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The Impact of Vascular Endothelial Growth Factor, Neutrophil Gelatinase-Associated Lipocalin, and Interleukin-38 Food and Air Allergy Patients Following the Pandemic of COVID-19 in Iraq

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RESEARCH ARTICLE

The Impact of Vascular Endothelial Growth Factor, Neutrophil Gelatinase-Associated Lipocalin, and Interleukin-38 Food and Air Allergy Patients Following the Pandemic of COVID-19 in Iraq

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ABSTRACT

Allergies are a common health issue where the immune system reacts to substances in the environment that are normally harmless. This study further investigates the effects of vascular endothelial growth factor (VEGF), neutrophil gelatinase-associated lipocalin (NGAL), interleukin-38 (IL-38), immunoglobulin E (IgE), and the neutrophil-lymphocyte ratio (NLR) in these individuals, offering insight into the probable processes behind allergic responses following the pandemic. The study comprised 120 non-vaccinated females with previous COVID-19 infection. Groups included controls and food and air (F&A) allergic patients, with 60 individuals matched for age and gender. Serum levels of IL-38, VEGF, IgE, and NGLA were assessed using ELISA kits, while complete blood count (CBC) parameters were analyzed using Coulter LH 750 Hematology Analyzer. Significant differences in biomarkers were found in individuals with F&A compared to controls. F&A patients had decreased white blood cell (WBC) counts but no significant differences in red blood cell count (RBC) or hemoglobin (Hb) count. VEGF and NLR were significantly increased in F&A patients ($p < 0.05$). NGAL levels increased ($p < 0.05$), whereas IL-38 levels decreased in F&A patients ($p < 0.05$). Elevated IgE levels were consistent with the allergic state. We can conclude that inflammatory events can be easily triggered in patients with food and airway allergies after the COVID-19 pandemic. Inhibition of IL-38 and upregulation of VEGF and NGAL expression are key features of inflammation-related esophageal and respiratory allergies, where they can be used as a prognostic tool for patients.

Keywords: Covid-19, Food and airway allergic, Interleukin-38, Neutrophil gelatinase-associated lipocalin, Neutrophil-lymphocyte ratio, Vascular endothelial growth factor

Introduction

The 2019 coronavirus, or as it is now known "COVID-19", is a serious respiratory illness caused by SARS-CoV-2.[1] Since the outbreak of the COVID-19 pandemic, several researches have attempted to uncover risk indicators for an advanced disease course. COVID-19 most commonly causes respiratory or digestive issues[2] Overweight, diabetes, cardiovascular disease, cancers, liver disease, chronic lung disease, renal disease, HIV infection, or transplantation are all recognized comorbidities that raise the risk of serious health conditions.[3] However, hardly anything is known about allergy disease as a possible risk factor for severe COVID-19.[4]

During the pandemic, several individuals changed their lifestyles and behaviors, like as their nutrition and food consumption.[5] For individuals with food allergies, this led to certain goods being inaccessible or carried depending on home-cooked meals, ingredient lists, and preparation techniques would witness a rise.[6] According to studies, individuals who

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have allergies may be more sensitive to COVID-19. Firstly, continued exposure to allergens in individuals with inhalational allergies can lead to chronic airway and skin irritation, and hence greater susceptibility to infections.[7,8] Second, the use of systemic immunosuppressive pharmaceuticals may augment this susceptibility, as found in different patient populations utilizing immunosuppressive drugs.[9,10] Third, SARS-CoV-2 has been demonstrated to stimulate mast cells and eosinophils, potentially putting individuals with mast cell conditions at risk for severe COVID-19.[11,12]

Allergic disorders have existed throughout the history of mankind, which is why it is critical to continue studying and researching a wide range of diseases associated with allergies.[13] Due to several exceptional contributions, the "European Academy of Allergy and Clinical Immunology EAACI" and the "World Allergy Organization WAO" developed anaphylaxis recommendations based on a clinical symptom-independent mechanism around the turn of the twenty-first century. Therefore, it is now feasible to distinguish between an allergy and immunological anaphylaxis, traditionally known as "pseudo-allergic" events.[14] Currently, anaphylaxis appears to be rising globally, possibly because of pollen, food allergies, and the increasing incidence of atopic diseases.[15]

