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Investigation of the effect of ultraprocessed food consumption on asthma using pulmonary function tests

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Abstract

Background: NOVA is a food classification system that classifies foods according to the scope and purpose of food processing, rather than nutrients. Asthma is usually characterized by chronic inflammation and respiratory symptoms such as wheezing, shortness of breath, chest tightness, cough, and variable expiratory airflow limitation. According to the NOVA food classification system, consumption of ultraprocessed foods (UPF) can affect asthma symptoms. **Aim:** In this study, the relationship between UPF consumption and pulmonary function test (PFT) results of asthma patients in adults aged 18 to 65 was investigated using biochemical parameters. **Methods:** This study was a cross-sectional study and, was conducted with 339 asthmatic participants diagnosed with asthma and receiving medical treatment. The participants' consumption of UPF was determined using a food frequency questionnaire. The evaluation of forced expiratory volume in one second (FEV_1) (L/s) and forced vital capacity (FVC) (L/s) in the respiratory function tests was based on the percentage of the measured and expected values. **Results:** Although no significant relationship was found between % FEV_1 expected value and UPF consumption ($P > 0.05$), it was concluded that % FVC expected and % FEV_1/FVC values decreased with increasing UPF consumption ($P < 0.05$). **Conclusion:** It has been concluded that consumption of UPF worsens respiratory function and asthma prognosis. Therefore, replacing UPF and beverage products with healthier foods or food processing methods will play an important role in maintaining health.

Keywords

Asthma, lung function, NOVA, pulmonary function test, ultraprocessed foods

Introduction

The issues that have gained importance for individuals since the existence of human beings have changed within the framework of the physical, economic, political, environmental, and many other issues of the area they live in. Apart from such changes, there are fundamental rights for people that will not change. One of these rights is the right to food, which is an important issue for all humanity. Based on the right to food, human beings have started to obtain food as much as their own needs in different ways from nature since the day they exist (Fellows, 2022). After this process of obtaining the food, they tried different methods in the process of storing the food and then processing and consuming this food. These methods have undergone significant changes since the hunter-gatherer era (Aguilera, 2018; Whitehurst and Van Oort, 2010; Naughton *et al*., 2017).

With the technological developments experienced in the historical process and especially with the Industrial Revolution, different cooking and storage methods such as vacuuming, canning, baking, etc. have been used (Lima *et al*., 2021; Johansson, 2021; Kargwal *et al*., 2023).

The rise in the global population has led to a preference for ready-to-eat and processed foods, which have had detrimental effects on people's health. To combat these negative consequences, changes have been made to the nutrition

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system. One of these changes is the NOVA food classification system, which categorizes foods based on the extent and purpose of their processing, rather than their nutrient content (Monteiro *et al*., 2018).

NOVA's definition of food processing encompasses the physical, chemical, and biological alterations that take place in food after they have been removed from their natural state but before they are consumed or used in meal preparation.

In addition, this classification divides all foods and food products into four groups. NOVA's fourth group consists of ultraprocessed foods (UPF) and beverage products, which are industrial formulations with five or more ingredients, often including additives like sugar, fat, salt, antioxidants, stabilizers, and preservatives. These products contain ingredients not commonly used in home cooking or traditional processed foods. Their purpose is to imitate the taste and texture of unprocessed foods or to mask undesirable qualities of the final product. The widespread consumption of processed and UPF has led to an increase in chronic noncommunicable diseases. For instance, respiratory diseases such as asthma are affected by UPF consumption (Monteiro *et al*., 2010; Moodie *et al*., 2013).

Asthma is a widespread and chronic respiratory illness, which impacts between 1% and 29% of individuals in different countries worldwide (GINA, 2023). The condition is identified by a range of symptoms that may vary, including wheezing, shortness of breath, cough, chest tightness, and inconsistent expiratory airflow limitation. The symptoms and degree of airflow obstruction frequently change in terms of duration and intensity (Choi *et al*., 2021; Trzil, 2020).

The Western diet is characterized by high consumption of processed foods, high amounts of refined carbohydrates, high fat, particularly high amounts of saturated fat, high amounts of processed meat, and excessive salt. This dietary pattern is often hypercaloric and associated with low levels of physical activity and sedentary behavior and leads to obesity (Hancu *et al*., 2019). As Western-style diets have become more common, the incidence of asthma has increased. Studies indicate that diets prioritizing plant-based foods may protect against developing asthma and alleviate symptoms by affecting systemic inflammation, oxidation, and microbial composition. Consuming more fruits and vegetables, reducing animal products, and maintaining a healthy weight can modulate cytokine release, free radical damage, and immune responses involved in asthma's onset and progression (Varraso, 2012). Thus, nutrition plays an important role in asthma prevention in addition to medical treatment.

