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Empirically Derived Dietary Patterns in Association with Asthma Symptoms in Children and Adolescents: A Cross-Sectional Study

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ABSTRACT

Background: Limited data exists regarding the association between dietary patterns and asthma. This study aims to determine the relationship between empirically derived dietary patterns and the likelihood of asthma among a large population of children and adolescents living in central Iran. **Methods**: A total of 7667 of male and female students aged 6-14 from 48 public and private schools in YAZD urban areas entered the current cross-sectional study. Data on dietary intakes, as well as asthma symptoms and other possible confounders, were collected using a self-administered questionnaire filled by parents. Factor analysis was applied to find major dietary patterns. Multivariate logistic regression was performed to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) for asthma development across quintiles of dietary patterns. **Results:** Two main dietary patterns were established. A "traditional diet" was determined by meat, fish, fruits, cooked vegetable, raw vegetable, legumes, cereals, bread, macaroni, rice, margarine, butter, olive oil, milk, yogurt, egg, nuts, potato, and a "western-like diet" was characterized by high intakes of simple sugars, fast food(hamburger), fast food (pizza), soft drinks, jelly, chocolate and biscuits of cocoa, ice cream, and sauce. After adjusting for potential confounders, individuals in the top quintile of traditional diet were 0.31 times less likely to have asthma than those in the lowest quintile (OR=0.69; 95% CI: 0.47-1.00). Moreover, individuals in the top quintile of traditional diet were 0.43 times less likely to have wheezing compared with those in the lowest quintile (OR=0.57, 95% CI: 0.46-0.70). However, individuals in the top quintile of the western diet were 0.35 times more likely to have wheezing than those in the lowest quintile (OR=1.35, 95% CI: 1.10-1.66). **Conclusions:** According to the results, a traditional diet might be associated with lower odds of asthma; however, a western-like diet might be adversely associated with asthma symptoms.

Introduction

Asthma is a common chronic airway sickness leading to shortness of breath, chest tightness, and cough among children and adolescents (Couriel, 2003). Every year, the World Health Organization (WHO) has estimated that 15 million disability-adjusted life-years are lost and

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250,000 asthma deaths are reported worldwide(García-Menaya *et al.*, 2019). It is estimated that there may be an additional 100 million people with asthma by 2025 worldwide (Masoli *et al.*, 2004). The disease significantly affects the quality of life, which is particularly substantial in adolescence (Lambrecht *et al.*, 2019).

The prevalence of morbidity from asthma in adolescents is as high as or higher than the rates in younger schoolchildren, and choosing the type of food can be one of the factors influencing the irritation or diminution of asthma symptoms (Towns and Van Asperen, 2009). For instance, it is proposed that fast food might negatively change asthma symptoms (Mai *et al.*, 2009) and also the intake of fruit and vegetables is correlated with a decrease in asthma symptoms (Hosseini *et al.*, 2017). Dietary patterns (DPs) analysis is developed as a new comprehensive approach towards the correlation between the whole diet and illnesses, in recent years (Hu, 2002). It is proposed that dietary patterns might be a better approach to study the association between diet and sickness compared to individual foods or nutrients because it provides a more general look into diet and considers the possible interactions (Newby and Tucker, 2004). There has been a limited number of research regarding the association between dietary patterns and asthma. For instance, Varrso *et al.* conducted a study among 54,672 adult females and extracted 3 DPs, including the "prudent" DP (high fruits and vegetable intake); the "Western" DP (high intakes of pizza/salty pies, desserts and cured meats); and the "nuts" DP. In this study, the Western DP was associated with an increased risk of reporting frequent asthma attacks (Jacka *et al.*, 2010, Varraso *et al.*, 2009). In a study directed by Lee e*t al.* a consistently positive association between unhealthy dietary pattern (high consumption of fast foods, high fat snacks, candy, and cheese, low consumption of fruits, vegetables, and rice) and current asthma, current severe asthma, and nocturnal cough (Lee *et al.*, 2012) .

