

ORIGINAL ARTICLE

Correlation between body mass index and dental caries among a sample of sudanese children

Correlação entre índice de massa corporal e cárie dentária em uma amostra de crianças sudanesas

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ABSTRACT

Introduction: Obesity and dental caries have a serious impact on a child's health; they can be potentially prevented by increasing the knowledge and awareness of proper oral hygiene practice in addition to healthy food consumption. **Objective:** To determine the correlation between body mass index and dental caries of a sample of 6-11 year old Sudanese children. **Material and Methods:** A Cross sectional school based study was conducted. A total of 360 children (50% boys, 50% girls) were examined for body mass index and dental caries prevalence. Physical examination was done by recording the child's height and weight to calculate the body mass index. Dental caries index was carried out following the WHO criteria. **Results:** The most prevalent body weight category was normal weight (60.6%) in both genders followed by the underweight group (28.3%), the overweight group (6.4%), and the obese group (4.7%). Boys exhibited a higher prevalence in the underweight category than girls, while overweight was more prevalent in girls (8.3%) than boys (4.4%). The mean dft for primary teeth was 4.68 in both genders and the mean DMFT for permanent teeth was 2.52 and 1.88 for girls and boys respectively. There was a negative correlation between dft and body weight category. No correlation between body weight category and DMFT was found. **Conclusion:** No correlation between dental caries and age-specific body weight category was found in permanent teeth while in primary teeth the underweight category was more related to the presence of dental caries than the other body weight categories.

KEYWORDS

Body mass index; Normal weight; overweight; Obesity; Dental caries.

RESUMO

Introdução: A obesidade e a cárie dentária tem um impacto importante na saúde de crianças; elas podem ser potencialmente prevenidas pelo aumento do conhecimento e conscientização da prática adequada higiene bucal, além de consumo de alimentos saudáveis. **Objetivo:** Determinar a correlação entre o índice de massa corporal e cárie dentária em uma amostra de crianças sudanesas de 6-11 anos de idade. **Material e Métodos:** Um estudo clínico transversal em escolas foi realizado. Um total de 360 crianças (50% meninos, 50% meninas) foram avaliadas e a massa corporal e prevalência de cárie dentária determinados. O exame físico foi feito através da obtenção de altura e peso da criança para calcular o índice de massa corporal. O índice de cárie dentária foi determinado seguindo os critérios da OMS. **Resultados:** A categoria de peso corporal mais prevalente foi de peso normal (60,6%) em ambos os sexos, seguido pelo grupo baixo peso (28,3%), o grupo de excesso de peso (6,4%), e o grupo de obesos (4,7%). Os meninos apresentaram maior prevalência do que as meninas na categoria de baixo peso, enquanto que o excesso de peso foi mais prevalente em meninas (8,3%) do que meninos (4,4%). O ceo médio foi 4,68 para ambos os gêneros e o CPOD médio foi 2,52 e 1,88 para meninas e meninos, respectivamente. Houve uma correlação negativa entre e ceo e a categoria de peso corporal. Nenhuma correlação entre a categoria peso corporal e índice CPOD foi encontrada. **Conclusão:** Não houve correlação entre cárie dentária e categoria de peso de acordo com idade em dentes permanentes. Em dentes decíduos a categoria baixo peso apresentou-se mais relacionada com a presença de cárie dentária do que as outras categorias de peso corporal.

PALAVRAS-CHAVE

Índice de massa corporal, Peso normal, Sobrepeso, Obesidade, Cárie dentária.

INTRODUCTION

Obesity is defined as a state of excessive accumulation of body fats; [1] many epidemiological studies concerning childhood obesity have been well documented in the literature in both industrialized and developing countries and the results showed a frightening increase in its prevalence among young age groups. [2]

According to the WHO in 2010, the overweight children under the age of five years globally were estimated to be over 42 million, nearly 35 million living in developing countries. [3]

A number of factors have been studied by different authors concerning etiological causes of childhood obesity such as: decreased physical activity, change in the leisure time activities from sports towards computer games and watching television, increased dietary intake of soft drinks and fast foods, and family history of diabetes and parental overweight. [4,5]

Childhood obesity is pandemic in many parts of the world. In Sudan, the prevalence of childhood obesity has increased among Sudanese children. [2]

