfectant for oral cavity (iodine glycerine)	12	4.9
Ointments with antibiotics	1	0.4
Local anaesthetics	3	1.2

which is often used as an alternative method for assessing a history of atopic dermatitis, was shown to be the most important predictor of adult hand eczema, with a prevalence ratio of 2.4 as compared with dentists without childhood eczema after adjustment for age and sex (5). Another study among Swedish dental personnel, including dentists and chair assistants (n = 7384), also showed that self-reported hand eczema was significantly correlated with eczema in childhood (19). Among New Zealand dentists (n = 1252), subjects currently suffering from hay fever, asthma or any other allergic condition had a significantly higher risk (OR 2.2, 95%CI: 1.7–2.8) of developing hand eczema in multivariate analysis (10). In general, atopic dermatitis is considered to be a risk factor for irritant contact dermatitis, which is the most frequent cause of occupational contact dermatitis, but respiratory manifestations of atopy are less predictive (1). Dental workers are exposed to both irritants, including wet work, and allergens, such as acrylate products, metals, and rubber chemicals.

Owing to the cross-sectional design of the present study, a history of lifetime atopic dermatitis is prone to recall bias, because atopic dermatitis often begins at an earlier age than respiratory atopic diseases, and may disappear during childhood (20). However, several prospective follow-up studies in young age groups have clearly shown that atopic dermatitis is a strong risk factor for hand eczema (20–22).

One more important finding related to atopic dermatitis is that subjects with hand eczema who have a personal history of atopic dermatitis tend to be more severely affected in their daily life. In Italian hand eczema patients (n = 766), clinically severe and refractory hand eczema has been reported to be significantly more common among patients with atopic dermatitis than among those with non-severe hand eczema (OR 2.16, 95%CI: 1.12–4.17) (23). A recent study in Swedish adolescents showed that moderate/severe atopic dermatitis was significantly associated with hand eczema (OR 3.0, 95%CI: 1.5–6.0), but the OR for mild atopic dermatitis was lower (OR 1.3) and not significant (21). In a recent Danish population-based study of adults (n = 2227), a history of atopic dermatitis was associated with both persistent and incident hand eczema (OR 9.0, 95%CI: 5.6–14.4 and OR 3.0, 95%CI: 1.7–5.2, respectively) (24).

Another significant endogenous risk factor for hand eczema among Japanese dental workers was self-reported dry skin. In our study, >60% reported having dry skin. A recently published population-based study in Europe (n = 12 377), using the same question, 'Do you think that you have dry skin?', as in the present study, showed that 54.1% had dry skin, with higher prevalence in women than in men (25). Furthermore, other previous studies obtained similar results (26–28). In a cross-sectional study among Dutch construction workers (n = 115 379 males), it was shown that subjects with dry skin had a significantly higher risk of developing hand eczema than those with normal skin (relative risk 2.0, 95%CI: 1.96–2.06) (26). Among 1375 German geriatric nurses, a life-long history of dry skin was shown to be a risk factor for current hand eczema, based on Osnabrück hand eczema severity index (OR 2.76; 95%CI: 2.02–3.76) (27). In a Danish population-based study (n = 3471), ever having generalized xerosis, which was defined by the question 'Have you ever had dry skin all over your body?', was significantly associated with hand eczema (OR 2.12, 95%CI: 1.69–2.65) after adjustment for other confounding factors, including atopic dermatitis and filaggrin gene mutation status (28). The authors discussed generalized xerosis as an independent risk factor for hand eczema (28).

Shorter duration of work, that is, young age, was a significant risk factor for both the 1-year prevalence and the point prevalence of hand eczema. One possible explanation for this finding is that hand eczema tends to develop in an early stage of working life, and to be controlled better in later phases. Another explanation could be that workers who are severely affected by hand eczema might leave their profession at a young age, resulting in a selection

Table 7. Association between lifetime history, 1-year prevalence and point prevalence of chronic hand eczema and potential risk factors (N = 504)

