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Evaluation of children with allergic and non-allergic rhinitis and the effect of obesity/overweight in patients with allergic rhinitis

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ABSTRACT

Aims: Allergic rhinitis (AR) and obesity are two of the most prevalent chronic health diseases in children. This report aims to investigate to types of allergic and non-allergic rhinitis (NAR) and the association between the frequency and severity of rhinitis symptoms in AR patients with and without overweight/obesity.

Methods: Patients aged 5-18 years with rhinitis symptoms who were referred to Sincan Training and Research Hospital pediatric immunology and allergy outpatient clinic were retrospectively evaluated. Demographic, clinical and laboratory characteristics of patients were recorded.

Results: The study included 385 children with a median age of 11 years (IQR8-14) (53.5% males). 31 (8.1%) of patients had atopic dermatitis and 22 (5.7 %) of patients had asthma. 283 (73.5%) patients were in the AR group. Total IgE level and eosinophil count were found significantly higher in AR group [256 (113-995) vs. 280 (160-480)] than NAR group [64 (25.5-210) vs. 170 (90-310)] (p=0.002 vs. p=<0.001). 61.3 % of patients were sensitized to grass pollen, 21% to cat, and 9.9% to house dust-mite. The number of patients with moderate-to-severe rhinitis were higher in AR group (65%) compared to NAR group (35%) (p=0.005). Nasal congestion (77.7%), sneezing (75.3%), rhinorrhea (42.6%) were more common symptoms. Postnasal drip, snoring-mouth breathing and adenoid hypertrophy were more common in the NAR group compared to AR group (p=0.011, p=0.013 and p<0.001, respectively). Among patients with AR, there were 79 (28%) patients with overweight/obesity. The rate of moderate-to-severe rhinitis was 68.4% in obese/overweight group and 63.7% in the non-obese/overweight group.

Conclusion: Our study found that moderate-to-severe rhinitis was higher in the AR group than the NAR group. No difference was found between the frequency and severity of rhinitis symptoms and aeroallergen sensitivities in patients with and without obesity/overweight.

Keywords: Rhinitis, allergic, severity, children, obesity

INTRODUCTION

Rhinitis is defined as a group of symptoms such as rhinorrhea, nasal congestion, sneezing and itching, that are caused by inflammation and/or dysfunction of the nasal mucous membranes. Roughly, rhinitis can be classified as allergic rhinitis (AR), infectious rhinitis and non-allergic, non-infectious rhinitis.[1,2] Several criteria can be used to classify phenotypes, including severity of disease (mild, moderate or severe), frequency of symptoms (intermittent/persistent), dominant symptom (nasal congestion, runny nose, sneezing, etc.) and trigger of symptoms (infectious agents, allergens, etc.).[1,2] The prevalence of AR in childhood ranges from 0.8% to 45%[3] and nowadays, it has become a very widespread disease in allergy clinics.

It is well established that obesity represents a significant global health problem. Obesity and AR are the most prevalent chronic health diseases in childhood. The frequency of both conditions is rising globally, leading to a reduction in quality of life and becoming an important public health problem. Many reports have shown the association between obesity and the development of asthma.[4,5] The effect of obesity on AR has been of interest in studies because the pathogenesis of AR and asthma is similar. It has been suggested that there is a relationship between AR and obesity, but this relationship has not been definitively proven.[6,7]

Obesity is a low-grade systemic inflammatory state characterized by altered levels of adipokines, bioactive molecules secreted by adipose tissue.[8,9] These immunological changes may decrease immunological tolerance to allergens and cause a shift toward a T Helper 2 cell immune response, which increases the risk of atopic diseases.[10] Basically, physical inactivity and lifestyle disorders occur in obesity, can lead to

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various harmful effects on the immune system. This condition may increase the incidence of allergic diseases such as AR.[11]

Obesity and AR are significant public health problems in the world therfore, determining the relationship between obesity and AR is crucial. We aimed to investigate the clinical features of patients with AR and NAR. In addition, we evaulated the relationship the severity, frequency and allergen sensitivity of rhinitis in AR patients, between overweight/obesity and non-overweight/obesity groups.

METHODS

Ethics

The present report was organised within the framework of the principles of the Declaration of Helsinki. Approval for this retrospective study was obtained from the Scientific Studies Ethics Committee of Ankara Atatürk Sanatorium Training and Research Hospital (Date: 09.10.2024, Decision No: 2024-BÇEK/151).