Dental caries is an infectious and communicable chronic disease defined as localized destruction of susceptible dental hard tissues by acidic products from bacterial fermentation of dietary carbohydrates; it is a dynamic process of demineralization and remineralization of enamel depending on salivary pH. [6] It has an impact on both the oral and general health of children. [7]

Multiple factors influence the initiation and progression of dental caries such as host factors, acid uric bacteria, a dietary substrate (Keyes' Triad) and the time factor. [8]

Dental caries and obesity are dietary health problems which may result from high consumption of carbohydrates, snacks and soft drinks. [9]

World Health Organization (WHO) defines body mass index (BMI) as an index of weight-

for-height that is commonly used to classify underweight, normal weight overweight and obesity in children and adults. BMI is calculated by dividing the weight in kilograms by the square of the height in meters kg/m^2 . [10]

Many studies regarding the association between dental caries and BMI in children have been conducted in different populations and the conclusions showed controversy; studies done by Hohenfellner et al, Willerhausen et al in Germany and Blettner in USA concluded that there was an association between an increase of dental caries prevalence and high body weight, Whereas, association between severe dental decay and an underweight group of children had been reported by Cameron et al Ngoenwiwatkul et al, Cinar et al and Floyd et al, Sanchez et al found that overweight children had a lower dmfs index compared to underweight children. In contrast Alm et al found a significant positive relationship between overweight / obesity and dental caries. On the other hand studies done by Sadeghi et al, Mojarad et al, Elangovan et al and Macek et al revealed no association between body mass index and dental caries [11-16].

No study has been done in Sudan. Therefore, this study was aimed to determine the correlation between body mass index and dental caries in a sample of Sudanese children.

MATERIAL AND METHODS

This was a descriptive, cross sectional, school based study conducted from July to September 2013 in Khartoum state, Sudan. A multi-stage cluster sampling technique was used. A total of 360 children from governmental and private schools were randomly selected proportionally from four localities in Khartoum state (Khartoum, Omdurman, Ombada and Eastern-Nile) only if they fit the inclusion criteria which included 6-11 year old, medically fit Sudanese children.

An ethical clearance was obtained from the research committee, faculty of dentistry, University of Khartoum as well as the head ministries of the selected schools in order to conduct this study.

A list of children from grades one to six was obtained from the schools authority. Then three to four children were randomly selected from each class. A consent letter was sent to the parents of the selected children through the school authorities. Clinical examination was performed by the main researcher to the children whose parents agreed to participate in the study.

Data were recorded by the main researcher with the assistance of a trained dental student. Selected children were called to the teacher's office and examined. After filling the data sheet, a measuring meter was used to record the height. Each child should take his/her shoes off, stood up right against the wall with his/her hands on his/her sides and the head straight. With the head, buttock and heels touching the wall, a flat object was passed over the upper border of the head and marked on the wall, then measured with a meter from the marked area to the base of the floor.

The weight was measured by a portable digital bathroom scale to the nearest 100 gram value; the child removed his/her shoes and heavy clothing, stood up right with both feet in the center of the scale.

Prior to dental examination children were instructed to rinse the mouth for better detection of visual caries. Dental examination was carried out with the child seated in a supine position in an ordinary chair under day light in front of the examiner.

Detection of dental caries was recorded according to WHO criteria,[17] using the dft (decayed, filled primary teeth) and DMFT (Decayed, Filled, Missed Permanent teeth) values. The missing primary teeth (m= missing) were not registered because the examined children were in the mixed dentition stage making it hard to identify the exact reason for missing primary teeth.[18] All children with dental problems were referred for treatment.

The BMI was calculated by dividing the body weight / height² (kg/m²). The obtained results were plotted on age and gender-specific

percentile curves by the Centre for Disease Control and Prevention [19] and categorized according to the BMI percentiles obtained from the chart

- Underweight group: BMI - for age- less than 5th percentile.
- Normal weight group: BMI- for age-greater than or equal to 5th percentile but less than 85 percentile”.
- Overweight group: BMI- for age-greater than or equal to 85 percentile but less than 95 percentile.
- Obese group: BMI-for age- greater than or equal to 95 percentile.

After two weeks of starting the clinical examination 10% of the sample (36 children) were reexamined for reliability; the kappa value ranged from 0.66- 0.86 for body weight, height, dft, DMFT and age of the children.

