

Prevalence and risk factors for latex glove allergy among female clinical nurses: a multicenter questionnaire study in China

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Background: Natural rubber latex glove use is widespread in mainland China, but the prevalence and risk factors for latex glove allergy among clinical nurses have previously been unreported.

Methods: A questionnaire was used to collect information on latex glove-related allergy among clinical nursing staff in 35 hospitals of eight provinces in the southern, central southern, and northern regions of China, and the risk factors were calculated with logistic regression analysis. Some subjects with glove dermatitis were patch tested with a modified European standard series of allergens.

Results: Among 8485 female nurses in eight provinces of China, overall prevalence of latex glove allergy was 8.8%. Of 743 symptomatic nurses, 573 (77.1%) and 475 (63.9%) reported symptoms suggestive of glove dermatitis and type I latex allergy, respectively. Of 69 randomly selected subjects with glove dermatitis, 18 (26.1%) had a positive patch to rubber additives. Employment seniority, positive family and personal history of allergic diseases, and longer extent of time spent in a single hospital room were associated with latex allergy, while using >5 pairs of gloves per working day may be a protective factor.

Conclusion: Chinese nurses are at high risk for latex sensitization. Nurses who develop latex-related symptoms after exposure to latex gloves should undergo screening tests for latex allergy. Low-protein, powder-free natural rubber latex gloves, or latex-free gloves should be widely adopted in China, along with other preventive measures.

Keywords: Latex allergy, Nurse, Risk factor, Prevalence

Introduction

Natural rubber latex (NRL) allergy has been an important occupational health problem for health care workers (HCWs) since the late 1980s. NRL obtained from the *Hevea brasiliensis* tree contains rubber polymer (cis-1,4-polyisoprene), resin, water, and varying amounts of proteins.^{1,2} Many medical devices are made of NRL, such as gloves, tourniquets, elastic bandages, ventilation balloons, and urinary catheters.³ These medical devices could become a hazard for latex-sensitized HCWs and patients.

NRL products can cause three types of adverse reactions: irritant contact dermatitis, type I hypersensitivity, and allergic contact dermatitis.⁴ It is generally reported that the prevalence of latex allergy is 3–12%

in HCWs and about 1% in the general population based on skin prick test (SPT).^{2,3} In a recent systematic review, the prevalence of latex allergy was 4.32% in HCWs and 1.37% in the general population.⁵ However, the prevalence of allergic reactions to NRL has declined recently in HCWs in Europe, North America, and elsewhere, because of improvement of NRL glove manufacturing process, and educational and practical interventions, and use of low-protein, powder-free NRL gloves in hospitals.²

To date, few data have been available from Chinese HCWs. The prevalence of latex allergy was 2.3% (3/130) based on total IgE detection and SPT in Taiwan.⁶ The questionnaire survey showed that the prevalences of glove dermatitis and latex allergy were 30.9 and 3.3% in Hong Kong, respectively.⁷ In mainland China, however, NRL gloves are widely used in hospitals, but the prevalence of latex glove allergy among HCWs has not been reported. In this study, we administered a questionnaire survey and

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patch testing to determine the prevalence and risk factors for latex glove allergy among clinical female nurses in eight provinces of China.

Materials and Methods

The study included two phases. The first phase was conducted in October 2008 to determine the baseline prevalence of NRL sensitivity in four hospitals in the city Zhanjiang in Guangdong province. The second phase was carried out in 2011 in 31 hospitals of eight provinces in the southern (Guangdong and Guangxi provinces), central southern (Hubei, Hunan, Henan, and Jiangxi provinces), and northern (Hebei and Liaoning provinces) regions of China. After gaining approval from ethical review board of the hospitals, a modified questionnaire based on the reports of Leung *et al.*⁷ and Smedley *et al.*⁸ was provided to these hospitals. Questionnaires were distributed to the volunteer participants by the head nurse of each department. Anonymous responses were collected within a 7-day period.