Based on all these data, in this study, the aim is to investigate the relationship between UPF consumption and forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), and FEV_1/FVC associated with pulmonary function tests (PFT) in individuals diagnosed with asthma.

Methods

Study design and research methodology

This study was a cross-sectional study and, was conducted between January 2021 and September 2021 with 339 asthmatic participants diagnosed with asthma and receiving medical treatment at Yedikule Chest Diseases and Thoracic Surgery Training and Reseaerch Hospital. Approval for the study was obtained from the Non-Interventional Clinical Research Ethics Committee of Tekirdag Namık Kemal University with the research protocol number 2021.279.12.02.

Determination of sample size

Power analysis was performed while determining the sample of the study. The sample size was calculated to be 339 people with effect size 0.4, error rate 0.05 and 95% power. The purpose and scope of the study were explained to the participants, and their Voluntary Informed Consents were obtained. The research was conducted in accordance with the "Helsinki Declaration Principles" and ethical guidelines for research and publication.

Study inclusion criteria

Individuals diagnosed with asthma and receiving medical treatment, without any accompanying respiratory illness, without any food allergies, and who are over 18 years old or under 65 years old and participants with informed consent were included in the study.

Study exclusion criteria

Individuals who are pregnant, have been diagnosed with asthma but are not receiving medical treatment, have accompanying respiratory illness, have any food allergies, and are under 18 years old or over 65 years old and participants without informed consent were excluded from the study.

Evaluation of demographic information, food frequency questionnaires, and anthropometric data

The demographic information of the participants was obtained with the participant information form, and the frequency of food consumption was obtained with the food frequency questionnaire. The foods in the food frequency questionnaire were divided into 4 groups using the NOVA food classification method and were scored between 0 and 6 according to each food frequency category (Never: 0, Daily: 6) (Melo *et al*., 2018). Group 1 consists of 20 unprocessed or minimally processed foods, with a score range of 0 to 120. Group 2 consists of 25 processed kitchen ingredients, with a score range of 0 to 150. Group 3 consists of 6 processed foods, with a score range of 0 to 36. Group 4 consists of 26 UPF and drinks, with a score range of 0 to 156. The list of foods is included in the Supplementary material. It has been determined which NOVA classification each food item included in the food frequency questionnaire belongs to. Accordingly, a high score for each group indicates that the participant consumes that food item more frequently. Anthropometric data such as body weight in kilograms (kg) and height in centimeters (cm) were reported, and body mass index (BMI) was calculated by dividing body weight by height squared in meters (kg/m^2). The BMI was classified based on the World Health Organization (WHO) criteria (WHO, 2020).

Evaluation of biochemical parameters

The evaluation of FEV_1 (L/s) and FVC (L/s) in the PFT was based on the percentage of the measured and expected values. Measured FEV_1 and FVC values were considered low if they were below 80% of the expected values. Similarly, values below 80% for FEV_1/FVC were considered low in evaluation.

Evaluation of data

The IBM SPSS 22.0 (Statistical Package for the Social Sciences) software was used for data analysis. The tabular and numerical summaries for qualitative data comprise the frequency and percentage of observations, while quantitative data is expressed as measures such as mean, median, range, and standard deviation. To investigate the association between two qualitative variables, the Chi-square test was employed. For data with two groups that do not meet the normality assumption, the Mann–Whitney U test was utilized. Meanwhile, the Kruskal–Wallis H test was used for non-normally distributed data with three or more groups. Also in asthma patients, the % FEV_1/FVC ratio was assessed as low (<80%) and high (>80%), and thus, UPF consumption was evaluated according to these ratios. The results were tested at a significance level of 5% (Ali and Bhaskar, 2016).

Results

Demographic characteristics of participants

Analysis of participant demographic characteristics was conducted and results are presented in Table 1. When examining the demographic characteristics of the participants included in the study, 74.0% were female (n: 251) and 26.0% were male (n = 88).