Study Population and Data Collection

The study included children aged 5-18 years with rhinitis who were being followed at pediatric immunology and allergy outpatient clinic at Sincan Training and Research Hospital between December 2023 and December 2024. We evaluated demographic information (age, gender, family history, etc.), anthropometric measurements, allergy history, clinical features, presence of atopic comorbidities (AD, FA, OFS), allergy tests positivity, laboratory features (total IgE values, eosinophil, neutrophil counts) from the patients' medical records. Exclusion criteria were the presence of chronic inflammatory or systemic diseases.

Determination and Classification of Patients with Rhinitis

In cases where clinical signs of rhinitis were evident, the skin prick test (SPT) and/or allergen-specific IgE were assessed. Positive values were classified as indicative of AR and negative values were classified as NAR.[12] Patients with rhinitis were divided as AR group and NAR group. AR is categorised according to symptom frequency and severity and classification were made according to ARIA criteria. Patients with AR symptoms occurring shorter than four days per week or less than four weeks were classified as having intermittent AR, while those with symptoms occuring more than four days per week or more than four weeks were categorised as having persistent AR. AR patients with at least one of the following symptoms: impairment in routine daily and sports activities, sleep disorder, impaired school performance and unpleasant symptoms are classified as moderate-severe AR while patients with none of these symptoms were categorised as mild AR.[13]

Skin Prick Tests

The SPTs were conducted using a panel of common aeroallergens [grass pollen mix (*Lolium perenne*, *Dactylis glomerata*, *Poa pratensis* ,*Phleum pratense*), *Cynodon dactylon, Dermatophagoides farinea, Dermatophagoides pteronyssinus,* cat, dog, *Alternaria alternata*, *Cladosporium herbarum,* a weed pollen mix (*Artemisia vulgaris*, *Wall pellitory, Chenopodium album), a* tree pollen mix (*Betula pendula, Corylus avellana*, *Olea europaea, cupressus)]* in the routine practice of the pediatric immunology and allergy outpatient clinic on patients with rhinits symptoms. Allergen extracts [Lofarma®, (Italy)] were performed on the volar surface of the forearm with positive and negative controls and assessed after fifteen minutes. Positive results were identified as a mean wheal diameter three mm greater than the negative control.[14,15]

Anthropometric Assessment

The body-mass index (BMI) was defined as body weight (kg) divided by height (m) and BMI (kg/m^2) was optimised as a measurement of obsesity. According to WHO growth reference values, obesity was determined as a BMI z-score greater than two standard deviations and overweight was determined as a BMI z-score greater than 1 standard deviation in children aged 5-19 years.[16]

Statistical Analysis

The statistical data analysis was conducted using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). We conducted descriptive analysis to define the demographical, immunological, clinical, and laboratory characteristics and data. We showed the values as the median and min-max for data not normally distributed. We used Pearson's Chi-square or Fisher's exact tests, Mann–Whitney U tests between-group comparisons. All statistical tests were two-sided, a p-value less than 0.05 was considered statistically significant.

RESULTS

Study Population

The study included 385 children with a median age of 11 years (IQR8-14) (53.5% males). 31 (8.1%) of patients had atopic dermatitis, 22 (5.7%) of patients had asthma, 6 (1.6%) of patients had OFS, and 4 (1%) of patients had FA. 165 (42.9%) patients had a family history of atopic diseases and 110 (28.6%) patients had a family history of AR (**Table 1**).

Comparison of Patients between AR and NAR Groups

102 (26.5%) patients were in the NAR group and 283 (73.5%) patients were in the AR group. The age of onset of AR symptoms was 6 years (IQR 4-10). There were 110 (28.6%) obese/overweight patients in all study groups. The number of patients with and without obesity/overweight was not statistically different. The family history of AR rate was higher 89 (31.4%) in the AR group than NAR group 21 (20.6%) (p=0.037). Total IgE level and eosinophil count were significantly higher in the AR group [256 (IQR 113-995) vs. 280 (IQR 160-480)] than in the NAR group [64 (IQR 25.5-210) vs. 170 (IQR 90-310)] (p=0.002 vs. p=<0.001). Age, gender and age at onset of rhinitis symptoms were not statistically different. When rhinitis severity was evaluated, the number of patients with moderate-to-severe rhinitis were higher in the AR 184 (65%) group compared to the NAR 99 (35%) group (p=0.005). There was no difference in frequency of rihinits symptomps (**Figure 1a**). Intermittent mild rhinitis (33% vs. 46.1%), intermittent moderate-to-severe rhinitis (33.6% vs. 18.6%), persistent mild rhinitis (2.1% vs.4.9%) and persistent

