

Association of Asthma and Beta-Agonists With Increased Risk Ratios for Disease

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ABSTRACT

OBJECTIVE: Current literature indicates that asthma may increase the risk of other inflammatory diseases. Whether the observed associations are due to the inflammatory process of asthma itself or if the administration of beta-agonists used to treat asthma has an impact on increased risk for other diseases is unclear. In this study, the risk of patients with and without asthma developing autoimmune diseases, reproductive issues, inflammatory diseases, and cancer was evaluated considering the presence of short-acting and long-acting beta-agonists (LABAs). Differences in selected laboratory values between patients with and without asthma were investigated in the presence or absence of asthma medications.

DESIGN: A retrospective population-based quantitative cohort study with a convenience random sample of 30,000 patients was conducted using Epic to retrieve medical records of patients diagnosed with asthma and without asthma at an academic hospital. The relative risk ratio was used to analyze the risk of disease. Student's *t*-test was used to identify the differences between laboratory values.

RESULTS: Patients with asthma only had an increased risk for miscarriage. When beta-agonists were considered, the risk for all of the diseases studied increased in patients taking both short-acting and LABAs.

CONCLUSIONS: Beta-agonists should be considered when evaluating increased risk of developing proinflammatory diseases.

ABBREVIATIONS: BPH - benign prostate hyperplasia, COPD - chronic obstructive pulmonary disease, ED - erectile dysfunction, eGFR - estimated glomerular filtration rate, ICD-10 - *International Statistical Classification of Diseases and Related Health Problems - 10th Revision*, IL - interleukin,

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IRB - institutional review board, LABA - long-acting beta-agonist, PCOS - polycystic ovarian syndrome, RA - rheumatoid arthritis, RR - risk ratio, SABA - short-acting beta-agonist, SLE - systemic lupus erythematosus.

INDEX TERMS: asthma, beta-agonists, risk ratios, disease associations, laboratory values.

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INTRODUCTION

Asthma is an inflammatory disease with a prevalence of 300 million people worldwide.¹ Asthma, like many other diseases, has no cure, and only symptom-relief treatments are available.² Studies have shown that asthma can trigger other inflammatory diseases, such as irritable bowel syndrome or benign prostate hyperplasia (BPH), as well as cancers, autoimmune diseases, gut inflammation, and impaired reproductive health.^{3–15} As such, the potential for asthma causing other inflammatory diseases should be investigated to prevent and better treat these other diseases. Because asthma is known to be associated with other inflammatory diseases, there is still the question of whether prevention or early intervention can be achieved.

It is unclear whether asthma medications—mainly beta-agonists—have an impact on the association of asthma with other diseases. Most patients with asthma are prescribed beta-2-agonist inhalers, which can be short-acting beta-agonists (SABAs) or long-acting beta-agonists (LABAs), both of which serve as bronchodilators.¹⁶ Side effects of these medications include tremors, headaches, dizziness, cough, and chills. The use of SABAs—known as rescue inhalers—can lead to worsening of the delayed response to an allergen, which affects the way the body responds to allergens in the future, leading to decreased SABA efficacy and asthma exacerbations.^{17,18} Inhaled corticosteroids are another class of medication that is used to help reduce inflammation. The use of LABA medications without the use or nonadherence to corticosteroid therapy can lead to worsening asthma exacerbations, which can lead to death.¹⁹ These reports bring up the questions of whether these medications may also be a contributing factor in the increased risk for other diseases, or whether, because their use can help reduce inflammation, it could, therefore, reduce the risk of other diseases. As there are a variety of laboratory tests available

for assessing the progression of inflammatory diseases, certain clinical laboratory values may be assessed to detect early presentation of associated diseases in patients with asthma. Thus, if clinicians can early detect asthma-associated diseases before complications arise, patients can promptly receive the corresponding treatment and prevent severe disease outcomes. The goal of this study was to investigate whether there is a relationship between asthma and other inflammatory diseases and to evaluate whether selected laboratory test values are significantly different at the time of diagnosis in patients with and without asthma. This study also investigated the influence of beta-agonist use in patients with asthma on the risk of developing certain diseases and the impact on selected laboratory values.