Table 1. Distribution of data on demographic characteristics of participants.

	n = 339	Percentage
Gender		
Female	251	74.0
Male	88	26.0
Age		
24 years and under	10	2.9
25–29 years	48	14.2
30–34 years	24	7.1
35–39 years	23	6.8
40–44 years	39	11.5
45–49 years	39	11.5
50–54 years	43	12.7
55–59 years	47	13.9
60 years and older	66	19.5
Educational status		
Illiterate	11	3.2
Primary-secondary school	170	50.1
High school	97	28.6
University	52	15.3
Postgraduate	9	2.7

Distribution of participants' BMI data

The results regarding the participants' classification based on their BMI are presented in Table 2. The WHO [16] was used as the basis for the BMI classification. Upon examination based on BMI, 4.4% (n = 15) of the participants in the study were underweight, 28.3% (n = 96) were normal weight, 32.7% (n = 111) were overweight (pre-obese), 24.5% (n = 83) were class I obese, 7.4% (n = 25) were class II obese, and 2.7% (n = 9) were class III obese.

Table 2. Distribution of participants' BMI data.

BMI	n = 339	Percentage
Underweight	15	4.4
Normal weight	96	28.3
Overweight (pre-obese)	111	32.7
Obese class I	83	24.5
Obese class II	25	7.4
Obese class III	9	2.7

BMI: body mass index.

Distribution of participants' data on NOVA classification

Food consumption frequency based on NOVA food classification of the participants was researched and the scores for each group are shown in Table 3. According to this, the average total consumption score of participants in group 1 was found to be 49.24 ± 8.98. This means that the participants consumed these foods less than once or twice a week, but more than once in 15 days. The average consumption score of group 2 was 50.73 ± 11.04, and participants consumed these foods once in 15 days. The average consumption score of group 3 was 15.94 ± 3.28, while participants consumed these foods less than once or twice a week, but more than once in 15 days. The average consumption score of group 4 was 29.84 ± 17.51, and participants consumed these foods more than once a month and less than once in 15 days.

Distribution of participants' PFT data

The data regarding the participants' spirometry tests in the study was analyzed, and the results are presented in Table 4.

Table 3. Distribution of participants' data on NOVA classification.

	n	Average	SD
Unprocessed or Minimally processed foods	339	49.24	8.98
Processed culinary ingredients	339	50.73	11.04
Processed foods	339	15.94	3.28
UPF and beverage products	339	29.84	17.51

SD: standard deviation; UPF: ultra-processed foods.

Table 4. Distribution of participants' PFT data.

	n	Average	SD
FEV_1 expected	339	2.86	0.75
FEV_1 measured	339	2.18	0.85
FEV_1/FVC expected	339	3.40	0.91
FEV_1/FVC measured	339	2.80	0.93

FEV_1: forced expiratory volume in the first second; FVC: forced vital capacity; PFT: pulmonary function test; SD: standard deviation.

According to this, the mean expected FEV_1 of the participants was 2.86 ± 0.75 L/s; the mean measured FEV_1 was 2.18 ± 0.85 L/s; the mean expected FEV_1/FVC was 3.40 ± 0.91 L/s, and the mean measured FEV_1/FVC was 2.80 ± 0.93 L/s.

Relationship between UPF consumption scores and demographic characteristics and BMI

The relationship between participants' consumption scores of UPF and their demographic characteristics was investigated, and presented in Table 5. Upon examining the relationship between the consumption scores of UPF and the ages of the participants included in the study, it was observed that as age increased, the average consumption score of UPF decreased. However, it was determined that this difference was not statistically significant ($P > 0.05$). When examining the relationship between gender and consumption scores of UPF, it was found that the mean consumption score of UPF for female participants included in the study was 28.78 ± 16.79, and for male participants, it was 32.85 ± 19.20. Nevertheless, it was established that this difference was not statistically significant ($P > 0.05$). Furthermore, the relationship between educational level and consumption scores of UPF was explored. Among the participants included in the study, those who were illiterate had a mean consumption score of 26.45 ± 17.95 for

Table 5. Relationship between UPF consumption scores and demographic characteristics and BMI.

