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A cross-sectional study into the correlation of common household risk factors and allergic rhinitis in Taiwan's tropical environment

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ABSTRACT

Objective: To discuss the effect of lesser-known potential risk factors, such as bedroom showers, on the prevalence of allergic rhinitis.

Method: A cross-sectional, population-based study was performed using both survey and fungal culturing in southern Taiwan. There were 998 participants enrolled in the survey, and 513 sets of fungal culture obtained. With score for allergic rhinitis (SFAR) more than 7, the patient was defined to have allergic rhinitis. Risks of allergic rhinitis were calculated as odds ratios for various predicted risk factors by logistic regression. Correlation between predicted risk factors and fungal level were examined with linear regression.

Results: The adjusted odds ratio of frequently using bedroom shower to having allergic rhinitis was 1.572 (95% confidence interval: 1.090–2.265), and 0.962 for people with older age to have AR (95% confidence interval: 0.949–0.976). As to the 24-hour fungal level, the standardized coefficient was 0.254 for frequent use of bedroom shower, and 0.106 for window open hours.

Conclusions: Use of bedroom shower is a potential risk factor for allergic rhinitis development.

1. Introduction

Over the past few decades, atopic disorders have shown a gradual rise in prevalence among the global population. Studies across numerous nations have suggested an increasing trend of atopic disorders, such as asthma and allergic rhinitis (AR). Furthermore, allergic rhinitis has now been identified as one of the most common disease among several nations across the globe [1,2]. The ARIA update in 2008 have estimated about 400 million people suffered from AR globally [1]. In the United States, allergic rhinitis has been recognized as the most common atopic disorder in the country, with the number of individuals with AR-associated symptoms reaching up to at least 35.9 million persons [2]. In Taiwan, a national study from 2000 to 2007 has identified the prevalence of AR to be about 26.3% of the total population [3].

Studies into the possible risk factors of allergic rhinitis have identified dampness and mold contamination of indoor environment as one of the primary risk factors for AR development [4–9]. Correlations between AR and 'signs of dampness', including the presence of mold spots, moldy odor, and water damage, were observed in the abovementioned studies. Further investigation into the relationship of indoor fungal level and home dampness revealed positive correlation between the two

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factors [10–12]. Examinations, under lab setting, of the effect of humidity on fungal growth provided further evidence that humidity served as an important factor for propagation of mold species [13,14]. Other additional investigation carried out in countries and locations with higher relative humidity have also shown increased ambient fungal level compared to other locations with lower humidity [7–15]. Taiwan, being a tropical island, has on average relatively high humidity all year round. Heavy seasonal rain, humid seasonal monsoon, and warm ocean current have all contributed to Taiwan's high humidity (about 70–85% average relative humidity all year) [16,17]. Taiwan's high average humidity and temperature provided an ideal condition for the growth of fungus.

The majority of current studies into the relationship of AR and indoor dampness have usually characterized 'dampness' under several home environmental characteristic. The most common characteristics referred to the presence of 'mold spots', 'moldy odor', and 'water damage' as defining traits of 'dampness' [5,7,9,18]. However, very little was known about other less-concerned source of indoor dampness. One such possible source was the presence of shower in the bedroom. Bedroom was where the majority of our time were spent (with a large portion of time spent sleeping in the bedroom). The en suite type bedroom usually featured shower and bathroom within the bedroom for easier access and better privacy for bedroom occupants. The frequent use of shower in bedroom could produce high level of humidity in the bedroom, making it a potential source of indoor dampness. The accumulation of humidity from shower could have provided ideal growth condition for mold species. As a result, mold contamination of the bedroom could occur. This was especially applicable in Taiwanese household due to Taiwan's already-high average humidity.

In addition to home dampness and fungal growth, previous studies have also identified poor home ventilation as possible risk factor for AR [9,19–23]. In this regard, several studies have indicated that poor air flow rate between indoor and outdoor air could result in the trapping of indoor allergens, including mold spores, house dust mites (HDM), and air moistures [22,23]. On the contrary, improved ventilation promoted air exchange between indoor and outdoor air, allowing the dispersion of indoor allergens outside.

All in all, this study aimed to investigate the relationship between prevalence of allergic rhinitis with several little-understood potential indoor risk factors. The investigation of vaguely-understood potential risk factors could offer new insights into enacting better preventive measure against AR risk factors, allowing for more effective home improvement plan and treatment of AR through environmental improvement. The identification of new AR risk factors could also provide additional information on the ever-expanding data on indoor risk factors, and allowed the establishment of better architectural and home-design guidelines in order to minimize the exposure of allergens to home occupants.

2. Materials and methods

2.1. Study design and sample population

To investigate the correlation of AR with potential risk factors, a cross-sectional, population-based study was performed in Kaohsiung area of Taiwan. To be included in the study, participants must be of age 20 or above, and mustn't have handicaps that prevent understanding of the survey in accordance to IRB regulations. A total of 1009 participants were randomly selected for the study, but 11 were excluded due to being under the required age for inclusion. Participants included were mostly local Taiwanese, with few foreigners of American origin mixed in. The selection process consisted of a team of researchers, stationed at Anshing Clinic, Kaohsiung, who recruited any visiting patient or accompanying relative willing to participate in the study. The study was divided into 2 parts: 1) Survey investigation and 2) Mold sampling and culture. A total of 998 participants were included in the survey investigation. Out of these 998 participants, 513 also volunteered for indoor air sampling and mold cultures.

2.2. Survey investigation

The survey investigation was divided into two categories: home environment and AR status assessment. For assessment of home environment, the participants were asked about the presence of Japanese style wooden floor or wall within their bedrooms. The participants were also inquired about the presence of bathroom in the bedroom, and the frequency of the bathroom use. In addition, the participants were inquired about their habit of opening window periodically, and the number of hours the window is usually opened. Common 'signs' of indoor dampness, included mold spots, moldy odor, and water leak, were also assessed. Finally, several minor parameters were also assessed, which included participants' daily cleaning habit, recent redecoration (within the past 3 months), periodic bedding change, and age of current home. Participants and other home occupants' smoking habit were also assessed.

For the participant's AR status, the score for allergic rhinitis (SFAR), developed and proposed in Annesi-Maesano *et al.*, was used for this assessment. SFAR covered a wide range of common clinical diagnostic parameters for allergic rhinitis [24]. SFAR assessed for the participants' AR symptoms (both nasal and ocular), duration of symptoms, potential triggers, professional diagnosis, IgE/SPT test results, and family history of atopic disorders. SFAR contained a total of 16 possible points, with the cutoff point at 7 points. Individuals with SFAR higher or equal to 7 were therefore considered to have AR, and vice versa [24]. In this survey investigation, SFAR was translated into Chinese and incorporated into the survey questionnaire. English version of the survey was also available for foreign participants.

2.3. Air sampling and mold culture

In order to investigate the role of fungal growth in relation to other risk factors proposed in this study, air sample and mold culture were done to assess the fungal level of the participants' indoor air. Air sampling was done through the settled dust method. A total of 513 participants from the survey population volunteered to be given 3 Sabouraud Dextrose Agar (SDA) plates per person. The participants were instructed to place the 3 SDA plates on floor level in the center of their bedrooms with about 2 m apart from each plate. The participants were then further instructed to open the cover of the 3 SDA plates, and exposed the plates to ambient air for 3 h before re-covering the plates and returning the plates for incubation.

The recovered SDA plates were incubated for 48 h at 28–30 °C. The plates were taken out after 48 h, and the colony forming units (CFUs) were counted for all 3 plates. The average of the CFUs count from the 3 plates was calculated. Plates that