Allergy is defined by the enhanced capacity of B lymphocytes to synthesize immunoglobulin E (IgE) against antigens that enter the body through the airways, skin, or gastrointestinal tract (GIT).[16] Allergies include atopic dermatitis, asthma, allergic rhinitis, and food allergies.[17] Air allergies or respiratory allergies occur when the immune system overreacts to harmless substances in the environment, such as pollen, dust, pets, birds, mold bacteria, and certain air pollutants.[18] The most common triggers for respiratory allergies are pollen from trees or flowers, grass, and weeds; dust particles found in house dust; pet penalties for cats, dogs, and other animals; and pot cells; Some air pollutants are like smoke.[19]

Asthma is a persistent inflammation of the lower airways caused by eosinophils and hyperresponsiveness. It is characterized by wheezing, coughing, and dyspnea.[20] This condition is induced when an individual is exposed to factors that cause inflammation in the bronchi, reducing the passage of air in the lungs.[21] The diagnosis is based on the clinical examination, disease history, pulmonary function, and allergy examination.[22] Treatment is indicated to prevent and reduce contact with allergenic elements; moreover, some drugs can be used, as such: β2-adrenergic, theophylline, anticholinergics, and corticosteroids.[18]

Allergic rhinitis is a chronic symptomatic nasal condition caused by exposure to allergens such as cold air, dust, smells, smoking, and pollution, which produce IgE-mediated inflammation in the nasal mucosa.[23] The clinical and family history of atopy, together with physical and laboratory investigations, are used to make the diagnosis.[24] There are two types of disease treatment: non-drug and drug-based. The first step is to regulate allergic components, reduce elements that promote dust collection, such as carpets and drapes, prevent animals and feathers, and maintain a clean and airy atmosphere at all times. The second is the use of treatments such as antihistamines that block the major allergy mediator, decongestants that increase vasodilation, and corticosteroids, which regulate protein synthesis and diminish the generation of inflammatory mediators.[25]

Food allergies are significant medical conditions resulting from an improper immune response to particular food items.[26] Food allergies occur when the immune system mistakenly identifies a particular food protein as harmful and responds by producing antibodies, causing allergic reactions.[27] The most frequent dietary allergies include peanuts, tree nuts, hen's eggs, cow's milk, fish, shellfish, soy, wheat, and seeds.[28] Symptoms of a food allergy range from mild to severe and may include nausea, pain, swelling of the lips, tongue, or throat, abdominal pain, vomiting, diarrhea, shortness of breath difficulty, and, in severe cases, anaphylaxis.[29] The diagnosis of food allergy is usually based on a combination of medical history, physical examination, allergy tests (such as dermatology or blood tests), and food elimination.[26] Until recently, medical management of food allergies consisted of rigorous allergen avoidance and immediate reactive treatment with emergency drugs in the case of an allergic reaction. Surprisingly, "The Food and Drug Administration FDA" approved the first drug (January 2020), a peanut oral immunotherapy (OIT) medicine, which was authorized to reduce allergic responses.[26]

Vascular endothelial growth factor (VEGF) is the primary signal protein stimulator of the formation of new blood vessels (angiogenesis). It influences both the adaptive as well as the innate immune responses by interfering directly with cells and indirectly by affecting the expression of proteins on endothelial cells or the permeability of blood vessels.[30] VEGF is believed to have a quiet role in the prediction of COVID-19 severity and comorbidities, especially, acute respiratory disorders.[31]

Neutrophil gelatinase-associated lipocalin (NGAL), also known as lipocalin 2 (LCN2), is a 25 KDa glycoprotein involved in neutrophilic inflammation. NGAL is regarded as an acute-phase protein since

its blood level is elevated under various inflammatory circumstances.[32] NGAL was initially identified as a matrix protein of specific gelatinase granules of human neutrophils, hence the name "neutrophil gelatinase-associated lipocalin" but was later found to be secreted by different cells, including renal tubular cells, immune cells, liver, lungs, adipose tissue, and respiratory epithelial cells.[33] Extracellular matrix proteins play a significant part in the process of airway remodeling, hence NGAL has been viewed as a possible biomarker of airway structural modification in patients with pulmonary diseases.[34]

Interleukins (ILs) are a group of cytokines that have been involved in the pathophysiology of many acute and chronic injuries,[35] metabolic disorders,[36] and immune pathologies.[37] Interleukins primarily serve to regulate growth, differentiation, and activation in the context of inflammatory and immunological processes.[38] Interleukin-38 (IL-38) is an anti-inflammatory cytokine of the IL-1 family, which is known also as IL-1F10 or IL-1HY2.[39]

