Original Article

The impact of Vitamin D deficiency on asthma, allergic rhinitis and wheezing in children: An emerging public health problem

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ABSTRACT

Background: Vitamin D deficiency has been declared a public health problem for both adults and children worldwide. Asthma and related allergic diseases are the leading causes of morbidity in children. The objective of this study was to investigate the potential role of Vitamin D deficiency in childhood asthma and other allergic diseases such as allergic rhinitis and wheezing. **Materials and Methods:** This cross-sectional study was conducted in Primary Health Care Centers (PHCs), from March 2012 to October 2013. A total of 2350 Qatari children below the age of 16 were selected from PHCs, and 1833 agreed to participate in this study giving a response rate of (78%). Face-to-face interviews with parents of all the children were based on a questionnaire that included variables such as socio-demographic information, assessment of nondietary covariates, Vitamin D intake, type of feeding, and laboratory investigations. Their health status was assessed by serum Vitamin D (25-hydoxyvitamin D), family history and body mass index. **Results:** Most of the children who had asthma (38.5%), allergic rhinitis (34.8%) and wheezing (35.7%) were below 5 years. Consanguinity was significantly higher in parents of children with allergic rhinitis (48.6%), followed by those with asthma (46.4%) and wheezing (40.8%) than in healthy children (35.9%) ($P < 0.001$). The proportion of severe Vitamin D deficiency was significantly higher in children with wheezing (23.4%), allergic rhinitis (18.5%), and asthma (17%) than in healthy children (10.5%). Exposure to the sun was significantly less in Vitamin D deficient children with asthma (60.3%), allergic rhinitis (62.5%) and wheezing (64.4%) than in controls (47.1%) ($P = 0.008$). It was found that Vitamin D deficiency was a significant correlate for asthma (odds ratio [OR] =2.31; $P < 0.001$), allergic rhinitis (OR = 1.59; $P < 0.001$) and wheezing (relative risk = 1.29; $P = 0.05$). **Conclusion:** The study findings revealed a high prevalence of Vitamin D deficiency in children with asthma and allergic diseases. Vitamin D deficiency was a strong correlate for asthma, allergic rhinitis and wheezing.

Key words: Allergic rhinitis, asthma, children, predictors, Qatar, Vitamin D, wheezing

INTRODUCTION

Asthma and related allergic diseases form substantial public health problems worldwide.[1] Asthma remains the most common chronic disease in children and is one of the leading causes of morbidity. The prevalence of asthma and allergic diseases has been increasing rapidly in western and industrialized countries, and it was recently proposed that Vitamin D deficiency may explain some part of this pattern.[2] Vitamin D deficiency has occurred despite the fortification of foods in some western countries, and in areas of the world that are considered sun-replete. It was documented that the global rise in asthma, and allergic diseases may be linked to lower serum 25-hydroxyvitamin D (25(OH)D).[3,4]

Some previous studies by Bener *et al*.[5-8] revealed that Vitamin D deficiency was more common in Qatari

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young population, and was a major contributing factor to many diseases like complications in maternity, diabetes, asthma and allergic diseases. Several other studies also found that Vitamin D deficiency may lead to an increase in the frequency of asthma and attacks of wheezing and necessitate more medications.[8,9] It is clear that Vitamin D protects children against viral infections and the exacerbation of asthma.[9,10] When taken during pregnancy, Vitamin D is proven to enhance lung development in infants, and has a preservative effect on the development of wheezing and asthma that may occur later.[11,12] Another recent study conducted in Qatar reported a high maternal Vitamin D deficiency in pregnant women which is significantly associated with elevated risk of adverse pregnancy outcome.[13] Although a previous study[7] was conducted to prove Vitamin D deficiency as a strong predictor of asthma in children, this study is the first to discover the impact of Vitamin D deficiency in childhood asthma, allergic rhinitis and wheezing.

