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Relation between asthma clinical presentation and diet patterns among adolescents living in Saudi Arabia: Evidence from national school-based study

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Abstract---*Background:* Dietary intervention based on evidence-based guidelines should be introduced into the clinical management of Asthmatic patients to promote overall health benefits and disease control. However, there is limited evidence in the Saudi medical literature. *Objective of the study:* To assess the association between diet patterns and asthma symptoms in Saudi adolescents. *Subjects and Methods:* In total, 4086 Saudi adolescents were recruited for the study. Data for this study were sourced from a national survey conducted by the Saudi Ministry of health. *Results:* 13.3% (n=543) of adolescents reported current wheeze in the past 12 months. The results showed that almost half of all adolescents reported unhealthy diet consumption on most or all days and a healthy diet was consumed at least twice per week in a third of them. The most important clinically relevant finding was a positive association between high weekly consumption of an unhealthy diet with asthma symptoms. *Conclusion:* Our findings suggest that the positive impact of diet on asthma control is encouraging. A healthy diet including fruits, vegetables, and fish, is implicated in the mitigation of asthma symptoms and severity.

Keywords---Asthma, adolescent, Saudi, Diet, Pattern

Introduction

Asthma is the most prevalent chronic non-communicable disease (NCD) in children and adults worldwide [1]. A total of 461000 deaths from Asthma were reported in 2019, affecting an estimated 262 million individuals [2]. In fact, Saudi Arabia is not an exception of that; in a national survey in Saudi Arabia, the overall prevalence of asthma symptoms was determined to be about 14.2 percent [3].

Patients with Asthma suffer from coughing, wheezing, shortness of breath, and chest tightness due to inflammation and narrowing of the lungs' tiny airways. Unfortunately, in low- and middle-income nations, Asthma is frequently misdiagnosed and undertreated [4]. In terms of costs, both direct and indirect, Asthma continues to be a major source of global economic burden [5]. In the United States of America, 1.75 million asthma-related ER visits and 456,000 asthma hospitalizations were recorded during one year [6]. Because Asthma

cannot be cured or effectively prevented, efforts to cut expenses should concentrate on improving disease management [5].

Based on evidence-based guidelines, dietary intervention should be incorporated into the routine clinical management of patients with Asthma to achieve overall health benefits and disease management [7]. On the other hand, fast food consumption could be linked to the rising prevalence of Asthma, rhino conjunctivitis, and eczema in adolescents and children. The picture is less clear for other foods, especially for adolescents and children. However, according to international dietary recommendations, diets rich in fruits and vegetables are more likely to protect against Asthma, allergic disease, and other NCDs [8].

Moreover, asthma symptoms can also be improved by eating fruits and vegetables. Fruit consumption at an early age was associated with reduced asthma symptoms. As well Long-term fruit intake was inversely associated with asthma symptoms and sensitization to inhaled allergens. [9]. Also, findings suggest that a higher fruit intake can help prevent respiratory allergic symptoms in schoolchildren [10].

Also, in another study, antioxidant food consumption appeared to be inversely connected to asthma development in children regardless of atopy or genetics [11]. An ecological analysis of symptom prevalence on Asthma, rhinitis, and eczema found substantial associations between consuming a lot of calories from cereal and rice, as well as protein from cereal and nuts, and decreased symptom prevalence of all three allergic conditions, as well as a potential protective effect from increased fruit consumption [12]. Furthermore, findings from another study showed that eating more fruits, vegetables, and fish was linked to a lower lifetime asthma prevalence, but eating a lot of burgers was related to a greater lifetime asthma prevalence [13]. In a study done in Portugal, eating a greater variety of vegetables was associated with a lower chance of airway inflammation and the prevalence of self-reported Asthma in schoolchildren [14].