Risk factors	n	Lifetime prevalence						One-year prevalence						Point prevalence					
		Univariate			Multivariate			Univariate			Multivariate			Univariate			Multivariate		
		OR	95%CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value
Sex																			
Male	403	1		<0.01	1		0.26	1		<0.01	1		0.55	1		0.35	1		0.57
Female	101	1.9	1.2–2.9		0.6	0.2–1.5		2.0	1.2–3.2		0.7	0.3–2.0		1.3	0.7–2.4		0.7	0.2–2.4	
Professions																			
Dentist	101	1		<0.05	1		0.48	1		<0.05	1		0.71	1		0.57	1		0.84
Hygienist	255	2.2	1.4–3.6		2.3	0.9–6.0		2.4	1.4–4.1		1.9	0.7–5.0		1.8	0.9–3.4		1.3	0.4–4.4	
Technician	20	0.8	0.3–2.4		0.9	0.3–2.6		1.5	0.5–4.2		1.6	0.5–4.9		1.7	0.5–5.9		1.5	0.4–5.5	
Assistant	70	1.8	0.9–3.3		2.4	0.8–6.8		2.1	1.1–4.2		2.1	0.7–6.1		1.1	0.5–2.7		0.9	0.2–3.6	
Receptionist	58	1.7	0.9–3.3		2.4	0.8–7.4		2.0	1.0–4.2		2.0	0.6–6.2		1.6	0.7–3.8		0.9	0.2–3.6	
Atopic disease history (AD, AS, ARC) (consulted a doctor)																			
No	311	1		<0.001	1		<0.001	1		<0.001	1		<0.05	1		<0.01	1		<0.05
AS and/or ARC only	127	2.0	1.3–3.0		1.9	1.2–2.9		1.5	1.0–2.3		1.4	0.9–2.2		1.1	0.6–1.9		1.1	0.6–1.9	
AD	66	4.8	2.6–8.7		4.1	2.1–7.7		2.9	1.7–4.9		2.2	1.2–3.9		2.7	1.5–5.0		2.3	1.2–4.4	
Do you think you have dry skin?																			
Yes	327	2.4	1.7–3.5	<0.001	1.9	1.2–2.9	<0.01	2.2	1.4–3.2	<0.001	1.7	1.1–2.7	<0.05	1.27	0.8–2.1	0.34	1.0	1.0–1.8	0.89
No	177	1			1			1			1			1			1		
Do you have metal allergy?																			
Yes	65	2.0	1.2–3.4	<0.05	1.5	0.8–2.7	0.17	1.7	1.0–2.9	<0.05	1.3	0.8–2.4	0.30	1.3	0.7–2.5	0.44	1.2	0.6–2.4	0.59
No	439	1			1			1			1			1			1		
How many hours do you work per week?																			
≤39.9	129	1		0.29	1		0.40	1		0.20	1		0.53	1		0.54	1		0.66
≥40	375	1.2	0.8–1.9		1.2	0.8–2.0		1.3	0.9–2.0		1.2	0.7–1.9		1.2	0.7–2.0		0.9	0.5–1.6	
How many years have you been working in dentistry?																			
≤10	231	2.0	1.3–3.0	<0.01	1.2	0.7–2.0	0.66	2.9	1.8–4.6	<0.001	2.0	1.2–3.5	<0.05	3.1	1.7–5.8	<0.001	2.9	1.4–6.0	<0.01
10.1–20	124	1.8	1.1–2.9		1.3	0.7–2.2		2.1	1.3–3.6		1.7	1.0–3.1		1.3	0.6–2.8		1.3	0.6–2.8	
≥20.1	149	1			1			1			1			1			1		
How many times do you wash your hands per day?																			
≤10	142	1		0.15	1		<0.05	1		0.23	1		<0.05	1		0.87	1		0.37
≥11	362	1.3	0.9–2.0		1.7	1.1–2.6		1.3	0.9–1.9		1.6	1.0–2.6		1.0	0.6–1.7		1.3	0.7–2.3	
For how long do you wear gloves per day?																			
≤6	275	1		<0.05	1		0.34	1		0.08	1		0.52	1		0.54	1		0.82
>6	229	1.4	1.0–2.0		1.2	0.8–1.9		1.4	1.0–2.0		1.2	0.7–1.8		1.2	0.7–1.2		0.9	0.5–1.7	
Do you use alcohol-based hand-rub disinfectants?																			
Yes	348	1		0.13	1		0.15	1		<0.05	1		0.10	1		<0.001	1		<0.001
No	156	1.3	0.9–1.9		1.4	0.9–2.1		1.5	1.0–2.2		1.4	0.9–2.2		2.7	1.7–4.2		2.4	1.5–4.0	