The growing data suggests that Vitamin D plays an important role in the protection against allergic diseases. The greatest burden of asthma and allergic diseases are during childhood, at which time the rapidly rising rates of diseases are most evident in the population. Considering the high prevalence of Vitamin D insufficiency and allergic diseases in the Qatari population, a cross-sectional study was conducted to better understand the significance of Vitamin D and investigate its impact on asthma, allergic rhinitis and wheezing in children. Furthermore, the study assessed the nondietary covariates and feeding practices in the study sample in order to determine the major contributing factors of Vitamin D deficiency in young Qataris with asthma and allergic diseases.

MATERIALS AND METHODS

Study population

This was a cross-sectional study conducted among the Qatari school children below the age of 16 years to investigate the role of Vitamin D deficiency on asthma and other allergic diseases in them. The survey was conducted at Primary Health Care Centers (PHCs) from March 2012 to October 2013. The IRB approval was obtained from the Research Ethics Committee of the Hamad Medical Corporation to conduct this study. An informed consent was obtained from all participants.

The power calculation was actually based on reported prevalence rate of asthma in Qatar[14] as 20%, allowing an error of 2%. With the level of significance at 5%, and with 95% confidence limits, the sample size needed to achieve the objective of the study was computed as 1833 children. A total of 2350 children were recruited for this study, and 1833 (78%) children below 16 years old were eligible for inclusion in the study. Eleven of the 22 PHCs were selected at random. Subjects were selected systematically 1-in-2 using a systematic sampling procedure. Each participant was provided with brief information about the study and was assured of the strict confidentiality of the data. Subjects were excluded if they had diseases of Vitamin D metabolism or were receiving Vitamin D supplementation.

Socio-demographic characteristics

Health professionals and nurses interviewed parents of all children and completed the questionnaires which covered the information such as age, gender, nationality, educational level, occupation, place of residence (urban and semi-urban), type of house, monthly income, and consanguinity. Also, it included assessment of nondietary covariates such as height, weight, color of the skin, family history, physical activity and duration of the exposure to sunlight. Height and weight were measured using standardized methods, and all the participants wore light clothes and no shoes for this part of the examination. Anthropometry is the measurement of certain parameters of the human body. It is frequently used to assess nutritional status in young children and adults. Anthropometry has also been used to study the growth and development of school-aged children and adolescents. Recently, an attempt been made to use anthropometric methods to assess acute under-nutrition in adolescents.[6,7,13] Two essential items are required for the use of anthropometry: An anthropometric indicator and a cut-off point. The indicator, often called an anthropometric index, is a measurement or a combination of measurements taken in the field, such as weight and height, or the combination of measurements with additional data, such as age. Different indices reflect different components of nutritional status. The index weight-for-height indicates thinness, and because acutely undernourished persons generally lose body weight but not height and weight-for-height decreases with acute under-nutrition. However, though young children with chronic under-nutrition may not be thinner than normal children, their growth in height may be retarded. Chronic under-nutrition may not be severe enough to cause weight loss, but does interfere with normal linear growth. As a result, height-for-age is decreased, and children become stunted. Weight-for-age reflects both acute and chronic under-nutrition because both thin children and stunted children are underweight.

The body mass index was calculated as the weight in kilograms (with 1 kg subtracted to allow for clothing) divided by height in meters squared. Furthermore, information on dietary intake, Vitamin D intake, type of feeding were collected. A major part of the designed questionnaire was validated in a previous study by

Bener *et al*.[6,7] This questionnaire was validated on 50 randomly selected children visiting health centers.

The questions concerning the diagnosis of asthma were "Has the child ever been diagnosed as having asthma by a doctor"? "Has the child ever needed treatment or hospital admission due to asthma? Similar questions were asked on wheezing allergies. The definition for asthma is a common inflammatory disease of the lungs characterized by episodic airway obstruction caused by extensive narrowing of the bronchi and bronchioles. Common symptoms of asthma include wheezing, coughing and shortness of breath. The International Classification of Diseases and Health Related Problems 10th Revision was used by the Medical Records Section of the HMC for coding the diagnosis, and J 45 was the ICD 10 code for asthma. Wheezing is the high-pitched whistling sound heard as you breathe when air flow is obstructed in the lung. At the beginning of an asthma attack, wheezing usually only occurs while breathing out or exhaling, but may occur while breathing in if the attack worsens. ICD 10 code was R06.2 for wheezing. Allergies are an abnormally high sensitivity to certain substances such as pollens, foods or microorganisms. Common indications of allergy may include sneezing, itching and skin rashes.

