ORIGINAL ARTICLE

e-ISSN: 2349-0659 p-ISSN: 2350-0964
doi: 10.21276/apjhs.2017.4.4.35

Fluoride level in drinking water and prevalence of dental fluorosis and dental caries among the school children: A descriptive cross-sectional study

Abdulrahman Hamoud Alanazi*, Fahad Abdullah Alsaab, Saud Sulaiman Alatal, Suliman Fahad Alfahaid, Abdulaziz Saeed Alharbi, Bader Shaleh Almutairi, S. Karthiga Kannan

Department of Maxillo-Facial Diagnostic Sciences, College of Dentistry, Majmaah University, Kingdom of Saudi Arabia

ABSTRACT

Background: Fluoride is very critical for the normal development and caries resistance of enamel. However, fluoride level above 1 part per million (PPM) will result in enamel hypoplasia. **Aim:** The study aims to estimate the fluoride level in the drinking water and the prevalence of dental fluorosis and dental caries among the schoolchildren in Al-Zulfi and Majmaah areas in Riyadh province of Saudi Arabia. **Materials and Methods:** Drinking water samples were analyzed from the study area, and screening camps were conducted for schoolchildren between 7 and 15 years of age, and 157 children were included in the study using simple random sampling. Written consent from the parents was obtained. The collected data were subjected to statistical analysis using SPSS version 21. **Results:** The drinking water sample showed a fluoride level between 0.56 PPM and 0.09 PPM and 39 children (24.8%) had fluorosis. 9 (23%) of them had fluorosis in primary dentition and 30 in permanent dentition (76.9%). A mean of total number of caries in permanent teeth is 1.87 and 2.35 in primary teeth. **Conclusion:** The drinking water in the study area had fluoride below the optimal level with an increased prevalence of dental caries. However, the presence of dental fluorosis could be attributed to other sources of dietary fluorides. This research highlights the necessity for maintaining optimum level of fluoride in drinking water and monitoring fluoride intake from other dietary sources.

Key words: Children, dental caries, drinking water, fluorides, fluorosis, hypoplasia

INTRODUCTION

Dental caries are being a major public health problem in most of the developing countries, affecting 60–90% of the schoolchildren.[1,2] Fluoride is considered as an important resource for the control of dental caries. Up to 1 part per million by weight (PPM), it is beneficial as it converts the hydroxylapatite crystals of enamel into fluorapatite, which are stronger and resist acid demineralization. The critical pH of hydroxyl appetite is 5.5 and for the fluorapatite is below 4 and therefore effectively resists caries formation.[3,4] Numerous dental public health researchers have concluded that fluoride is a double-edged weapon and the effect of this element on the dentition is dose-dependent.[5] Above certain levels, fluoride exposure produces visible changes in dental structure, mainly in enamel. This condition is known as dental fluorosis. It is important to emphasize that dental fluorosis is expected to occur only in case of excessive and prolonged fluoride ingestion during the period of dental development, i.e., during amelogenesis[3,4] clinically, dental fluorosis appears in different forms, depending on the fluoride dose, duration of exposure, and the stage of tooth development. Post-eruptive enamel staining is an important aspect to be considered because it is not a direct result on amelogenesis influenced by fluoride, but it is rather of exogenous origin, after tooth eruption.[6]

The purpose of the present study was to assess the fluoride level in drinking water and prevalence of dental fluorosis and dental caries among the schoolchildren in Al-Zulfi and Majmaah, in Saudi Arabia.

MATERIALS AND METHODS

A descriptive cross-sectional study design is used and participants were included using a simple random sampling. A dental team comprising students and faculty from College of Dentistry, Majmaah University, Kingdom of Saudi Arabia, collected the samples of drinking water from various drinking water sources from Al-Zulfi and Majmaah. The samples were analyzed in General Directorate of water, Zulfi branch, by diluting the water samples with equal quantities of Total Ionic Strength Adjustment Buffer and the fluoride ion concentration was determined using a combination fluoride-ion-selective electrode and by reading a digital read out ion-meter. Meanwhile, screening camps for schoolchildren aging between 7 and 15 years old in Al-Zulfi and Majmaah were conducted to establish the prevalence of dental fluorosis and dental caries in both primary and permanent dentitions. A pro forma has been designed for recording history regarding drinking water and intraoral clinical findings. The

Address for correspondence:
Abdulrahman Hamoud Alanazi, Department of Oral Medicine and Radiology, College of Dentistry, Majmaah University, Kingdom of Saudi Arabia. Phone: +966532074974. E-mail: Okaok501ok@gmail.com

Received: 13-10- **Revised:** 23-10-17 **Accepted:** 01-12-17

collected data were subjected to statistical analysis using SPSS version 21; an independent sample t-test was done to compare the prevalence of dental caries in primary and permanent teeth between those children with fluorosis against those without fluorosis.