Neutrophils and lymphocytes are blood cells that play significant roles in inflammatory responses. The quantity of these cells may change during inflammation.[40] When an allergen occurs, neutrophils are the first cells to make their way to the site of inflammation. Neutrophils, which are produced in the bone marrow and have a limited lifespan, move to the location of inflammation by entering the bloodstream in about an hour.[41] The neutrophil-lymphocyte ratio (NLR) has been reported as a prognostic factor and marker of inflammation in several disorders, including cardiovascular diseases and malignancies.[42] However, how the NLR changes in allergies, another inflammatory condition is not known.[43]

This study aims to investigate the effects of vascular endothelial growth factor (VEGF), neutrophil gelatinase-associated lipocalin (NGAL), IL-38, and the neutrophil-lymphocyte ratio in individuals with airway and food allergies compared to healthy individuals, offering insight into the probable processes behind allergic responses following the pandemic.

Materials and methods

Study population

The study included 120 non-vaccinated females with a previous infection of COVID-19 from the Consultation Clinic for Chest and Respiratory Diseases (Al-Rusafa, Baghdad). Two groups were designed as control and food and allergy patients who were confirmed to have chronic sensitivities to CCD/Bromelain, Olive pollen, Date palm pollen, Bermuda Grass pollen, Rye pollen, Grass Mix, Mugwort pollen, Plantain pollen, Goosefoot pollen, Russian Thistle pollen, Cat/Dog epithelia Mix, Cage Birds Mix, Feathers Mix 11, the allergens (Pnotatum A fumigatus, Cherbarum A alternate, Candida albicans, Dipteronyssiuns/ D.farinae, Blomia tropicalis). Each group contained 60 females of matched age (20-60 years) and gender distribution. Samples were collected from July to October 2023, and the study was approved by the Ethical Committee at the College of Science, Mustansiriyah University, and the patients signed a consent agreement. None of the patients smoked or consumed alcohol. Additionally, none of the individuals had a family history of allergies. Patients with diabetes, hypertension, and hyperthyroidism were excluded.

Specimen collection

From each individual, 10 ml of blood was drawn through a vein puncture using disposable syringes, 2 ml was collected in an EDTA tube and 8 ml was collected in a gel tube. After collection, the whole blood samples were stored in a cooling fridge at 2–4 °C. The samples in the gel tubes were centrifuged at 3000 rpm for 10 minutes. The resulting serum was stored at –20 °C until the time of analysis.

Evaluation of clinical parameters

Serum levels of VEGF, NGLA, IL-38, and IgE, were estimated using Sandwich ELISA kits (Shanghai, China) with an ELISA microplate reader (BioNTech, USA). Complete blood count (CBC) was analyzed for the whole blood by using Coulter LH 750 Hematology Analyzer. Leukocytes, erythrocytes, hemoglobin (Hb), and neutrophil-to-lymphocyte ratio (NLR) were detected for each individual.[3]

Statistical analyses

The statistical package for the social sciences computer program version 26.0 (IBM SPSS Statistic software, IBM Corporation, New York, United States) was used for the analysis. Descriptive statistics were used to analyze the data, and the findings are reported as means ± standard deviation (SD). For assessing mean differences between the two groups (patients and controls), a student t-test with independent samples was used. In addition, Pearson's correlation analysis, the Receiver Operating Characteristic (ROC) curve, and the corresponding Area Under the Curve (AUC) are used in this study for VEGF, NGLA, IL-38, and IgE to identify the correlations and indicate their potential utility. The statistical tests are considered to be significant at $p < 0.05$ with a 95% Confidence

Table 1. Studied biomarkers between F&A allergy patients and control.

	Control (n = 60)		F&A allergy patients (n = 60)		
Parameters	Mean ± SD	SE	Mean ± SD	SE	P-value
Age	32.92 ± 7.44	0.961	34.78 ± 10.15	1.310	0.523 NS
WBC $\times 10^3$ (Cell/μL)	6.41 ± 1.20	0.155	1.87 ± 0.24	7.671	<0.001*
RBC $\times$ 10^6 (Cell/μL)	4.72 ± 0.58	0.074	4.56 ± 0.64	0.083	0.139 NS
Hb (g/dL)	12.84 ± 0.71	0.133	12.61 ± 1.002	0.129	0.139 NS
VEGF (ng/L)	94.98 ± 27.20	3.512	132.89 ± 39.79	5.137	<0.001*
NGAL (ng/mL)	34.44 ± 14.98	1.934	100.74 ± 32.08	4.141	<0.001*
IL-38 (ng/mL)	7.55 ± 2.02	0.260	3.09 ± 1.47	0.190	<0.001*
NLR	1.40 ± 0.33	0.042	2.07 ± 0.89	0.115	<0.001*
IgE (ng/mL)	1.75 ± 1.03	0.133	56.94 ± 20.27	2.617	<0.001*

n: number of cases, * significant at p ≤ 0.01, NS: Non-significant.

