

# **Elevated Body Mass Index is associated with severity of Allergic Rhinitis: Results from a cross sectional study**

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## **Abstract**

**Background:** Allergic rhinitis is a prevalent chronic respiratory problem that can impair quality of life, sleep and work. The increase in the prevalence of allergic rhinitis among the general population appears to have an association with weight. Obese individuals are more vulnerable to allergy. Since obesity appears to be linked with the occurrence of allergic rhinitis, it is hypothesized that obesity also has an influence on the severity levels of allergic rhinitis. This study was designed to investigate the patterns and severity of allergic rhinitis patients, determine the prevalence of obesity in patients with allergic rhinitis, examine the association between the severity of allergic rhinitis and body mass index, and develop recommendations for further research.

**Methods:** This study involved a descriptive cross-sectional design. Forty five respondents aged 8 to 55 years recruited from an outpatient clinic in the Department of Immunology Fremantle Hospital from March to August 2007 completed a questionnaire, and had their height and weight measured by a trained researcher. Statistical analyses performed included chi-square, independent t-test, and logistic regression.

**Results:** Increased BMI was associated with more severe conditions (up to six fold) of both nasal and non-nasal symptoms of Allergic Rhinitis.

**Conclusions:** Weight control should be considered as a potential strategy to improve the health status of patients with Allergic Rhinitis, through the control of symptoms and the improvement of general health.

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## **BACKGROUND**

Allergic rhinitis (AR) is the most common type of rhinitis caused by antigen-antibody reaction. It is known to impair quality of life, sleep and work.<sup>1</sup> It is recognized as a global health issue, with its prevalence significantly increasing in many countries. Worldwide, it affects approximately 25% of the general population, particularly adolescents and adults.<sup>2</sup> In Australia, AR has been identified by a National Health Survey as a long term medical condition and the most prevalent respiratory problem affecting adolescents and young adults.<sup>3</sup> Although it does not usually lead to severe morbidity and mortality, the impacts of AR on health-related quality of life and the cost of treatment have substantial consequences at both the individual and community levels.<sup>5</sup> The combination of nasal symptoms of AR (sneezing, nasal itching, rhinorrhea, nasal congestion) and non-nasal symptoms (headache and sleep disturbance) can impair an individual's physical, social, occupational and emotional functions.<sup>6</sup> Reed et al<sup>5</sup> noted that an impairment of cognitive function, such as an inability to concentrate, learn or make decisions, can lead to decreased worker productivity and student performance, and hence, the impact of AR is a significant issue.

The severity of AR is considered to be an essential factor in the management of AR, regardless of what methods are used to evaluate it.<sup>7</sup> The level of severity determines the selection of appropriate treatment for patients with AR. The Allergic Rhinitis and Its Impact on Asthma (ARIA) health initiative proposed a new classification of AR based on severity.

The term 'intermittent and persistent rhinitis' was proposed to replace seasonal and perennial AR.<sup>8-11</sup> The ARIA also proposed two grades of AR severity: mild and moderate/severe.

To date, few studies have focused on assessment of the severity of AR. Exploring factors that influence the severity of this condition would be beneficial for the management of AR. Since obesity appears to have a link with the occurrence of AR<sup>12-14</sup>, it is hypothesized that obesity also has an influence on the severity levels of the condition. This paper presents the findings of a study that investigated the severity of AR symptoms, as well as the association between AR and body mass index.

## **METHODS**

### ***Sample***

Participants of the study were recruited from an outpatient clinic in the Department of Immunology Fremantle Hospital, Fremantle, Western Australia. A convenience sampling

method was used to recruit participants of the study. An inclusion criterion was developed in order to determine whether a patient was eligible to be recruited into the study.

### ***Inclusion criteria***

AR patients (perennial type with or without seasonal) in the outpatient clinic who:

- visited the outpatient clinic Department of Immunology Fremantle Hospital from March to August 2007 (20 weeks) in accordance with the schedule of the Immunology clinic (twice weekly);
- had been diagnosed by a physician (immunologists) based on the results of allergy diagnostic test (at least one type of allergy diagnostic test, either skin prick test or blood test (Radioallergosorbent test/RAST) was conducted with positive results);
- was aged 8 to 60 years;
- presented with or without co-morbidities such as asthma, sinusitis, conjunctivitis, otitis media, atopic dermatitis (eczema) and other allergies; and
- was able to give consent by themselves for those aged 18 years and older or by parents/guardians for those under 18 years old.