RESULTS

A total of 157 students were included in this study and the mean age was 10.98, with a minimum of 7 years old and maximum of 15 years old (Table 1). The estimation of fluoride level in drinking water in Al-Zulfi and Majmaah areas in Riyadh province of Saudi Arabia revealed 0.56 PPM in Al-Zulfi East as highest and 0.09 PPM in Majmaah East and Al-Zulfi North as lowest values in our study (Graph 1).

Inference: Fluoride level in drinking water of different places in Majmaah and Al-Zulfi appears to be below normal level. Highest of 0.56 ppm in Al-Zulfi East and lowest of 0.09 ppm in Majmaah East and Al-Zulfi North were seen.

Out of 157 students, only 39 (24.8%) were found to be affected with fluorosis. Out of 39 students, 9 (23%) of them have fluorosis in primary dentition and 30 had in permanent dentition (76.9%) (Table 2). A mean of a total number of carious permanent teeth for 157 students is 1.87 (Table 3). Mean of a total number of carious primary teeth for 157 students is 2.35 (Table 4).

Regarding the caries distribution among specific primary teeth, it appears that all the second molars are most commonly affected and incisors were least affected (Graph 2).

Caries distribution among specific permanent molar reveals that 46 is the most commonly affected teeth (Graph 3).

An independent sample t-test was calculated comparing the averages caries in permanent teeth between those children with fluorosis against those without fluorosis. No significant difference was found (t [2] =0.934, $P > 0.05$). The mean number of caries in those children with fluorosis (m = 2.13, sd = ±1.809) was not significantly different from the mean

Table 1: Age distribution within the 157 subjects

Descriptive statistics					
Age	**N**	**Minimum**	**Maximum**	**Mean**	**SD**
Age in completed years	157	7.00	15.00	10.9873	1.37742

Inference: The mean age of 157 students is about 10.98, with minimum of 7 years old and maximum of 15 years old. SD: Standard deviation

Table 2: Fluorosis prevalence

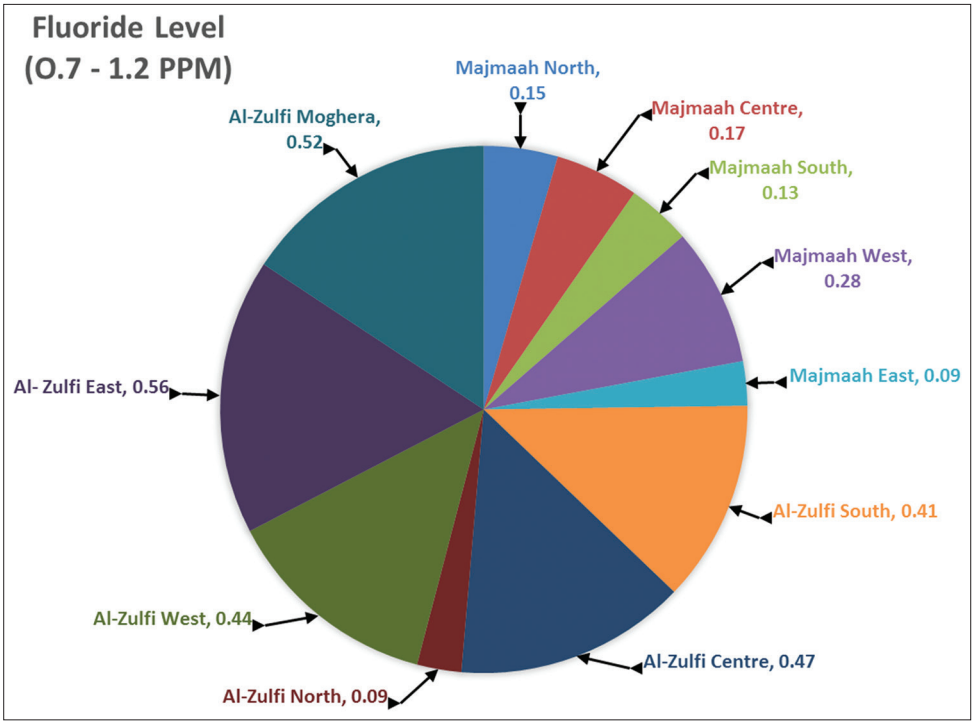
Fluorosis status	Frequency (%)
Present	39 (24.8)
Absent	118 (75.2)
Total	157 (100.0)

