The Relationship Between Eczema and Asthma Control in Atopic Versus Non-Atopic Asthma Patients

ABSTRACT

Rationale: There are few previous studies exploring the relationship between eczema and asthma status in the context of atopy. The purpose of this study is to investigate this relationship in a region with a high prevalence of asthma, within the New York City borough of the Bronx.

Methods: We reviewed 120 charts of asthma patients at Montefiore's Asthma Center (MAC) at their initial evaluation and last evaluation, with asthma severity assessed by Asthma Control Test (ACT) scores. Patient criteria for atopy included 1 positive skin prick test and/or positive specific immunoglobulin E test, and eczema status was determined by the presence of eczema history at the time of patients' initial evaluation. Demographic factors including BMI and healthcare utilization were also assessed. Linear regression and t-tests were used for analyses.

Results: We observed no significant association between eczema status and baseline ACT scores within a population with high prevalence of asthma and eczema ($p = 0.1364$). However, significant improvements in ACT scores from baseline to the last visit were observed in both eczema ($p < 0.0001$) and atopic patients ($p < 0.0001$). No significant change in ACT scores was noted in non-atopic patients.

Conclusions: There appears to be an association between eczema and asthma status in the context of atopy. The findings demonstrate that early identification and management of eczema within this context are vital for adequate asthma control. Further understanding of this relationship can aid in providing tailored treatment strategies to treat both diseases, optimizing health care outcomes and improving quality of life for affected individuals.

BACKGROUND

Asthma significantly impairs the quality of life among New York State residents, with over 1.4 million adults in the state currently carrying an asthma diagnosis.[1] The burden of asthma is especially severe in the Bronx, a borough of New York City, which has disproportionately elevated rates of asthma compared to the rest of the state. Specifically, the rate of asthma-related emergency department (ED) visits in the Bronx stands at 198.6 per 10,000, compared to 68.9 per 10,000 for New York State overall.[2] The prevalence of asthma-related morbidity, particularly when associated with atopy, is notably high among racial and ethnic minorities in the economically disadvantaged Bronx borough. Several possible causes for asthma morbidity include exposure to indoor allergens, environmental tobacco smoke, and medication non-adherence.[3]In addition to indoor factors, exposure to outdoor air pollutants such as ozone and particulate matter are well-established risk factors for asthma. Neighborhood-level characteristics, including poor housing quality and other social determinants of health, may also play a significant role in asthma exacerbations. These environmental and social factors contribute to the disproportionately high rates of asthma in certain communities, such as the Bronx. Understanding these contributing factors is crucial for developing targeted interventions to reduce asthma morbidity in these high-risk populations.

Along with asthma, eczema is another chronic condition that widely impairs quality of life and increases healthcare utilization throughout New York and the United States. This condition affects 10.2% of those in the United States. Eczema most commonly presents in childhood, with 80% of individuals affected by eczema experiencing disease onset prior to age 6. The prevalence of childhood eczema has risen significantly, increasing from 8% to 15% since 1997, demonstrating the importance of prevention and early detection and treatment. Additionally, there are significant healthcare disparities in eczema with Black children being 1.7 to 2.1 times more likely to be diagnosed with eczema compared to White children. Latinx and Black children are also 3 times more likely to have persistent eczema than their White counterparts, further illustrating the disproportionate burden of eczema within these at-risk populations.

While both asthma and eczema can manifest as either atopic or non-atopic, there has been limited research on the relationship between atopy and these two conditions. It is known that high levels of immunoglobulin (IgE), driven by type 2 helper (Th2)-mediated responses, are characteristic of atopic conditions. However, 10% of childhood asthma cases associated with eczema exhibit normal levels of total IgE without specific IgE responses to allergens. Clinically, these patients are indistinguishable from those with elevated IgE levels, suggesting that IgE-independent mechanisms may also play a role in the pathogenesis of both eczema and asthma. Importantly, patients with both asthma and eczema tend to experience worse clinical outcomes than those with either condition alone.[1]

Building upon these existing gaps in knowledge, this study aims to further explore the role of atopy in the association between eczema and asthma, with a focus on the Bronx, New York City—a region with an extremely high prevalence of asthma. By examining the interplay between eczema and asthma control in atopic versus non-atopic patients, this study seeks to provide insights into potential mechanisms and management strategies. Understanding how eczema status influences asthma control could lead to more tailored and effective treatments, particularly for populations in high-risk areas like the Bronx.