MATERIALS AND METHODS

After obtaining institutional review board (IRB) approval (IRB no. 23-0357), a nonexperimental, quantitative, retrospective, nonanonymized study using a convenience random sample of patients with asthma (*International Statistical Classification of Diseases and Related Health Problems, 10th Revision* [ICD-10] J45) and patients without asthma defined as general wellness examination patients (ICD-10 Z00.00) was performed. We used the Epic Electronic Health Record System (version 2024; Epic Systems Corporation, Verona, WI) to collect patient data from January 2013 through December 2023 from patient records at an 800-bed academic hospital. Patients with alcohol dependence (ICD-10 F10.2), nicotine dependence (ICD-10 F17.210), and any history of smoking were excluded from this study to potentially eliminate patients with chronic obstructive pulmonary disease (COPD). Demographic data, including age and sex, were evaluated to assess the general patient population. Associated diseases were defined according to the corresponding current procedural terminology codes as diagnosis of systemic lupus erythematosus (SLE); rheumatoid arthritis (RA), hypothyroidism, hyperthyroidism; BPH; polycystic ovarian syndrome (PCOS); erectile dysfunction (ED); miscarriage; liver disease; kidney disease; pancreatitis; or breast, lung, or prostate cancer at any point during the 10 years of the study after they received a diagnosis of asthma or went for a routine wellness examination. The laboratory values for creatinine, estimated glomerular filtration rate (eGFR), total bilirubin, thyroid-stimulating hormone, T4, T3, alanine transaminase, aspartate transaminase, alkaline phosphatase, and lipase performed within a week before or after the patient received a diagnosis in their medical record with the associated disease were collected. The 1-week timeframe was established to find the laboratory values closest to the time the patients were diagnosed. Prescription of SABA and/or LABA in the medical records of the patients was also collected.

IBM SPSS Statistics 28 and Excel were used for all statistical analyses. The independent variables included asthma and nonasthma with dependent variables defined as the presence or absence of associated disease. Administration of SABA and/or LABA medications were also considered dependent variables. To assess the risk of asthma and associated diseases as well as the effect of beta-agonists on associated diseases, a risk ratio (RR; relative risk) was calculated for each disease and patient group in which an RR of 1.0 indicates no effect, RR less than 1.0 indicates reduced risk, and RR greater than 1.0 indicates increased risk. A Student's *t*-test and Cohen's *d* for effect size were performed to assess the differences between laboratory values in patients with and without asthma and in those prescribed or not beta-agonists. A *P* value of less than .05 was considered significant, and a Cohen's *d* of less than 0.2 demonstrated no effect, 0.2–0.5 demonstrated small effect, 0.5–0.8 demonstrated medium effect, and greater than 0.8 demonstrated large effect.

RESULTS

Population Characteristics

A total of 30 000 patients were analyzed. The population consisted of 60.3% female and 39.8% male patients. Out of these patients, 25.73% of female patients and 34.13% of male patients had a diagnosis of asthma. The majority of the population was in the 25–49-years-old age group.

Asthma and RR of Associated Diseases

The RR for patients with and without asthma of developing inflammatory or malignant disease was established by identifying the frequency of disease in the corresponding group, as depicted in Figure 1. Hypothyroidism, BPH, and ED were the most frequent diseases in patients without asthma, whereas hypothyroidism, liver disease, and kidney disease were the most frequent in patients with asthma.

In patients with asthma, the risk of miscarriage was 1.206 times higher compared with those without asthma. For all other associated diseases, patients with asthma were found to have a reduced RR, as summarized in Figure 2.

Effect of Asthma on Laboratory Values

In patients with asthma with SLE and kidney disease, creatinine (*P* value = .03 and .03, respectively) was significantly different compared with patients without asthma diagnosed with SLE and kidney disease. Similarly, in patients with asthma and SLE, eGFR was significantly different (*P* value = .02) compared with patients without asthma with SLE. For all other laboratory values, no statistically significant differences were observed (Table 1).