Data were collected, summarized, coded and entered to the Statistical Package for Social Sciences (SPSS) program (version 17) in the computer. Frequency distribution tables, graph, means and standard deviations were used to represent the results.

Chi square test was used to examine the association between body weight category with age and gender, Spearman rank correlation was applied for the correlation between body weight category and dental caries, while an Independent sample t-test was used to compare dental caries between genders. For all statistical tests a P-value of less than 0.05 was considered as significant.

RESULTS

A total of 360 children (180 boys, 180 girls) were included in this study selected from elementary schools in Khartoum state as follows: Omdurman (31.9%), Khartoum (26.7%), Eastern-Nile (21.4%) and Ombada (20%).

Age of the examined children ranged from 6-11 years (figure1).

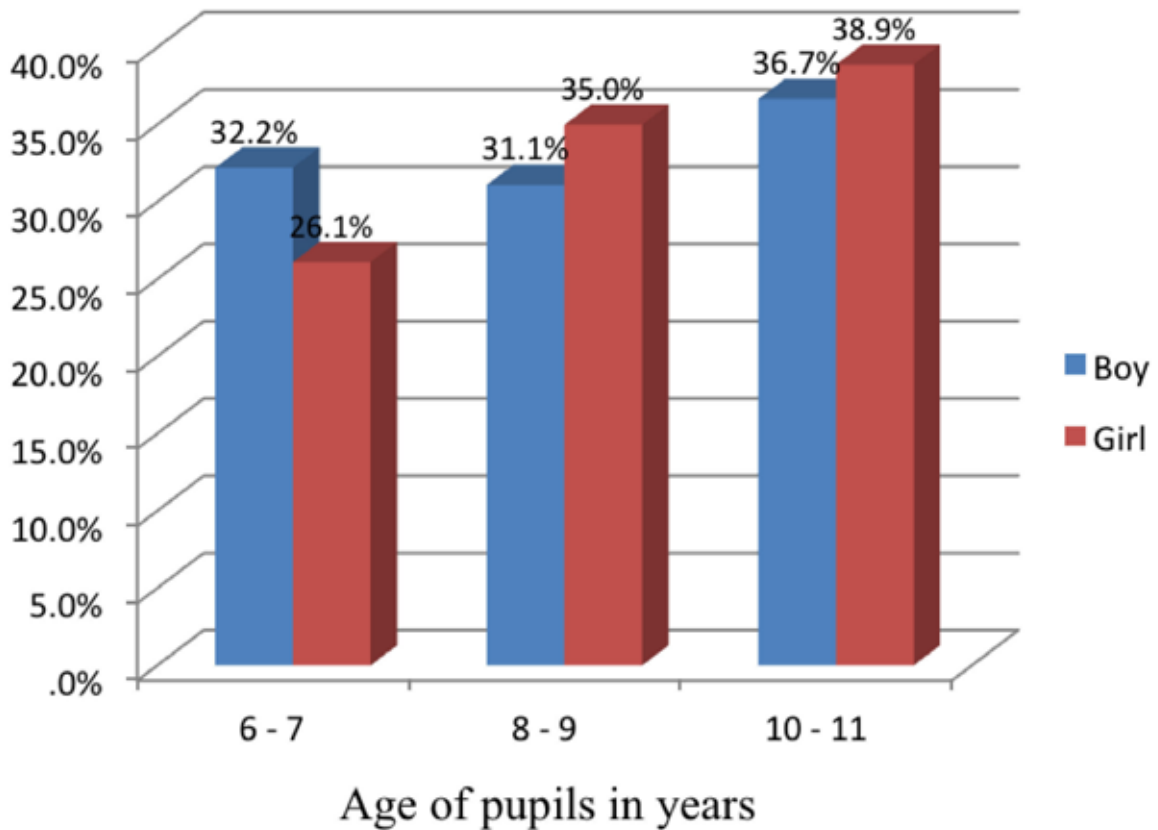


Figure 1 - Age distribution of 360 children.

Dentition Status

The majority of the examined children were in the mixed dentition stage (88.6%) while permanent and primary dentitions (6.1%) and (5.3%) of the children respectively.

No significant difference was found regarding type of dentition among gender (Table1).