Physicians in the Immunology clinic assisted in the selection of potential participants who conformed to the inclusion criteria. After the referral of a potential participant, the researcher explained the reason of the study and obtained written informed consent from the potential participant or his/her guardian. Forty six patients were eligible for inclusion in the study.

### ***Study design***

The study involved a descriptive cross-sectional design. A self-report questionnaire was completed by each participant, and body weight and height were measured at the hospital by the researcher. All questionnaires returned to the researcher within the period from March to August 2007 were included (n=45/46 patients). Ethics approval was granted by the Curtin University Human Ethics Committee and all participants provided informed consent prior to involvement in the study

### ***Instrument (Questionnaire)***

A self-report questionnaire was developed to obtain information about the characteristics of AR patients. The questionnaire was divided into five sections as follows:

- Section one: demographic characteristics including age, sex, level of education, main language spoken at home;
- Section two: the history and pattern of AR  
(This section aimed to obtain information about how long the respondents have suffered from AR since the diagnosis of the condition by a doctor; the period and the pattern of the occurrence of the symptoms; the frequency of the symptoms; possible triggers of the symptoms; and the impact of the symptoms on sleep and daily activities, which are important in assessing the severity of the condition);
- Section three: the presence of comorbidities: asthma, conjunctivitis, eczema; and the family history of asthma, skin allergy and nasal allergy/hay fever;
- Section four: visual analog scales for assessing the severity of AR  
(Visual analog scales (VAS) have been recommended for evaluating the level of severity of AR symptoms according to the ARIA guidelines.<sup>15</sup> Bousquet et al.<sup>16</sup> also find that VAS is a simple quantitative method that can be used for the evaluation of AR severity in primary care settings); and
- Section five: the history and pattern of medication  
(This section aimed to obtain information about the pattern of the use of the medical treatment, including the use antihistamines, corticosteroids, and immunotherapy. The type of medical treatment used can be an indication of the level severity of AR<sup>17</sup>; for example, patients who take antihistamines only are more likely have a milder condition of AR than those who take more than one kind of treatment. The use of alternative medication such as herbal medicine was also evaluated).

The questionnaire was provided to participants when they visited the outpatient clinic. If the participants were unable to fill out the questionnaire in the clinic, a questionnaire was provided to be completed at home with a prepaid envelope. Confidentiality of data collected was maintained throughout the study and all data were de-identified in all reports and publications associated with the study.

## **Measurements**

### *Body Mass Index*

Body weight and height were measured by the researcher at the time respondents visited the clinic. Body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in meters ( $\text{kg}/\text{m}^2$ ). The standard National Institutes of Health definition of obesity<sup>18</sup> was used in assessing overweight or obesity among adults. A new international standard definition for overweight and obesity published by the International Obesity Task Force<sup>19</sup> was used in assessing overweight and obesity among children and adolescents (aged 8-18 years). Based on his/her BMI, an individual was classified into normal (BMI ranged from 18.5 to 24.9  $\text{kg}/\text{m}^2$ ), overweight (BMI 25-29.9  $\text{kg}/\text{m}^2$ ), or obese (BMI  $\geq 30 \text{ kg}/\text{m}^2$ ).

### *Level of severity of Allergic Rhinitis*

AR severity was determined by adapting a standardised questionnaire from the ARIA guidelines<sup>7</sup> and a questionnaire for AR symptoms assessment developed by the Joint Task Force on Practice Parameters, representing the American Academy of Allergy, Asthma, and Immunology, the American College of Allergy, Asthma, and Immunology, and the Joint Council of Allergy, Asthma, and Immunology<sup>15</sup>. The level of severity was determined based on nasal symptoms, non-nasal symptoms, and quality of life related to AR issues including sleep disturbance at night, impaired work performance and/or social or recreational activities.