The questionnaire was designed to collect demographic data (age, sex, employment duration, and department), symptoms related to latex gloves (itching, redness, and papulovesicles of the hands or wrists; urticaria; rhinorrhea; chest tightness/dyspnea), occupational exposure (number of latex gloves used per day, hours of glove use, and continuous time spent working in a room where others are wearing latex gloves), and personal and family history of allergic diseases (drug, food, metal, and pollen allergy; dermatitis and eczema; allergic rhinitis; asthma).

For the purposes of analysis, we defined cases of glove dermatitis (GD) as those who reported itching, redness, or papulovesicles of the hands or wrists in the absence of urticaria. We considered type I hypersensitivity to be present when respondents reported urticaria, rhinorrhea, or chest tightness/dyspnea occurring within 2 hours of glove use.⁷

From Guangdong nurses, we randomly selected 69 allergic participants who reported GD symptoms and 31 non-allergic participants for patch testing. Patch testing was done using a modified European standard series of allergens supplied by Chemotechnique Diagnostics (Malmö, Sweden). Allergens were applied to the upper back for 48 hours. Readings were recorded on day 3, and reactions between '+' and '+++' were considered positive.

Data were entered into a spreadsheet program and analyzed by Student's *t*-test and Chi-squared test. Logistic regression was also performed to evaluate risk factors, and risk estimates were expressed as adjusted odds ratios (OR), 95% confidence intervals (95% CI), and probability (*P*) values.

Results

A total of 9574 clinical nurses were targeted for the study, of whom 8823 (92.2%) returned the questionnaires. We excluded 338 male nurses. Response rate on the risk analysis portion of the questions was low among asymptomatic respondents, so we evaluated the risk factors for latex glove allergy among a subset of 882 respondents, all in Guangdong province, who completed the entire questionnaire. All 100 participants selected for patch testing agreed to participate in that aspect of the study.

Of the 8485 female nurses aged 18–61 years, 743 (8.8%) had symptoms suggestive of the possibility of latex glove allergy. The age, employment seniority, and positive rates of personal and family history of anaphylactic diseases in sensitized nurses were superior to those in unsensitized ones (Table 1). The prevalence of latex glove allergy differed by province ($\chi^2=119.99$, $P<0.001$) and region ($\chi^2=40.88$, $P<0.001$), with the highest in Guangdong province and southern region and the lowest in Hubei province and central southern region (Table 2).

Table 2 Prevalence of latex glove allergy among 8485 female nurses in eight provinces of China

Region	Total cases	No. of allergy
Southern region	4078	449 (11.0%)
Guangdong	2823	364 (12.9%) ^{**Δ}
Guangxi	1255	85 (6.8%) ^{**†}
Central southern region	2590	155 (6.0%) [‡]
Hubei	638	16 (2.5%)
Hunan	831	59 (7.1%) ^{**†}
Jiangxi	307	22 (7.2%) ^{**}
Henan	814	58 (7.1%) ^{**}
Northern region	1817	139 (7.7%) ^{‡◇}
Hebei	1055	102 (9.7%) ^{**Δ}
Liaoning	762	37 (4.9%) [*]

Notes: * $P<0.05$, ** $P<0.01$, when compared with Hubei province.

^Δ $P<0.01$, when compared with Liaoning province.

[†] $P<0.05$, when compared with Hebei province.

[‡] $P<0.01$, when compared with southern region.

[◇] $P<0.05$, when compared with central southern region.

Table 1 General characteristics of 8485 female nurses in eight provinces of China

Group	Cases (%)	Mean age (years)	Working age (years)	Family history of allergy (%)	Personal history of allergy (%)
Non-allergy	7742 (91.2)	30.65 ± 7.16	9.16 ± 7.51	502 (6.5)	510 (6.6)
Allergy	743 (8.8) [*]	31.97 ± 8.43 [*]	10.88 ± 8.91 [*]	154 (20.7) [*]	294 (39.6) [*]

Note: * $P<0.001$, when compared with both groups.

Clinical manifestations of latex glove allergy

In this study of 8485 participants, 743 (8.8%) reported at least one symptom associated with the use of latex gloves. Of the 743 symptomatic nurses, 58.1% had more than one symptom. GD was reported in 573 (77.1%) cases, while type I latex allergy occurred in 475 (63.9%) cases. The most common complaints were itching of the hands or wrists (65.9%) and urticaria (55.2%), whereas chest tightness/dyspnea occurred in 41 (5.5%) cases (Table 3).