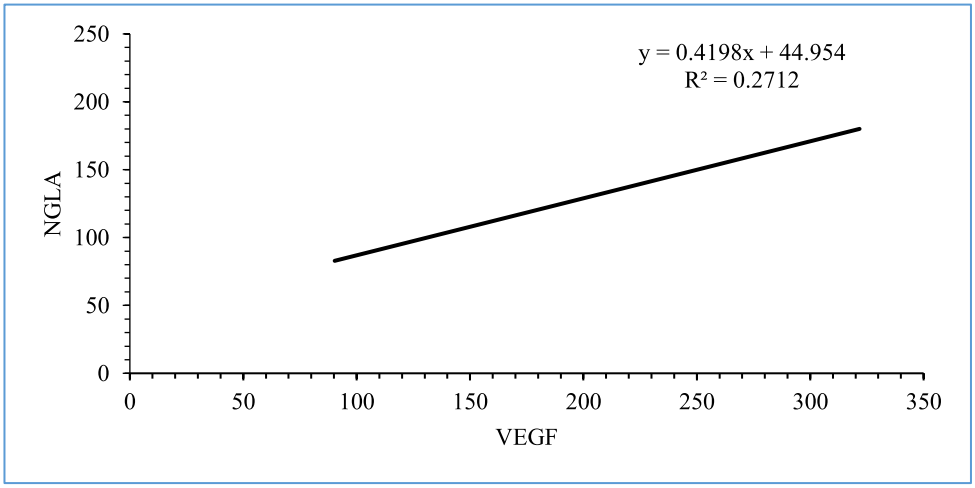

Fig. 1. Correlation between VEGF and NGLA in patients.

Interval, and highly significant at p ≤ 0.01 with a 99% Confidence Interval. [4]

Results and discussion

The data shown in Table 1. presents the mean ± standard deviation (SD) and standard error (SE) to compare biomarkers between individuals with F&A and the control group. The mean WBC count was significantly ($p < 0.001$) lower in Food and Airway (F&A) allergy patients (1.87×10^3 cells/μL) compared to the control group (6.41×10^3 cells/μL). While there was no statistically significant ($p < 0.001$) difference in RBC count between F&A allergy patients (mean RBC count 4.56×10^6 cells/μL) and the control group (mean RBC count 4.72×10^6 cells/μL). Similarly, there was no statistically significant ($p < 0.001$) difference in Hb levels between F&A allergy patients (mean Hb 12.61 g/dL) and the control group (mean Hb 12.84 g/dL).

The difference in VEGF levels between the two groups is statistically significant (p < 0.001). The mean VEGF level is significantly higher (132.89 ng/L) in F&A allergy patients compared to the control group (94.98 ng/L). Additionally, the mean NGAL level in patients with F&A allergies (100.74 ng/mL) is significantly ($p < 0.001$) higher than in the control group (34.44 ng/mL). The mean IL-38 level in patients with F&A allergies (3.09 ng/mL) is significantly ($p < 0.001$) lower than in the control group (7.55 ng/mL). The results suggest significant differences in NLR levels between the control group and the F&A allergy patients group. NLR is higher in F&A allergy patients compared to the control group, as shown in Fig. 1. The mean IgE level was significantly higher in F&A allergy patients (56.94 IU/mL) compared to the control group (1.75 IU/mL) (p < 0.001). This is consistent with the known association between elevated IgE levels and allergic conditions, including food and airway allergies.

Table 2. presents correlation coefficients (r) and associated p-values for various biomarkers and parameters measured in individuals with food and respiratory allergies. The results show that there is a significant positive correlation between VEGF and

Table 2. Correlation in food and respiratory allergic patients.