Another study conducted by Mai showed that the consumption of fast food aggravates asthma symptoms in children. This case–control study included 246 children with allergist-diagnosed asthma and 477 non-asthmatic controls aged 8–10. Fast food consumption is associated with asthma in children and potentially counteracts the protective result of prolonged breastfeeding on asthma (Mai *et al.*, 2009).

Some studies have also been conducted in Iran, but the sample size was small (Gomez-Llorente *et al.*, 2017, Huang and Pan, 2001). The present cross-sectional study was conducted to investigate the association between DPs and asthma symptoms among a large sample of Iranian children and adolescents.

Materials and Methods

Participants

The present study was conducted as a part of Global Asthma Network (GAN)- a multi-center, multi-country, epidemiological research (Nagel and Linseisen, 2005). GAN recommended that at least 3,000 samples should be recruited to estimate the prevalence of asthma (Li *et al.*, 2001). The YUMS Ethics Committee reviewed the study aims and procedures and then approved the study ethically for conduct.

In the present study, students from 48 and 36 high and elementary schools (state and private schools in YAZD city December 2020 - January 2022) were randomly selected from 2 educational districts using a cluster sampling method, respectively. All the students aged 13-14 and parents of children aged 6-7 filled questionnaires on asthma and its symptoms and risk factors. Once the questionnaire was translated into Persian, the reliability of the translated version was confirmed by a study conducted on 100 selected subjects using Cronbach's alpha. The alpha coefficient for asthma symptoms were estimated to be 0.862, thus exhibiting appropriate internal consistency. Finally, the questionnaire was translated back into English and sent to the GAN principals in order to be approved. Due to the school closures during COVID-19 pandemic, the data for all adolescents and a number of children aged 6-7 were filled electronically. Only children with Iranian nationality were included in the present study.

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Asthma and its symptoms confirmation

The GAN questionnaire which was derived from ISAAC questionnaire (Tamay *et al.*, 2013), asked several questions about the symptoms of allergic diseases and related risk factors. ISSAC was developed in 1991 and used a simple methodology for providing valuable data on the prevalence of the symptoms of childhood asthma, allergic rhinoconjunctivitis and eczema in different countries (Behniafard *et al.*, 2021, Nafei *et al.*, 2021).

In this study, the researchers used those questions which were about asthma symptoms:" asthma medications use", "asthma confirmed by doctors as well as “experiencing wheezing”. “Current asthma” was defined as a history of confirmed asthma by a doctor and having had wheezing and/or using asthma medication in the past 12 months.

Dietary intakes assessment

The dietary intakes of food groups in the preceding year was assessed using multiple choice questions recommended by GAN study (Tamay *et al.*, 2013). The food groups consisted of the following: meats, fish, fruits, vegetables, legumes, cereals, bread, pasta, rice,margarine, animal butter, olive oil, milk, dairy, eggs, nuts, potatoes, sugar, fast foods, soft drinks, ice cream, and sauces. The participants reported if they never consumed each food groupnever or very little, once or twice a week, every day, or more.

Assessment of other variables

In this study, the authors analyzed age, sex, ethnicity, wheezing in the past 12 months, weight, height, body mass index (BMI), and physical activity.

Ethical considerations

The original study (the GAN study among Iranian children and adolescents) was ethically approved by the ethics committee of Shahid Sadoughi University (SSU) of Medical Sciences Yazd, Iran (ethics approval code: IR.SSU.REC.1398.244). The present study was also ethically approved by the same ethics committee (ethics code: IR.SSU.SPH.REC.1400.124). Permission was then obtained from Yazd Education Administration to conduct the study in elementary and junior high schools. Parents were asked to fill out an informed consent before entering their children and adolescents into the current study.

