

# Screening for Latex Sensitization by Questionnaire: Diagnostic Performance in Health Care Workers

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## ■ Abstract

*Background:* Latex allergy has emerged as a major cause of allergic reactions in health care workers. However, information is limited regarding the diagnostic methods available.

*Objective:* The aim of this study was to investigate diagnostic performance (sensitivity, specificity, and predictive values) of screening for natural rubber latex sensitization by questionnaire among health care workers, using skin prick test (SPT) as the gold standard for diagnosis.

*Methods:* The study population consisted of 260 randomly selected health care workers from the public health units in the city of Florianópolis, Brazil. The subjects were recruited from 2 groups: those who used latex gloves in their work (140) and those who were not exposed to latex (120). The mean (SD) age of the study population was 38.6 (0.6) years. Logistic regression analysis was used to predict SPT result from the questionnaire on previous symptoms of latex sensitization.

*Results:* Symptoms of (1) dryness, fissuring, swelling, pruritus, or cutaneous rash on the hands, and (2) pruritus of the oral mucosa or local redness after eating certain fruits (avocados, bananas, kiwis, chestnuts, mango, melons, or peaches) were the most sensitive and specific questionnaire items, respectively. The combination of these items with a cutoff point derived from the logistic regression led to 100% sensitivity and specificity for the prediction of SPT results in the population studied, with 95% confidence intervals of 51.7% to 100% for sensitivity and 98.1% to 100% for specificity.

*Conclusion:* A questionnaire applied in a group of health care workers displayed excellent screening performance for latex sensitization.

**Key words:** Latex allergy. Screening. Questionnaire. Health care workers.

## ■ Resumen

*Antecedentes:* La alergia al látex se ha manifestado como una de las principales causas de reacciones alérgicas entre los trabajadores del ámbito de la sanidad. Sin embargo, existe una escasa información sobre los métodos de diagnóstico disponibles.

*Objetivo:* El objetivo de este estudio fue investigar los procedimientos diagnósticos (sensibilidad, especificidad y valor diagnóstico) de la detección selectiva para la sensibilización al látex, mediante un cuestionario distribuido entre trabajadores del ámbito de la sanidad, utilizando la prueba cutánea como método de referencia para el diagnóstico.

*Métodos:* La población de estudio constó de 260 trabajadores del ámbito de la sanidad, seleccionados aleatoriamente en centros de sanidad pública en la ciudad de Florianópolis, en Brasil. Los sujetos se incluyeron a partir de dos grupos: los que usaban guantes de látex en el trabajo (140) y los que no estaban expuestos al látex (120). La media (DE) de edad de la población de estudio fue de 38,6 (0,6) años. Se utilizó el análisis estadístico de regresión logística para pronosticar el resultado de la prueba de punción, a partir del cuestionario sobre los síntomas previos a la sensibilización al látex.

*Resultados:* Los síntomas de (1) sequedad, fisuración, tumefacción, prurito o erupción cutánea en las manos y (2) prurito de la mucosa oral o rubor local después de la ingestión de ciertas frutas (aguacates, plátanos, kiwis, castañas, mangos, melones o melocotones) fueron los componentes del cuestionario más sensibles y específicos, respectivamente. La combinación de estos componentes con un valor de corte derivado de la regresión logística, llevó a una sensibilidad y especificidad del 100 % para la predicción de los resultados de la prueba cutánea en la población estudiada, con el 95 % de los intervalos de confianza del 51,7 % al 100 % para la sensibilidad y del 98,1 % al 100 % para la especificidad.

*Conclusión:* Un cuestionario aplicado a un grupo de trabajadores del ámbito de la sanidad mostró unos procedimientos de detección selectiva excelentes para la sensibilización al látex.

**Palabras clave:** Alergia al látex. Detección selectiva. Cuestionario. Trabajadores del ámbito de la sanidad.

## Introduction

Latex sensitization has emerged as a major cause of allergic reactions. Clinical manifestations of immunoglobulin (Ig) E-mediated latex allergy include hand dermatitis, rhinoconjunctivitis, asthma, food allergy, angioedema, and anaphylaxis [1,2].

Exposure to latex is known to be high in some specific groups such as health care workers who have regular contact with latex gloves, patients with urogenital abnormalities who have undergone frequent surgical procedures, and workers in the rubber industry [1]. The prevalence of latex allergy in health care settings is affected by several factors, including atopy, frequency of glove use, prior or current hand dermatitis, and the length of professional exposure [1-3]. The prevalence tends to be higher in health care workers than in the general population, although the results vary considerably across countries: 2.6% [4] to 17% [5] in Europe, 6.1% [6] to 30% [7] in the USA, and 8% in Brazil [8].