In Saudi Arabia, a case-control study showed that asthmatic children reported eating more fast food and eating diets that were lower in vegetables, milk, magnesium, vitamin E, fiber, potassium, sodium, and calcium than their non-asthmatic peers [15]. According to a regional study in Najran, the biggest dietary risk factor for the prevalence of bronchial Asthma among school children was vegetable and egg consumption, whereas a diet rich in fruit, seafood, and dairy products was linked to a decreased risk of Asthma [16]. Another study found that Self-reported asthmatics were more likely to be men, overweight or obese, had a lower father's educational level, and consumed more milk and energy drinks [17]. Western diets are likely to aggravate Asthma, although the evidence is still low. A balanced diet combined with exercise may be an effective method to improve asthma outcomes, and the combination of these two non-pharmacological therapies has to be investigated thoroughly [7].

Despite the importance of this topic, only a few studies have been done in Saudi Arabia to assess the association between Asthma and diet on a subnational level. However, this is the first national study to investigate the relationship between diet and asthma symptoms and severity in adolescents using globally

standardized methods developed by the Global Asthma Network (GAN). This study will help the asthma program in the Ministry of health to make use of their adolescent health data to explore and improve the situation of Asthma in Saudi Arabia.

Aim: Emphasize the significance of a nutritious diet in controlling clinical features of Asthmatic patients.

Objectives: To assess the association between diet patterns and asthma symptoms in Saudi adolescents

Material and Methods

An analytical cross-sectional study was conducted using secondary data from the Ministry of health.

Sample Size and Sampling Technique

Data for this study were sourced from a national survey conducted by the Saudi Ministry of health. The sample size was estimated using a 95 percent confidence interval, a prevalence of 50%, and a margin of error of 1.5 percent. Given the study population size of 683,317 and a non-response rate of 10%, the sample was calculated to be 4666. In order to accurately calculate a nationally representative sample, according to GAN, surveys should include at least 3000 people per age group to detect a difference with a statistical power of > 90% at a significance level of 1% [18].

The sample size was proportionally distributed among Saudi Arabia's 20 administrative regions. A multistage sampling method was adopted, starting with stratification based on region, gender, and school type (public or private). According to their Ministry of Education unique identifier code, an online random picker was utilized to select schools within each region. In total, 140 intermediate schools were randomly selected from all regions, while seven major regions were approached to select the private schools due to comparatively small samples in other regions. A cluster of 40 and 30 students were selected from each governmental and private school, respectively, while a simple random sampling was used to select participants within each school.

Data Collection: The present study started in June 2022, and used the data base of national study that was conducted in Saudi Arabia from March 2019 to April 2020 in intermediate schools. The subjects were school children of age group 13 to 14 years (first and second intermediate grades), Saudi schoolchildren who were studied in private and governmental schools.

Data were gathered using a self-administered, standardized questionnaire developed by the GAN and provided by the International Study of Asthma and Allergies in Childhood (ISAAC) [19]. The GAN recommended techniques were used to validate the questionnaire across the country. It was translated into Arabic and back-translated into English by two independent bilingual experts familiar with national sociocultural aspects. In addition, a pilot study was conducted on a

small sample of participants who were representative of the study groups in order to test the questionnaire and make any necessary changes.

The fundamental questions are the same as those used in phases 1 and 3 of ISAAC and the GAN [19]. The questionnaire consists of demographic data including school-related information, date of birth, nationality, and sex. It also assesses the prevalence and severity of Asthma and explores asthma management, diet, environmental factors and lifestyle. The questions are sensitive, specific and have good predictive validity [20].

Variables and Measurements

Sociodemographic characteristics included: age, gender, and anthropometric measurements. Asthma prevalence or "current wheeze" was determined based on the question "Have you experienced chest wheezing or whistling in the previous 12 months?" Severe Asthma was defined by the existence of current wheeze (wheeze in the past 12 months) and four or more attacks of wheeze, or 1 night or more per week of sleep disturbance from wheeze or wheeze affecting speech in the past 12 months.

A validated 22-item Food Frequency Questionnaire (FFQ) was used, which assessed the past 12-month intake frequency of 22 food groups or food items. We categorized the food into healthy food and unhealthy food. Healthy food was identified from the collected and defined as plant based food, fruit, vegetables, whole grain and proteins. On the contrary, unhealthy food was defined as the high fat food, food and drinks with added sugars.

Data Handling and Quality: The data were imported into Microsoft Excel sheets. Data quality was assured. An independent individual re-entered 10% of all entered data for data validation purposes. A third person then compared the original and re-entered data. The percentage of errors was less than 5%, which is considered within an acceptable level of accuracy.