A *P* value of <.05 is considered significant. A Cohen's *d* value <0.2 indicates no effect, 0.2–0.5 indicates small effect, 0.5–0.8 indicates medium effect, and >0.8 indicates

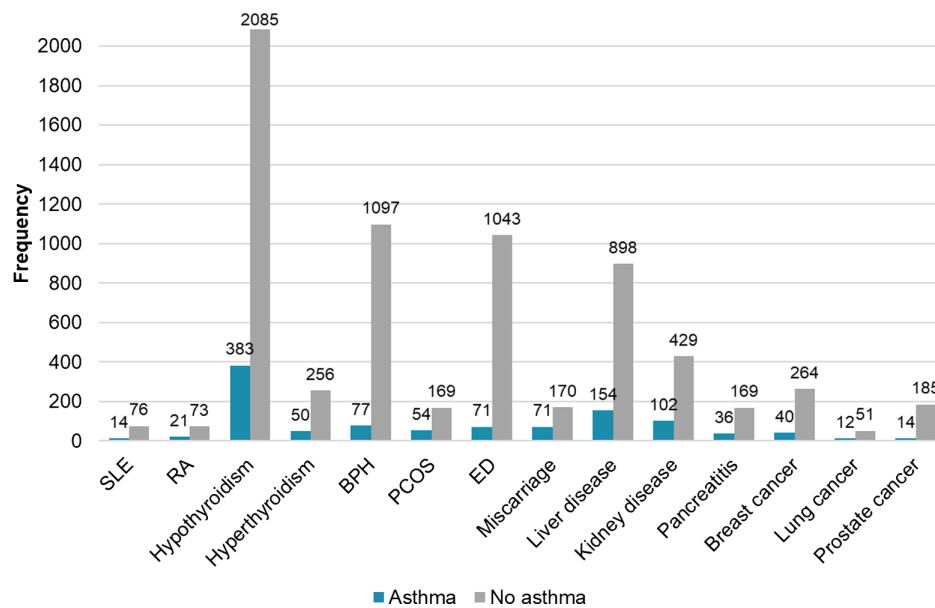


Figure 1. Frequency of associated disease in patients with and without asthma.

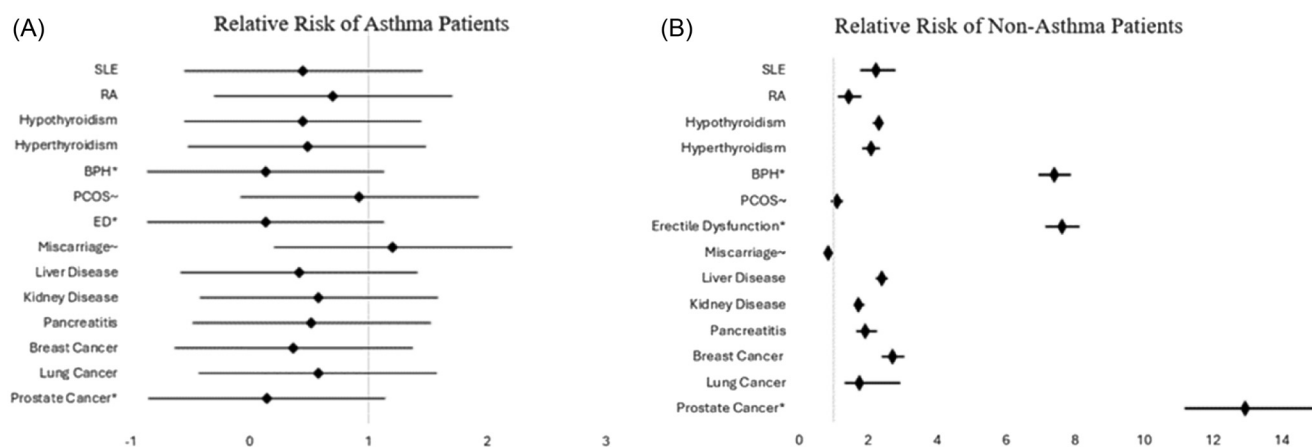


Figure 2. Relative risk of associated diseases in patients (A) with asthma and (B) without asthma. **Only male patient data were used to calculate the relative risk. Only female patient data were used to calculate the relative risk. Relative risk <1 is not a risk factor, 1 is no effect, and >1 increases the risk of the disease.

large effect. ALP, alkaline phosphatase; ALT, alanine transaminase; AST, aspartate transaminase; T bili, total bilirubin; TP, total protein; TSH, thyroid-stimulating hormone.

