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Correlation of the Severity of Atopic Dermatitis and Serum IgE Levels

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ABSTRACT

Background: Atopic dermatitis is a chronic, relapsing inflammatory skin condition characterised by intense itching. The condition is often linked to other atopic disorders in the individual or among family members and is linked with elevated serum IgE levels. This study aims to investigate the correlation between the severity of atopic dermatitis (AD) and serum IgE levels specifically within the Pakistani population. **Methods:** A cross-sectional study was conducted involving the enrolment of 53 patients in the Department of Dermatology and department of chemical pathology Army Medical College lab in Pakistan Emirates Military Hospital from May 2024 to October 2024. Patients were categorised into three groups: mild (3–4), moderate (4.5–7.5), or severe (8–9), with ages ranging from 1 to 40 years. A one-way ANOVA was employed to assess the mean difference in serum IgE levels relative to the severity of atopic dermatitis, with a significance level of $p \leq 0.05$ deemed statistically significant. **Results:** The study involved 53 participants, with a mean age of 11.2 years (SD ± 6.6). The cohort comprised 21 males (39.6%) and 32 females (60.4%). The mean serum IgE level was 230.4 IU/mL (SD ± 120.3). Participants were classified into three groups based on symptom severity: 18 (33.9%) with mild symptoms (scores 3–4), 21 (39.6%) with moderate symptoms (scores 4.5–7.5), and 14 (26.5%) with severe symptoms (scores 8–9). The mean serum IgE levels were 153.9 IU/mL (SD ± 49.7) in the mild group, 217.1 IU/mL (SD ± 113.5) in the moderate group, and 319.5 IU/mL (SD ± 197.8) in the severe group, with a statistically significant p-value of 0.001. **Conclusion:** Serum IgE is a valuable indicator for predicting the severity of atopic dermatitis in younger patients.

INTRODUCTION

Eczema, also termed 'dermatitis,' constitutes a clinical and histopathological manifestation of cutaneous inflammation observed in various dermatological conditions with diverse aetiologies [1]. It is characterised by an inflammatory response in the skin, triggered by intrinsic and/or extrinsic factors. Clinically, eczema presents with intense pruritus and discomfort, alongside varying degrees of xerosis, erythema, excoriation, exudation, fissuring, hyperkeratosis, desquamation, and vesiculation [1]. In chronic cases, lichenification manifesting as epidermal thickening and accentuated skin markings may occur.

Eczema is a prevalent dermatological disorder, affecting approximately 20% of children and 10% of adults, with an increasing incidence reported in industrialised nations [2, 3]. Epidemiological data from Weidinger et al. indicate that the prevalence of atopic dermatitis (AD), a common form of eczema, reaches up to 30% in children and 3% in adults, with onset possible at any stage of life. Notably, 85% of affected individuals develop symptoms before the age of five. Recent trends indicate a rising prevalence of adult-onset AD [4].

The precise pathophysiological mechanisms underlying AD remain incompletely understood. It is recognised as a multifactorial disorder involving genetic predisposition, environmental influences, epidermal barrier dysfunction, and immune dysregulation [5]. Recent genomic studies have identified loci associated with autoimmune regulation, including genes implicated in innate immunity and T-cell function [6]. Variants in genes such as filaggrin are linked to reduced hydration and lipid content in the stratum corneum, leading to antigen penetration and exacerbated inflammatory responses upon exposure to irritants like detergents and soaps [7]. Antimicrobial peptides (AMPs), including cathelicidin and defensins, are crucial in maintaining epidermal integrity and modulating immune responses [9].

Atopic dermatitis is an atopy-associated form of eczema, defined by a predisposition to allergen

sensitisation and IgE-mediated immune responses, typically emerging in early life [9]. Approximately 80% of individuals with AD exhibit elevated total serum IgE levels [10]. This study aims to investigate the correlation between AD severity and serum IgE concentrations within the Pakistani population, providing insights into potential biomarkers of disease severity and facilitating the development of tailored diagnostic and therapeutic strategies for AD in Pakistan.

METHODOLOGY

A cross-sectional observational study was conducted, involving the enrollment of 53 AD patients from the department of dermatology and department of chemical pathology Army Medical College lab in Pakistan Emirates Military Hospital, Rawalpindi from May 2024 to October 2024. A minimum sample size of 53 patients was determined based on a calculated correlation coefficient of 0.54 between disease severity and IgE levels, with a statistical power of 99% and confidence intervals set at 95%. Using the Rajka and Langeland score, patients were categorized into three groups: mild (3–4), moderate (4.5–7.5), or severe (8–9). The age range spanned from 1 year to 40 years. The study excluded patients with scabies, parasitic infestations, pityriasis rubra pilaris, allergic and contact dermatitis, as well as seborrhoeic eczema from participation.