	VEGF		IL-38		NGAL		WBC		NLR	
Parameters	r	*p*	r	*p*	r	*p*	r	*p*	r	*p*
IL-38	0.050	0.703	–	–	–0.189	0.147	0.034	0.797	–0.056	0.669
NGAL	0.521*	<0.001	–0.189	0.147	–	–	0.056	0.672	0.032	0.811
WBC	0.134	0.308	0.034	0.797	0.056	0.672	–	–	0.023	0.859
NLR	0.203	0.120	–0.056	0.669	0.032	0.811	0.023	0.859	–	–
RBC	0.152	0.245	–0.057	0.668	0.129	0.328	0.355*	0.005	0.063	0.633
Hb	0.116	0.379	–0.012	0.928	0.085	0.519	0.058	0.658	–0.001	0.991
Age	0.172	0.190	–0.233	0.073	0.131	0.320	0.110	0.403	–0.110	0.404
IgE	0.232	0.075	–0.048	0.714	0.164	0.210	0.104	0.428	0.122	0.353

* Correlation is significant at the 0.01 level.

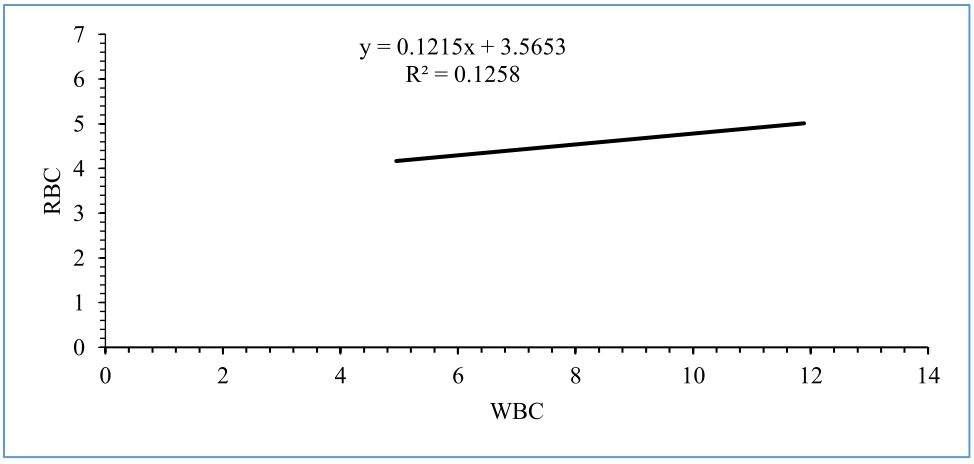

Fig. 2. Correlation between WBC and RBC in patients.

Table 3. ROC curve analysis and area under the curve (AUC) of food and air allergy.

Parameters	AUC	SE	*p*-value	Cut-off value	Sensitivity%	Specificity%
VEGF	0.785	0.041	<0.001	100.43	78.3	61.7
IL-38	0.964	0.015	<0.001	5.19	90	91.7
NGLA	0.978	0.010	<0.001	51.66	95	83.3
NLR	0.764	0.044	<0.001	1.55	70	73.3

NGAL ($r = 0.521$, $p < 0.001$), indicating that higher levels of VEGF are associated with higher levels of NGAL in food and respiratory allergic patients, and indicating potential interactions between these markers in the context of allergic responses, as shown in Fig. 1 There is a moderate positive correlation between RBC count and WBC count, and it is statistically significant ($r = 0.355$, $p = 0.005$). This suggests that RBC count decreases, while WBC count decreases as well in food and respiratory allergic patients, as shown in Fig. 2. In contrast, there were no significant correlations between VEGF or NGAL, and other biomarkers (IL-38, WBC, NLR, RBC, Hb, Age, IgE) in food and respiratory allergic patients. However, no significant correlations were observed between IL-38 and other biomarkers in food allergy patients, highlighting the need for further research to understand the role of IL-38 in the context of food allergies.

Table 3. presents the results of the Receiver Operating Characteristic (ROC) curve analysis and the corresponding Area Under the Curve (AUC) values for various parameters in food and air allergy patients. VEGF and NLR have shown good sensitivity with an AUC value of 0.785 and 0.764, respectively. The reduction in the level of IL-38 can be used as a prognostic marker with excellent sensitivity having an AUC value of 0.964 with a cut-off value $\leq$ 5.19 pg/mL. Moreover, NGLA has shown excellent sensitivity to predict immunity and inflammation in the food and air allergy group having an AUC value of 0.978 with a cut-off value $\geq$ 51.66 ng/mL. The ROC curve of each biomarker is shown in Fig. 3.