Beta-Agonists and Relative Risks of Associated Diseases

To determine whether the observed disease associations between patients with and without asthma were attributed to the administration of beta-agonist medications rather than the presence of asthma alone, patients who were prescribed SABA or LABA medications were identified to assess the disease RR. A total of 8095 patients with asthma were prescribed SABA, and 1375 were prescribed LABA. It was also found that 4776 patients without asthma

received SABA medications, and 479 received LABA medications (Table 2).

The use of medication, raw number, and percentage are described.

In patients with asthma taking SABA medications, it was observed that they had an increased risk for hyperthyroidism (3.79), BPH (1.82), ED (1.67), liver disease (1.24), kidney disease (1.5), and pancreatitis (2.71). Interestingly, when patients with asthma were categorized into those taking SABA medications, a decreased risk for SLE (0.46) and prostate cancer (0.68) was observed. In patients with asthma taking LABA, miscarriage was the only condition found to have a decreased risk (0.77), whereas all other diseases showed increased risk (Table 3). In patients without asthma taking SABA, all diseases showed an increased risk, with the top

Table 1. Student's *t*-test comparing patients with and without asthma with associated diseases according to selected laboratory tests

Disease	Tests	Asthma Group (Mean ± SD)	No Asthma Group (Mean ± SD)	Significance (P)	Cohen's <i>d</i>
SLE	Creatinine (mg/dL)	1.9 ± 1.4	0.9 ± 0.4	.03	1.5
	eGFR (mL/min/1.73 m ²)	48.3 ± 26	78.7 ± 27.2	.02	1.1
Hypothyroidism	TSH (mIU/L)	2.9 ± 2.3	3.6 ± 3.9	.3	0.2
	T4 (µg/dL)	1.2 ± 0.5	1.2 ± 0.4	.2	0.1
	T3 (ng/dL)	10.4 ± 12	11.3 ± 15.9	.5	0.06
Hyperthyroidism	TSH (mIU/L)	0.5 ± 0.3	1.3 ± 2.6	.3	0.3
	T4 (µg/dL)	1.7 ± 0.3	1.4 ± 1	.3	0.2
	T3 (ng/dL)	3.3 ± 0.5	18.7 ± 24.4	.2	0.7
Erectile dysfunction	Testosterone (ng/dL)	217 ± ID	389.9 ± 243.4	.2	0.2
Liver disease	ALT (U/L)	52.8 ± 45.9	40.4 ± 42.5	.2	0.2
	AST (U/L)	30.2 ± 21.9	29.8 ± 19.1	.4	0.02
	ALP (IU/L)	72 ± 27.4	74.3 ± 20.9	.4	0.1
	T bili (mg/dL)	0.8 ± 0.8	0.7 ± 0.4	.3	0.2
	TP (g/dL)	7.1 ± 0.3	7.3 ± 1.8	.4	0.1
Kidney disease	Creatinine (mg/dL)	2.2 ± 2.5	1.6 ± 1.3	.03	0.3
	eGFR (mL/min/1.73 m ²)	45.4 ± 22.9	49.1 ± 23.3	.2	0.1
Pancreatitis	Lipase (U/L)	187.6 ± 180.7	156.8 ± 107.8	.4	-0.2

Table 2. Frequency of patients with and without asthma prescribed SABA and LABA medications

Diagnosis	Medication	Frequency	%
No asthma	Not taking SABAs	16 503	77.6
	Taking SABAs	4776	22.4
	Not taking LABAs	20 800	97.7
	Taking LABAs	479	2.3
	Not taking SABAs or LABAs	16 467	77.4
	Taking SABAs only	4333	20.4
	Taking LABAs only	36	0.2
	Taking both SABAs and LABAs	443	2.1
	Not taking SABAs	626	7.2
	Taking SABAs	8095	92.8
Asthma	Not taking LABAs	7346	84.2
	Taking LABAs	1375	15.8
	Not taking SABAs or LABAs	597	6.8
	Taking SABAs only	6749	77.4
	Taking LABAs only	29	0.3
	Taking both SABAs and LABAs	1346	15.4

3 diseases with the highest RRs being lung cancer (14.17), kidney disease (4.07), and pancreatitis (2.69) (Table 4). In patients without asthma taking LABA, only miscarriage and PCOS were found to have a decreased risk, with an