Table 1. The characteristics of the study group and its subgroups according to AR and NAR groups

	Total group (n=385)	NAR (n=102)	AR (n=283)	*p value
Age, year¶	11 (8-14)	10 (8-13.25)	11 (8-14)	0.321
Gender-male, n (%)	206 (53.5)	49 (48)	157 (55.5)	0.197
Breast milk intake	349 (90.6)	93 (91.2)	256 (90.5)	0.831
AD, n (%)	31 (8.1)	9 (8.8)	22 (7.8)	0.738
FA, n (%)	4 (1)	1 (1)	3 (1)	0.558
Asthma n (%)	22 (5.7)	3 (2.9)	19 (6.7)	0.159
OFS, n (%)	6 (1.6)	1 (1)	5 (1.8)	0.582
Obese-overweight	110 (28.6)	31 (30.4)	79 (27.9)	0.635
Rhinits, age at onset, year¶	6 (4-10)	6 (3-9)	6 (4-10)	0.225
Phenotypes (according to ARIA classification)				0.010
Intermittent mild	140 (36.4)	47 (46.1)	93 (33)	
Intermittent moderate-to-severe	114 (29.6)	19 (18.6)	95 (33.6)	
Persistent mild	11 (2.9)	5 (4.9)	6 (2.1)	
Persistent moderate-to-severe	120 (31.2)	31 (30.4)	89 (31.4)	
Laboratory values of patients				
Total IgE (kU/L)¶	201 (77-568)	64 (25.5-210)	256 (113-995)	0.002
Eosinophil (n)¶	250 (140-420)	170 (90-310)	280 (160-480)	<0.001
Neutrophil (n)¶	3785 (3042-5195)	4400 (3210-5790)	3740 (2951-4830)	0.249
Familial AR history, n (%)	110 (28.6)	21 (20.6)	89 (31.4)	0.037
Familial atopy history, n (%)	165 (42.9)	37 (36.3)	128 (45.2)	0.117

¶median, IQR (interquartile range); AR: Allergic rhinitis, NAR: Non-allergic rhinitis, FA: Food allergy, AD: Atopic dermatitis, OFS: Oral food syndrome, ARIA: Allergic rhinitis and its impact on asthma guidelines, *Chi-square test and Mann–Whitney U-test was used.

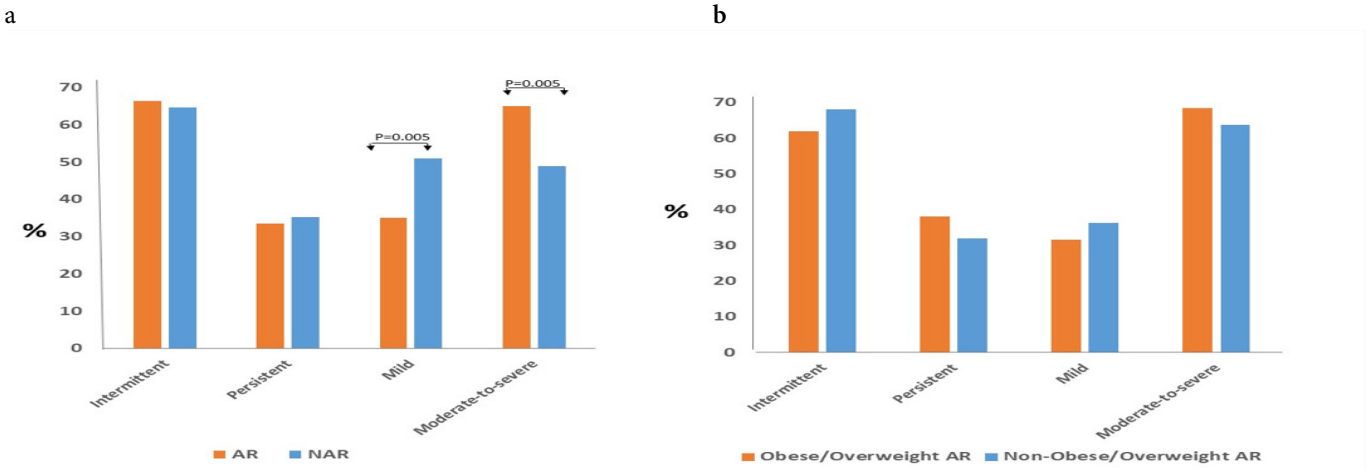

Figure 1. The comparison of severity and frequency of rhinits symptomps according to ARIA classification according to AR-NAR group (**1a**) and obese/overweight and non-obese/overweight group (**1b**)
ARIA: Allergic rhinitis and its impact on asthma guidelines, AR: Allergic rhinitis, NAR: Non-allergic rhinitis

moderate-to-severe rhinitis (31.4% vs.30.4%) were detected in AR and NAR groups, respectively (p=0.010) (Table 1).