This study sheds light on the intricate interplay between immune and vascular responses in food and air allergy patients, emphasizing the importance of considering multiple biomarkers for a comprehensive

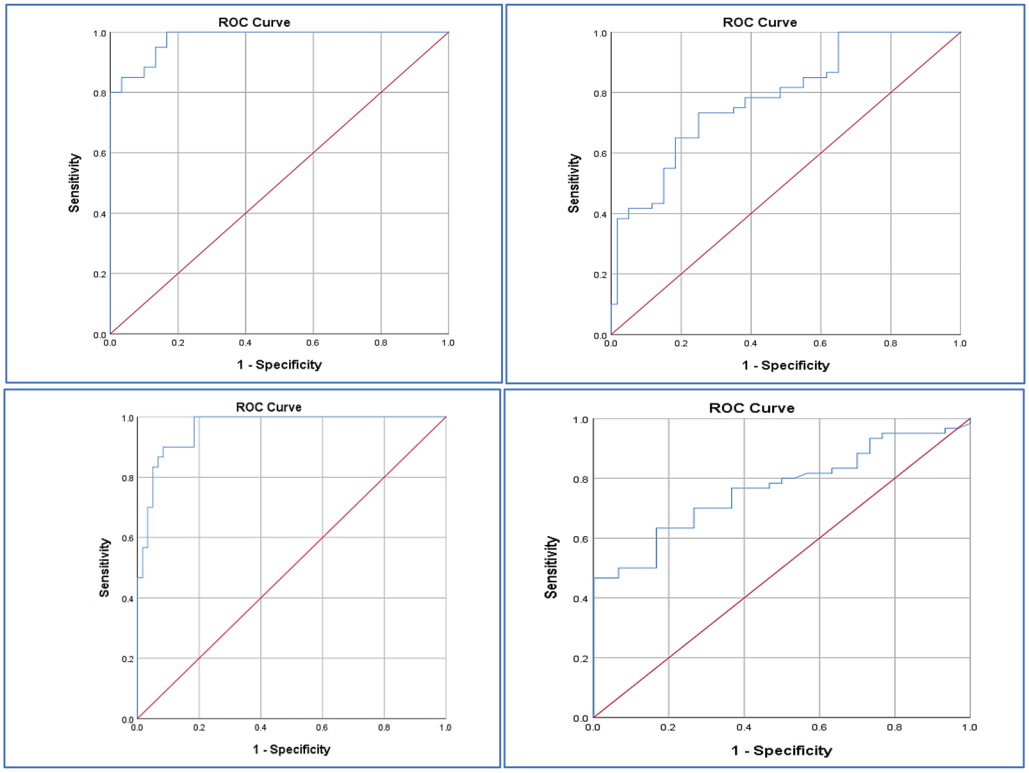

Fig. 3. ROC curve for A) VEGF, B) IL-38, C) NGLA, and D) NLR.

understanding. These findings may contribute to the broader discourse on immune dysregulation in allergic conditions, especially in the evolution following the COVID-19 pandemic. The results of this study suggest that individuals with allergies, both food and airways, may have lower circulating white blood cells than healthy individuals. These results are consistent with other studies' findings that demonstrated a decrease in levels of WBCs in food and airway-allergic patients compared to healthy individuals.[44–46] On the other hand, there were no significant differences observed in RBC count or Hb levels between the two groups. Moreover, in a study designed by Karabulut *et al.*, allergic- and non-allergic rhinitis patients were tested for hematological investigation. The results indicated non-significant differences regarding leukocytes, erythrocytes, and Hb.[47] Nevertheless, Eliseeva et al. reported high levels of leukocytes in children and adolescents with food allergies (10.42 × 10^3 cell/μL).[48] A lower WBC count may indicate a possible difference in immune response against disease in allergic populations, which may affect the degree of immune response to allergens.[49] These findings provide insights into the differences in biomarkers between individuals with allergies and those without allergies, which may help in understanding the underlying mechanisms and developing targeted interventions for these conditions. Overall, these results suggest that there may be some differences in hematological parameters between allergic subjects (food and airway) and healthy subjects but the precise mechanisms responsible for these differences are what clinical implications will require further investigation. Additionally, it is important to consider other factors such as medications, comorbidities, and lifestyle factors that may affect these blood components in healthy individuals.