Inference: Out of 157 students, only 39 (24.8%) were found to be affected with fluorosis. Out of 39 students, 9 of them have fluorosis in primary dentition and 30 had in permanent dentition

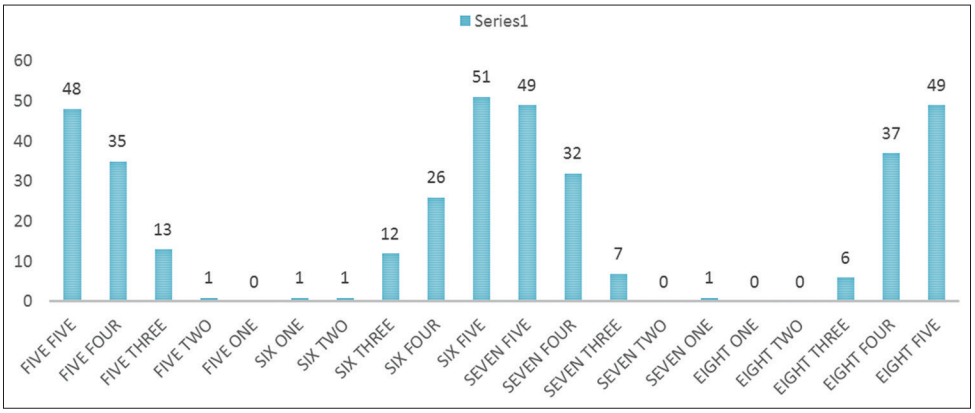
Table 3: Mean and standard deviation of total number of carious permanent teeth

Descriptive statistics				
Carious permanent teeth	**N**	**Sum**	**Mean**	**SD**
Total number of carious permanent teeth	157	294	1.87	2.025

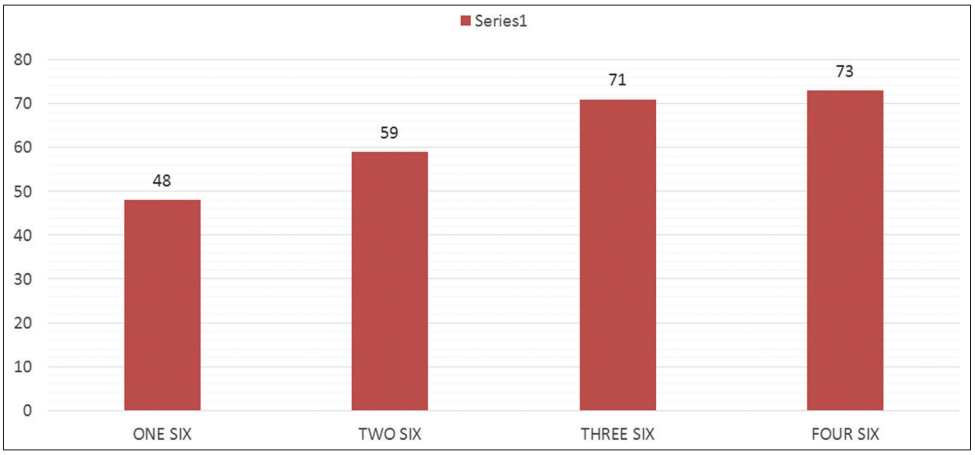
SD: Standard deviation. Inference: Mean of total number of carious permanent teeth for 157 students is 1.87



Graph 1: Level of fluoride in drinking water.



Graph 2: Caries distribution among specific primary teeth. Inference: Caries distribution among specific primary teeth appears to be more in all the second molars and lesser in incisors



Graph 3: Caries distribution among specific permanent molar teeth. Inference: Caries distribution among specific permanent molar reveals that 46 is the most commonly affected teeth.

Table 4: Mean and standard deviation of total number of carious primary teeth descriptive statistics

Descriptive statistics				
Carious permanent teeth	**N**	**Sum**	**Mean**	**SD**
Total number of carious permanent teeth	157	369.00	2.3503	2.48809

SD: Standard deviation. Inference: Mean of total number of carious primary teeth for 157 students is 2.35

number of caries for children without fluorosis (m = 1.78, sd = ±2.097) (Table 5).

An independent sample t-test was calculated comparing the average primary carious teeth between those children with fluorosis against those without fluorosis. No significant difference was found (t [2] = −0.256, $P > 0.05$). The mean number of caries in those children with fluorosis (m =2.25, sd = ±2.279) was not significantly different from the mean number of caries for children without fluorosis (m = 2.3761, sd = ±2.572) (Table 6).