When the symptoms of rhinitis were evaluated, nasal congestion 299 (77.7%), sneezing 289 (75.3%), and rhinorrhea 164 (42.6%) were more common symptoms in patients with rhinitis, respectively. Postnasal drip (30.4% vs. 18.4%), snoring-mouth breathing (12.7% vs. 5.3%) and adenoid hypertrophy (17.6% vs. 4.2%) were more frequent in the NAR group compared with the AR group, respectively (p=0.011, p=0.013 and p<0.001). Itchy eyes (27.6% vs.18.6%) were more frequent in the AR group compared with the NAR group (p=0.075) (Table 2).

Comparison of Patients between Obese/Overweight Group and Non-Obese/Overweight

79 (28%) obese/overweight patients were present in AR group. The age of onset of AR symptoms was lower in the obese/overweight group [6 years (IQR 3-8)] than non-obese/overweight group [7 years (IQR 4-10)] (p=0.081). Family history of atopy rate was higher (49%) in the non-obese/overweight group than obese/overweight group (35.4%) (p=0.040) (Table 3). The number of patients with moderate-to-severe rhinitis were 68.4% in obese/overweight group and 63.7% in the non-obese/overweight group. There was no statistical difference in severity and frequency of rhinits

Table 2. Allergic rhinitis symptoms of the study group and its subgroups

	Total group (n=385)	NAR (n=102)	AR (n=283)	p value	Obese/overweight AR group (n=79)	Non-obese/overweight AR group (n=204)	*p value
Nasal congestion, n (%)	299 (77.7)	78 (76.5)	221 (78)	0.736	61 (77.2)	160 (78.4)	0.824
Sneezing, n (%)	289 (75.3)	73 (71.6)	216 (76.3)	0.341	52 (67.1)	163 (80)	0.023
Rhinorrhea, n (%)	164 (42.6)	45 (44.1)	119 (42)	0.717	39 (49.4)	80 (39.2)	0.121
Cough, n (%)	130 (33.8)	34 (33.3)	96 (34)	0.914	32 (40.5)	64 (31.4)	0.145
Itchy nose, n (%)	116 (30.1)	31 (30.4)	85 (30)	0.946	22 (27.8)	63 (31)	0.617
Itchy eyes, n (%)	97 (25.2)	19 (18.6)	78 (27.6)	0.075	19 (24)	59 (29)	0.411
Watery eyes and redness in eyes, n (%)	96 (24.9)	21 (20.6)	75 (26.5)	0.237	16 (20.3)	59 (29)	0.138
Postnasal drip, n (%)	83 (21.6)	31 (30.4)	52 (18.4)	0.011	20 (25.3)	32 (15.7)	0.061
Snoring, mouth breathing, n (%)	28 (7.3)	13 (12.7)	15 (5.3)	0.013	6 (7.6)	29 (4.4)	0.284
Adenoid hypertrophy, n (%)	30 (7.8)	18 (17.6)	12 (4.2)	<0.001	2 (2.5)	10 (4.9)	0.375

* Chi-square test was used. AR: Allergic rhinitis, NAR: Non-allergic rhinitis

Table 3. The characteristics of the obese/overweight and non-obese/overweight groups

	Obese/overweight AR group (n=79)	Non-obese/overweight AR group (n=204)	*p value
Age, year¶	10 (8-12)	11 (8-14)	0.122
Gender-male, n (%)	42 (53.2)	115 (56.4)	0.626
Breast milk intake, n (%)	71 (89.9)	185 (90.7)	0.835
Height (cm)¶	142 (131-162)	145.5 (130-162)	0.809
Weight (kg)¶	48 (35-68)	39 (26-54)	<0.001
BMI (kg/m^2)¶	23.4 (21-25)	17.7 (15-19)	<0.001
AR, age at onset, year¶	6 (3-8)	7 (4-10)	0.081
Phenotypes (according to ARIA classification)			0.640
Intermittent mild	24 (30.4)	69 (33.8)	
Intermittent moderate-to-severe	25 (31.6)	70 (34.3)	
Persistent mild	1 (1.3)	5 (2.5)	
Persistent moderate-to-severe	29 (36.7)	60 (29.4)	
Familial AR history, n (%)	22 (27.8)	67 (32.8)	0.417
Familial atopy history, n (%)	28 (35.4)	100 (49)	0.040