Data analysis

Factor analysis with orthogonal transformation was applied to assess major dietary patterns. Dietary patterns retained for further analysis were based on their natural interpretation, Eigenvalues (>1), and Scree test (Zaknun *et al.*, 2012). The chi-square for Bartlett’s test of sphericity was statistically significant ($P<0.01$), and the Kaiser-Meyer-Olkin measure of sampling adequacy was a score of 0.85, showing that the correlation among the nutrients was strong enough for a factor analysis. The derived DPs were named on the basis of the authors’ interpretation of the data. They computed the factor score for each pattern by summing intakes of 22 food groups weighted by their factor loadings (Zaknun *et al.*, 2012). Each participant received a factor score for each identified pattern. Subjects were then categorized based on quintiles of dietary nutrient pattern scores.

The participants’ general characteristics as well as the dietary intakes were compared between quintiles of DPs using chi-square test. Multi variable logistic regression was performed to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) for asthma across the quintile of model considering the lowest quintile as the reference. The analyses were done in different models: crude model, a model adjusted for age and sex as model 1, model 2 in which watching TV and computer use were additionally adjusted, and model 4 in which the BMI was also adjusted. The associations were considered significant if P values of less than 0.05 were observed. All the analyses were done using the STATA software (version14, State Corp., College Station, TX).

Results

In total, from 7214 adolescents, and 3026 children, 5141 (71.3%) and 2526 (83.5%) participants completed the questionnaires, respectively. The

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general characteristics of the study subjects according to the presence of asthma are shown in **Table 1**. From 7667 eligible subjects, the prevalence of asthma confirmed by a doctor was 4.3 which was higher among boys (58.0%). The subjects without asthma confirmed by a doctor were likely to be younger and were more wheezing in the past 12 months compared with the asthma confirmed by a doctor (P<0.05). There were no significant differences between the asthma confirmed by a doctor and the non-confirmed one regarding BMI, ethnicity, and physical activity (P> 0.05).

Table 1. General characteristics of the subjects participated in the current study according to asthma status.

Variables	Asthma confirmed by a doctor		
	Without (n=7343)	With (n=324)	P-value[a]
Age (years)	10.9±3.37[b]	11.70±2.94	<0.001
Body mass index (kg/m^2)	18.9±10.40	19.10±4.18	0.35
Sex			
Male	3226 (43.93)	188 (58.02)	<0.001
Female	4117 (56.07)	136 (41.98)	
Ethnicity			
Kurd	38 (0.52)[c]	5 (1.55)	0.13
Turk	73 (1.00)	2 (0.63)	
Persian	7064 (96.20)	311 (95.90)	
Lor	62 (0.84)	4 (1.30)	
Arab	55 (0.75)	1 (0.31)	
Baloch	51 (0.69)	1 (0.31)	
Physical activity (watch TV and computer use)			
2-4 hours	3945 (53.70)	163 (50.40)	0.38
5-8 hours	2463 (33.60)	103 (34.80)	
9-14 hours	935 (12.70)	48 (14.80)	
Wheezing (in the past 12 months)			
Yes	553 (7.50)	56 (17.20)	<0.001
No	6790 (92.50)	268 (82.80)	

[a]: Chi square test for ordinal qualitative variables and t-test for continuous variables; [b]: Mean±SD; [c]: n (%).

Two dietary patterns were extracted using the principal component analysis. The first DP (labeled as the "western DP") was characterized by high intakes of simple sugars, fast food (hamburger, and pizza), soft drinks, jelly, chocolate and biscuits of cocoa, ice cream, sauce which explained 48.7% of the variation in the participants' diet. The second DP labeled as the "traditional DP" which was characterized by high intakes of meat, fish, fruits, cooked vegetable, raw vegetables, legumes, cereals, rice, butter, olive oil, milk, yogurt, egg, nuts, and potato, accounted for 46.8% of the total variance. The loading factor matrix of dietary food groups is provided in **Table 2**.

The subjects in the top quintile of traditional DP had a higher intake of meat, fish, fruits, vegetables, legumes, cereals, bread, pasta, rice, dairy, sugar, fast-food, soft-drinks, ice cream, and sauces compared with those in the lowest quintile (P < 0.05). The same differences were also seen for western DP except for the participants in the upper quintile who had a lower intake of vegetables and bread than those in the lowest quintile (**Table 3**).