Statistical Analysis: IBM SPSS Statistics for Windows, Version 26 was used to analyze the data (IBM Corp.). After cleaning the data and removing missing or skipped responses, all analyses was carried out. Frequency tables was used to present demographic data and Chi-square analysis was used to examine the relationships between categorical dependent and independent variables. Significant factors linked with asthma prevalence were identified using logistic regression analysis. Bivariate logistic models were used to assess the prediction of different variables on asthma prevalence.

Ethical Considerations: Approval to use the secondary data was given by the Ministry of health. Before the school visits and data collection, the Ministry of Education granted further permission. The IRB number is H- 01-R-012. Participation in this survey was voluntary, and consent was taken from study participants. All recorded files were kept in a locked room. Participants were anonymized and assigned identification numbers.

Result

A total of 4666 adolescents were invited to participate in this study, and 528 of them declined informed consent or were inaccessible; 4138 of them participated, and 52 subjects were excluded for missing data. In total, 4086 adolescents were included for data analysis; half were girls with a mean age of 13.4 ± 0.6 years. The participants' mean weight was 48.7 ± 11.7 Kg, and the mean height was 1.5 ± 0.1 m. The mean BMI of the participants was 20.5 ± 4.2 kg/m², with a third having normal weight. (**Table I**).

Table I.
Sociodemographic characteristics of adolescents in Saudi Arabia (n=4086)

Demographic characteristics	Mean	± SD*
Age (year)	13.4	± 0.6
Weight (kg)	48.7	± 11.7
Height (m)	1.5	± 0.1
Older siblings(n)	2.7	± 2.9
Younger siblings(n)	2.2	± 1.7
	Frequency	Percentage
Gender		
Male	1973	49.5
Female	2015	50.5
Body Mass Index		
Underweight	1147	28.1
Normal weight	1374	33.6
Overweight	387	9.5
Obese	76	1.9

* *Standard Deviation*

Concerning the prevalence of Asthma, **Table 2** shows that 13.3% (n=543) of adolescents reported current wheeze in the past 12 months, with a positive correlation between boys and girls ($P < 0.001$). Almost 41.8% (n=227) reported severe asthma symptoms with no significant correlation between boys and girls. In comparison, those who reported exercise wheeze during the same period were 19.1% (n=781), with a significant correlation between boys and girls ($P < 0.001$). Furthermore, nearly 15.7% (n= 643) of the participants had experienced asthma-ever with a significant correlation between boys and girls ($P < 0.001$). Two-thirds (74 %) of them reported that doctors diagnosed their Asthma, and only a third (32 %) reported having had a written plan for controlling their Asthma, with no significant correlation between boys and girls.

Table 2.
The prevalence and severity of asthma symptoms among adolescents

History of Asthma	Total (n=4086) n (%)	Boys (n=1973) n (%)	Girls (n=2015) n (%)	P value
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Current wheeze ^b	543 (13.3)	318 (16.1)	210 (10.4)	<.001 ^a
Symptoms of severe asthma ^c				
All participants	227 (5.6)	139 (7.0)	79 (3.9)	.135
Participants with current wheeze	227 (41.8)	139 (43.3)	79 (37.1)	.170
Exercise wheeze in the past 12 months	781 (19.1)	458 (23.2)	298 (14.8)	<.001 ^a
Night cough in the past 12 months	1051 (25.7)	509 (25.8)	513 (25.5)	.593
Asthma ever	643 (15.7)	380 (19.3)	243 (12.1)	<.001 ^a
Asthma confirmed by a doctor				
All participants	474 (11.6)	282 (14.3)	179 (8.9)	<.001 ^a
Participants with Asthma ever	474 (74.8)	282 (75.2)	179 (74.3)	.796
A written plan for asthma control				
All participants	198 (4.8)	114 (5.8)	76 (3.8)	<.001 ^a
Participants with Asthma ever	198 (32.4)	114 (32.0)	76 (32.3)	.935

^a Statistically significant at $p < 0.001$

^b Participants with wheeze in the past 12 months (percentages were calculated for all participants).