Table 1 - Distribution of dentition status among gender

Gender	Dentition status			Chi square
	Primary N (%)	Mixed N (%)	Permanent N (%)	
Boys	10(5.6%)	159(88.3%)	11(6.1%)	0.056
Girls	9(5.0%)	160(88.9%)	11(6.1%)	
Total	19(5.3%)	319(88.6%)	22(6.1%)	

Body Mass Index

Normal body weight was recorded in (60.6%) of the sample followed by the underweight group (28.3%), the overweight group (6.4%), and (4.7%) of children were on the obese group (Table 2).

Body mass index, age and gender of the child

Normal body weight was the most common type of body weight category among all age groups, while the obese was the least occurring one and it was more frequent among 6-7year old children. However, no statistically significant difference was found (Table 2).

Table (3) shows that boys exhibit a higher prevalence of underweight than girls in all age

Table 2 - Association between age and body mass index in 360 children

Age groups	Body Mass Index				Total	Chi square	P-value
	Underweight N (%)	Normal N (%)	Overweight N (%)	Obese N (%)			
6-7 years	30 (28.6%)	61(58.1%)	4 (3.8%)	10(9.5%)	105(100.0%)	12.018	0.062
8-9 years	32(26.9%)	71(59.7%)	10(8.4%)	6 (5.0%)	119(100.0%)		
10-11 years	40(29.4%)	86 (63.2%)	9 (6.6%)	1(7%)	136(100.0%)		
Total	102(28.3%)	218(60.6%)	23(6.4%)	17(4.7%)	360(100.0%)		

Table 3 - Association between body mass index, age and gender of the child

Gender	Age in years	Body Mass Index				Total	Chi square	P-value
		Underweight	Normal	Overweight	Obese			
Boys	6-7	18 (31.0%)	32 (55.2%)	3 (5.2%)	5 (8.6%)	58 (100%)	5.705	0.457
	8-9	18 (32.1%)	33 (58.9%)	3 (5.4%)	2 (3.6%)	56 (100%)		
	10-11	28 (42.4%)	35 (53.0%)	2 (3.0%)	1 (1.5%)	66 (100%)		
Total		64 (35.6%)	100 (55.6%)	8 (4.4%)	8 (4.4%)	180(100%)		
Girls	6-7	12 (25.5%)	29 (61.7%)	1 (2.1%)	5 (10.6%)	47 (100%)	11.64	0.071
	8-9	14 (22.2%)	38 (60.3%)	7 (11.1%)	4 (6.3%)	63 (100%)		
	10-11	12 (17.1%)	51 (72.9%)	7 (10.0%)	0 (0.0%)	70 (100%)		
Total		38 (21.1%)	118 (65.6%)	15 (8.3%)	9 (5.0%)	180(100%)		

groups. Whereas the overweight group was more prevalent among girls (8.3%) than boys (4.4%), except for the age 6-7 year old in which overweight was more recorded in boys. Majority of underweight boys were found in age 10-11 years. Overweight in girls was equally found in age groups 8-9 and 10-11 years.

Prevalence of dental caries

Association between age and mean dft, DMFT values revealed a highly significant relationship between them at all age groups in boys and girls (Table 4).

It is apparent from table (5) that:

- No difference was found between genders in relation to dft (4.68).

- The mean DMFT was more in girls (2.52) than boys (1.88) which is statistically significant (P 0.004).

Table 4 - Association between age and dft /DMFT among participants

Gender	Caries index	Age in years	Mean	N	Std. Deviation	P-value
Boy	dft	6-7	5.57	58	3.885	0.000
		8-9	5.36	56	3.159	
		10-11	3.09	56	2.553	
		Total	4.68	170	3.424	
Boy	DMFT	6-7	0.87	48	1.248	0.000
		8-9	1.70	56	1.426	
		10-11	2.77	66	2.326	
		Total	1.88	170	1.945	
Girl	dft	6-7	6.09	47	3.374	0.000
		8-9	4.68	62	3.114	
		10-11	3.56	59	2.555	
		Total	4.68	168	3.153	
Girl	DMFT	6-7	1.21	39	1.592	0.000
		8-9	2.57	63	1.521	
		10-11	3.21	70	2.419	
		Total	2.52	172	2.087	

Table 5 - Association between gender and mean dft/ DFMT

Caries index	Gender	Mean	Std. Deviation	t	P-value
dft	Boy	4.68	3.424	0.011	0.992
	Girl	4.68	3.153		
DMFT	Boy	1.88	1.945	-2.973	0.004
	Girl	2.52	2.087		

Correlation between body mass index and dental caries:

The results of the present study showed a correlation between dft and body weight category, whereas no correlation between body weight category and DMFT existed (Table 6).