The diagnosis of latex allergy is complicated by the presence of cross-reactions with a large number of fruits and vegetables such as avocado, banana, kiwi, papaya, tomato, sweet pepper, and chestnut, sometimes referred to as the "latex-fruit-syndrome" [9-11]. The best diagnostic method for latex allergy is still a subject of debate. The diagnosis typically begins with a clinical history linking latex exposure and symptoms of allergy, followed by confirmatory skin and serologic test responses for latex-specific IgE antibody levels [12,13]. Skin prick test (SPT) is considered the gold standard for assessment of patients at high risk of latex allergy due to its high specificity and sensitivity compared to serological tests using anti-IgE antibodies [12,13]. However, it is not practical for screening purposes when patient risk status is unknown. Therefore, there is an increasing need for a screening instrument for latex sensitization that is simple to administer and provides quick results, such as a short questionnaire. However, surprisingly few publications have explicitly addressed the issues of the sensitivity, specificity, and predictive values of such a questionnaire.

The objective of this study was to investigate diagnostic performance (sensitivity, specificity, and positive and negative predictive values) of a short questionnaire for natural rubber latex sensitization among health care workers using SPT as the gold standard.

## Subjects and Methods

This study was conducted between May 2004 and April 2005 in a random sample of 23 out of 49 public health units in Florianopolis, Brazil. All 328 subjects who worked in the selected units were invited to participate in the study. After a brief explanation of the research project, they were invited to fill in a questionnaire on symptoms suggestive of latex allergy; the questionnaire took approximately 5 minutes to complete. There were no refusals to respond to the questionnaire. After applying exclusion criteria (use of  $\beta$ -blockers, antihistamines, tricyclic antidepressants, or corticosteroids in the 3 weeks prior the study, as well as pregnancy or breast feeding), 260 of the 328 individuals remained in the study and underwent SPT. The duration of SPT was 15 minutes on average for each test.

The study was performed in compliance with the Declaration of Helsinki (1964) [14] and the design was approved by the local ethics committee and included informed consent from all participants.

The subjects were recruited from 2 groups with known differences in occupational exposure to latex: health care workers (nurses, pharmacists, physicians, dentists, and laboratory assistants) who had frequent contact with gloves or latex products and health care workers involved in administration (health unit director, accountant, financial director, and administrative assistant), who did not have frequent contact with gloves or latex products.

The questionnaire was adapted from the American Clinical Association of Allergy, Asthma and Immunology guidelines for latex allergy [15]. The questionnaire asked about age, sex, job category, current latex-glove-allergic symptoms, weekly frequency and daily hours of latex glove use, family and personal histories of allergic disorders (including asthma or rhinitis), symptoms of hand dermatitis (dryness, fissuring, swelling, pruritus, cutaneous rash), symptoms of fruit allergy (pruritus of the oral mucosa or local redness after eating avocados, bananas, kiwis, chestnuts, mango, melons, or peaches), multiple surgical interventions, sneezing or rhinorrhea associated with airborne glove powder or toy balloons containing latex allergen, immediate systemic, ocular, nasal, or pulmonary complaints, itching or redness associated with the use of condoms containing latex, direct mucosal or parenteral exposure to latex during medical procedures, or exposure to latex products such as diaphragms, balloons, shoe soles, rubber handles, rubber bands or elastics, or clothing (Table 1).

SPT was performed with disposable sterile lancets on the volar surface of the forearm with latex antigen containing 2 mg of latex mix (Allergofar, Rio de Janeiro, Brazil). Histamine at 10 mg/mL (Allergofar, Rio de Janeiro, Brazil) and a sterile saline solution (NaCl, 0.95%) were used as positive and negative controls, respectively. SPT was considered positive when wheal diameters of at least 3 mm were obtained 15 minutes after puncture [16]. The tests were done in a room with access to emergency equipment and medical support.

Statistical analysis included descriptive statistics of demographic and clinical characteristics of the population and logistic regression to predict SPT result from the questionnaire containing specific "yes/no" questions for past experiences with allergy. Statistical differences between variables were analysed by the  $\chi^2$  test. Various questionnaire items were tested, both separately and in combination, in order to identify those with best sensitivity, specificity, and predictive values. A range of probability cutoff points from 0.1 to 0.5 was tested.