Table 4 presents multivariable-adjusted ORs and 95% CIs for the association between adherence to the dietary patterns and likelihood of asthma confirmed by a doctor. After adjustment for age and sex, the individual in the top quintile of traditional diet were 0.32 times less likely to have asthma than those in the lowest quintile (OR=0.68, 95% CI: 0.47-0.99, $P_{\text{-trend}}$ = 0.04). This association remained significant even after

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adjustment for all other potential confounders, (OR=0.69, 95% CI: 0.47-1.00, P_{-trend} = 0.05).

There was no significant association between adherence to the traditional or western DPs and the odds of medication use for asthma (**Table 5**) and "current asthma" (**Table 6**) in crude and multivariable adjusted models.

Table 2. Factor-loading matrix for major DPs derived by using the principalcomponent analysis.

Food groups	Dietary patterns	
	Western	Traditional
Meats		0.401
Fish		0.325
Fruits		0.439
Cooked vegetable		0.512
Raw vegetable		0.505
Legumes		0.433
Cereals		0.395
Bread	-	-
Pasta	-	-
Rice		0.312
Margarine	-	-
Butter		0.352
Olive oil		0.323
Milk		0.442
Yogurt		0.480
Eggs		0.421
Nuts		0.389
Potato		0.313
Simple sugars	0.452	
Fast food (hamburger)	0.617	
Fast food (pizza)	0.644	
Soft drinks	0.598	
Jelly	0.623	
Chocolate and biscuits of cocoa	0.599	
Ice-cream	0.417	
Sauce	0.510	
Eigenvalues	3.74	1.91
Variance explained	48.7%	46.8%

Loading factors less than <0.30 were omitted for simplicity

Table 7 presents multivariable adjusted ORs and 95% CI between adherence to DPs and wheezing in the past 12 months. After adjustment for all confounding variables, the participants in model 3, those in the top quintile of traditional diet, were 0.43 times less likely to have wheezing than those in the lowest quintile (OR=0.57, 95% CI: 0.46-0.70, P_{-trend}<0.001). In contrast, those with highest western diet score had a significantly higher chance of developing wheezing than those in the lowest quintile (OR=1.35, 95% CI:1.10-1.66, P_{-trend}<0.001).

Discussion

People who follow a traditional diet are less likely to develop asthma and show fewer symptoms. People on a western diet have more severe symptoms. Several studies were positively correlated with the present study. Barros et al. conducted a study on 32644 adults, 53% female, from the 4th Portuguese National Health Survey in 2015, and showed that there was a negative association between fish, vegetables, and fruits. DP was found to be positively correlated with both current asthma and current asthma medication use as well as the prevalence of severe asthma (Barros *et al.*, 2015).

Similar to the findings regarding the relationship between dietary factors and asthma and allergic sensitization, a cross-sectional study involving 7432 French schoolchildren aged 9 to 11 found that butter intake was positively correlated with atopic wheeze, and the results showed that asthma symptoms, asthma, and allergic sensitization were more common in boys than girls. Compared to never or occasionally eating lunch at the canteen, fruit juice consumption was associated with a lower prevalence of lifetime asthma as well as a lower prevalence of past-year wheezing, lifetime asthma, and allergic sensitization. Butter and fast food consumption were linked to an increased prevalence of asthma but meat consumption was inversely related to wheezing in atopic children over the previous year. In non-atopic children, fish consumption was linked to a lower prevalence of asthma. None of the dietary variables were linked to bronchial hyper-responsiveness (BHR) (Saadeh *et al.*, 2015). BHR is often regarded as a 'hallmark' of asthma, and bronchoprovocation testing is frequently performed to support a diagnosis of asthma. However, BHR is also found in a spectrum of other lung diseases and can be provoked by a variety of specific stimuli (Saadeh *et al.*, 2015).