VEGF levels were significantly increased in food and respiratory-allergic patients. The findings of this study are in agreement with other studies that demonstrated an elevation of VEGF levels in food and respiratory allergic patients compared to healthy individuals.[50–52] Some studies have shown that VEGF levels may be elevated in individuals with allergic diseases such as asthma, allergic rhinitis, and atopic dermatitis.[53–55] VEGF has been proposed to have a significant impact on angiogenesis and the consequent airway remodeling in bronchial asthma[56] and the different phenotypes of asthma.[57] This role can be engaged via the angiogenesis activity of VEGF in the airway tract.[50] However, the specific relationship between VEGF and food allergies is less well-established and may not be as extensively studied. Elevated levels of VEGF in the food and air of allergic patients highlight potential tissue involvement in these conditions. VEGF, being an important regulator of blood

vessels, may indicate increased vascular permeability and inflammatory response.

NGAL levels were significantly increased in food and respiratory-allergic patients. The findings of this study are in agreement with other studies that demonstrated an elevation of NGAL levels in food and respiratory allergic patients compared to healthy individuals.[58–60] In food allergies, elevated NGAL levels may indicate the presence of inflammation in the gastrointestinal tract or other tissues involved in the allergic response to ingested allergens.[61] In airway allergies, such as allergic asthma or allergic rhinitis, elevated NGAL levels may reflect inflammation in the respiratory tract.[62] Choi *et al.* reported a high level of NGAL in inflamed allergic patients, where it was correlated with some pro-inflammatory cytokines. According to their statement, an increase in NGAL levels may be strongly associated with allergic inflammation and a potential development of fibrosis in the airways.[63] The dual role of NGAL, acting both as a bacteriostatic agent and as an inflammatory marker, underscores its complexity in the allergic milieu.[64] The elevation of NLR in allergic patients may reflect the ongoing immune response, with neutrophils and lymphocytes providing valuable insights into the inflammatory balance. The relationship of VEGF with NGAL also suggests a complex interplay between angiogenesis and neutrophil activation under inflammatory conditions. This suggests that allergic reactions, particularly those involving food and airborne allergens, may induce inflammation and tissue injury, leading to higher NGAL levels.

The present study observed a significant reduction of IL-38, which is a key anti-inflammatory cytokine of the IL-1 family that has been involved in respiratory inflammation. The major function of IL-38 is the inhibition of the production of TH17 response cytokines and antagonism of IL-36, therefore, participating in the repression of inflammatory events and restricting them within the benefit level.[65] Sun *et al.* reported that reduced levels of IL-38 can cause hyperreactivity of allergic asthma in the airways. They have indicated that IL-38 has an antagonist effect on the intracellular STAT1, STAT3, p38 MAPK, ERK1/2, and NF-κB pathways, and upregulates the expression of the host defense-related gene POU2AF1 and anti-allergic response gene RGS13.[66] Gu *et al.* reported high levels of IL-38 in patients with allergic rhinitis, where they suggested that this increase indicates either a controlled mechanism to reduce the effects of pro-inflammatory cytokines which increased significantly, or IL-38 has a pro-inflammatory activity at high levels. Their indication was based on the positive correlation between IL-38 and IL-36Ra in the peripheral blood.[67] Lower IL-38 levels may indicate a reduced ability to regulate inflammation, which could contribute to the development or exacerbation of allergic reactions in food and respiratory allergic patients.

Neutrophil-to-Lymphocyte Ratio (NLR) is a marker of systemic inflammation and immune system activation.[68] It is calculated by dividing the absolute neutrophil count by the absolute lymphocyte count.[69] NLR levels were significantly increased in food and respiratory-allergic patients. The significantly higher NLR in this study is constant with other studies that suggested elevated levels of NLR in food and respiratory allergic patients compared to the control group.[70–72] The elevation of NLR indicates an imbalance in the immune response, with a relatively higher contribution from neutrophils compared to lymphocytes.[69,73,74] This suggests an increased inflammatory state in food and respiratory allergic patients, potentially reflecting the activation of innate immune responses in allergic reactions.