## **Data analysis**

The association between BMI and AR severity was analysed after the respondents were divided into groups based on BMI and the level of severity. The cut-off point of BMI used in the analysis was 25  $\text{kg}/\text{m}^2$  (e.g. all else classified as overweight or obese).. Respondents were categorized into two levels of severity based on the Visual Analog Scales (VAS) for the severity of total symptoms, group symptoms (nasal and non-nasal symptoms), and individual symptoms, such as sneezing, runny nose, stuffiness, conjunctivitis, and cough. Participants scoring three or less on the VAS were categorized as having mild symptoms. Participants scoring more than three were categorized as having non-mild symptoms. Data obtained from the VAS of nasal and non-nasal symptoms were analysed using inferential statistics with the level of significance set at 0.05. In order to compare the mean of the severity level between the two groups, an independent sample t-test was utilized. Mann-Whitney U test was used to examine possible differences in the severity level of nasal and non-nasal symptoms where a

normal distribution was not assumed. Logistic regression was also used in the analysis to assess the association between BMI and the severity of AR.

## RESULTS

### *Sample recruitment*

All patients with AR who attended the Fremantle Hospital Department of Immunology between March and August 2007 were screened (n=46). Forty five patients completed the questionnaire and their height and weight were measured at the hospital. One patient chose to fill out the questionnaire at home but did not return it to the researcher. This represented a 98% response rate from patients with AR in the immunology clinic Fremantle Hospital.

### *Demographics*

More than half of the respondents were males (n = 26, 53.3%) and the remaining 46.7% were females. The mean age of the respondents was 22 years old (SD 15 years). Children and adolescents aged 8 to 17 years represented 60% (n = 27) of the sample population, with the remaining 40% adults aged 18 to 55 years.

### *Body Mass Index*

The BMI of all respondents ranged from 14.70 to 46.46 kg/m<sup>2</sup> and the mean BMI was 23.32 kg/m<sup>2</sup> (SD 6.78). The mean BMI of females was 1.99 kg/m<sup>2</sup> higher than males but it was not statistically significant (p = 0.116). Compared to children, the mean BMI of adult respondents was significantly higher (p < 0.001) with a mean difference of 7.62 kg/m<sup>2</sup> (see Table 1).

Based on his/her BMI, an individual was classified into normal (BMI ranged from 18.5 to 24.9 kg/m<sup>2</sup>), overweight (BMI 25-29.9 kg/m<sup>2</sup>), or obese (BMI ≥ 30 kg/m<sup>2</sup>). The proportion of respondents with a BMI < 25 kg/m<sup>2</sup> was 57.8% (n = 26) and the remaining 42.2% (n = 19) were those with a BMI ≥ 25 kg/m<sup>2</sup>. The proportion of overweight individuals was 26.7%; and 15.6% of respondents were obese. Due to the small sample size, respondents were commonly grouped into two groups, those who were not overweight or obese (BMI <25 kg/m<sup>2</sup>) and those that were overweight or obese (BMI ≥ 25 kg/m<sup>2</sup>). In those classified as overweight or obese (BMI ≥ 25 kg/m<sup>2</sup>), 57.9% were males and 42.1% were females. The proportion of children who were overweight or obese was almost equal to adults (47.4% vs. 52.6%) (see Table 2).

With a BMI cut-off point of 25 kg/m<sup>2</sup>, there was no statistical difference in BMI between males and females (p = 0.6) or between children and adults (p = 0.139).

#### *Characteristic of allergic rhinitis*

All respondents presented at the Immunology Clinic with AR symptoms (nasal symptoms, e.g. sneezing, runny nose or blocked nose) in the past 12 months. Most of the respondents (88.9%) reported that their nasal symptoms were accompanied by itchy and watery eyes (rhinoconjunctivitis).

Twenty two per cent of the respondents were newly diagnosed (one year or less) with AR and the remainder (78%) had suffered from AR for more than one year. On average, respondents had been diagnosed with AR by a doctor when they were 12 years old (12.6 ± SD 10.4).

Perennial AR was the most common type in the study population (88.9%). In respondents who had the symptoms all year round, 70% reported having worse symptoms during a particular season (perennial AR with seasonal exacerbation), mainly in spring and summer. Five out of 45 respondents (11.1%) reported having nasal problems during the same season each year (seasonal AR), particularly in September to November (spring season) or in May (fall season). In addition, 8.9% of respondents were classified with occupational AR as their nasal symptoms mainly occurred during the working day and then disappeared on weekends or holidays.