METHODS

Patient cohort

Patient charts from the Montefiore Asthma Center (MAC) Database within our institution's electronic health record (EHR) system. Montefiore Medical Center (MMC), the largest healthcare provider in the Bronx, cares for around 40,000 asthma patients across its inpatient and outpatient services. In response to the need for patient-focused interventions to enhance education and outcomes among a vulnerable population in the Bronx, the MAC was established in June 2011, providing a unique team-based approach to provide high quality care with collaboration between pulmonologists, allergists/immunologists, respiratory technicians, and asthma educators. The MAC Database was created within our institution's EHR system and facilitated the collection of demographic characteristics and healthcare outcomes of patients with severe or refractory asthma who received treatment at the MAC from 2011-2015. Patients in this database are 18 years of age and older and have severe asthma. Severe asthma is defined as having at least one hospitalization, one emergency department visit, or having received oral corticosteroids at least once for an asthma exacerbation in the previous year. Further information about this template can be found in Kaur et al.[11] From this template, an eczema-focused database was created with chart review of these patients with asthma. This eczema-focused database includes characteristics of asthma patients includingtotal IgE (elevated IgE is ≥ 150 IU/ml)**,** eosinophilia (≥ 300 cells/μL), skin prick test (SPT) positivity, and history of eczema. Demographic characteristics include gender, age range, insurance, race, number of hospitalizations, number of ED visits, Asthma Control Test (ACT) initial scores, and ACT last visit scores. This study was approved by the Institutional Review Board at the Albert Einstein College of Medicine.

Chart review procedures

Manual chart review was conducted to obtain patient-level information including history of eczema, atopy status, and other demographic information were extracted from the EHR system, and included in the eczema-focused database. Patient criteria for atopy were 1 positive skin prick test and/or positive specific IgE test, and eczema status was determined by the presence of eczema history at the time of patients' initial evaluation. Patients with available chart-based

information about eczema status and baseline ACT scores, and last visit ACTscores[9] were included in this study.

Statistical Analysis

Descriptive statistics were utilized to summarize characteristics of patients. Results were reported as mean±standard deviation [SD] or median ± interquartile range (IQR). These clinical and demographic characteristics were analyzed and compared within the cohort of patients chart-identified to have asthma and stratified by age group (19-39 years, 40-59 years, 60-85 years), gender, atopic status, eczema status, and food allergy history. For analysis, t-tests were used to compare baseline ACT scores by eczema status, last visit ACT scores by eczema status, eczema patients by baseline versus last visit ACT scores, non-eczema patients by baseline versus last visit ACT scores, baseline ACT scores by atopic status, last visit ACT scores by atopic status, atopic patients by baseline versus last visit ACT scores, and nonatopic patients by baseline versus last visit ACT scores. Linear regression with interaction terms was performed to determine the association between asthma and atopy with baseline ACT scores and between asthma and atopy with last visit ACT scores. A p-value < 0.05 was considered statistically significant. Patient groups included atopic asthma patients, non-atopic asthma patients, asthma and eczema patients, and non-eczema asthma patients.

RESULTS

Demographic, clinical, and laboratory characteristics of the entire cohort

Of 227 patients with severe or refractory asthma who received treatment at the MAC from 2011-2015, 120 patients who met the inclusion criteria were included in this study. The four groups analyzed were atopic asthma patients, non-atopic asthma patients, eczema and asthma patients, and non-eczema asthma patients.

The demographic and clinical characteristics for the cohort are shown in Table 1, stratified by age. Females comprised 80% of the cohort, reflecting a female predominance in this patient population. The majority of patients were Hispanic (55.8%), followed by Black non-Hispanic (37.5%). Other ethnicities, such as Asian and White, were represented in smaller percentages. The majority of patients had commercial insurance coverage (83.3%). In addition, 61.7% of the patients were classified as obese with a BMI ≥ 30, and 30.0% were overweight (BMI between 25 and less than 30). A minority of the cohort reported a history of eczema (11.7%), while food allergies were more common, affecting 46.7% of patients. In addition, 35% of patients reported having no asthma-related hospitalizations. 86.7% reported having at least 1 visit to the ED. In terms of asthma control, the majority of patients (93.3%) had an initial ACT score of ≤ 19, indicative of poorly controlled asthma.