	n	UPF average	SD	Median	Minimum–maximum	Statistics test	*P*
Age							
≤24	10	37.40	26.73	28.50	11–89	9,209	0.325
25–29	48	34.21	16.96	34.00	8–86		
30–34	24	34.08	21.77	31.50	5–75		
35–39	23	30.00	12.87	26.00	8–57		
40–44	39	27.28	16.70	24.00	6–68		
45–49	39	26.18	13.63	23.00	8–68		
50–54	43	28.14	15.45	25.00	6–75		
55–59	47	27.15	18.00	23.00	0–86		
≥60	66	30.62	18.95	24.00	7–75		
Gender							
Female	251	28.78	16.79	25.00	0–89	12,443.0	0.077
Male	88	32.85	19.20	26.00	0–86		
Educational status							
Illiterate	11	26.45	17.95	23.00	6–68	3,787	0.436
Primary-secondary school	170	30.38	16.99	26.00	0–86		
High school	97	27.66	16.75	24.00	0–75		
University	52	31.90	18.45	26.50	5–77		
Postgraduate	9	35.33	27.84	22.00	7–89		
BMI							
Underweight	15	32.93	14.84	30.00	5–68	2,763	0.736
Normal weight	96	30.07	17.69	26.00	4–89		
Overweight (pre-obese)	111	29.04	17.57	25.00	0–86		
Obese class I	83	30.35	18.00	26.00	0–86		
Obese class II	25	27.44	15.94	24.00	7–68		
Obese class III	9	34.11	21.37	24.00	6–68		

Mann–Whitney U test.
BMI: body mass index; UPF: ultraprocessed foods.

Table 6. Relationship between UPF consumption scores and PFT.

	Low (<%80)		Normal (>%80)			
	Cover ± SD	Cover (minimum–maximum)	Cover ± SD	Cover (minimum–maximum)	Statistics test	P
$\%FEV_1$ expected	31.35 ± 19.38	26.00 (0–89.00)	27.91 ± 14.63	25.00 (6–75)	13,166.50	0.269
%FVC measured	33.56 ± 20.43	28.50 (0–89.00)	26.44 ± 13.52	24.00 (0–68)	11,864.50	0.006*
$\%FEV_1$/FVC	35.65 ± 18.21	30.00 (5–86.00)	28.67 ± 17.16	24.00 (0–89)	5974.50	0.002*

Kruskal–Wallis H test.
*$P < 0.05$.
FEV_1: forced expiratory volume in the first second; FVC: forced vital capacity.

UPF, those with primary-secondary education had a mean consumption score of 30.38 ± 16.99, high school graduates had a mean consumption score of 27.66 ± 16.75, university graduates had a mean consumption score of 31.90 ± 18.45, and postgraduate degree holders had a mean consumption score of 35.33 ± 27.84 for UPF. However, it was determined that this difference was not statistically significant ($P > 0.05$). Additionally, the relationship between BMI and consumption scores of UPF was examined. The mean consumption score of UPF for individuals classified as underweight was 32.93 ± 14.84, for those classified as normal weight was 30.07 ± 17.69, for those classified as overweight was 29.04 ± 17.57, for those classified as obese class I was 30.35 ± 18.00, for those classified as obese class II was 27.44 ± 15.94, and for those classified as obese class III was 34.11 ± 21.37. However, it was found that this difference was not statistically significant ($P > 0.05$).

After the participants' food consumption frequency was separated according to the NOVA classification system, the relationship between their consumption score from UPF and their PFT was investigated and the results are presented in Table 6. According to this, the average consumption score from UPF of those with a low expected value of % FEV_1 (<%80) was 31.35 ± 19.38 while the average consumption score from UPF of those with a normal expected value of $\%FEV_1$ (>%80) was 27.91 ± 14.63, and it was determined that this difference was not significant ($P >$ 0.05). The average consumption score from UPF of those with a low expected value of %FVC (<%80) was 33.56 ± 20.43 while the average consumption score from UPF of those with a normal expected value of %FVC (>%80) was 26.44 ± 13.5, and it was determined that this difference was significant ($P < 0.05$). The average consumption score from UPF of those with a low expected value of $\%FEV_1$/FVC (<%80) was 35.65 ± 18.21 while the average consumption score from UPF of those with a normal expected value of $\%FEV_1$/FVC (>%80) was 28.67 ± 17.16, and it was determined that this difference was significant ($P < 0.05$).