Most of respondents reported having nasal symptoms daily (46.7%) and a few times each week (31.1%). The remainder (22.2%) had symptoms less often: weekly (6.7%); monthly (8.9%); and a few times each year (6.7%). Using the ARIA guidelines, the respondents can be classified into two groups: first, a persistent group - those who have daily symptoms and symptoms a few times each week (77.8%); and second, an intermittent group (22.2%) - those who have symptoms less often.

#### *Comorbidities*

Of the four common comorbidities of AR evaluated in this study, 88.9% of respondents (n=40) reported allergic conjunctivitis symptoms (conjunctivitis symptoms with swelling of eyelids), 95.6% (n=42) reported conjunctivitis symptoms (watery and itchy eyes, redness), 62.2% (n=28) had asthma and 62% of respondents (n = 28) reported sleep disturbances. This



last finding was different from the respondents' answers in the VAS where more details of what kinds of sleep problems were provided. Data obtained from the VAS showed that 77.8% (n=35) of respondents reported a sleep problem regardless of the severity level of AR. The majority of respondents (n = 37, 82%) reported that their nasal problems disturbed their daily activities, school, work, leisure, or sport. The impact of this disturbance varied from a little (n=16, 43%), to moderate (n=16, 43%) or a lot (n=4, 14%).

#### *Severity levels of allergic rhinitis*

There were two ways of assessing respondents' severity levels used in the questionnaire. The first was by using the VAS, which provide more detailed information of severity levels for each nasal and non-nasal symptom. Table 3 shows the summary of the findings of the VAS. The second method was by using the following questions: 'In the past 12 months, how often did these symptoms occur?' (Question.7); 'In the past 12 months, have these nose problems accompanied by sleep disturbance?' (Question 9); and 'In the past 12 months, how much has this nose problem interfered with your daily activities, and/or school, and/or work, and/or leisure, and/or sport?' (Question.10).

According to the ARIA guidelines, individuals with AR can be classified into four groups: mild intermittent, mild persistent, moderate/severe intermittent, and moderate/severe persistent. Based on respondents' answers from the VAS and Questions. 7, 9 and 10, all respondents could be classified into the moderate/severe group. Most of them (77.8%) fell into the moderate/severe persistent group and the remaining 22.2% were moderate/severe intermittent.

When respondents were asked to rate the impact of both nasal and non-nasal symptoms severity on their general health condition (global assessment, Question 21), they reported that, on average, they could tolerate the symptoms and were not severely affected by the symptoms (mean score 3.8 out of 7; where score 1 means severely affected and score 7 means excellent condition). Although respondents who were overweight or obese ( $BMI \geq 25 \text{ kg/m}^2$ ) had a higher mean score (4.1) than those with  $BMI < 25 \text{ kg/m}^2$  (mean score 3.7), the mean difference was not statistically significant ( $p = 0.415$ ).

### **Association between comorbidities of allergic rhinitis and body mass index**

There were no significant associations between BMI and physician-diagnosed asthma, eczema and allergic conjunctivitis, however a significant association ( $p = 0.029$ ) was found between BMI and sleep disturbance based on VAS. Table 4 shows that almost all respondents with a BMI  $\geq 25$  kg/m<sup>2</sup> (94.7%) reported sleep problems; yet the proportion of those with a BMI  $< 25$  kg/m<sup>2</sup> who experienced sleep problems was also high (65.4%). Compared to other comorbidities, sleep disturbance was more likely to occur in those with a high BMI. The risk of experiencing sleep disturbance in respondents who were overweight or obese was 10 times higher (OR 9.524, 95% CI 1.088-83.333) than those who were normal weight.

### **Association between the severity levels of allergic rhinitis and body mass index**

There were two types of analyses used to explore the association between the severity levels of AR and BMI: non-parametric (chi-square test) and logistic regression.

#### *Non-parametric analysis*

BMI had a significant association with all AR symptoms (the total of nasal and non-nasal symptoms) and non-nasal symptoms when analysing VAS data only (see Table 5). Individuals with a BMI  $\geq 25$  kg/m<sup>2</sup> had six times greater risk of having more severe conditions of all AR symptoms ( $p = 0.024$ ) and 3.5 greater risk of having more severe non-nasal symptoms ( $p = 0.047$ ) than those with a BMI  $< 25$  kg/m<sup>2</sup>. Table 5 shows the association between BMI and the severity level of AR among respondents.