Risk factors related to latex glove allergy

The risk factors for latex glove allergy were evaluated among 882 respondents (274 allergic and 608 non-allergic subjects) in Guangdong province. We compared nurses working in surgical departments (operating room, surgery, gynecology and obstetrics, and ear, nose, and throat) and non-surgical departments

Table 3 Clinical manifestations of 743 allergic cases after exposure to latex gloves

Symptom	Cases (%) [*]
Glove dermatitis	573 (77.1)
Itching	101 (13.6)
Redness	48 (6.5)
Papulovesicles	18 (2.4)
Itching + redness	198 (26.6)
Redness + papulovesicles	17 (2.3)
Itching + redness + papulovesicles	191 (25.7)
Type I latex allergy	475 (63.9)
Urticaria	382 (51.4)
Rhinitis	41 (5.5)
Chest tightness/dyspnea	18 (2.4)
Urticaria + rhinitis	11 (1.5)
Urticaria + chest tightness/dyspnea	11 (1.5)
Rhinitis + chest tightness/dyspnea	6 (0.8)
Urticaria + rhinitis + chest tightness/dyspnea	6 (0.8)

Note: ^{*}Totals exceed 743 as respondents could report more than one symptom.

(internal medicine, pediatrics, oncology, infectious diseases, dermatology, traditional Chinese medicine, medical technology, outpatient department, etc.). The employing departments had no impact on latex allergy (OR=1.02, 95% CI=0.71–1.48, $P>0.05$). Symptoms were more common in nurses who had >10 years employment (OR=1.49, 95% CI=1.01–2.22, $P<0.05$) and a positive family (OR=2.27, 95% CI=1.34–3.85, $P<0.01$) and personal history (OR=2.26, 95% CI=1.47–3.47, $P<0.001$) of allergic diseases and other allergies (OR=4.73, 95% CI=3.25–6.89, $P<0.001$). In a work shift, the risk tended to increase with frequency of spending >1 hour in a room where others were wearing latex gloves (OR=2.49, 95% CI=1.66–3.73, $P<0.001$), but to decrease with the number of gloves used >5 pairs (OR=0.36, 95% CI=0.21–0.61, $P<0.001$). Contrarily, no association existed with length of single pair glove use of >1 hour (OR=0.96, 95% CI=0.60–1.52, $P>0.05$) (Table 4).

Patch test results

Sixty-nine GD patients and 31 non-allergic comparison underwent patch testing (Table 5), and the positive rate in GD (73.9%) was superior to that in controls (25.8%). The most common allergens identified were cobalt chloride (29.0%), potassium dichromate (24.6%), formaldehyde (21.7%), para-phenylenediamine (PPD) (20.3%), and nickel sulfate (18.8%) in GD patients; and cobalt chloride (12.9%) and potassium dichromate (12.9%) in controls. Of 69 GD subjects tested, 18 (26.1%) were responsive to rubber additives including thiuram mix (6), black rubber mix (5), carba mix (4), and mercapto mix (3). However, in controls, all rubber additive patch tests were negative.

Table 4 Logistic regression analysis of latex allergy status and clinical variables in 882 nurses (after adjustment for age in three strata)

Factor	Allergy (n=274)	Non-allergy (n=608)	OR (95% CI)	P
Family history of allergic diseases (yes/no)	74/200	32/576	2.27(1.34–3.85)	<0.01
Personal history of allergic diseases (yes/no)	118/156	67/541	2.26(1.47–3.47)	<0.001
Other allergies (yes/no)	179/95	112/496	4.73(3.25–6.89)	<0.001
Working departments (surgical/non-surgical)	91/183	193/415	1.02(0.71–1.48)	>0.05
Employment duration (</>10 years)	181/93	281/327	1.49(1.01–2.22)	<0.05
Number of gloves per day (</>5 pairs)	36/238	197/411	0.36(0.21–0.61)	<0.001
Each glove use (</>1 hour)	72/202	229/379	0.96(0.60–1.52)	>0.05
Working time in a room where others are wearing latex gloves (</>1 hour)	98/176	130/478	2.49(1.66–3.73)	<0.001

Table 5 Patch test results in glove dermatitis and normal control

Group	n	Age (year)* (mean ± standard deviation)	No. of positive patch allergens				
			1	2	3	≥4	Total
Glove dermatitis	69	19–52 (33.04 ± 8.46)	7	26	3	15	51 (73.9%)
Normal control	31	20–52 (31.19 ± 9.83)	4	3	1	0	8 (25.8%) ^A

Notes: ^{*} $P>0.05$, when compared with both groups.