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Table 4. The association between adherence to DPs and odds of asthma confirmed by a doctor.

Dietary pattern	Q1	Q2	Q3	Q4	Q5	P_{-trend}[a]
	0R (95% CI)	0R (95% CI)	0R (95% CI)	0R (95% CI)	0R (95% CI)	
Traditional diet						
Number of the subjects with/without asthma	1465/69	1461/72	1467/67	1467/66	1483/50	
Crude	1.00	1.04 (0.74-1.46)	0.96 (0.68-1.36)	0.95 (0.67-1.34)	0.71 (0.49-1.03)	0.07
Model 1	1.00	1.01 (0.72-1.43)	0.92 (0.65-1.31)	0.91 (0.64-1.29)	0.68 (0.47-0.99)	0.04
Model 2	1.00	1.01 (0.72-1.43)	0.92 (0.65-1.31)	0.92 (0.65-1.30)	0.69 (0.47-1.00)	0.05
Model 3	1.00	1.01 (0.72-1.42)	0.92 (0.65-1.31)	0.92 (0.65-1.30)	0.69 (0.47-1.00)	0.05
Western dietary						
Number of the subjects with/without asthma	1469/65	1472/61	1474/60	1460/73	1468/65	
Crude	1.00	0.93 (0.65-1.33)	0.91 (0.64-1.31)	1.13 (0.80-1.59)	1.00 (0.70-1.42)	0.62
Model 1	1.00	0.95 (0.66-1.36)	0.93 (0.65-1.33)	1.11 (0.79-1.57)	0.95 (0.67-1.36)	0.85
Model 2	1.00	0.94 (0.66-1.35)	0.92 (0.64-1.33)	1.10 (0.78-1.56)	0.93 (0.65-1.34)	0.94
Model 3	1.00	0.94 (0.65-1.35)	0.92 (0.64-1.33)	1.10 (0.78-1.56)	0.93 (0.65-1.34)	0.94

Model 1: adjusted for age and sex; **Model 2**: further adjusted to watch TV and computer use; **Model 3**: additionally, adjusted for BMI; **Q**: Quintile; **OR**: Odds ratio; **CI**: confidence interval; [a]: Logistic regression was used.

Table 5. The association between adherence to DPs and odds of medication use for asthma.

Dietary pattern	Q1	Q2	Q3	Q4	Q5	P-value
	0R (95% CI)	0R (95% CI)	0R (95% CI)	0R (95% CI)	0R (95% CI)	
Traditional diet						
The number of participants with/without Medication prescribed Asthma	1494/40	1495/38	1498/36	1495/38	1494/39	
Crude	1.00	0.94 (0.60-1.48)	0.89 (0.56-1.41)	0.94 (0.60-1.48)	0.97 (0.62-1.52)	0.92
Model 1	1.00	0.90 (0.57-1.41)	0.84 (0.53-1.33)	0.89 (0.56-1.40)	0.92 (0.58-1.44)	0.73
Model 2	1.00	0.90 (0.57-1.41)	0.84 (0.53-1.34)	0.90 (0.57-1.41)	0.93 (0.59-1.46)	0.78
Model 3	1.00	0.90 (0.57-1.41)	0.85 (0.53-1.34)	0.89 (0.57-1.41)	0.93 (0.59-1.46)	0.79
Western dietary						
The number of participants with/without Medication prescribed Asthma	1507/27	1500/33	1488/46	1480/53	1501/32	
Crude	1.00	1.22 (0.73-2.05)	1.72 (1.06-2.78)	1.99 (1.25-3.19)	1.18 (0.70-1.99)	0.12
Model 1	1.00	1.21 (0.72-2.02)	1.70 (1.05-2.75)	1.93 (1.21-3.10)	1.14 (0.68-1.92)	0.16
Model 2	1.00	1.20 (0.72-2.00)	1.67 (1.03-2.71)	1.88 (1.17-3.01)	1.08 (0.64-1.84)	0.25
Model 3	1.00	1.20 (0.72-2.01)	1.67 (1.03-2.71)	1.87 (1.16-3.00)	1.09 (0.64-1.85)	0.24

Model 1: Adjusted for age and sex; **Model 2**: Further adjusted for watch TV and computer use; **Model 3**: Additionally adjusted for BMI.