Blood collection and serum measurements of Vitamin D

Trained phlebotomist collected venous blood sample, and serum separated and stored at −70°C until analysis. Serum 25(OH)D, Vitamin D metabolite, was measured using a commercially available kit (DiaSorin Corporate Headquarter, Saluggia, Italy). The treated samples were then assayed using competitive binding radioimmunassay technique. Subjects were classified into four: (1) Severe Vitamin D deficiency, 25(OH) D <10 ng/ml; (2) moderate deficiency, 25(OH) D 10-19 ng/ml; (3) mild deficiency, 25(OH) D 20-29 ng/ml; and (4) normal/optimal level is between 30 and 80 ng/m.[7,8,13] According to the recommendations of other studies,[15,16] we categorized Vitamin D levels as deficient if 25(OH) D was <20 ng/ml, insufficient if it was between 20 and 29 ng/ml and sufficient if >=30 ng/ml. Total and allergen-specific IgE (to a panel of common food and environmental allergens) levels were measured from serum.

Statistical analysis

Statistical significance between two continuous variables was determined using Student's *t*-test, and Mann–Whitney test was used for nonparametric data. Chi-square was performed to test for differences in proportions of categorical variables between two or more groups. Odds ratio (OR) was calculated with 95% confidence interval to identify the predictors for asthma, allergic rhinitis and wheezing in children. P <0.05 was considered as statistically significant.

RESULTS

Table 1 shows the socio-demographic characteristics of the study population. Most of the children with asthma (38.5%), allergic rhinitis (34.8%) and wheezing (35.7%) were below the age of 5 years. Mother's education ($P < 0.001$), father's occupation ($P = 0.001$), mother's occupation ($P < 0.001$), home ($P = 0.026$) were significantly different between healthy subjects and allergic children. Consanguinity was significantly higher in parents of children with allergic rhinitis (48.6%) followed by asthma (46.4%) and wheezing (40.8%) than in healthy children (35.9%) ($P < 0.001$).

Table 2 shows the prevalence of serum vitamin level in healthy subjects and children with asthma, allergic rhinitis and wheezing. The proportion of severe Vitamin D deficiency was significantly higher in asthmatic children and those with allergic diseases; wheezing (23.4%), allergic rhinitis (18.5%), asthma (17%) than in controls (10.5%) ($P < 0.001$). Also, moderate deficiency was more frequent in children who wheezed (39.4%), who had asthma (35.9%) and allergic rhinitis (31.2%) with a significant difference to healthy children (24%) ($P < 0.001$).

Table 3 assesses the Vitamin D deficiency in healthy, asthmatic and children with an allergic disease in terms of nondietary covariates and feeding practice. A history of Vitamin D deficiency was more common in mothers of children with allergic rhinitis (42.6%), wheezing (35.6%), asthma (31.6%) compared to healthy children (29.9%). The majority of the cases with Vitamin D deficiency had either wheatish or brown/black skin complexion; asthma (72.4%), allergic rhinitis (78.4%) and wheezing (81.3%) compared to controls (66.9%). A significant difference was observed between Vitamin D deficient, healthy and allergic children ($P < 0.001$) in terms of physical activity. More than half of the vitamin deficient children with asthma (56.9%) and allergic rhinitis (55.1%) participated in less physical activity. Exposure to the sun was less in Vitamin D deficient children with asthma (60.3%) and allergy rhinitis (62.5%) and wheezing (64.4%) than in controls (47.1%) with a significant difference between these groups ($P = 0.001$). Vitamin D deficient children with asthma (71.3%), allergic rhinitis (68.2%) and wheezing (64.4%) were breast fed for longer than 6 months with a significant difference with controls ($P = 0.001$).