^Δ $P<0.001$, when compared with both groups.

Discussion

The present study has been the first epidemiological survey of latex allergy in mainland China. This multicenter survey included 8485 nursing staff in 35 hospitals of eight provinces in the southern, central southern, and northern regions of China. The overall prevalence of latex glove allergy was 8.8%, ranging from 2.5% in Hubei province to 12.9% in Guangdong province, and was generally higher in the southern region than in the northern and central southern regions. In Hong Kong, Leung *et al.* found that the prevalence of latex allergy was 34.2% of 1472 hospital employees using a questionnaire.⁷ Given Hong Kong and Guangdong province are adjacent, we wonder whether the humid subtropical climate and widespread use of air-conditioning could be contributory factors for a higher incidence of latex allergy. Repeated hydration from the atmosphere or from wet work, followed by dessication from air-conditioning, could further aggravate the epidermis weakened from environmental humidity.⁹ Jungbauer *et al.* reported a high risk of hand dermatitis in nurses, related to intense exposure to wet works.¹⁰ Meanwhile, the aeroallergens originating from powdered latex gloves may persist longer and spread easily in a humid atmosphere and an enclosed environment, resulting in excessive deposits in the human airway and skin. Although all latex devices could be dangerous to HCWs, Leung *et al.* found that allergic symptoms caused by latex devices other than gloves were rare.⁷ Wan *et al.* also found that disposable medical gloves, particularly powdered gloves, were the major reservoir of latex allergens.⁶ Both sterile and non-sterile disposable powdered latex gloves are widely used in all hospitals of China. Therefore, latex allergy in Chinese HCWs may substantially be due to latex gloves.

In this study, of 743 symptomatic nurses, 77.1% presented with one or more symptoms suggestive of GD, and 63.9% had symptoms suggestive of type I latex allergy. The definition of GD and type I latex allergy may be arbitrary,⁷ and the coexistence was not uncommon in our study. Definite diagnosis of latex allergy requires SPT, latex-specific IgE, and patch tests.² The prevalence of SPT positivity among HCWs has been 2.9–12.1% in previous European and North American studies. Smedley *et al.* found, among 33 subjects with symptoms suggestive of type I hypersensitivity, that only one was positive on both SPT and latex-specific IgE test.⁸ Three (2.3%) of 130 nurses had increased latex-specific IgE and positive SPT in Taiwan,⁶ and nine (6.8%) of 133 subjects possessed a positive SPT to one or more of the glove extracts in Hong Kong.⁷ On the contrary, the incidence of latex allergy for ordinary gloves was 16% by SPT and 48% by skin exposure test in

Korea.¹¹ Unfortunately, SPT and latex-specific IgE test were impractical in our multicenter study, so the true prevalence of type I latex allergy remains to be validated.

Both irritant contact dermatitis and allergic contact dermatitis may coexist in GD patients, and the disrupted skin barrier function could induce the increased permeability of latex protein and then lead to type I allergy.¹² Patch testing using NRL glove extracts can testify both type I and IV latex allergy reactions.² The prevalence of type IV allergy to rubber additive series ranged 2.4–17.7% in previous studies. Of 295 Italian HCWs with glove-related symptoms, 31 (10.5%) exhibited positive patch test to rubber-related allergens, and thiuram mix and carba mix were the most common.¹³ In a retrospective 10-year review of 686 patients, 121 (17.7%) had a positive patch to at least one of the common rubber additives such as sulfur-containing vulcanizers (mercaptobenzothiazoles, carbamates, and thiurams), antioxidants (amines), and rubber pigments.¹⁴ Among 59 symptomatic operating room staff, the prevalences of type IV allergy to latex and rubber additives were 16.7 and 14.6%, respectively, and the most common rubber additives was tetramethylthiuram.¹⁵ In our study of 69 GD subjects, 73.9% exhibited positive patch reactions to common allergens such as cobalt chloride, potassium dichromate, formaldehyde, PPD, and nickel sulfate. Interestingly, 26.1% of GD patients were responsive to rubber additives including thiuram mix, black rubber mix, carba mix, and mercapto mix, but non-allergic controls were not. Because cobalt chloride, potassium dichromate, formaldehyde, PPD, and nickel sulfate are common components of daily necessities and industrial products, our results suggest that GD may be often due to daily domestic activities rather than to NRL products. However, GD patients should undergo a patch test to detect type IV allergy to rubber additives.