Spearman correlation revealed that type of correlation between dental caries and body weight category is negative (Table 7).

DISCUSSION

The association between the prevalence of dental caries and body mass index has been well documented in the literature. [20] However, in Sudan to our knowledge there has been no published study concerning this relationship. Dental caries and obesity are both serious health problems which need increase in awareness among the population and organized preventive programs.

Table 7 - Spearman Correlation between body weight category and mean dft/ DMFT in 360 child

Dental caries index	Body Weight Category	
dft	0.035	P Value
	-0.115	Correlation coefficient
DMFT	0.678	P value
	-0.023	Correlation coefficient

In the present study the most prevalent body weight category among the Sudanese children was the normal weight group (60.6%) followed by the underweight group (28.3%), overweight group (6.4) and the obese group (4.7%), which were consistent in distribution order with a previous study done by Nagwa et al among Sudanese children 10-18 years as the normal weight formed the major group (65.6%).[2] However, Nagwa reported a higher prevalence of overweight (10.8) and obesity (9.7). This difference can be attributed to differences in the sample size, ages of the examined group as well as the time interval between the two studies.

Studies in middle eastern countries showed an increasing trends in childhood obesity; Al-Sendi et al in Bahrain studied 506 students (249 boys and 257 girls) age 12-17 years found the overall obesity to be 15% in boys and 18%

Table 6 - Correlation between body mass index and mean dft/DMFT

Caries index	Body weight category	Number (N)	Mean	Std. Deviation	F	P-value
Dft	Underweight	94	5.33	3.635	2.869	0.031
	Normal	207	4.49	3.150		
	Overweight	20	3.25	2.613		
	Obese	17	5.12	3.039		
	Total	338	4.68	3.287		
DMFT	Underweight	98	2.32	2.171	1.072	0.360
	Normal	206	2.17	2.021		
	Overweight	22	2.55	1.920		
	Obese	16	1.44	1.504		
	Total	342	2.20	2.040		

in girls.[21] Whereas in Saudi Arabia al-Nuaim et al reported the prevalence of overweight and obese boys 11.7% and 15.8% respectively.[22] In addition Al- Isa et al in Kuwait found much higher prevalence of overweight 30.0% and obesity 14.7% among 14659 adolescents; [23] also in the Islamic Republic of Iran Mohammad pour-Ahranjani et al observed overweight and obesity in 21.1% and 7.8% of 11-16 years old children. [24] More or less a similar finding of normal body weight representing the most prevalent body weight category was reported in Germany, India and USA.[11,15,25]

In comparing the present study with studies done in India, [15] underweight children demonstrate a high prevalence (23.3%, 22.2%) respectively followed by overweight and obese groups. However, the order of body groups differed in Germany and USA with Germany having more overweight (11.9%) and obese (9.7%) than underweight (3.6%) and USA having more overweight (10.5%) and nearly similar percentages regarding obese (6.3%) and underweight (6.8%). [11,25]

The differences in body weight categories among different populations may be due to variations in socioeconomic status, dietary habits, age groups, the size of the examined group, in addition to the public awareness about the side effect of high body weight.

In the present study both genders exhibited a high prevalence of normal weight (55.6% boys, 65.6% girls). Boys showed higher prevalence of underweight than girls (35.6% boys, 21.1% girls). On the other hand girls were more overweight than boys (8.3% girls, 4.4% boys). This finding, in agreement with previous Sudanese results where normal weight was found in 61.0% of boys and 69.6% girls. [2]

Differences between genders in the Sudanese sample may be partially attributed to different leisure time activities; boys prefer outdoor sports while girls prefer indoors which may lead to increase in the quantity of food consumption.

In this study the caries index in primary teeth was 4.68, where a lower dmft mean was reported (1.68 among 275 preschool children 4-5 years resident in Khartoum). Numbers of previous studies reported low prevalence of dmft 2.52 and 2.06 among Iranian and Indian children 6-12year old [14,15], 0.19-3.2 dmft was reported among Jordan children[26] .In contrast, a slightly high dmft 3.3 was reported by Mitola et al in USA [16], 4.6 dmft by Al-Mutawa among Kuwaiti children [27] and 5.00 dmft among Saudi children[28].