The severity levels of itchy nose, chronic cough, ear symptoms (e.g. itching, popping, fullness, and decreased hearing), headache, mental function (e.g. difficulties to concentrate, learning impairment), and sleep disturbance seemed to have an association with BMI. Even though there was no statistical significance found in this individual symptom analysis, a high BMI may lead to a higher risk of more severe conditions of these symptoms particularly in non-nasal symptoms as shown in Table 6. For example, individuals with a BMI of 25 kg/m<sup>2</sup> had a 2.7 fold greater risk of experiencing chronic cough, a non-mild symptom.

#### *Logistic regression analysis*

A logistic regression analysis showed that BMI was significantly associated with the severity of total symptoms of AR ( $p = 0.031$ ) with a crude odd ratio (OR) of 6.233 (95% CI 1.186-32.748). When it was tested with potential confounders (age, sex, asthma, or history of

immunotherapy), none were statistically significant ( $p > 0.05$ ). Therefore, age, sex, asthma or history of immunotherapy were not confounders in the association between BMI and the severity of total symptoms of AR.

A second significant result was obtained from a logistic regression analysis for the severity of non-nasal symptoms and BMI ( $p = 0.03$ , adjusted OR 4.650) where sex was found to be a significant confounder in this association. Being a female with a BMI  $\geq 25$  kg/m<sup>2</sup> was associated with a more than four times greater risk of having more severe conditions of non-nasal symptoms. In contrast, there was no significant association between BMI and the severity of nasal symptoms using logistic regression analysis. Furthermore, none of the potential confounders were statistically significant in this association.

### **Limitations of the study**

There are limitations to the conclusions that can be drawn from this study. Firstly, the convenience sampling used in this study was a non-probability approach that may lead to sampling bias. Secondly, although this study included all but one of the patients who presented with AR (based on the inclusion criteria) to this major immunology clinic, the sample size was relatively small ( $n=45$ ) thus limiting the general applicability of the findings of the study. A small sample size may also lead to some limitations in the application of quantitative analysis. Due to the small sample size, no stratified analysis was conducted. Thirdly, the measurements in this study were conducted at one point of time (cross sectional) and thus, the probability of recall bias was high. Respondents often have trouble answering symptoms-related questions, particularly when completing visual analog scales (VAS), because the frequency and severity of allergic rhinitis symptoms could fluctuate over time. Fourthly, the severity of the symptoms was assessed based on subjective measurements. Therefore, the responses given by the respondents may not be consistent to represent the real condition of the respondents.

It should be noted that the immunology clinic from which the sample were recruited is in one of the major hospitals in WA and all but one of the eligible patients who attended the clinic participated in the study. While this study had some limitations, the findings suggest validation by further research is worthwhile.

## DISCUSSION

The aim of this study was to investigate the association between AR and body mass index. To achieve this, finding the characteristics of individuals with AR, including the demographic factors, comorbidities and the severity of the condition, and observing obesity-related issues among respondents were considered to be essential.

### *Characteristics of patients with allergic rhinitis*

The first characteristic of interest in patients with AR was age. This study found that the majority of patients with AR in the Immunology Clinic Fremantle Hospital were children (n = 27, 60%). This is in agreement with the findings of the National Health Survey where the prevalence of AR was high in children and adolescents.<sup>3, 4</sup> Furthermore, this study also observed that, on average, the symptoms of AR started at a young age, where the mean age of being first-diagnosed with AR was 12 years old ( $\pm 10$  years). Huurre et al<sup>20</sup> argued that typically, AR symptoms begin during childhood and continue into adulthood. Thus, a high prevalence of AR in children and adolescents can be attributed to the natural history of AR. A high proportion of children in this study may also be attributed to parents' decisions to take their children to the specialised clinic for better treatment of AR symptoms. AR is known to have an impact not only on children's daily activities, social and emotional functions, and their performance at school (inability to learn and concentrate)<sup>6, 21</sup>, but it may also affect parents productivity<sup>22</sup>.

The second characteristic of interest was gender. As reported by several epidemiological studies, the prevalence of AR was slightly higher in males than females.<sup>11, 20, 23</sup> In this study, the proportion of male and female respondents was almost equal (53% vs. 47%). This suggests that females may have the same risk as males in developing AR.