AD, atopic dermatitis; ARC, allergic rhinitis/conjunctivitis; AS, asthma; CI, confidence interval; OR, odds ratio.

process called the ‘healthy worker effect’. In accordance with our results, a shorter duration of experience after graduation was associated with a significantly higher risk (OR 1.8 for <10 years and OR 1.8 for 11–20 years versus >31 years) of developing hand eczema according to a cross-sectional study on New Zealand dentists (n = 1252) (11). In Swedish dental personnel, the prevalence of hand eczema decreased significantly with increasing age ($p < 0.001$) (19). However, Taiwanese nurses (n = 1132) with >10 years of working experience were reported to have a significantly higher risk of developing chronic

hand eczema (OR 1.5, 95%CI: 1.1–2.2) than those with <5 years of working experience (29). In terms of age or length of working experience as a risk factor for hand eczema, the results in previous studies are controversial, but it seems more likely that younger dental workers have a higher risk than older dental workers.

Frequent hand washing, that is, >10 times per day, was a significant risk factor for both the lifetime prevalence and the 1-year prevalence of hand eczema. Wet work is considered to be a relevant risk factor for the development of irritant contact dermatitis (1, 2). Frequent

washing has been shown to be a significant risk factor in several epidemiological studies. Wet work (defined as >2 h per day) was shown to be a significant risk factor (OR 1.7, 95%CI: 1.1–2.8) in a Danish population of 28–29-year-olds (n = 899) (30). The daily frequency of hand washing, at home and at work, was reported to be a significant predictor of the 1-year prevalence of hand eczema (OR 1.02, 95%CI: 1.01–1.04) in Swedish population of 29–32-year-olds (n = 1516) (22). Moreover, a high frequency of hand washing has been identified as a significant risk factor for hand eczema in many studies among hospital workers (14, 29, 31–33). However, to our knowledge, our study is the first study to show that a high frequency of hand washing is also a significant risk factor for hand eczema in dental workers.

Disinfectants are potential irritants and may cause hand eczema (4), as described previously. However, the present study showed that not using alcohol-based hand rub disinfectants was a highly significant risk factor for the point prevalence of hand eczema. In fact, it has been shown by experimental studies that alcohol-based hand disinfectants cause significantly less skin irritation than sodium lauryl sulfate, a major ingredient of detergents (34, 35). The use of alcohol-based disinfectant when hands are not visibly dirty is therefore highly recommended (36), and it also has a better outcome for hand hygiene than hand washing only (37). Another interesting finding is that dental workers in this study sample had the false notion that alcohol-based hand disinfectants constitute a major cause of hand eczema. Interestingly, the same result was obtained in the study of self-reported hand eczema in Korean hospital nursing staff, where 63.0% of the subjects believed that alcohol-based hand rubs constituted a cause of hand eczema, followed by hand washing (57.7%) and wearing gloves (39.2%) (36). A German study showed that approximately two-thirds of nurses believed that alcohol-based disinfectants were more skin irritating than hand washing (38). Alcohol-based hand rubs induce a burning sensation on irritated skin. This unpleasant sensation may explain

why alcohol-based hand disinfectants are believed to constitute a cause of hand eczema. In addition, the pain may have resulted in avoidance of alcohol-based hand disinfectants: because of the study design (cross-sectional study), it is possible that the workers' behaviours were affected by their hand eczema.

A limitation of the present study is the low response rate of 31.4%, based on clinics. Unfortunately, no demographic information was available for the non-respondents. Another limitation of the present study is that domestic exposure to wet work, which may be more prevalent among women than among men in general, was not included. However, ~80% of the study subjects were female, and sex was not a significant risk factor for all outcomes after adjustment for the other factors. One more limitation is that immediate-type allergy to latex was not investigated with a questionnaire and skin tests.

In conclusion, dental workers in Japan had a high prevalence of hand eczema in the present cross-sectional study, based on a self-reported questionnaire, and they were heavily exposed to both wet work and allergens such as (meth)acrylates or rubber. Younger workers with atopic dermatitis had a higher risk of developing hand eczema. Frequent hand washing and not using alcohol-based hand rub disinfectants were associated with an increased risk of development of hand eczema, indicating a lack of knowledge about skin protective measures. Japanese dental workers require education on skin protective measures, especially at the beginning of their working life, ideally during their initial professional training period. Patch testing should be performed more often in Japan in patients with hand eczema, as detection of contact allergies improves the management of the disease.

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