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Table 6. The association between adherence to the DPs and odds of current asthma.

Dietary pattern	Q1	Q2	Q3	Q4	Q5	P_{-trend}
	0R (95% CI)	0R (95% CI)	0R (95% CI)	0R (95% CI)	0R (95% CI)	
Traditional diet						
The number of participants with and without current asthma	9/1418	12/1426	3/1417	6/1432	5/1456	
Crude	1.00	0.79(0.36-1.7)	0.58(0.25-1.34)	0.91(0.43-1.89)	0.37(0.14-0.97)	0.1
Model 1	1.00	0.78(0.36-1.69)	0.61(0.26-1.40)	0.92(0.44-1.93)	0.38(0.14-0.98)	0.11
Model 2	1.00	0.78(0.36-1.69)	0.61(0.26-1.40)	0.92(0.44-1.93)	0.38(0.14-0.98)	0.11
Model 3	1.00	0.78(0.36-1.69)	0.61(0.26-1.40)	0.92(0.44-1.93)	0.38(0.14-0.98)	0.11
Western dietary						
The number of participants with/without current asthma	5/1442	10/1437	5/1444	9/1408	6/1418	
Crude	1.00	1.2(0.51-2.79)	1.31(0.57-3.00)	1.77(0.80-3.88)	0.41(0.13-1.33)	0.6
Model 1	1.00	1.12(0.48-2.62)	1.25(0.54-2.86)	1.73(0.79-3.81)	0.43(0.13-1.39)	0.68
Model 2	1.00	1.12(0.48-2.62)	1.24(0.54-2.86)	1.72(0.78-3.80)	0.42(0.13-1.38)	0.68
Model 3	1.00	1.12(0.48-2.62)	1.24(0.54-2.86)	1.72(0.78-3.80)	0.42(0.13-1.38)	0.68

Model 1: adjusted for age and sex; **Model 2**: further adjusted for watch TV & computer use; **Model 3**: additionally adjusted for BMI.

Table 7. The association between adherence to the DPs and odds of wheezing in the past 12 months.

Dietary pattern	Q1	Q2	Q3	Q4	Q5	P-value
	0R (95% CI)	0R (95% CI)	0R (95% CI)	0R (95% CI)	0R (95% CI)	
Traditional diet						
The number of participants with/without wheezing	1380/154	1398/135	1413/121	1410/123	1457/76	
Crude	1.00	0.86 (0.67-1.1)	0.76 (0.59-0.98)	0.78 (0.60-1.00)	0.46 (0.35-0.62)	<0.001
Model 1	1.00	0.87 (0.72-1.05)	0.77 (0.64-0.94)	0.77 (0.64-0.93)	0.55 (0.45-0.67)	<0.001
Model 2	1.00	0.88 (0.73-1.06)	0.78 (0.64-0.94)	0.79 (0.66-0.96)	0.57 (0.46-0.70)	<0.001
Model 3	1.00	0.88 (0.73-1.06)	0.78 (0.64-0.94)	0.79 (0.65-0.96)	0.57 (0.46-0.70)	<0.001
Western dietary						
The number of participants with/without wheezing	1441/93	1430/103	1417/117	1386/147	1384/149	
Crude	1.00	1.11 (0.83-1.49)	1.27 (0.96-1.69)	1.64 (1.25-2.15)	1.66 (1.27-2.18)	<0.001
Model 1	1.00	1.21 (0.98-1.49)	1.51 (1.23-1.86)	1.68 (1.37-2.05)	1.59 (1.30-1.95)	<0.001
Model 2	1.00	1.17 (0.95-1.45)	1.44 (1.17-1.76)	1.53 (1.25-1.88)	1.35 (1.10-1.66)	<0.001
Model 3	1.00	1.17 (0.95-1.45)	1.44 (1.17-1.76)	1.53 (1.25-1.87)	1.35 (1.10-1.66)	<0.001

Model 1: Adjusted for age and sex; **Model 2**: Further adjusted for watch TV& computer use; **Model 3**: Additionally adjusted for BMI.