Discussion

"Nutrition Decade" was designated by the United Nations (UN) Sustainable Development Support Goals from 2016 to 2025 (Monteiro *et al.*, 2018). Thus, the effectiveness of nutrition models in promoting health is of great importance. The prevalence of asthma has shown a growing trend in recent years. It is believed that changing nutrition conditions contribute to the prevalence of asthma (Hancu *et al.*, 2019). The Western diet, characterized by high processed food, high refined carbohydrates, high fat, especially high saturated fat, high processed meat, and excessive salt consumption, is a diet model. This diet model is usually hypercaloric and is associated with low physical activity and sedentarism, leading to obesity (Brigham *et al.*, 2015). The Mediterranean diet, rich in olive oil, fish, fruit, vegetables, and nuts, and high in fat content, is considered a diet with many positive effects on health (Davis *et al.*, 2015).

When examining the relationship between gender and frequency of UPF consumption scores, although the results of the study showed that the differences were not statistically significant it is observed that men have higher scores in UPF consumption compared to women. Similar findings were reported by Machado *et al.* (2020a) in their study examining the relationship between UPF consumption and obesity in Australian adults, where men were found to have higher rates of UPF consumption compared to women. Likewise, in a study conducted by Rauber *et al.* (2020) investigating the relationship between UPF consumption and obesity, it was found that men had higher rates of UPF consumption compared to women. We believe that this situation may be attributed to men spending more time outside the home and exhibiting a greater tendency to select a wider variety of foods.

When examining the relationship between age groups and frequency of UPF consumption scores, it is observed that as age increases, the consumption scores of UPF decrease. Yang *et al.* (2020), in their study utilizing data from the National Health and Nutrition Examination Survey in the United States (NHANES) (2009–2016) among adults aged 30 to 74 without cardiovascular disease, found that as age increases, the consumption rates of UPF decrease. We believe that this result can be attributed to an increasing inclination toward healthy eating habits as individuals age, as well as to the tendency of young adults to spend more time outside the home where access to UPF products is easier.

When examining the relationship between education level and consumption of UPF, it is observed that as educational attainment increases, participants' consumption scores of UPF tend to rise. Parallel to this study, Machado *et al.* (2020b) found in their research that as the number of years of education increases among participants, their consumption of UPF also significantly increases.

In contrast to these studies, Juul *et al.* (2021) investigated the relationships between UPF, CVD incidence, and mortality. In their study, they found that as participants' education levels increased, their inclination toward UPF decreased, but this difference was not statistically significant.

Based on these results, there is no definitive conclusion regarding the relationship between education level and consumption of UPF. While an increase in the duration of education may lead to an increase in awareness of healthy eating habits, potentially resulting in a decrease in the consumption of UPF, on the other hand, an increase in educational duration may also lead to more involvement in the workforce and a decrease in the time allocated for meals, potentially leading to an increase in the consumption of UPF.

When examining the relationship between BMI and consumption of UPF, it is observed that individuals with class III obesity have the highest scores, although the difference is not significant. In a study by Rauber *et al.* (2021) investigating the consumption of UPF and obesity risk among adults in the United Kingdom, it was found that as the percentage of energy derived from UPF increased, participants' BMIs also increased. Similarly, in a study of Canadian adults aged 18 to 65, the relationship between obesity and consumption of UPF was examined. It was found that UPF accounted for nearly half (45%) of the daily caloric intake among Canadian adults, with higher consumption observed among men, young adults, those with lower levels of formal education, smokers, physically inactive individuals, and individuals born in Canada. Additionally, it was concluded that as consumption of these foods increased, BMIs also increased (Nardocci *et al.*, 2019).

The high energy content of UPF contributes to weight gain and consequently to higher BMIs. The findings of these studies support this notion.

Possible mechanisms that contribute to the protective effects of fruits and vegetables include their antioxidant and anti-inflammatory properties, as suggested by the observed association between the consumption of fruits and vegetables and lower levels of oxidative stress and inflammation, along with higher levels of antioxidant markers (Holt *et al.*, 2009; Rink *et al.*, 2013).

In a study investigating the relationship between dietary intake of magnesium, vitamin C, and other antioxidant vitamins and the decline in lung function, food frequency and FEV_1 measurements were taken from 2633 adults aged 18 to 70. The study found that individuals with lower vitamin C intake had lower FEV_1 volume compared to those who consumed 100 mg of vitamin C daily. There was no relationship observed between dietary intake of magnesium, vitamin E, and vitamin A, and FEV_1 volume (McKeever *et al.*, 2002). Another study also found a positive correlation between increased consumption of firm fruits, such as apples (consuming 5 or more apples per week), and lung function (FEV_1). The study revealed a 138 mL higher FEV_1 for individuals who consumed 5 or more apples per week compared to nonconsumers (Butland *et al.*, 2000).