^c Participants with wheeze in the past 12 months who have had ≥ 4 attacks of wheeze or ≥ 1 night per week sleep disturbance from wheeze, or wheeze affecting speech.

Almost half of all adolescents reported unhealthy diet consumption on most or all days. On the other hand, a healthy diet was consumed at least twice per week in a third of the all adolescents in the present study (**Figure 1**).

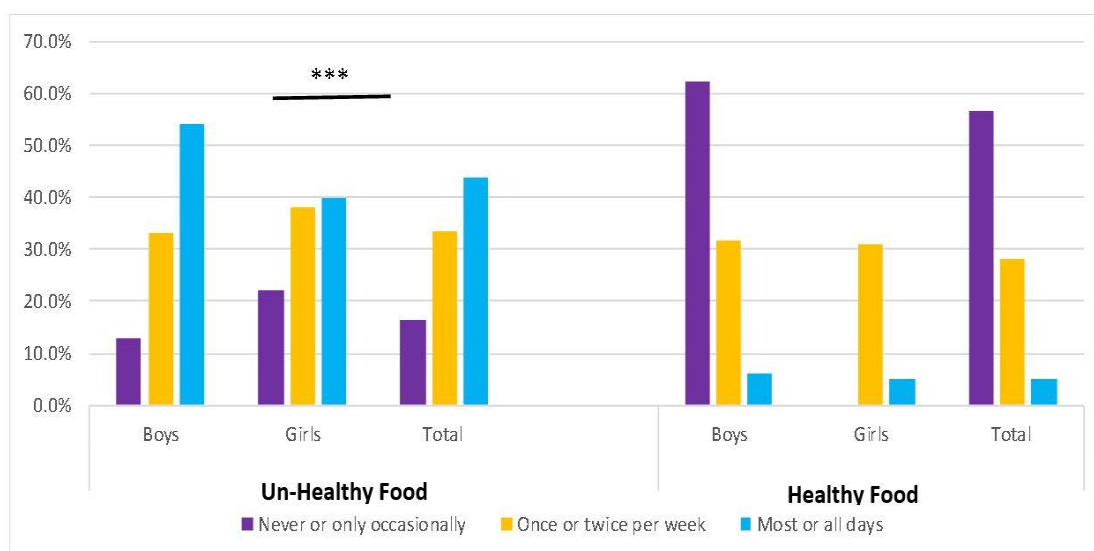


Figure 1. Frequency of unhealthy food and healthy food consumption in the past 12 months among adolescents in Saudi Arabia. *** $P < .001$.

Girls were less likely to develop asthma symptoms (OR = 0.6; 95% CI: 0.5–0.7; $P < 0.001$). Furthermore, compared with underweight, the overweight adolescents are two times more risk to have asthma symptoms. For other factors, having younger siblings was the only significant factor associated with asthma severity among adolescents (OR = 1.7; 95%CI: 1.0-2.7; $P = 0.037$) (**Table 3**).

Table 3.

Univariate analysis between adolescents' medical history of Asthma and their demographic characteristics

Demographic characteristics	Current wheeze (n= 4086)		Asthma severity (n= 4086)	
	Crude OR (95% CI)	P value	Crude OR (95% CI)	P value
Age				
12	1		1	
13	0.9 (0.5-1.7)	.807	0.9 (0.3-2.7)	.848
14	1.1 (0.6-2.0)	.752	1.0 (0.3-2.9)	.959
15	1.2 (0.6-2.5)	.538	0.7 (0.2-2.7)	.608
Sex				
Boys	1		1	
Girls	0.6 (.5-0.7)	< .001*	0.8 (0.5-1.1)	.153
Twin born				
No	1		1	
Yes	1.3 (0.8-2.1)	.379	1.6 (0.6-4.3)	.544
Having older siblings				
No	1		1	
Yes	1.0 (0.8-1.3)	.775	1.1 (0.7-1.6)	.670
Having younger siblings				
No	1		1	
Yes	0.9 (0.7-1.2)	.463	1.7 (1.0-2.7)	.037*
BMI (Body Mass Index)				
Underweight	1		1	
Normal weight	1.4 (1.1-1.8)	.011*	0.9 (0.5-1.4)	.560
Overweight	1.7 (1.2-2.3)	.003*	1.0 (0.6-1.9)	.892
Obese	1.6 (0.9-3.1)	.138	2.7 (0.8-9.5)	.120