## Results

The final study group consisted of 260 subjects, of which most (80%) were women. The mean (SD) age of the subjects was 38.6 (0.6) years. There were no statistically significant differences in age distribution between health care workers who had been frequently exposed to latex gloves and those without this level of exposure ( $\chi^2$  with 5 degrees of freedom = 1.83,  $P = .872$ ). However, there were more women in the group

Table 1. Questionnaire on Natural Rubber Latex Sensitization<sup>a</sup>

I. Demographic Characteristics		Sex: Female	Male	Age	(years old)
Name	Job category				
Latex glove use	1-3 hours/day	3-5 hours/day		> 6 hours/day	
II. Risk Factor Assessment/ Exposure History					
Are you a health care worker?				Y	N
Do you wear latex gloves regularly or are you otherwise exposed to latex regularly?				Y	N
Do you have any history of eczema or other rashes on your hands?				Y	N
Do you have a medical history of frequent surgery or invasive medical procedures?				Y	N
Did these take place when you were an infant?				Y	N
Do you have a history of "hay fever" or other common allergies?				Y	N
Do your fellow workers wear latex gloves regularly?				Y	N
Do you take a beta-blocker medication?				Y	N
III. Circle any foods below that cause hives, itching of the lips or throat, or more severe symptoms when you eat or handle them Apple, apricot, avocado, banana, carrot, celery, cherry, chestnut, fig, kiwi, grape, hazelnut, melon, nectarine, papaya, passion fruit, pear, peach, pineapple, plum, potatoes, tomatoes					
IV. Hand Dermatitis Assessment					
Do you have rash, itching, cracking, chapping, scaling, or weeping of the skin from latex glove use?				Y	N
Have these symptoms recently changed or worsened?				Y	N
Have you used different brands of latex gloves? If so, have your symptoms persisted?				Y	N
Have you used non-latex gloves? If so, have you had the same or similar symptoms as with latex gloves?				Y	N
Do these symptoms persist when you stop wearing all gloves?				Y	N
When you wear or are around others wearing latex gloves do you get hives, red itchy swollen hands within 30 minutes or, "water blisters" on your hands within a day?				Y	N
V. Aerosol Reaction Assessment					
When you wear or are around others wearing latex gloves, have you noted any:					
• Itchy, red eyes, fits of sneezing, runny or stuffy nose, itching of the nose or palate?				Y	N
• Shortness of breath, wheezing, chest tightness or difficulty breathing?				Y	N
• Other acute reactions, including generalized or severe swelling or shock				Y	N
VI. History of Reactions Suggestive of Latex Allergy					
Do you have a history of anaphylaxis or of intra-operative shock?				Y	N
Have you had itching, swelling or other symptoms following dental, rectal or pelvic exams?				Y	N
Have you experienced swelling or difficulty breathing after blowing up a balloon?				Y	N
Do condoms, diaphragms or latex sexual aids cause itching or swelling?				Y	N
Do rubber handles, rubber bands or elastic bands or clothing cause any discomfort?				Y	N

<sup>a</sup>Adapted from the American Clinical Association of Allergy, Asthma and Immunology guidelines for latex allergy [15].

with frequent exposure to latex (89%) than in those without (68%), and this difference was statistically significant ( $\chi^2$  with 2 degrees of freedom = 18.96,  $P < .001$ ). Among health care workers using latex gloves at work regularly, the average daily use was 3.5 hours.

Symptoms of hand dermatitis and of fruit allergy were the most sensitive and specific questionnaire items, respectively (Table 2). Combining the symptoms of hand dermatitis and fruit allergy on the basis of logistic model parameters, a 100% sensitive and specific screening for SPT was achieved in the sample analysed, with 95% confidence intervals (CI) of 51.7% to 100% for sensitivity and 98.1% to 100% for specificity. A simple rule was derived to predict SPT-positive cases, where only those who reported any of the symptoms of hand dermatitis listed above and satisfied the following equation were considered true SPT positive cases:

$$\{[e^{**}(k - 2.8717)] / [1 + e^{**}(k - 2.8717)]\} > 0.1$$

where  $e$  is the base of the natural logarithm,  $**$  is the exponential, and  $k$  takes the value of 1 if fruit allergy was reported or zero otherwise.

## Discussion

Powdered latex gloves have been identified as a major source of occupational allergenic exposure because they contain water-soluble proteins responsible for antigenic sensitization [1]. Increased use of latex gloves has been associated with an increase in the number of reported cases of latex sensitivity [4-8]. A previous study by our research group provided clear evidence of an association between latex allergy and symptoms of hand dermatitis, which affected 57% of the health care workers in Florianopolis, Brazil and was considered the greatest risk factor for an individual to develop latex allergy [3]. In the present study

**Table 2.** Sensitivity, Specificity, and Positive and Negative Predictive Values of Some Symptom Checklist Items Based on Results of Skin Prick Testing

Symptom Checklist	SPT <sup>a</sup>		Diagnostic Performance <sup>b</sup>			
	+	-	Sensitivity	Specificity	PPV	NPV
Hand dermatitis symptoms <sup>c</sup>	+ 6 - 0	72 182	100 (51.7-100)	71.7 (65.6-77.0)	7.7 (3.2-16.6)	100 (97.4-100)
Reaction to aerosol	+ 3 - 3	48 206	50.0 (13.9-86.1)	81.1 (75.6-85.6)	5.9 (1.5-17.2)	98.6 (95.5-99.6)
Fruit allergy symptoms <sup>d</sup>	+ 3 - 3	31 223	50.0 (13.9-86.1)	87.8 (83.0-91.4)	8.8 (2.3-24.8)	98.7 (95.9-99.7)
Any of the above	+ 6 - 0	110 144	100 (51.7-100)	59.4 (53.1-65.5)	5.5 (2.3-12.1)	100 (96.9-100)

Abbreviations: SPT, skin prick test; PPV, positive predictive value; NPV, negative predictive value.