Table 4 identified the predictors of the development of asthma, allergic rhinitis and wheezing in children. Vitamin D deficiency (OR = 2.31; $P < 0.001$), breast feeding >6 months (OR = 2.14; $P < 0.001$) and parental consanguinity (OR = 1.90; $P = 0.034$) were the major predictors of asthma in Qatari children. For allergic rhinitis,

Table 1: Sociodemographic characteristics of asthmatic and allergic diseases and control children (*n*=1833)

Variables	Allergic children (*n*=751) *n* (%)			Healthy *n*=1082 *n* (%)	*P*
	Asthma *n*=377	Allergic rhinitis *n*=276	Wheezing *n*=98		
Age group (years)					
<5	145 (38.5)	96 (34.8)	35 (35.7)	352 (32.5)	0.126
5-10	109 (28.9)	75 (27.2)	24 (24.5)	280 (25.9)	
11-16	123 (32.6)	105 (38.0)	39 (39.8)	450 (41.6)	
Sex					
Male	180 (47.8)	138 (50.0)	53 (54.1)	556 (51.4)	0.570
Female	197 (52.2)	138 (50.0)	45 (45.9)	526 (48.6)	
Education of father					
Illiterate	33 (8.8)	19 (6.9)	5 (5.1)	94 (8.7)	0.018
Primary	38 (10.1)	27 (9.8)	13 (13.3)	172 (15.9)	
Intermediate	61 (16.2)	41 (14.9)	23 (23.5)	178 (16.5)	
Secondary	131 (34.7)	95 (34.4)	30 (30.6)	368 (34)	
University	114 (30.2)	94 (34.1)	27 (27.6)	270 (25)	
Education of mother					
Illiterate	16 (4.2)	15 (5.4)	4 (4.1)	104 (9.6)	<0.001
Primary	44 (11.7)	36 (13.0)	18 (18.4)	156 (14.4)	
Intermediate	111 (29.4)	66 (23.9)	13 (13.3)	334 (30.9)	
Secondary	113 (30.0)	73 (26.4)	31 (31.6)	264 (24.4)	
University	93 (24.7)	86 (31.2)	32 (32.7)	224 (20.7)	
Occupation of father					
Not working	22 (5.8)	15 (5.4)	8 (8.2)	52 (4.8)	<0.001
Sedentary/professional	132 (35.0)	114 (41.3)	37 (37.8)	286 (26.4)	
Clerk	16 (4.2)	19 (6.9)	10 (10.2)	104 (9.6)	
Businessman	111 (29.4)	68 (24.6)	26 (26.5)	338 (31.2)	
Government officer	96 (25.5)	60 (21.7)	17 (17.3)	302 (27.9)	
Occupation of mother					
Sedentary/professional	98 (26.0)	87 (31.5)	30 (30.6)	236 (21.8)	0.033
Clerk	30 (8.0)	28 (10.1)	8 (8.2)	110 (10.2)	
Businesswomaan	31 (8.2)	28 (10.1)	8 (8.2)	118 (10.9)	
Housewife	218 (57.9)	133 (48.2)	52 (53.1)	618 (57.1)	
Place of living					
Urban	353 (93.6)	249 (90.2)	85 (86.7)	1012 (93.5)	0.026
Semi-urban	24 (6.4)	27 (9.8)	13 (13.3)	70 (6.5)	
Household income					
1500-2999 US dollars	99 (26.3)	82 (29.7)	27 (27.6)	264 (24.4)	0.270
3000-5000 US dollars	127 (33.7)	87 (31.5)	30 (30.6)	412 (38.1)	
>5000 US dollars	151 (40.1)	107 (38.8)	41 (41.8)	406 (37.5)	
Consanguinous parents					
None	202 (53.6)	142 (51.4)	58 (59.2)	694 (64.1)	<0.001
First degree relatives	133 (35.3)	109 (39.5)	33 (33.7)	308 (28.5)	
Second degree relatives	42 (11.1)	25 (9.1)	7 (7.1)	80 (7.4)	

breast feeding >6 months (OR = 2.10; $P < 0.001$), short outdoor time (OR = 1.73; $P = 0.003$), and Vitamin D deficiency (OR = 1.59; $P < 0.001$) were the strong predictors. For wheezing, breast feeding <6 months (OR = 1.67; $P = 0.044$) and Vitamin D deficiency (OR = 1.29; $P = 0.046$) were the significant contributing risk factors.