In the present survey, we also try to determine the relationships between potential risk factors and latex allergy. Previously reported occupational risk factors for latex sensitization in HCWs include work in operating rooms, employment seniority, atopy, prior or current hand dermatitis, high frequency of glove use, long duration of wearing gloves, and use of powdered gloves.^{16,17} Females were generally more susceptible to develop latex allergy than males.¹⁵ In our study, the overwhelming majority of responders were females, so we excluded 338 male nurses. Others have reported that HCWs were most likely to become sensitized in operating rooms, intensive care units, and endoscopy units where levels of latex aeroallergens were higher.^{17,18} However, no significant correlation was present between working department and latex allergy in this survey. This may be due to the simple classification of surgical and non-surgical

departments in the logistic regression analysis. Consistent with previous findings,^{17,19} longer duration of employment was associated with latex allergy in this study. Atopy and preexisting hand dermatitis are common predisposing factors for latex allergy,¹² and we also found a significant correlation between positive family and personal history of allergic diseases and other allergies and latex allergy.

It is not clear to what extent various aspects of glove use can influence the development of latex allergy. In some studies, daily glove use was a significant risk factor,^{7,17} but in others the number of gloves used daily and duration of latex glove exposure were not.^{8,15} Smedley *et al.*⁸ found no significant association with the use of gloves for >1 hour in total and increase in risk from working in a room where others were wearing latex gloves.⁸ Nevertheless, the association was insignificant with the glove use for >1 hour, but the risk tended to increase with working >1 hour in a room in this study. Interestingly, the use of >5 pairs gloves daily was a protective factor. Hyperhydration of stratum corneum and damage to permeability barrier may be the most important occlusive effects of gloves on the epidermal barrier.^{20,21} We speculate that contact and/or inhalation of excessive aeroallergens may contribute to the increased risk when nursing staff spend >1 hour in a particular room. Long-term wear of latex gloves may reinforce the invasion of irritants and hydrophilic allergens on the inner surface of gloves via augmenting hand sweating and occlusion effect. By contrast, relatively frequent change of gloves can maintain the dryness of the hand and thus reduce the possibility of sensitization.

Limitations

Several limitations are present in this study. First, the symptomatic subjects were not diagnosed by SPT and/or latex-specific IgE test. Given that the sensitivity and specificity of self-reported symptoms were often low to moderate,²² the true prevalence of glove-related latex allergy in Chinese HCWs remains unclear. Second, the number of patients that underwent patch testing was not enough, thus these results may not be reflective of general patients. Lastly, in addition to the European standard series, the NRL glove extracts and rubber additive series should be served as a patch screen for rubber allergy.

Conclusion

Our results demonstrate that the clinical female nurses are at high risk for latex allergy in China though the true prevalence of latex glove allergy should be validated by objective evaluation with SPT, latex-specific IgE test, and patch test in the future. The employment seniority, positive family and personal history of allergic diseases and other allergies, and long resident time in a working room seem to be risk factors

for latex allergy, while relatively frequent change of gloves may be protective. Nurses who develop latex-related symptoms after exposure to latex gloves should undergo the screening tests for latex allergy. In order to reduce the prevalence of latex allergy, it is advocated that low-protein, powder-free NRL gloves or latex-free gloves should be widely adopted, along with other preventive measures in nursing activities.

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Disclosure

The authors declare no conflicts of interest.

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