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A cross-sectional study of 10-year-old Taiwanese children found that those who consumed a Western diet with high protein and fat had a strikingly increased risk of allergic rhinitis (AR). Furthermore, compared to children with AR, those without AR were found to consume less meat, dairy, and fruits (Lin *et al.*, 2016) .

In a different study, frequent consumption of fast food was linked to AR in Mexican schoolchildren (OR: 1.5; 95% CI: 1.1–2.0) (Barraza-Villarreal *et al.*, 2006). The findings of this study were supported by Patel et al.'s findings, which showed a positive association between Western diet and asthma risk. High adherence to the Western diet pattern was significantly correlated with having an official diagnosis of asthma and being 8 (OR: 2.19; 95% CI: 1.20-4.01, *P*=0.01; OR: 2.59; 95% CI: 1.15-5.81, *P*=0.02; respectively). Current asthma at age 11 was associated in a similar way (OR: 2.20; 95% CI: 1.07-4.51, *P*=0.03). At either age (8 or 11 years), there was no evidence of a link between dietary habits and current wheezing or allergic sensitization (Patel *et al.*, 2014).

Brigham *et al.*'s research did not support a connection between the incidence and prevalence of asthma and a Western dietary pattern (Brigham *et al.*, 2015). Additionally, the results of the present review's investigation into the protective effects of a traditional diet on asthma/wheezing symptoms in children extended those found in systematic reviews with meta-analyses conducted by Garcia (Garcia- Marcos *et al.*, 2013) and another study (Lv *et al.*, 2014).

The authors suggested that Western dietary pattern have a negative effect on asthma and symptoms of wheezing. A Western dietary pattern often includes high pro-inflammatory and low-antioxidant food items, which could affect responsiveness to environmental stimuli. Omega-6 fatty acids exist in greater amounts in fast foods and processed foods in Western DP that are converted to arachidonic acid and switched to inflammatory mediators, i.e. leukotrienes and prostaglandins (Black and Sharpe, 1997). For instance, prostaglandin E2 inhibits T-helper cell type 1 (Th1) and enhances Th2 phenotype, which is prominently found in allergic condition (Black and Sharpe, 1997). Moreover, low levels of antioxidants cannot prohibit the activation of nuclear factor-κB (NF-κB) by higher levels of reactive oxygen species (ROS) (Blackwell and Christman, 1997), thus inducing innate immune reactions via cytokine production and devastation of cellular elements such as DNA, and proteins (Zaknun *et al.*, 2012).

The high pro-inflammatory and low antioxidant content of a typical Western diet may affect how responsive the body is to environmental stimuli (Black and Sharpe, 1997). Fast food and processed foods contain higher levels of omega-6 polyunsaturated fatty acids called arachidonic acid in Western DP that shifts to inflammatory mediators like leukotrienes and prostaglandins (Black and Sharpe, 1997). The prostaglandin system, which contributes to the arachidonic and prostaglandin E2 (PGE2) pathways and has the potential to be harmful, can be enhanced by fat (Zaknun *et al.*, 2012). IL-17 production and macrophage activation are two of the pathways that pro-inflammatory PGE2 activates (Kalinski, 2012). Additionally, the lipids in immune cells' membranes are altered by dietary fats, which impairs the cells' ability to function normally (Calder, 2011, Kim *et al.*, 2013). The ability of modern dietary fat to immediately start the inflammatory response is perhaps its most concerning trait.