Figure 1 reveals Vitamin D status in cases and controls. Vitamin D deficient group was higher in asthma, allergic rhinitis and wheezing children, whereas Vitamin D insufficient group was higher in healthy children $P < 0.001$.

DISCUSSION

The epidemic rise in asthma and related allergic disease is a major public health problem worldwide.[1] Several studies have reported that Vitamin D deficiency is associated with an increased incidence of asthma and allergy symptoms.[17,18] In the current study sample, there was a high prevalence of Vitamin D deficiency in Qatari children with asthma and allergic diseases than in healthy children. The prevalence of severe Vitamin D deficiency was significantly higher in Qatari children with

asthma (17%), allergic rhinitis (18.5%), wheezing (23.4%) than in healthy children (10.5%), which is in agreement with the studies conducted among African-American[19] and Iranian[20] children. A few epidemiological studies have reported a similar finding that Vitamin D deficiency is associated with an increased incidence of asthma and allergy symptoms.[2,20,21] However, some studies[22,23] failed to confirm these results. An Australian multicenter study[23] reported that there was no association between any of the Vitamin D related measures and childhood asthma and allergic disorders.

Table 2: Serum Vitamin D level in cases and healthy children (*n*=1833)

Variables	Allergic children (*n*=751) *n* (%)			Healthy children *n*=1082 *n* (%)
	Asthma *n*=377	Allergic rhinitis *n*=276	Wheezing *n*=98	
Vitamin D status (ng/ml)				
Sufficient (30-80)	65 (19.8)	46 (16.6)	14 (14.9)	182 (16.8)
Mild deficiency (20-29)	90 (27.4)	93 (33.7)	21 (22.3)	526 (48.6)
Moderate deficiency (10-19)	118 (35.9)	86 (31.2)	37 (39.4)	260 (24.0)
Severe deficiency (<10)	56 (17.0)	51 (18.5)	22 (23.4)	114 (10.5)
P significance*	<0.001	<0.001	<0.001	

*Chi-square test comparison of cases versus healthy children

In the study sample of Qatari children, nearly half of the healthy children also had mild Vitamin D deficiency (48.6%) and 10.5% had severe deficiency. This shows that the incidence of Vitamin D insufficiency is surprisingly high in the general population. It was reported[24] that Vitamin D deficiency is highly prevalent even in sun-replete areas of the world and that Vitamin D supplementation and fortification of foods were inadequate to prevent deficiency. This shows that Vitamin D deficiency was very common in the general population as is the prevalence

Table 3: Assessment of the nondietary covariates and feeding practice in cases and healthy children

Variables	Vitamin D deficiency *n* (%)				*P*
	Healthy children *n*=374	Allergic children (*n*=370)			
		Asthma *n*=174	Allergic rhinitis *n*=137	Wheezing *n*=59	
Vitamin D deficiency %	34.5	46.1	49.6	60	
Maternal history of vitamin D deficiency					
Yes	112 (29.9)	55 (31.6)	75 (42.6)	21 (35.6)	0.028
No	262 (70.1)	119 (68.4)	101 (57.4)	38 (64.4)	
Color of skin					
White	124 (33.2)	48 (27.6)	38 (21.6)	11 (18.6)	0.022
Wheatish	194 (51.9)	95 (54.6)	95 (54.0)	36 (61.0)	
Brown or black	56 (15)	31 (17.8)	43 (24.4)	12 (20.3)	
Physical activity					
None	0 (0)	5 (2.9)	28 (15.9)	25 (42.4)	<0.001
Moderate physical activity	210 (56.1)	99 (56.9)	97 (55.1)	20 (33.9)	
Vigorous activity daily	164 (43.9)	70 (40.2)	51 (29.0)	14 (23.7)	
Exposure to sunlight					
Yes	198 (52.9)	69 (39.7)	66 (37.5)	21 (35.6)	0.001
No	176 (47.1)	105 (60.3)	110 (62.5)	38 (64.4)	
Body mass index (kg/m^2)					
Normal (<85th percentile)	292 (78.1)	127 (72.5)	95 (69.3)	43 (72.9)	0.194
Overweight (85-95th percentile)	62 (16.6)	34 (19.6)	36 (22.6)	12 (20.3)	0.107
Obesity (>95th percentile)	20 (5.3)	13 (7.5)	11 (8)	4 (6.8)	0.652
Vitamin D supplement during breast feeding					
Yes	166 (44.4)	78 (44.8)	78 (44.3)	29 (49.2)	0.920
No	208 (55.6)	96 (55.2)	98 (55.7)	30 (50.8)	
Type of feeding					
Breast feeding					
≤6 months	72 (19.3)	50 (28.7)	56 (31.8)	21 (35.6)	0.001
>6 months	302 (80.7)	124 (71.3)	120 (68.2)	38 (64.4)	
Formula feeding					
Never	86 (23)	51 (29.3)	52 (29.5)	16 (27.1)	0.033
≤6 months	22 (5.9)	24 (13.8)	14 (8.0)	4 (6.8)	0.009
>6 months	266 (71.1)	99 (56.9)	110 (62.5)	39 (66.1)	<0.001