¶median, IQR (interquartile range), AR: Allergic rhinitis, ARIA: Allergic rhinitis and its impact on asthma guidelines,* Chi-square test and Mann–Whitney U-test was used.

symptoms (Figure 1b). When the symptoms of rhinitis were evaluated, there was a higher frequency of sneezing (80% vs. 67%) in the non-obese/overweight group compared with the obese/overweight group. No statistically significant difference was observed in the number of other symptoms of rhinitis (Table 2).

Aeroallergen Sensitivity and Skin Prick Tests

SPTs were applied in the whole group with rhinits symptoms and the presence of aeroallergen sensitivity was shown in 283 (73.5%) patients. 61.3% of patients were sensitized to grass pollen, 54.5% to weed pollen, 31.2% to tree mix, 21% to cat, and 9.9% to house dust mite. There was no statistically significant difference in aeroallergen sensitivity between the obese/overweight group and the non-obese/overweight group. Figure 2 shows the aeroallergen sensitivities observed in the obese/overweight and non-obese/overweight groups.

Treatment

265 (68.8%) patients were treated with antihistamines and 43 (11.1%) of them had prolonged antihistamine treatment. 97(25%) were treated with nasal steroids. 132 (34.3%) patients received leukotriene receptor antagonist treatment. Leukotriene receptor antagonist treatment was found to be higher in the obese/overweight group (40.5%) than non-obese/overweight group (29.4%) (p=0.074). One patient received immunotherapy treatment due to severe AR symptoms. There was no statistical difference in the number of receiving all treatments between AR and NAR groups and obese/overweight group and non-obese/overweight groups.

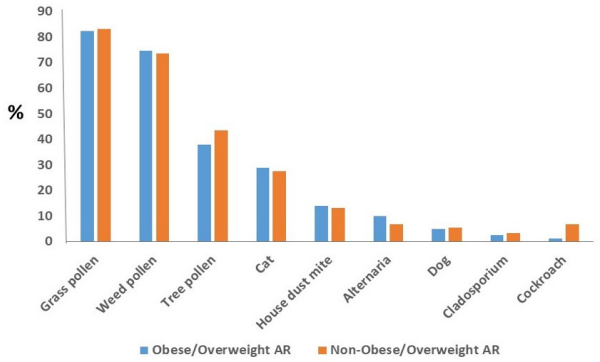

Figure 2. Distribution of aeroallergen sensitivities in obese/overweight group and non-obese/overweight group

DISCUSSION

AR and obesity are very common diseases and major public health problems worldwide. A link between obesity and increased risk of asthma has been observed.[5] However, the relationship between obesity and other atopic conditions such as AR is not clear. In this study, most of the patients presenting to our outpatient clinic with rhinitis symptoms were diagnosed with AR. Nasal congestion, sneezing and rhinorrhea were prevalent and these symptoms were detected at similar rates in both AR and NAR groups. Moderate-to-severe rhinitis was higher in the AR group than in the NAR group. Our findings indicated no significant difference in the frequency and severity of rhinitis symptoms between patients with and without obesity/overweight.

Only one in four to five patients with rhinitis referred to allergy clinics is diagnosed with NAR, but this estimation is biased due to the specific nature of referrals to such clinics. The prevalence of NAR is higher in the general population and accounts for approximately 50 per cent of all cases of rhinitis.[17] In our study, we detected 26.5% NAR in patients with rhinits. This can be related that the study was conducted in the allergy clinic as mentioned. A second reason may be that, non-allergic rhinitis (NAR) usually affects adults. In children the most frequent form of NAR is infectious rhinitis[18] in the present study, we eavulated the paediatric patients.

Differently from AR, atopy is not detected in NAR and patients with NAR have negative results for skin test reactivity, allergen specific IgE and nasal allergen challenges with allergen. Patients with NAR do not have symptoms triggered by contact with allergens.[18,19] In this study, we detected atopy in 75.5% patients with rhinitis. Male gender, birth in the pollen season, antibiotic treatment at an early age, maternal smoking, exposure to household allergens, high IgE levels (>100 IU/ml) before the age of six, detection of allergen-specific IgE and family history of atopy have been shown as risk factors for AR.[20,21] In this report, similarly, 55% of patients were male in AR group. Family history of AR rate, Total IgE level and eosinophil count were detected significantly higher in AR group than NAR group.