Another point of interest was comorbidities. All respondents reported that they had at least one comorbid condition. Conjunctivitis was the most common comorbidity among respondents (n = 42, 96%). This finding is in agreement with other studies where rhinitis often coexists with conjunctivitis.<sup>7, 24, 25</sup> That is why rhinoconjunctivitis has been frequently used as a dependent variable in surveys of AR or atopic diseases, such as the ISAAC and the European Community Respiratory Health Survey (ECRHS), instead of using rhinitis only.<sup>7, 24</sup> Although the majority of respondents in this study had eye symptoms, only one third of them reported that they had been diagnosed with allergic conjunctivitis. There are two reasons why

the prevalence of allergic conjunctivitis is often underestimated. Firstly, conjunctivitis symptoms with/without allergy, such as red and/or itchy eyes, have been considered to be less important than other symptoms by patients with rhinitis and/or asthma and it is more likely that patients do not report this problem spontaneously.<sup>7</sup> Secondly, allergic conjunctivitis can present with a variety of signs, symptoms, and responses to treatment. Thus an accurate history of the symptoms presented and a thorough eye examination are required to avoid misdiagnosis.<sup>26</sup>

This study also shows that sleep disturbance was a major issue in patients with AR. Almost all respondents who were overweight or obese (95%) reported sleep problems. It has been known that a high body mass index is strongly associated with sleep disturbance.<sup>27-30</sup> However, this study showed that not only those who have a high BMI experienced sleep disturbance, as it was also prevalent in those with normal weight. Almost two third of respondents (65%) with normal weight reported the same problems. This finding suggests that sleep disturbance is an important issue in individuals with AR, regardless of their BMI.

Compared to those who were normal weight, respondents who were overweight or obese had a 10 fold greater risk of experiencing sleep disturbance. There were two factors why those with AR and also a high BMI were more susceptible to experiencing sleep problems. Firstly, a high BMI has a significant impact on sleep and secondly, as illustrated above, AR itself has a direct impact on sleep.<sup>21, 31-33</sup> The combination of these two factors can lead to a more severe sleep disturbances among individuals with AR and also a high BMI. Milder sleep problems were more likely to occur in those with a normal BMI. However, this study cannot explain which factor, obesity or AR, had the dominant role in the development of sleep disturbance.

### ***Obesity in patients with allergic rhinitis***

Obesity was a significant issue among respondents in this study. The prevalence of overweight or obese (BMI  $\geq$  25 kg/m<sup>2</sup>) was high in both children and adults regardless of sex. One in three children was overweight or obese (33%). One in two adults (55.7%) was overweight or obese; and at least, one in four adults (28%) was classified as obese (BMI  $\geq$  30 kg/m<sup>2</sup>). The prevalence of overweight or obese in adults observed in the latest National Health Survey (1994-1995) was similar to this study. In the National Health Survey, the prevalence of overweight or obese observed was, on average, 53.5% (62% of males, 45% of

females). This finding is also in agreement with Seidell and Flegall<sup>34</sup> where the prevalence of overweight or obese appeared to have a link with age. As age increased, the prevalence of overweight or obesity also increased.

High childhood obesity was also observed in this study. The prevalence of obesity among children in this study (7.4%) is similar to the findings of a cross-sectional survey of 2184 children in Victoria, Australia where the prevalence of obesity was 7.6 ( $\pm$  0.6%).<sup>35</sup> It confirms that high childhood obesity is evident at the population level and thus, is one of the major public health problems in Australia.

### ***Obesity and the severity of allergic rhinitis***

Based on the ARIA classification, the severity level of all respondents in this study was moderate/severe, where most of them (78%) presented with persistent rhinitis and the remainder (22%) with intermittent rhinitis. This finding is in agreement with the findings of a cross-sectional study in France<sup>9</sup> where the majority of AR patients who visited specialist clinics had severe symptoms; and persistent rhinitis was more prevalent than intermittent rhinitis in the study population. Bousquet et al<sup>9</sup> argued that most patients with AR who consulted with a specialist present with severe and/or persistent symptoms.