Table 3. Relative risk of patients with asthma taking both SABA and LABA or either SABA or LABA alone

Diseases	Relative Risk Asthma	Asthma With SABA	Asthma With LABA
SLE	0.45	0.46	2.97
RA	0.7	0.73	4.86
Hypothyroidism	0.45	1.02	3.33
Hyperthyroidism	0.48	3.79	4.55
BPH*	0.14	1.82	5.97
PCOS~	0.92	0.83	1.6
ED*	0.13	1.67	7.77
Miscarriage~	1.21	0.82	0.77
Liver disease	0.42	1.25	3.7
Kidney disease	0.58	1.5	5.56
Pancreatitis	0.52	2.71	3.4
Breast cancer	0.37	0.7	1.24
Lung cancer	0.57	0.93	7.48
Prostate cancer	0.15	0.68	13.59

*Only male patient data were used to calculate the relative risk. ~Only female patient data were used to calculate the relative risk.

RR value of 0.49 and 0.74, respectively. All other diseases showed an increased risk (Table 4). Further classification of patients according to the administration of SABA and LABA or either was explored. In patients with asthma taking

Table 4. Relative risk of patients without asthma taking both SABA and LABA or either SABA or LABA alone

Diseases	Patients Without Asthma Risk Ratio	Patients Without Asthma Taking SABA	Patients Without Asthma Taking LABA
SLE	2.23	2.4	4.41
RA	1.43	2.28	5.34
Hypothyroidism	2.31	1.81	1.82
Hyperthyroidism	2.07	1.81	1.6
BPH*	7.38	2.06	2.08
PCOS~	1.08	1.6	0.74
Erectile dysfunction*	7.61	1.4	1.1
Miscarriage~	0.83	1.46	0.49
Liver disease	2.4	2.3	1.45
Kidney disease	1.72	4.07	3.38
Pancreatitis	1.92	2.69	1.6
Breast cancer	2.71	2.07	1.18
Lung cancer	1.74	14.17	5.79
Prostate cancer	12.93	2.6	2.2

*Only male patient data were used to calculate the relative risk. ~Only female patient data were used to calculate the relative risk.

only SABA, pancreatitis (1.86), kidney disease (1.01), and BPH (1.08) were found to have an increased risk, whereas in those taking LABA, only miscarriage (2.7), kidney disease (5.15), and breast cancer (6.85) had increased risk. In patients with asthma taking both SABA and LABA, an increased risk for all the diseases except miscarriage (0.65) was observed (Table 5). In patients without asthma treated with only SABA, an increased risk for all diseases except SLE was identified. Similarly, in this same patient population, when both SABA and LABA were prescribed, an increased risk for all diseases except PCOS and miscarriage was found (Table 6).

Effect of Beta-Agonists on Laboratory Values

An independent Student's *t*-test comparing patients with and without asthma taking SABA or LABA medications was performed to assess the effect of beta-agonists on certain laboratory tests. Only creatinine (*P* value = .03) and eGFR (*P* value = .01) were found to be significant in patients with SLE prescribed SABA (Table 7).

A *P* value of <.05 is considered significant. A Cohen's *d* value <0.2 indicates no effect, 0.2–0.5 indicates small effect, 0.5–0.8 indicates medium effect, and >0.8 indicates large effect. ALP, alkaline phosphatase; ALT, alanine transaminase; AST, aspartate transaminase; T bili, total bilirubin; TP, total protein.

Table 5. Relative risk of patients with asthma prescribed SABA and/or LABA

Diseases	SABA and LABA	SABA and Not LABA	LABA and Not SABA
SLE	1.11	0.31	0
RA	2.22	0.39	0
Hypothyroidism	2.14	0.69	0
Hyperthyroidism	1.71	0.38	0
BPH*	6.56	1.08	0
PCOS~	1.19	0.69	0
ED*	6.95	0.88	0
Miscarriage~	0.65	0.94	2.7
Liver disease	3.11	0.81	0
Kidney disease	5.66	1.01	5.15
Pancreatitis	6.21	1.86	0
Breast cancer	2.96	0.42	6.85
Lung cancer	3.11	0.44	0
Prostate cancer	3.49	0.27	0

*Only male patient data were used to calculate the relative risk. ~Only female patient data were used to calculate the relative risk.