Laboratory characteristics for the entire asthma cohort (n=120) are summarized in Table 2. The median serum total IgE level at baseline was 212 IU/ml. A significant portion of the cohort, 52.5%, had elevated IgE levels. In terms of absolute eosinophil counts at baseline, the median value was 200.0 cells/μL, with a range from 100.0 cells/μL at the 25th percentile to 400.0 cells/μL at the 75th percentile. Notably, 33.3% of patients had elevated eosinophil counts. The majority of patients were atopic, with 92.5% having a positive atopic status.

Comparison of Baseline and Last Visit ACT Scores in the cohort

ACT scores at baseline and last visit were compared across various groups. The average time from the first visit to the last visit for this cohort was 16.1 months. Atopic patients exhibited a significant improvement in ACT scores from baseline to the last visit (Figure 1). The mean baseline ACT score for this group was 10.5, increasing to 15.0. The mean difference was 4.6 (SEM ± 0.7412), with a 95% confidence interval from 3.1 to 6.0. This improvement was statistically significant ($p<0.0001$). In contrast, non-atopic patients did not show a statistically significant change in ACT scores from baseline to the last visit (Figure 2). The mean baseline score was 13, slightly increasing to 14.1. The mean difference was 1.1 (SEM ± 2.643), with a 95% confidence interval from -4.5 to 6.7, and a p-value of 0.6798.

For patients with eczema, there was a significant improvement in ACT scores from baseline to the last visit (Figure 3). The mean baseline ACT score was 8.9, which increased to 17.3 at the last visit. The mean difference observed was 8.4 (SEM ± 1.584), with a 95% confidence interval from 5.2 to 11.7. This change was statistically significant ($p<0.0001$). Similarly, patients without eczema also demonstrated significant improvement in ACT scores from baseline to the last visit (Figure 4). The mean baseline score was 10.9, improving to 14.6 at the last visit. The mean difference was 3.7 (SEM ± 0.7745), with a 95% confidence interval from 2.2 to 5.3. This change was statistically significant ($p<0.0001$).

Association Between Eczema Status and Baseline Asthma Control Test (ACT) Scores

The analysis investigating the association between eczema status and baseline ACT scores did not reveal a statistically significant difference (Figure 5). The mean ACT score for patients with an eczema history was 8.9 compared to 10.9 for those without an eczema history. The difference between these means was -2.0 (SEM ± 1.360), with a 95% confidence interval ranging from -4.7 to 0.7. The p-value for this comparison was 0.1364, indicating no significant difference. However, a significant difference was observed in the variances of these groups ($F=4.667$, $p=0.0034$).

DISCUSSION

Our study, conducted within the socioeconomically diverse and high-asthma-prevalence Bronx area, aimed to examine the relationship between eczema, atopy, and asthma control. No

significant correlation between eczema status and baseline asthma control was found. The majority of patients (93.3%) had poorly controlled asthma at baseline, as indicated by initial ACT scores of ≤ 19. Although this is the case, the significant improvement in ACT scores by the last visit for both eczema and atopic patients suggests that comprehensive asthma management, perhaps enhanced by tailored treatment strategies for both diseases, may yield significant benefits over time. The high prevalence of atopy within the cohort (92.5%) aligns with previous findings highlighting the Bronx as a hotspot for atopic diseases, likely exacerbated by environmental and socioeconomic factors.[9] The Bronx's unique environmental challenges, including heavy traffic and associated pollution from three major highways, are well-documented contributors to respiratory ailments.[20] Studies have shown that air pollution is associated with elevated IgE levels and increased atopy prevalence, thereby supporting our findings of elevated atopy and suggesting an environmental etiology.[14]