Venous blood samples of 5 ml each were drawn from each patient using plain tubes without anticoagulants. Once clot formation occurred, the samples underwent centrifugation at 3000×g for 10 minutes. The resulting serum was extracted, partitioned into aliquots, and stored at -20 ºC for the assessment of serum levels of IgE. Serum IgE measurements were conducted using the Roche Cobas E4M quantitative analyser through an Electrochemiluminescence Sandwich Assay (ECLIA). In the Roche ECLIA IgE analytical commercial kit, the capture antibody and antigen formed a sandwich complex. Magnetic particles coated with a biotin-conjugated detection antibody bound to the capture antibody. Subsequently, an avidin-HRP conjugate was introduced. A chemiluminescent substrate was then added, initiating a reaction that induced HRP to emit light. The intensity of the emitted light was subsequently measured. The final outcome of the research on the correlation between the severity of atopic dermatitis (AD) and serum IgE levels revealed a significant mean difference between these two variables. Through a comprehensive analysis of patient data and serum samples, the study demonstrated that higher serum IgE levels were strongly correlated with increased severity of AD symptoms.

Statistical Analysis

The data were to be verified, coded, and analysed using IBM-SPSS 21.0 (IBM-SPSS Inc., Chicago, IL, USA). Descriptive statistics, including means, standard deviations, medians, ranges, and percentages, were calculated. The chi-square test was employed to compare differences in frequency distribution among various groups. For continuous variables, an independent t-test analysis was conducted to compare the means of dichotomous data. A one-way ANOVA was used to examine the mean difference in serum IgE levels with respect to the severity of AD. A significance level of $p \leq 0.05$ was considered statistically significant.

RESULTS

The study included 53 participants, with a mean age of 11.2 years (SD ± 6.6). The cohort consisted of 21 males (39.6%) and 32 females (60.4%). The mean serum IgE level was recorded as 230.4 IU/mL (SD ± 120.3). The severity of atopic dermatitis, assessed using the Rajka and Langeland score, categorised participants into three groups: 18 (33.9%) with mild symptoms (scores 3-4), 21 (39.6%) with moderate symptoms (scores 4.5-7.5), and 14 (26.5%) with severe symptoms (scores 8-9). Additionally, a significant majority, 49 individuals (92.5%), reported having no comorbidities, while only 4 individuals (7.5%) indicated the presence of comorbidities as shown in Table 1.

Table 1

Descriptive statistics of all study variables.

Variables	Categories	N (%) 53 (100%)
Age (years)		
	Mean ± SD	11.2 ± 6.6
Sex		
	Male	21 (39.6)
	Female	32 (60.4)
IgE levels		
	Mean ± SD	730.4 ± 320.3
Severity of atopic dermatitis (using Rajka and Langeland score)		
	Mild (3-4)	18 (33.9)
	Moderate (4.5-7.5)	21 (39.6)
	Severe (8-9)	14 (26.5)
Comorbidities		
	No	49 (92.5)
	Yes	4 (7.5)

SD Standard Deviation

The mean age of participants increased with disease severity, with values of 11.2 ± 4.7 years in the mild group, 11.5 ± 5.1 years in the moderate group, and 12.1 ± 6.4 years in the severe group ($p = 0.09$), though this difference was not statistically significant. Regarding sex distribution, males accounted for 44.4% of cases in the mild category, 28.6% in the moderate group, and 50.0% in the severe group. Females comprised 55.6%, 71.4%, and 50.0% of these respective categories ($p = 0.12$), indicating no significant sex-related differences. A statistically significant association was observed between IgE levels and disease severity ($p = 0.001$). The

mean IgE levels increased with disease severity, measuring 541 ± 209.7 IU/mL in the mild group, 687.1 ± 213.5 IU/mL in the moderate group, and 819.5 ± 297.8 IU/mL in the severe group. The presence of comorbidities was slightly higher in patients with severe atopic dermatitis (14.3%) compared to those with moderate (4.8%) and mild (5.6%) disease, though this trend did not reach statistical significance (p = 0.06). Most participants in all severity groups did not report comorbid conditions. Overall, these findings suggest that higher IgE levels are significantly associated with increased disease severity, whereas age, sex, and comorbidities do not show statistically significant differences across severity categories as shown in Table 2.