Early studies conducted on the general population indicated a significant correlation between the consumption of magnesium and lung function, airway hyper-responsiveness, and wheezing (Britton *et al.*, 1994), although these findings were not consistently replicated (Butland *et al.*, 2000). In a study involving a UK population, higher intake of magnesium was cross-sectionally associated with increased FEV_1 (each additional 100 mg/day of magnesium intake was linked to a 52.9 mL increase in FEV_1), but no relationship was observed between magnesium intake and the longitudinal decline in FEV_1 (McKeever *et al.*, 2002). Magnesium may have a beneficial role in respiratory function and chronic obstructive pulmonary disease (COPD) due to its protective effects against inflammation and bronchoconstriction (Al Alawi *et al.*, 2018). While the existing evidence suggests potential protective effects of certain minerals on lung function and COPD, particularly those with antioxidant and anti-inflammatory properties, further prospective studies are needed to confirm these findings.

Other potential dietary factors that may provide protection include polyphenols, which are the most abundant antioxidants naturally found in plant-based foods and possess strong anti-inflammatory properties. The flavonoid class of polyphenols, in particular, has been associated with beneficial effects on respiratory function (Potì et al., 2019). In a study conducted in the Netherlands, the intake of catechins showed a positive correlation with FEV_1 (mean difference in FEV_1 comparing high vs. low catechin intake = 130 mL) and a negative association with all three COPD symptoms (phlegm, breathlessness, and cough comparing high vs. low catechin intake = 0.60–0.72) (Tabak *et al.*, 2001). Similarly, a slower decline in lung function over time was observed with higher intake of anthocyanidins in elderly men in the United States (Mehta *et al.*, 2016). A favorable association was found between dietary intakes of isoflavones and soy, which is a rich source of isoflavones, and lung function and COPD prevalence in Japanese adults (Hirayama et al., 2009, 2010).

In this study, the relationship between the PFT results and UPF consumption during the treatment of asthma patients was evaluated. According to our results, we think that this significance, which is between expected FVC values in patients with the average UPF consumption score for individuals with a lower FVC, causes a restrictive respiratory limitation due to the fact that those who are consuming these processed products are overweight. In the literature, there have been some studies examining the relationship between asthma and consumption of UPF in children, however, the relationship between the results of

PFT and FEV_1, FVC and FEV_1/FVC has not been studied before. In this study, it was observed that as the consumption of UPF increased, the expected %FEV_1, expected % FVC, and % FEV_1/FVC, which indicate the presence of restriction and obstruction in the airways, also decreased. However, this decrease was only significant in expected %FVC and %FEV_1/FVC.

UPF consumption worsens respiratory function and asthma prognosis. In contrast, dietary intake of vitamins, minerals, vegetables, fruits, and polyphenols improves lung function. Weight gain impairs asthma control and affects PFT results, as demonstrated by our study. This study is the first to investigate the relationship between PFT results and UPF consumption and contributes positively to the literature. However, more studies are needed to clarify the relationship between UPF consumption and asthma.

Food processing has become inevitable due to population growth and the need to meet nutritional demands. These methods have been used historically for storage, extending shelf life, and enhancing flavor. However, it is important to note that food processing can also lead to chronic diseases such as obesity, diabetes, cardiovascular diseases, and asthma. Particularly, UPF and beverage products reduce total lung capacity and worsen respiratory functions in asthma patients. Therefore, replacing UPF and beverage products with healthier foods or alternative processing methods is crucial for maintaining health.

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Author contributions

ROI, MA, and STO were involved in conceptualization, methodology formal analysis, investigation, writing—original draft, writing—review & editing, and supervision.

Data availability statement

The manuscript incorporates all datasets produced or examined throughout this research study.

Consent for publication

The authors give permission for the Journal to publish this work. This study was a cross-sectional study and, was conducted between January 2021 and September 2021 with 339 asthmatic participants diagnosed with asthma and receiving medical treatment at Istanbul Yedikule Chest Diseases and Chest Surgery Education and Research Hospital.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethics committee statement

Approval for the study was obtained from the Non-Interventional Clinical Research Ethics Committee of Tekirdağ Namık Kemal University with the research protocol number 2021.279.12.02.

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Supplemental material

Supplemental material for this article is available online.

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