*Children with moderate and severe Vitamin D deficiency

Table 4: Predictors for asthma, allergic rhinitis and wheezing in children (*n*=1833)

Independent variables	OR	95% CI	*P*
Asthma			
Vitamin D deficiency	2.39	1.85-3.61	<0.001
Breast feeding <6 months	2.03	1.59-3.12	<0.001
Parental consanguinity	1.94	1.65-2.28	0.034
Low duration of outdoor time	1.56	1.18-2.29	0.008
Serum IgE level	1.62	1.31-1.81	0.015
Allergic rhinitis			
Breast feeding <6 months	2.16	1.52-2.94	<0.001
Serum IgE level	1.88	1.49-2.36	<0.001
Low duration of outdoor time	1.69	1.24-2.58	0.003
Vitamin D deficiency	1.63	1.38-1.95	<0.001
Maternal history of vitamin D deficiency	1.58	1.12-2.23	0.016
Wheeze			
Breast feeding <6 months	1.71	1.12-2.82	0.044
Vitamin D deficiency	1.34	1.09-1.71	0.046

CI: Confidence interval; OR: Odds ratio; IgE: Immunoglobulin E

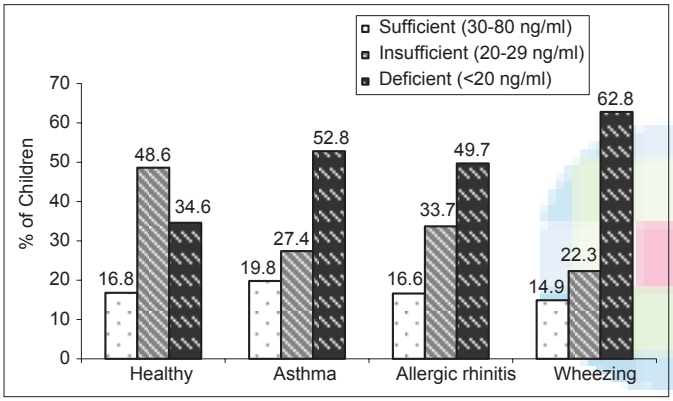

Figure 1: Vitamin D status in the studied children with asthma and allergic diseases and healthy children $P < 0.001$

of asthma and allergies and it confirms that Vitamin D levels may affect the risk for the development of asthma and allergies.