According to the 2024 Global Initiative for Asthma guidelines, allergic asthma commonly begins in childhood and is associated with a past medical history of allergic diseases including eczema, food allergies, and rhinitis as well as exacerbating factors such as obesity.[21] This was reflected within the cohort as there was a high prevalence of elevated BMI, food allergies, and other comorbid conditions, factors that are crucial in understanding the broader implications of asthma management. A substantial portion of the patients were classified as obese (61.7%) or overweight (30.0%), aligning with emerging evidence that links obesity with poorer asthma control and increased severity.[12] Obesity, potentially acting through mechanical and inflammatory pathways, could exacerbate asthma symptoms and complicate its management, underscoring the need for holistic approaches that address weight management as part of asthma care.[22] Moreover, the prevalence of food allergies in nearly half of the cohort (46.7%) adds another layer of complexity to managing asthma, as food allergens can trigger exacerbations and influence overall disease control.[23] These comorbidities, combined with the high prevalence of atopy (92.5%), suggest a multifaceted interaction between asthma and allergic diseases, which may be further influenced by environmental and socioeconomic factors prevalent in urban settings like the Bronx. These findings stress the importance of comprehensive care strategies that go beyond standard asthma treatment to address the wide range of factors that can impact disease control and quality of life.

Furthermore, the cohort displayed significant allergic inflammation, evidenced by elevated IgE levels in 61.2% of patients, with median IgE levels substantially higher than those typically observed in the general population. The median baseline IgE level in this study was 212 IU/mL while the general United States population is about 40 IU/mL.[12] This finding is critical, as elevated IgE is a hallmark of allergic asthma, which necessitates specific therapeutic approaches.[19] The eosinophilic profile of the patients further corroborates the allergic underpinning of their asthma, with 36% displaying eosinophilia, suggesting a severe allergic component to their asthma. Eosinophilia in the blood in patients with asthma has been associated with more severe disease, worse control, as well as a poorer prognosis.[24]

In our cohort, the comparison of baseline and last visit ACT scores revealed significant improvements in asthma control among certain subgroups. Atopic patients and those with eczema showed marked improvements, with atopic patients demonstrating a mean ACT score increase of 4.6 points and eczema patients exhibiting an even greater improvement of 8.4 points. Previous in vitro and in vivo studies have suggested that prostaglandins and leukotrienes play a key role in the pathogenesis of atopic dermatitis.[25] These improvements in asthma control for atopic patients and those with eczema could be influenced by the treatment plan targeting this pathway. Interestingly, while patients without eczema also showed significant improvement in their ACT scores, non-atopic patients did not experience a statistically significant change, highlighting the potential impact of atopy and eczema on asthma control and the potential for personalized treatment strategies.[18,25]

The association between eczema status and baseline ACT scores did not yield significant differences, with the mean ACT score for patients with eczema only slightly lower than those without (8.9 vs 10.9, respectively). The lack of a significant difference may suggest that while eczema and asthma are often comorbid, the presence of eczema does not necessarily correlate with worse baseline asthma control. However, previous studies have found that adults with eczema have more persistent disease and asthma exacerbations when compared to those without.[5] This finding underscores the complexity of the relationship between these conditions and the need for further investigation to identify the specific factors that influence asthma control in patients with eczema.[8] The observed improvement in ACT scores over time, despite these baseline similarities, emphasizes the effectiveness of comprehensive asthma management in this high-risk population, regardless of initial eczema status.[9]

Our findings emphasize the importance of comprehensive asthma management that includes environmental control measures, especially in urban areas with high pollution levels in which asthma levels have been steadily rising.[1] Early life exposure to nitrogen dioxide and mean particulate matter is associated with asthma incidence by early and middle childhood, showing the importance of longitudinal asthma control.[15] The significant improvement in asthma control over time in this study highlights the efficacy of the multidisciplinary approach employed at the Montefiore Asthma Center, including the use of inhaled corticosteroids and patient education on adherence and inhaler technique.[9]

This study is primarily limited by its observational design and the specific demographic and environmental context of the Bronx, which may not be representative of other populations. The reliance on self-reported measures of asthma control and eczema status introduces potential response bias and may not fully capture the clinical severity of these conditions.[16] Therefore, while the findings offer valuable insights into asthma and eczema management in a high-risk urban population, caution should be exercised when generalizing these results to different demographic or environmental contexts. Future studies should aim to include more diverse populations including children and adults especially considering many population-wide studies

on eczema have included only children, studies should also utilize objective measures of environmental exposure as well as sociodemographic factors including environmental hazards to better understand the universal applicability of our findings.[9, 12]