Most people with asthma have AR. We detected that 5.7% of patients had asthma in patients with rhinitis, although not statistically significant, the percentage of asthma was higher in the allergic individuals than non-allergic individuals. The incidence of AR significantly raises the probability of asthma: up to 40% of people with AR have or will have asthma.[22,23] The presence of AR complicates the control of asthma and is related to increased frequency of attacks and hospitalisation. Eriksson et al.[24] found that the prevalence of AR in asthmatic patients was 64% and the prevalence of asthma in patients with rhinitis was 20%. The frequency of oral allergy syndrome in patients with AR has been reported as 8.8%.[25] We found fewer OFS patients (1.8%) in the AR group compared to the literature.

Symptoms of NAR and AR are sometimes similar. Distribution symptoms of rhinitis were similar between subgroups in our study population and we found nasal congestion, sneezing, rhinorrhea were more common symptoms in patients. In a study involving 303 children with rhinitis, rinore and nasal congestion were found to be similar in AR and NAR patients. Nasal itching, sneezing and oculer findings were more common in patients with AR.[26] Adenoid hypertrophy, which is reported as one of the most common co-morbidities of AR, has been associated with the severity of AR.[27] We reported that adenoid hypertrophy was more frequent in the NAR group compared with the AR group.

In children, sensitisation begins as early as 4 years of age to aeroallergens (such as house dust mites, cat-dog allergens) that are constantly present in the indoor environment before the AR clinic develops and then develops against pollen and other inhalant allergens.[28] For this reason, SPTs were applied on patients aged 5-18 years with rhinitis symptoms in our study. Grass pollen sensitisation was the most common sensitisation. Cat and house dust mite sensitisation were common indoor allergens in our study. In our country, house dust mite is the most frequent indoor allergen and grass pollen is the most frequent outdoor allergen in aeroallergen sensitisation.[15]

In non-allergic patients, symptoms are usually perennial, sneezing and itchy nose are mild or absent. Patients complain of chronic nasal congestion and/or runny nose triggered by temperature and humidity, smell. Patients with AR have symptoms triggered by contact with allergens.[19,29] We reported that the number of patients with moderate-to-severe rhinitis were higher in the AR group compared to the NAR group. There was no difference in frequency of symptoms. A systematic search evaluated 171 studies and 33.843 patients to describe AR and NAR and found that symptoms were more severe in AR than NAR on Visual Analogue Scale (VAS) ($p<0.001$).[30]

A relationship between high BMI and AR has been hypothesised but has not been clearly demonstrated. Obesity is a risk factor for atopic allergic disorders in childhood. In this study, 28% of patients with AR were obese or overweight. We evaluated the severity and frequency of rhinitis symptoms in the AR group and found no statistically significant difference between obese/overweight group and Non-obese/overweight group. Previous reports have found that increased BMI is significantly associated with the occurrence of AR in childhood.[31-33] A meta-analysis of 30 observational reports showed a statistically significant association between obesity and the risk of AR in paediatric patients.[33] Previous studies supported that obese children with AR exhibit more severe clinical symptoms.[34]

Contrary to these studies, several reports show no significant difference or negative correlation between AR and obese paediatric patients.[35-37] Kusunoki et al.[36] investigated the relationship between obesity and several allergic conditions in children and reported a negative relationship between high BMI and allergic conjunctivitis and AR ($p<0.0001$), particularly in boys. Also on this subject, Sybilski et al.[35] found that overweight and obesity were associated with a reduced prevalence of AR in men. However, the influence of obesity/overweight on the prevalence of sensitization to aeroallergens was not observed. The relationship between AR and obesity is not yet well characterised and further comprehensive studies are needed.

Limitations

The primary limitation of this report is that the study was carried out in a single centre, which constitutes a limitation in terms of generalisability of the results. In addition, the lack of a healthy control group and the retrospective nature of the study were other limitations however in accordance with the purpose of the study, the severity and frequency of symptoms were compared between subgroups of study population.

CONCLUSION

In conclusion, AR and obesity may have a significant impact on physical, psychological and social aspects for both children and parents. Further studies on the relationship between obesity and AR may shed light on the etiology of the diseases and lead to new management options for AR.

ETHICAL DECLARATIONS

Ethics Committee Approval

Approval for this retrospective study was obtained from the Scientific Studies Ethics Committee of Ankara Atatürk Sanatorium Training and Research Hospital (Date: 09.10.2024, Decision No: 2024-BÇEK/151).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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