Over the last 20 years, there was an increase of dental caries prevalence in primary teeth among Sudanese school children which may be attributed to the lack of dental awareness and school dental health services in addition to the increase in availability and easy accessibility to cariogenic food stuff. Moreover to promote healthy teeth in children, most industrial nations have been conducting preventive programs for many decades as an objective for healthy teeth for 12 years old children for the year 2000.

In the present study DMFT for permanent teeth was 2.2, whereas previous studies in Sudan reported 0.15 -3.2 DMFT value.[29-32] In 1986, Ibrahim et al studied urban, rural and semiurban sudanese children aged 6-12 year and found the DMFT to be 2.9, 3.2 and 2.3 respectively.[29] Two years later, Aziz Ghandour et al examined 600 school children age 11-13 years for caries prevalence and reported 3.2 DMFT. [30] Raadal et al 1993 reported a lower DMFT (0.15) among a sample of Sudanese school children 7-8 years [31]. Recently a slightly low DMFT 0.4 was found by Nurehuda et al among 12 year old Sudanese children.[32]

Different age groups have been examined among the Sudanese population it was difficult to interpret if the prevalence of dental caries in Sudanese children increased or decreased. Twelve years is a unique age and should be investigated separately for dental caries because most permanent teeth present are at this age.

In Nigeria, low DMFT (0.14) was reported by Taiwo et al in a group of 402 suburban Nigerian children age 12 years old. [33] In contrast, a higher DMFT of 3.5 was reported by Al Agili et al in Saudi Arabia [28] and Al-Mutawa et al in Kuwait reported DMFT value for 12 and 14 year olds as 2.6 and 3.9 respectively [27].

Primary teeth in this study for both genders showed no variation in the mean dft (4.68), while permanent teeth showed a significant difference in DMFT between genders (girls 2.52, boys 1.88).

In the present study, higher prevalence of dental caries in primary teeth were found in underweight groups; this finding is relevant to the results of Cameron et al in UK when 165 children aged 3-11 years were examined and severe dental caries was associated with underweight children. [12] In addition, the same results had been reported by Floyd [13]

Inverse correlation between caries prevalence in primary teeth and body weight category explained by more intake of proteins and fatty meals by overweight and obese children which are the least type of cariogenic diets.

The current study revealed that there is no correlation between prevalence of dental caries in permanent teeth and body mass index which is in agreement with results reported in Iran by Sadeghi et al among 6-11 year old children, [14] as well as Elangovan et al in India among 6-12 year old children. [15] Moreover, Macek et al concluded that there is no correlation between body mass index and caries prevalence in permanent teeth. [16]

CONCLUSION

The body weight category showed an inverse relation with the caries index in primary dentition. No significant relationship between the body weight category and caries index in

permanent teeth. No difference in the dft value in gender; the DMFT was higher in girls.

The most prevalent body weight was the normal weight followed by the underweight. Boys displayed a higher prevalence of the underweight than girls, while the overweight was more prevalent in girls.

The prevalence of dental caries was high in primary teeth and low in permanent teeth.

Limitations of the study

- Using the WHO criteria of caries detection without bitewing radiographs may underestimate the actual prevalence of dental caries.

- Using dft index for primary teeth instead of dmft may underestimate the caries prevalence in primary teeth; but it is a known index used sometimes to avoid inaccurate cause of missing of the tooth especially since in this study the parents were not present during the examination day.

Strengths of the study

- This is the first study in Sudan concerning the correlation between body weight categories and dental caries and could be a base for future researches in this field.

- All children included in the study were given a written referral to dental clinic as needed.

RECOMMENDATION

Further studies in the correlation between body mass index and prevalence of dental caries including a larger sample size of different age groups may help in clarifying the association between body mass index and dental caries.

COMPETING INTEREST

The authors declare that they have no competing interests.

The authors did not receive any fund or payment from any organization

AUTHORS' CONTRIBUTIONS

Tyseer Seid Ahmed designed the article and carried out the data collection from the schools, data analysis and writing of the article. Amal Abuaffan supervised all the steps and assisted in designed writing/editing of the article. All authors have read and approved the final manuscript.

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