In conclusion, our study underscores the intricate relationship characterized by comorbidity between asthma control, eczema, and atopy.[17] The significant improvements in ACT scores for atopic patients with eczema in the cohort reflect the need for targeted interventions and treatment plans. Future research should focus on the long-term outcomes of comprehensive asthma care programs, especially in high-risk urban populations like the Bronx, to develop tailored strategies for patients who are dealing with both asthma and eczema in the setting of atopy. Promising areas of research for tailored strategies include monoclonal antibodies such as dupilumab which has shown efficacy in severe asthma and eczema treatment through IL-4 and IL-13 inhibition.[18,19]

CONCLUSION

Our study demonstrates a connection between eczema and asthma in relation to atopy. These results highlight the importance of early detection and treatment of eczema in this setting to effectively manage asthma. Gaining deeper insights into this link could help develop personalized treatment plans for managing both conditions, ultimately enhancing health care outcomes and the quality of life for those affected.

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Tables

Table 1. Demographic and clinical characteristics of the cohort at baseline (stratified by age).

		Age Range					
		19-39 yrs		40-59 yrs		60-80 yrs	
		Count	Column N %	Count	Column N %	Count	Column N %
Gender	F	19	76.0%	55	79.7%	22	84.6%
	M	6	24.0%	14	20.3%	4	15.4%
Race	Asian	2	8.0%	0	0.0%	2	7.7%
	Black	9	36.0%	28	40.6%	8	30.8%
	Hispanic	14	56.0%	38	55.0%	15	57.6%
	Other	0	0.0%	1	1.4%	1	3.8%
	White	0	0.0%	2	2.9%	0	0.0%
Insurance	Commercial	20	80.0%	60	87.0%	20	76.9%
	Medicaid	1	4.0%	2	2.9%	1	3.8%
	Medicare	0	0.0%	2	2.9%	2	7.7%
	N/A	4	16.0%	5	7.2%	3	11.5%
BMI Range	>= 30 (Obese)	11	44.0%	48	69.6%	15	57.7%
	18.5 - < 25 (Healthy weight)	6	24.0%	2	2.9%	2	7.7%
	25 - < 30 (Overweight)	8	32.0%	19	27.5%	9	34.6%
Hx of Eczema	N	21	84.0%	60	87.0%	25	96.2%
	Y	4	16.0%	9	13.0%	1	3.8%
Food Allergies	N	8	32.0%	39	56.5%	17	65.4%
	Y	17	68.0%	30	43.5%	9	34.6%
Hospitalizations Range	0	7	28.0%	25	36.2%	10	38.5%
	1	8	32.0%	18	26.1%	11	42.3%
	2-4	5	20.0%	22	31.9%	4	15.4%
	5+	3	12.0%	4	5.8%	1	3.8%
	N/A	2	8.0%	0	0.0%	0	0.0%
ED Range	0	4	16.0%	4	5.8%	5	19.2%
	1	5	20.0%	19	27.5%	12	46.2%
	2-4	9	36.0%	26	37.7%	7	26.9%
	5+	5	20.0%	19	27.5%	2	7.7%
	N/A	2	8.0%	1	1.4%	0	0.0%
ACT Initial Range	<= 19	23	92.0%	64	92.8%	25	96.2%
	> 19	2	8.0%	5	7.2%	1	3.8%
ACT Last Visit Range	<= 19	17	68.0%	50	72.5%	19	73.1%
	> 19	8	32.0%	19	27.5%	7	26.9%

Table 2. Laboratory characteristics of the cohort at baseline (stratified by age).

		Entire Cohort	19-39 yrs	40-59 yrs	60-80 yrs
Total IgE Baseline - Median		212	190	259	211
IgE	< 150	40 (38.8)	7 (36.8)	23 (37.7)	10 (43.5)
	>= 150	63 (61.2)	12 (63.2)	38 (62.3)	13 (56.5)
Abs Eos Baseline- Median		200	200	200	100
Abs Eos	<300	71 (64.0)	14 (60.1)	40 (63.5)	17 (68.0)
	>=300	40 (36.0)	9 (39.8)	23 (36.5)	8 (32.0)
Atopic	N	9 (7.5)	4 (16.0)	3 (4.3)	2 (7.7)
	Y	111 (92.5)	21 (84.0)	66 (95.7)	24 (92.3)
Eosinophilia	N	71 (64.0)	14 (60.9)	40 (63.5)	17 (68.0)
	Y	40 (36.0)	9 (39.1)	23 (36.5)	8 (32.0)