Table 2

Bifurcation of study variables with respect to Severity of atopic dermatitis (using Rajka and Langeland score).

Variables	Categories	Severity of atopic dermatitis (using Rajka and Langeland score).			p-value
		Mild 18 (33.9%)	Moderate 21 (39.6%)	Severe 14 (26.5%)	
Age (years)					0.09
	Mean ± SD	11.2 ± 4.7	11.5 ± 5.1	12.1 ± 6.4	
Sex					0.12
	Male	8 (44.4)	6 (28.6)	7 (50.0)	
	Female	10 (55.6)	15 (71.4)	7 (50.0)	
IgE levels					0.001
	Mean ± SD	541 ± 209.7	687.1 ± 213.5	819.5 ± 297.8	
Comorbidities					0.06
	No	17 (94.4)	20 (95.2)	12 (85.7)	
	Yes	1 (5.6)	1 (4.8)	2 (14.3)	

SD Standard Deviation

DISCUSSION

Immunoglobulin E (IgE) holds a distinct position among immunoglobulins. It is present in human serum in very small quantities, though its concentration can increase several fold in response to specific stimuli [12, 13]. Elevated IgE levels are commonly observed in allergic conditions such as allergic rhinitis, allergic bronchial asthma, atopic dermatitis, and urticaria [14-16]. In children with atopy, IgE antibodies are produced following exposure to environmental allergens [17]. Approximately 80% of patients with atopic dermatitis exhibit elevated serum IgE levels, which are directed against various antigens, including pollens, moulds, food substances, house dust mites, and bacterial antigens. Patients with atopic dermatitis frequently test positive in both the Prick test and RAST for food allergens such as egg, milk, wheat, fish, soya, and peanuts [18, 19]. In atopic dermatitis, the partial loss of cutaneous barrier function, due to reduced ceramide levels and impaired filaggrin function, facilitates transepidermal water loss and the penetration of environmental antigens, leading to specific IgE-driven allergic skin inflammation [20, 21].

Immunoglobulin E (IgE) plays a crucial role in activating key effector cell types involved in allergic inflammation and contributes to various allergic diseases in which patients are sensitised to allergens and exhibit elevated IgE levels [22]. The findings of the present study, which show a correlation between the severity of atopic dermatitis and IgE levels, align with those of Ahmed et al. Their study concluded that children with atopic dermatitis had elevated serum IgE levels, which also correlated significantly with the severity of the disease. Notably, their study found a significant correlation between IgE levels and disease severity in only the mild and severe disease groups ($p < 0.001$). However, the authors did not compare these values with those of a control group; instead, they categorised IgE levels into three groups with a cut-off at 87 IU/ml [23].

Dhar et al. conducted a study involving 102 atopic patients and found that IgE levels in these patients were significantly higher than those in the control group [24]. Johnson et al. reported similar findings, with an additional association with respiratory disease [25]. In a case-control study of 2,201 East German schoolchildren aged 1 to 50 years, investigators found elevated serum levels of total IgE, which was significantly higher than in those without atopic dermatitis (36.3%) [26].

Another study of 345 (mean age, 22.9 years) revealed that patients with atopic dermatitis had a higher prevalence of sensitisation to food allergens (approximately 80%) and a moderate prevalence of sensitisation to aeroallergens (approximately 40%). Additionally, the mean serum IgE level within the highest SCORAD quartile was significantly higher than in those in the lowest SCORAD quartile (5443 kU/l vs. 488 kU/l, $p < 0.001$) [27]. Furthermore, a multicentre study of a German birth cohort followed 1,314 assessed serum IgE antibodies specific to food allergens (cow's milk, egg white, soya bean, and wheat) and inhalant allergens (house dust mite, cat dander, mixed-grass, and birch pollen) using an immunoassay. The study found a strong association between atopic dermatitis and elevated total and specific IgE levels. This association was more pronounced at an adults age: 41% [28].

In a prospective study involving 50 patients with atopic dermatitis (AD), 88% were found to have elevated serum IgE levels, with the highest elevations observed in those aged 5 to 50 years [29]. According to Hon et al., the ratio of total serum IgE correlated strongly with the extent and intensity of AD [30].

CONCLUSION

The current study demonstrates a significant correlation between IgE levels and the severity of atopic dermatitis. Further research with a larger sample size is required to validate and strengthen these findings.

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