This study found that there was a significant association between the severity of AR and BMI. Respondents who were overweight or obese had a six times greater risk of having more severe conditions of all AR symptoms ( $p = 0.024$ ) than those with normal weight ( $BMI < 25 \text{ kg/m}^2$ ), where age, gender, asthma or immunotherapy was controlled for. In the analysis of symptom groups (logistic regression), a significant result was found in non-nasal symptoms only. Respondents who were overweight or obese had a 3.5 times greater risk of having more severe non-nasal symptoms, such as ocular symptoms, cough, ear symptoms and headache. The risk increased when gender was put into the model (adjusted OR 4.650, 95% CI 1.156-18.700,  $p=0.03$ ). Being an overweight or obese female was associated with a more than four times greater risk of having more severe non-nasal symptoms. In contrast, the association between BMI and the severity of nasal symptoms was not statistically significant (crude OR 1.382, 95% CI 0.340-5.617,  $p=0.62$ ).

In the analysis of individual symptoms, it was evident that, compared to those with normal BMI, respondents who were overweight or obese were more likely to experience more severe

conditions of the following symptoms: itchy nose (OR 1.589, 95% CI 0.459-5.498); cough (OR 2.738, 95% CI 0.565-13.267); ear symptoms (OR 1.944, 95% CI 0.528-7.166); headache (OR 1.440, 95% CI 0.435-4.771); mental function (OR 1.974, 95% CI 0.562-6.939); and sleep disturbance (OR 1.179, 95% CI 0.357-3.887). Although the association between BMI and these individual symptoms was not statistically significant ( $p>0.05$ ), these findings suggest that a high BMI may play an important role in the severity of individual symptoms of AR.

Studies assessing the association between AR and BMI have conflicting results. Several epidemiological studies showed a positive association between AR and high BMI,<sup>14, 36-38</sup> whereas other studies reported that there was no association between AR and BMI<sup>39,40</sup>. While it is uncertain if BMI has an important role in the occurrence of AR, this study suggests that BMI was significantly associated with the severity of AR. Furthermore, it appears that obesity may be a potentially modifiable risk factor for AR, particularly relating to the severity of AR symptoms. Promoting healthy weight to patients with AR may have a favourable impact on controlling the severity of AR symptoms. However, further studies may need to be designed to investigate this issue further.

## **CONCLUSIONS**

Weight control should be considered as a potential strategy to improve the health status of patients with AR. This strategy could be applied together with the treatment of AR recommended by the ARIA, which includes the combination of allergen avoidance, pharmacotherapy and immunotherapy. Healthy weight may play an important role in preventing individuals with AR from experiencing more severe AR symptoms as well as reducing the risk of experiencing sleep disturbance. The possibility that AR may lead to obesity should also be considered. For example, poor sleep associated with AR could lead to reduced energy, increased stress and stress-related eating, and/or less inclination to exercise, resulting in excessive weight gain. Incorporating weight control in the management of AR is useful not only for reducing the severity of AR symptoms, but also for improving general health, including reducing the risk of obesity-related diseases, such as cardiovascular disease, diabetes, hypertension and stroke.

Within the limitations of the current study, the research provides insight into the characteristics of patients with AR and the association between BMI and the severity of AR.

These will assist in understanding and improving the management of AR. The findings of this study also have implications for future research. These relate to the extension of the focus of the research, replication of the methods used, the selection of target population and the duration of the research. Further research focusing on investigating potential factors that can contribute to the severity of AR is recommended. Furthermore, since AR is a chronic condition, the development of a long-term strategy as well as short-term strategy to manage the condition is important.

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### List of abbreviations used

**ARIA** Allergic Rhinitis and Its Impact on Asthma  
An international health initiative on allergic rhinitis which aims to educate and implement evidence-based management of allergic rhinitis in conjunction with asthma.

**ISAAC** The International Study of Asthma and Allergy in Childhood  
International collaborative research projects which focus on asthma, allergic rhinitis and eczema by promoting a standardized methodology.

**BMI** Body Mass Index  
A simple index of weight-for-height ( $\text{kg}/\text{m}^2$ ). It is commonly used to define obesity. An individual is considered obese if his/her BMI is greater than  $30 \text{ kg}/\text{m}^2$ .

**VAS** Visual Analog Scales  
A tool used to help a person rate the intensity of certain sensations and feelings, such as severity of nasal symptoms. The visual analog scale for severity of nasal symptoms is a straight line with one end meaning no problem and the other end meaning the most severe condition imaginable. A patient marks a point on the line that matches the amount of severity of nasal symptoms he or she feels.

### Competing Interests

The author(s) declare that they have no competing interests.