Figures

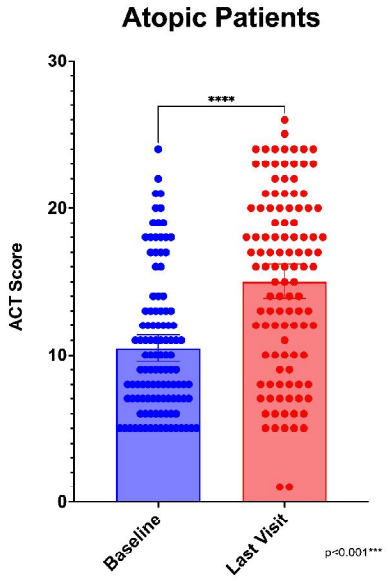

Figure 1. Comparison of Baseline and Last Visit ACT Scores in Atopic Patients

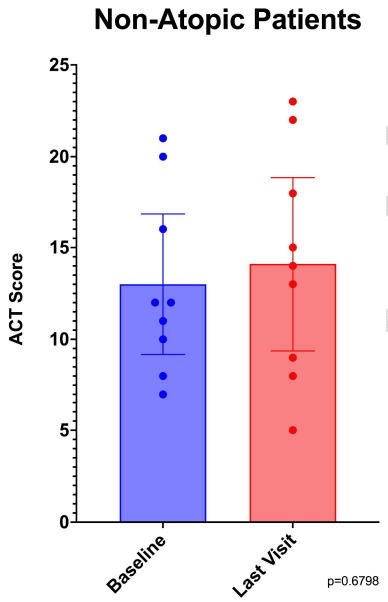

Figure 2. Comparison of Baseline and Last Visit ACT Scores in Non-Atopic Patients

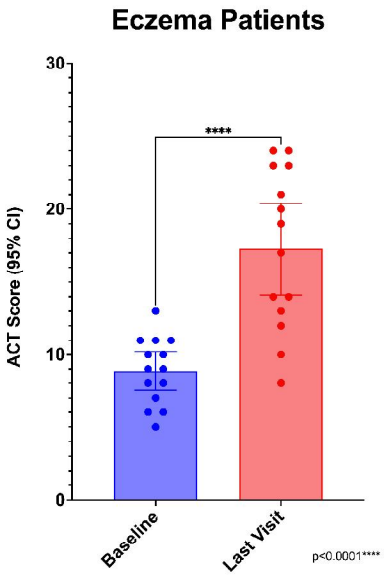

Figure 3. Comparison of Baseline and Last Visit ACT Scores in Eczema Patients

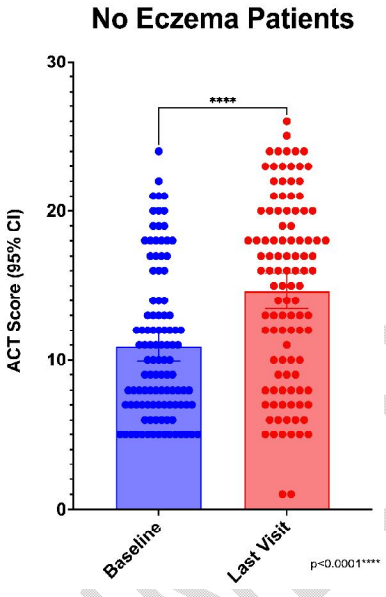

Figure 4. Comparison of Baseline and Last Visit ACT Scores in Non-Eczema Patients

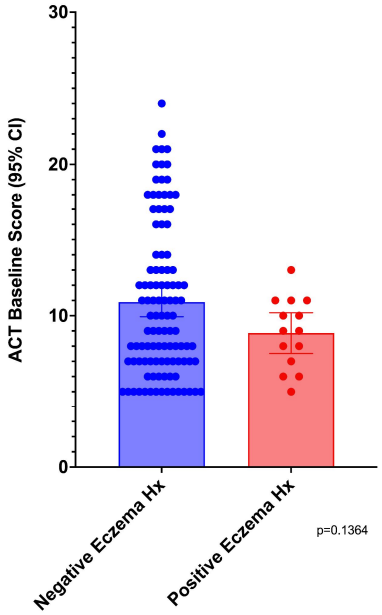

Figure 5. Comparison of Baseline ACT Scores in Eczema and Non Eczema Patients