Table 6. Relative risk of patients without asthma taking SABA and/or LABA

Diseases	SABA and LABA	SABA and Not LABA	LABA and Not SABA
SLE	5.07	0.38	10.39
RA	6.76	1.81	0
Hypothyroidism	2.1	1.78	2.35
Hyperthyroidism	1.8	1.8	2.77
BPH*	2.6	2.01	1.24
PCOS~	0.91	1.67	0
ED*	1.13	1.43	1.75
Miscarriage~	0.58	1.55	0
Liver disease	1.87	2.35	1.7
Kidney disease	5.85	3.88	0
Pancreatitis	2.35	2.72	0
Breast cancer	1.58	2.12	0
Lung cancer	22.3	13.3	0
Prostate cancer*	3.122	2.54	0

*Only male patient data were used to calculate the relative risk. ~Only female patient data were used to calculate the relative risk.

DISCUSSION

Epidemiological studies have demonstrated the associations of asthma comorbidities and proinflammatory diseases, such as cardiovascular disease, BPH, SLE, thyroid function, and reproductive health.^{20,21} From our findings,

Table 7. Student's *t*-test comparing the laboratory values of asthma and non-asthma-prescribed beta-agonists

	Disease	Tests	Asthma Group (Mean ± SD)	No Asthma Group (Mean ± SD)	<i>P</i>	Cohen's <i>d</i>
SABA	SLE	Creatinine (mg/dL)	1.90 ± 1.41	0.91 ± 0.32	<.05	1.22
		eGFR (mL/min/1.73 m ²)	48.26 ± 26.06	76.40 ± 18.80	<.05	1.39
	RA	T bili (mg/dL)	0.50 ± 0.14	0.51 ± 0.25	.47	0.054
	Hypothyroidism	TSH (mIU/L)	2.88 ± 2.28	3.96 ± 5.35	.27	0.21
		T4 (µg/dL)	1.26 ± 0.50	1.19 ± 0.33	.18	0.21
	Hyperthyroidism	TSH (mIU/L)	0.53 ± 0.03	1.50 ± 2.35	.29	0.43
		T4 (µg/dL)	1.67 ± 1.33	1.09 ± 0.41	.13	0.69
	Liver disease	ALT (U/L)	52.83 ± 45.88	31.60 ± 23.71	.16	0.79
		AST (U/L)	30.20 ± 21.89	26.79 ± 11.86	.29	0.26
		ALP (IU/L)	72.00 ± 27.36	79.42 ± 18.56	.19	0.38
		T bili (mg/dL)	0.73 ± 0.80	0.74 ± 0.37	.47	0.02
		TP (g/dL)	7.12 ± 0.30	7.05 ± 0.39	.34	0.18
	Kidney disease	Creatinine (mg/dL)	2.04 ± 2.32	1.78 ± 1.64	.19	0.14
		eGFR (mL/min/1.73 m ²)	47.31 ± 21.77	44.31 ± 22.53	.28	0.134
Pancreatitis	Lipase (U/L)	187.58 ± 180.68	153.40 ± 108.88	.37	-0.24	
SLE	Creatinine (mg/dL)	1.07 ± 0.34	0.85 ± 0.10	.09	0.96	
	eGFR (mL/min/1.73 m ²)	68.60 ± 7.35	71.92 ± 18.91	.41	0.19	
RA	T bili (mg/dL)	0.45 ± 0.07	0.73 ± 0.29	.14	1.08	
Hypothyroidism	TSH (mIU/L)	2.71 ± 2.95	5.27 ± 5.44	.21	0.55	
	T4 (µg/dL)	1.22 ± 0.41	1.15 ± 0.38	.33	0.16	
LABA	Liver disease	ALT (U/L)	27.33 ± 10.02	29.00 ± 1.41	.42	0.20
		AST (U/L)	21.67 ± 3.06	22.50 ± 2.12	.38	0.3
	Liver disease	ALP (IU/L)	68.33 ± 24.68	73.00 ± 16.97	.42	0.21
		T bili (mg/dL)	0.58 ± 0.40	0.83 ± 0.69	.17	0.42
	TP (g/dL)	7.33 ± 0.21	6.70 ± 0.70	.11	1.43	
Kidney disease	Creatinine (mg/dL)	2.16 ± 3.13	2.17 ± 1.11	.23	0.22	
	eGFR (mL/min/1.73 m ²)	52.63 ± 26.27	46.69 ± 23.88	.27	0.24	

it is important to note that although the presence of asthma is shown to have reduced risk for the studied associated diseases, this is not considered protective; rather, the low-risk ratio indicates that patients with asthma have less risk than patients without asthma in developing the disease.⁹