### Author's contributions

HA was a Masters student and carried out the data collection and analysis.

AM was HA's supervisor and assisted with the study design, methodology and analysis.

DM was the Immunologist at Fremantle Hospital assisting with the study.

CN assisted with the synthesis of material and preparation of the article.



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The patients of Fremantle Hospital Department of Immunology who gave their time

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## TABLES

**Table 1 The Body Mass Index of respondents**

	All	By sex		By age group	
		Males	Females	Children ( $< 18$ year old)	Adults ( $\geq 18$ year old)
Mean	23.3236	22.3946	24.3852	20.2730	27.8994
Median	22.1600	20.0800	22.6200	19.5400	26.8050
Std. Deviation	6.7832	7.5865	5.7288	4.5579	7.0969
Minimum	14.70	15.09	14.70	14.70	19.22
Maximum	46.46	46.46	34.25	31.23	46.46
Mean difference (p value)		1.9906 ( $p = 0.116$ )*		7.6265 ( $p < 0.001$ )**	

\* Mann-Whitney U test

\*\* T-test

**Table 2 Prevalence of overweight and obesity in patients with allergic rhinitis in Immunology Clinic Fremantle Hospital (March-August 2007)**

	Prevalence		
	Normal weight n (%)	Overweight n (%)	Obese n (%)
All	26 (57)	12 (26.7)	7 (15.6)
By sex			
Males	13 (54.2)	7 (29.2)	4 (16.7)
Females	13 (61.9)	5 (23.8)	3 (14.3)
By age group			
Children	18 (66.7)	7 (25.9)	2 (7.4)
Adults	8 (44.4)	5 (27.8)	5 (27.8)

**Table 3 Respondents' severity levels of allergic rhinitis based on 7-point visual analog scales (VAS)**

	Mean	SD
All symptoms	3.4	1.0
Nasal symptoms	4.01	1.19
Sneezing	3.83	1.47
Runny nose	4.18	1.48
Congestion (stiffness)	4.76	1.56
Itchy nose	3.81	1.85
Postnasal drip	3.49	1.87
Non-nasal symptoms	3.04	1.09
Eye symptoms	3.49	1.52
Throat symptoms	3.14	1.56
Chronic cough	2.43	1.50
Ear symptoms	2.86	1.67
Headache	2.97	1.67
Mental function	2.73	1.74
Sleep disturbance	3.63	1.94

**Table. 4 Cross-tabulation between BMI and sleep disturbance**

			BMI		Total
			< 25 kg/m2	≥ 25 kg/m2	normal
Sleep disturbance	yes	Count % within BMI_cut25	17 65.4%	18 94.7%	35 77.8%
	no	Count % within BMI_cut25	9 34.6%	1 5.3%	10 22.2%
Total		Count % within BMI_cut25	26 100.0%	19 100.0%	45 100.0%

Fisher's exact test: p = 0.029

**Table 5 Non-parametric analysis between BMI and the groups of severity of allergic rhinitis symptoms**

Severity	Chi-square (p-value)	OR	95% CI for OR	
			Lower	Upper
All symptoms	0.020 0.024*	6.233	1.186	32.748
Nasal symptoms	0.651 0.736*	1.382	0.340	5.617
Non-nasal symptoms	0.047	3.467	0.994	12.088

\* Fisher's exact test

**Table 6 Non-parametric analysis between BMI and the severity levels of each symptoms of allergic rhinitis**

Symptoms	Chi-square (p-value)	OR	95% CI for OR		
			Lower	Upper	
Nasal symptoms	Sneezing	0.912	1.071	0.316	3.636
	Runny nose	0.954	0.963	0.269	3.451
	Stiffness	0.623 0.704*	0.682	0.147	3.160
	Itchy	0.463	1.589	0.459	5.498
	Postnasal drip	0.862	0.900	0.275	2.941
Non-nasal symptoms	Eye	0.227	0.476	0.142	1.598
	Throat	0.532	0.681	0.203	2.282
	Cough	0.200 0.253*	2.738	0.565	13.267
	Ear	0.314	1.944	0.528	7.166
	Head	0.550	1.440	0.435	4.771
	Mental function	0.286	1.974	0.562	6.939
	Sleep	0.787	1.179	0.357	3.887

\* Fisher's exact test