The Th2 phenotype, which is notably present in allergic conditions, is enhanced by prostaglandin E2, which also inhibits T-helper cell type 1 (Th1) (Black and Sharpe, 1997). Additionally, low levels of antioxidants are unable to prevent the activation of nuclear factor-κB (NF-κB) by higher levels of reactive oxygen species (ROS) (Blackwell and Christman, 1997), which causes the production of cytokines and triggers innate immune responses by damaging proteins and DNA in cells (Zaknun *et al.*, 2012).

According to numerous studies, eating the foods high in antioxidants (such as fruits and vegetables) along with a traditional diet can help protect

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against allergic conditions (Tamay *et al.*, 2013)though some studies found no relationship between the two or found only a weak one (Kim *et al.*, 2005, Nagel and Linseisen, 2005, Tamay *et al.*, 2013).

One of the positive effects of consuming a traditional diet is the use of colored fruits such as grapes in the diet, which has a good protective effect in reducing asthma symptoms (Li *et al.*, 2001). Red grape skin extract contains both bioflavonoid polyphenols and non-bioflavonoid polyphenols derived from cinnamic and benzoic acids (quercetin, catechins, flavonols, and proanthocyanidins). The anti-inflammatory antioxidant oligomeric proanthocyanidins have an impact on lipid peroxidation, oxygen-free radical scavenging, and the inhibition of inflammatory cytokine production (Li *et al.*, 2001). Resveratrol (3,4′,5-trihydroxystilbene), a polyphenolic stilbene found in grape skins, can also inhibit cytokine-stimulated inducible nitric oxide synthase expression and nitrite production in human primary airway epithelial cells (Donnelly *et al.*, 2004). The anti-oxidant properties of grape phenolic content may be the mechanism by which eating grapes reduces wheezing and allergic rhinitis symptoms.

It appears that a traditional diet high in fish (which contains long-chain n-3 PUFA) can also improve lung function. This may also play a role in the beneficial inverse relationship between the traditional DP and anxiety in participants who were of normal weight. The refined carbohydrate content of the typical western diet may contribute to elevated C-reactive protein (Maes, 1999). Significant correlations exist between elevated hs-CRP levels and the prevalence of non-allergic asthma and respiratory symptoms. The population of this study was selected from an area that received more energy compared with the one which consumed refined carbohydrates. Furthermore, serum hs-CRP levels were positively correlated with the number of sputum eosinophils, negatively with the FEV1, FEV1/FVC, and FEF25-75%, and marginally with the numbers of macrophages and neutrophils (Büyüköztürk *et al.*, 2004, Enright *et al.*, 1996, Ólafsdóttir *et al.*, 2005).

The present study had several strengths. In this study, the sample size was large, which included both sexes in children and adolescents. On the other hand, the researchers controlled a wide range of confounding factors that may affect the outcome of the study.Participants in this study were selected from different economic and social groups. In addition, participants were selected from urban and rural areas without bias in sample selection. Additionally, due to factors that were either not measured at all or were measured incorrectly, the authors were unable to completely rule out the possibility of residual confounding in the analysis.

This study also had some limitations. Although measurement error was a known drawback of diet assessment methods, it was possible. Another issue with the study's use of an FFQ was the potential for participant misclassification. Additionally, this study's duration was short, necessitating additional research that took into account longer study periods.

Conclusion

In the present study, two dietary patterns were extracted using the analysis factor. One DP was the traditional diet and the other was the western diet. Traditional diet was associated with reduced asthma symptoms and wheezing, but the western diet was associated with worsening asthma symptoms. The present study suggests that following a traditional DP can play an effective role in improving the symptoms of asthmatic patients. In fact, setting a proper diet with a traditional diet can reduce asthma symptoms.

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Authors' contributions

Pishdad S and Sasanfar B participated in the study design, analysis and drafting of the initial version. Pishdad S implemented comments and suggestions of the co-authors. Nafei Z, Behniafard N, Karimi M and Salehi-Abargouei A contributed to conception, design and data analysis, and Behniafard N and Salehi-Abargouei A supervised the

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Conflict of interests

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