(*) Statistically significant at $p < 0.05$

OR: Odds Ratio

CI: Confidence Interval

Table 4 reported that the consumption of unhealthy diet most or all days was a significant factor associated with asthma symptoms among adolescents (OR = 1.3; 95%CI: 1.0-1.8; P = 0.033) but no significant association with asthma severity (P > 0.05). Other risk factors showed no significant association with asthma symptoms or severity including consumption of healthy diet (P > 0.05).

Table 4.

Univariate analysis between adolescents' medical history of Asthma and their types of diet (healthy or unhealthy)

Diet	Current wheeze (n= 4086)		Asthma severity (n= 4086)	
	Crude OR (95% CI)	P value	Crude OR (95% CI)	P value
Consumption of an un-healthy diet (most or all days)				
○ Never or only occasionally	1		1	
○ Once or twice per week	1.0 (0.8-1.4)	.884	1.4 (0.8-2.4)	.206
○ Most of all days	1.3 (1.0-1.8)	.033 *	1.3 (0.8-2.1)	.359
Consumption of a healthy diet (most or all days)				
○ Never or only occasionally	1		1	
○ Once or twice per week	0.9 (0.7-1.1)	.273	1.1 (0.7-1.6)	.636
○ Most of all days	1.1 (0.7-1.7)	.609	0.7 (0.3-1.5)	.317

(*) Statistically significant at $p < 0.05$

OR: Odds Ratio

CI: Confidence Interval

Discussion

There is compelling evidence that dietary choices play a key role both in the onset of Asthma, development of symptoms, and severity, as well as the degree to which it can be managed. It has been shown that following a Mediterranean diet, which is characterized by high consumption of vegetables, fruits, fish, and products made with whole wheat, can be beneficial in controlling the symptoms of Asthma as well as the severity of the symptoms [21]. On the other hand, "Western" diets, which are characterized by their high consumption of processed foods, saturated fat, sugar, and salt, have been linked to increased asthmatic symptoms [22]. However, there is no consensus on the type of diet regimen recommended for Asthma patients [7, 22].

The epidemiological findings of the current study revealed that most Saudi adolescents consume excess unhealthy food and less healthy one, which is considered an alarm sign and risk factor for metabolic syndromes besides Asthma. Moreover, unhealthy eating habits increase with age and have been linked to later health problems in adulthood [23].

Regarding the prevalence of Asthma, the current study showed that 13.3% of adolescents reported current wheezing in the past 12 months. This finding is consistent with other studies that concluded that Asthma in Saudi Arabia was approximately 12.6% [24], with regional variations between 3.1% to 33.7% [25]. Higher intake of healthy food should be encouraged among Saudi adolescents to control the risk of asthma symptoms and severity. Moreover, healthy diet components should be added to the table of adolescents to minimize wheezing. Fruits and vegetables should be recommended as a proactive diet as well. Therefore, Saudi adolescents should be encouraged to shift from the Western diet pattern to the Mediterranean diet pattern for mitigation of asthma symptoms and severity.

The limitation of the current study is the descriptive design, and it would be better to be well-designed randomized controlled studies aiming for formulated Saudi-specific guidelines to be integrated into the current pharmacological therapy for adolescents with Asthma.

Conclusion

Asthma is a prevalent chronic inflammatory allergic disease with a high global as well as a national burden. Dietary factors were included to play a key role in the development of asthma symptoms and severity with both clinical and financial obligations. The current survey study confirmed that a healthy diet including fruits, vegetables, and fish, is implicated in the mitigation of asthma symptoms and severity. The Western diet pattern, including fast food, soft drinks, and processed meat, prevails among adolescents in Saudi Arabia with serious impacts on asthma symptoms and severity. Therefore, the findings of this study encourage the intervention and asthma management programs that incorporate diet plans as an essential part. Moreover, further controlled studies are needed for evidence-based guidance.

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