The present study assessed the nondietary covariates and breast feeding practice in cases and controls. A history of Vitamin D deficiency was more prevalent in mothers of children with allergic rhinitis (42.6%), wheezing (35.6%), asthma (31.6%) than in healthy children (29.9%). Camargo *et al*.[25] reported that high Vitamin D levels during maternity decreased childhood wheezing by nearly 50% compared with low maternal 25(OH)D. This suggests that a lower Vitamin D level was associated with an increased risk of recurrence of allergic diseases in young children. The developing foetus depends entirely on its mother for the supply of 25(OH)D and poor maternal Vitamin D status is reflected in the infant's health at birth. Another study in the UK[22] also found that higher Vitamin D consumption by the pregnant mother was significantly associated with a decreased risk of allergies in children aged 5 years. Also, Vitamin D supplement during breastfeeding was very poor in the study sample. More than half of the healthy (55.6%), asthma (55.2%), allergic rhinitis (55.7%) and wheezing (50.8%) children did not have Vitamin D supplement. Vitamin D deficient allergic children were breastfed for longer than 6 months; asthma (71.3%), allergic rhinitis (68.2%) and wheezing (64.4%). Hence, maternal Vitamin D deficiency could be one of the reasons for the high prevalence of Vitamin D deficiency in Qatari children that led to the risk for asthma and allergic diseases in children.

The rise in allergic diseases is unequivocally linked to environmental and lifestyle factors associated with industrialization and progressive westernization. Webb[26] reported that the determinants of Vitamin D status include exposure to the sun and time spent outdoors, diet and supplement use, latitude, season, age, skin color and skin coverage. It was quite evident in the study sample that exposure to sunlight and physical activity were less in Qatari children. More than half of the children with asthma (60.3%), allergic rhinitis (62.5%) and wheezing (64.4%) had significantly less exposure to sunlight than the healthy children (47.1%). Also, a significant difference was observed between healthy and allergic children in terms of physical activity. A majority of the Qatari children had either whitish or brown skin complexion; asthma (72.4%), allergic rhinitis (78.4%) and wheezing (81.3%). A study by Bose *et al*.[27] reported that a combination of limitations in sunlight exposure and darker pigmentation may amplify the risk of Vitamin D deficiency contributing to greater asthma morbidity than their white counterparts. Vitamin D has received tremendous amount of attention recently due to the ever-increasing reports of its association with a wide range of conditions, from cancer to fertility to longevity.[28] The fascination of the association of disease with Vitamin D deficiency comes from the relatively easy solution to overcoming such a risk factor, that is, either by an increase in sun exposure and/or diet supplementation. Many reviews have been written on a protective role of Vitamin D in asthma and related morbidities.[5-13,15,16,28] In Qatar, although there is sufficient ultraviolet B intensity for cutaneous synthesis of 25(OH)D throughout the year, the cutaneous Vitamin D synthesis is limited by the lifestyle factors of Qatari community such as limitations to outdoor activities, pattern of clothing and the extreme climate throughout the year. The state of Qatar is a rapidly developing country with influences of a western life style which is changing the lifestyle of the people, from life outdoors to more time spent indoors. The study findings reveal that the lifestyle patterns and environment in Qatar do not promote Vitamin D synthesis in children

which might have increased the risk for asthma and other allergies.

It was identified that Vitamin D level was a significant major predictor for asthma (OR = 2.31, $P < 0.001$), allergic rhinitis (OR = 1.59; $P < 0.001$) and wheezing (OR = 1.29; $P = 0.05$). The current study suggests that adequate or higher concentrations of 25(OH) D in childhood generally give protection from allergic diseases, although a few studies have shown an adverse effect of Vitamin D on asthma and allergies. Variations in Vitamin D status and intake have been implicated in the development of allergies and are considered one of a number of explanations for epidemiological and immunological associations. Hence, it may be useful to measure the levels of Vitamin D of infants with asthma and allergic diseases and give them Vitamin D supplementation in order to prevent asthma and allergic diseases.

CONCLUSIONS

The present study investigated the role of Vitamin D in childhood asthma and allergies. The data showed lower serum 25(OH) D levels in children with asthma, allergic rhinitis and wheezing than healthy children. Vitamin D insufficiency was common in the study sample whereas severe Vitamin D deficiency was significantly higher in children with asthma and allergic diseases than in healthy children. In the study sample, the determinants of Vitamin D deficiency in asthma and allergies included less exposure to sun, less time spent outdoors, breast feeding for longer than 6 months, maternal Vitamin D deficiency and parental consanguinity. Increased exposure to the sun could also be associated with decreased likelihood of asthma.

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