Significant increases in IgE levels in this study may be related to IgE's ability to defend against parasitic infections; however, this aspect is debated.[75] Allergens that bind to IgE and engage with receptors cause fast degranulation of these effector cells, resulting in the release of numerous components such as histamine, enzymes, and lipid mediators. The release of all these substances causes tissue damage and an initial inflammatory response.[76] Histamine plays a crucial role in acute and allergic hypersensitivity as part of the allergic response to antigen antibodies (IgE), which bind to the surface of MCs and basophils through high affinity produced Fc receptors (constant fraction) that are IgE-specific.[77] Allergic patients produce IgE antibodies against antigens that are regularly inhaled. This is a hereditary trait known as a "possible gene product" Histamine is considered a humoral and cellular modulator that induces rapid hypersensitivity responses.[78]

Conclusion

Food and respiratory allergies involve an imbalance between pro- and anti-inflammatory factors, where allergic-associated inflammation can be observed in patients. The combined role of VEGF and NGLA can enhance the local inflammation in the airway by angiogenesis mechanism, and increased vascular permeability. Moreover, the reduction of IL-38 in patients enhances the inflammatory processes via the absence of its antagonist effect against the IL-36 receptor. These effects might be magnified after the COVID-19 pandemic caused by the after-recovery effects. More studies are required to confirm the effects

of COVID-19 after-recovery effects on allergic and non-allergic inflammatory conditions.

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Authors' declaration

- Conflicts of Interest: None.
- We hereby confirm that the figures and tables in the manuscript are ours. Furthermore, figures and images that are not ours have been included with the necessary permission for re-publication, which is attached to the manuscript.
- No animal studies are present in the manuscript.
- Authors signed on ethical consideration's approval.
- Ethical Clearance: The project was approved by the local ethical committee at Mustansiriyah University.

Authors' contributions

E. H. K. contributed to the study design and carried out the experimental work, and data collection. Both authors did the data analysis, results discussion, writing, and drafting. Z. N. N.contributed to the editing of the paper. Both authors checked and approved the overall manuscript, and approved the final version of the manuscript.

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تأثير نسبة VEGF وNGAL وIL-38 وN/L على مرضى حساسية الطعام والهواء بعد جائحة كوفيد-19 في العراق

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الخلاصة

الحساسية هي مشكلة صحية شائعة حيث يتفاعل الجهاز المناعي مع المواد الموجودة في البيئة والتي عادة ما تكون غير ضارة. تبحث هذه الدراسة أيضًا في تأثيرات عامل نمو بطانة الأوعية الدموية (VEGF) ، lipocalin المرتبط ب gelatinase الخاص بالخلايا الحبيبية المتعادلة (NGAL) ، والإنترلوكين 38(IL-38) ، ونسبة الخلايا الحبيبية المتعادلة إلى الخلايا اللمفاوية (NLR)لدى هؤلاء الأفراد، مما يوفر نظرة ثاقبة للعمليات المحتملة وراء الاستجابات التحسسية بعد الوباء .شملت الدراسة 120 أنثى لم يتم تطعيمهن بعدوى سابقة بكوفيد-19. شملت المجموعات الاصحاء والمرضى الذين يعانون من حساسية الطعام والهواء (F&A)، مع 60 فردًا لكل منهم، متطابقين بالنسبة للعمر والجنس. تم تقييم مستويات مصل الدم IL-38، VEGF، IgE، وNGLA باستخدام تقنية ELISA، كما تم تحليل موشرات CBC.تم العثور على اختلافات كبيرة في المؤشرات الحيوية المختلفة في الأفراد الذين يعانون من حساسية مجرى الهواء و الغذاء(F&A) ، مقارنة مع الاصحاء. كان لدى مرضى F&A انخفاض في عدد خلايا الدم البيضاء (WBC) ولكن لا توجد فروق ذات دلالة إحصائية في عدد خلايا الدم الحمراء (RBC) أو عدد الهيموجلوبين .(Hb) كما تبين زيادة VEGF و NLR بشكل ملحوظ في مرضى F&A. زادت مستويات NGAL ، في حين انخفضت مستويات IL-38 في مرضى F&A. كانت مستويات الغلوبولين المناعي E (IgE) المرتفعة متوافقة مع حالة الحساسية. يمكننا أن نستنتج أن الحالات الالتهابية يمكن أن تحدث بسهولة لدى المرضى الذين يعانون من الحساسية الغذائية وحساسية الشعب الهوائية بعد جائحة كوفيد-19. يعد تثبيط IL-38 وتنظيم تعبير VEGF و NGALمن السمات الرئيسية لحساسية المريء والجهاز التنفسي المرتبطة بالالتهاب، حيث يمكن استخدامها كأداة تشخيصية للمرضى.

الكلمات المفتاحية: الحساسية الغذائية والشعب الهوائية، كوفيد-19، عامل نمو بطانة الأوعية الدموية، الليبوكالين المرتبط بالجيلاتيناز، إنترلوكين 38 ونسبة الخلايا الليمفاوية المتعادلة.