Nonetheless, the majority of published studies have not investigated the effect of asthma medications on disease outcomes. The results presented in this study suggest that the presence of beta-agonists has an impact on increased RRs for certain diseases. The results of this study showed that, except for miscarriage, there was no increased risk for all of the diseases analyzed. However, when the patient population is analyzed in the context of exposure to SABA and LABA, the RRs for most diseases increase in both populations of patients with and without asthma.

From the studied population, it is unknown the reason why patients without asthma were prescribed

beta-agonists, but tobacco smoking, a known condition for the administration of SABA and LABA, was excluded from the study. A limitation in the results originates from the missing clinical history record for which patients without asthma were prescribed beta-agonists. Factors such as exercise-induced bronchoconstriction, bronchitis, or respiratory infections are treated using beta-agonists; however, these conditions were not evaluated in this study, so it is unknown whether any of the subjects were under any of these conditions.²²⁻²⁴

The results presented herein support the evidence that patients with asthma taking SABA and/or LABA medications have an increased risk for RA as observed in the literature.²⁰ Other studies found that asthma increases the risk of ED, PCOS, and SLE in patients without comorbidities, but the use of inhaler medication was not mentioned.^{15,25,26} Our results show these 3 diseases to have increased risk in patients with asthma taking both

SABA and LABA and in patients without asthma taking either or both medications. In most of the current literature, it is observed that asthma medications are not considered as a possible variable that may be causing the increased risk of disease. Hence, the impact of beta-agonists should be further studied.

The data presented in this study pointed out that in patients with SLE, creatinine and eGFR were significantly different between patients with and without asthma. Similarly, in patients with kidney disease, their creatinine values were significantly different. Other studies have demonstrated a similar observation in which patients with asthma have 37% increased odds of developing SLE.⁴ A likely explanation for this association is that both asthma and SLE have increased expression of interleukin (IL)-4, IL-5, and IL-13^{27,28}—hence, possibly explaining the reason why the laboratory results for kidney function are different compared with patients without asthma with SLE.^{4,29} The observed differences in creatinine and eGFR in patients with asthma with SLE suggest that it would be prudent to routinely monitor the kidney function of patients who have been recently diagnosed with asthma. Future studies should also investigate the creatinine and eGFR values in patients with asthma who have either SLE or kidney disease and develop adjusted reference ranges to promptly detect kidney damage.

Similarly, there should be increased disease surveillance in patients taking beta-agonists, as their risk for developing other diseases may increase. SABA and LABA medications are used to reduce inflammation.¹⁶ However, they may be linked to having an increased risk of the development of other inflammatory diseases. LABA medications should not be used alone, as they do have a Food and Drug Administration black-box warning indicating they may worsen asthma exacerbations.¹⁶ The results from this study suggest that they may also cause an increased risk for other inflammatory diseases, such as BPH, SLE, and hyper- or hypothyroidism. At the time of this study, there is no known research explaining or investigating how SABA and LABA medications may cause other inflammatory diseases that are not directly related to asthma. There are several side effects found in these medications, such as muscle, cardiovascular, and metabolic symptoms, due to the vasodilation they cause, which may be related to the mechanism of action in causing an increased risk of the diseases studied.³⁰

The results presented here should be evaluated with caution as there are many other factors such as environmental pollutants and genetics, that can play a role in the development of a disease and not being directly affected by asthma or beta-agonists. Likewise, the exclusion of COPD cannot be completely ruled out, as exposure to environmental factors associated with COPD was not part of the clinical history of the evaluated cohort. However, based on the data presented, it is sensitive to make the clinical recommendation to evaluate patients with asthma for kidney function and to evaluate the risk

for other diseases in patients currently taking beta-agonists.

IRB STATEMENT

The IRB at our institution reviewed this study via an expedited review procedure and determined that the project meets the criteria for exemption from review (IRB no. 23-0357).

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