<sup>a</sup>Data are shown as number of patients.

<sup>b</sup>Data are shown as % (95% confidence interval).

<sup>c</sup>Dryness, fissuring, swelling, pruritis, or cutaneous rash.

<sup>d</sup>Pruritis in oral mucosa and local redness after eating any of the following fruits: avocados, bananas, kiwis, chestnuts, mango, melons, or peaches.

we have demonstrated 100% sensitivity (95% CI, 51.7% - 100%) for reporting hand dermatitis and 87.8% specificity (95% CI, 83% - 91.4%) for reporting fruit allergy when SPT was used as the gold standard (Table 2). Other studies of health care workers reported a 62% incidence of hand dermatitis symptoms associated with the use of latex gloves in 1996 [17] and a 37% prevalence of hand dermatitis in a hospital setting [8]. In a prospective study of patients with latex allergy in Spain, based on SPT as the gold standard for diagnosis of latex allergy, the authors also achieved a sensitivity of 98% and a specificity of 100% [12].

Fruit allergy can be suggestive of latex sensitization. Reports of fruit intolerance include avocados, bananas, kiwis, chestnuts, mangos, melons, and peaches [9]. Latex-fruit syndrome is a well-defined disorder affecting patients with latex allergy [10,11]. Buss and Fröde [3] also showed that 23% of health care workers in Florianopolis, Brazil who were considered at risk for development of latex sensitization also had some kind of fruit allergy symptoms (pruritus of the oral mucosa or local redness after eating avocados, bananas, kiwis, chestnuts, mango, melons, or peaches). The high specificity (87.8%) for fruit allergy observed in our study (Table 2) can be explained by the fact that hevein protein is present both in some fruits (avocado, banana, kiwi, chestnuts, mango, melons, and peaches) and in latex gloves [10,11,18,19].

Blanco et al [12] reported a sensitivity of 98% and a specificity of 100% for SPT with natural latex extract in 50 patients with a clinical history suggestive of latex allergy in the allergy department of a university hospital in Spain. In contrast, latex-specific IgE determinations performed in that study showed a sensitivity of 86% with the CAP system and 84% with the AlaSTAT assay [12]. Other studies reported that skin testing provides significantly higher sensitivity (93% vs 95%) [13,20] and specificity (100%) [13,20] than does anti-latex IgE serologic testing in North America and Europe [21].

Our study is not the first to demonstrate that questionnaire items on hand dermatitis and previous fruit allergy identify

those at risk of further latex sensitization with precision. Other studies have also shown good sensitivity (84%) and specificity (98%) of a postal questionnaire as an indicator of latex allergy among health care workers [22], as well as high specificity (94%) and poor sensitivity (58.3%) of a questionnaire screening for latex allergy among dentists when SPT was used as the gold standard [23]. The latter study also showed a very low positive predictive value (18%) and a very high negative predictive value (98.8%) of the questionnaire.

Compared to in vitro serologic assays, SPT offers the advantages of being substantially more sensitive, cheaper, easier to perform, and of providing more immediate results [12,13,20-25]. It is these characteristics that provide the basis for using it as the gold standard in the diagnosis of latex allergy [22,23].

Another study using a questionnaire and SPT to screen for latex sensitization in a population with chronic latex exposure showed that the prevalence of latex sensitization was 11.4% in children with spina bifida and in rubber and doll-manufacturing workers [26]. In patients with spina bifida, the prevalence of latex sensitization varies from 16.7% to 56.3% [26-30]. In this context, Pires et al [28] showed that multiple interventions and higher levels of total serum IgE are significant and independent risk factors for latex sensitization in children with spina bifida.

Despite the limitations of our study, which used the same subjects to derive the SPT prediction algorithm and to test its diagnostic performance, the results suggest that questionnaire screening for latex allergy is a viable approach. A cross-validation of the questionnaire in future studies is likely to provide more accurate measures of its diagnostic performance. The findings of our study underline the potential of such a screening instrument in hospital settings where many patients are likely to be subjected to medical procedures that use natural rubber latex products.

In conclusion, a questionnaire on past symptoms of latex allergy can be an important tool to aid diagnosis of latex sensitization in health care workers. This screening method can also pave the way

for patient understanding and management of latex allergy reactions on a daily basis, thus preventing serious complications. Other groups considered at risk to develop latex allergy should be evaluated by this method to validate the results obtained.

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