DISCUSSION

Fluoride inhibits dental caries by interfering with the process of demineralization of teeth. Fluoride decreases the loss of tooth minerals when it is present in the oral cavity in optimum and constant concentration; it consequently decreases the rate of caries progression in the population.[7] However, when excess fluoride is ingested during enamel mineralization, dental fluorosis occurs.[8] Thus, an optimum concentration of fluoride in drinking water is necessary to be effective and to achieve caries control with a minimum risk of fluorosis.[9]

In our study, the mean concentration of fluoride from 11 regions of Majmaah and Al-Zulfi, Saudi Arabia, was found to be ranging from 0.09 ppm to 0.56 ppm F which is less when compared to a study done in Riyadh, Saudi Arabia, which reported 0.79 ± 0.09 mg/L with a range from 0.5 to 0.83 mg/L. and this concentration is also below the optimum level required to prevent dental caries.[10] The American Dental Association recommends a range of 0.7–1.2 PPM of fluoride in community water supplies to protect against tooth decay.[11] A study done in the central region of Saudi Arabia showed that the fluoride levels varied between 0.00 and 6.20 ppm. The highest level of 6.20 ppm was recorded at Al-Madnab (Qassim region), while there was virtually no fluoride in the drinking water in Darul Baida (Riyadh region). However, due to the larger amount of water consumption, recommended level of fluoride in the water for warm countries like Saudi Arabia should be in the range of 0.6–0.8 ppm compared to the temperate countries.[12]

Table 5: Comparison of the average caries in permanent teeth between those children with fluorosis against those without fluorosis

Group statistics					Independent samples test						
					T	Df	Significant (two-tailed)	Mean difference	Standard error difference	95% confidence interval of the difference	
Fluorosis status	N	Mean	SD	Standard error mean						Lower	Upper
Total number of carious permanent teeth											
Present	39	2.13	1.809	0.290	0.934	154	0.351*	0.350	0.375	−0.391	1.092
Absent	118	1.78	2.097	0.194							

SD: Standard deviation

Table 6: Comparison of the average caries in deciduous teeth between those children with fluorosis against those without fluorosis

Independent samples test											
Group statistics					T	Df	Significant (two-tailed)	Mean difference	Standard error difference	95% confidence interval of the difference	
Fluorosis status	N	Mean	SD	Standard error mean						Lower	Upper
Total number of carious primary teeth											
Present	39	2.2564	2.27940	0.36500	−0.259	154	0.796*	−0.11966	0.46282	−1.03396	0.79464
Absent	118	2.3761	2.57215	0.23780							

SD: Standard deviation

The prevalence of fluorosis observed in the present study is 24.8%, but the mean fluoride concentration is 0.30 ppm F which is far below the optimum level required to cause dental fluorosis. This higher prevalence of dental fluorosis could be from the intake of fluoride from other dietary sources such as milk, toothpastes, and chewing gums. These fluoride vehicles are effective and safe when used with care; hence, special attention must be given especially to young children, who can swallow fluoride from these products. In this sense, close monitoring of all the other sources of fluoride intake at regular intervals is very important. A study done in the UK among 6–7 years old children to assess the various dietary sources for fluoride intake and concluded fruit juices, cordials, cooked rice, pasta, vegetables and bread, and carbonated soft drinks were the most important contributors to dietary fluoride intake.[13] Apart from fluoride other possible cause for these hypoplastic enamel defects in teeth of children includes occurrence of infectious diseases such as chickenpox, measles, asthma, mumps, scarlet fever, and pneumonia during the mineralization phase of tooth development.[14-16]

In the present study, out of 157 students, only 39 (24.8%) were found to be affected with fluorosis. Out of 39 students, 9 (23%) of them have fluorosis in primary dentition and 30 had in permanent dentition (76.9%), our findings correlates with a similar study from Gujarat, India, showed 20–33% of dental fluorosis in patients from area of high fluoride content in water and the permanent dentition shows more fluorosis changes than deciduous dentition.[17] Similar range of 33% prevalence of dental fluorosis was reported from schoolchildren in Dammam, Saudi Arabia.[18]

Whereas a study on the prevalence of fluorosis in primary teeth in the US showed 11.1% of incidence and is most frequently seen on the posterior teeth, particularly the primary second molars, which form at later stages of development. This finding suggests that primary tooth fluorosis is mostly a postnatal phenomenon and is associated with higher water fluoride levels.[19] In a study conducted by Stiefel *et al*. in low drinking water F area (0.3 ppm), the highest values of F in the outer most surface of the permanent teeth enamel were (300 and 600 μg F/g of ash), but in the deep layers, the F content was only 20–30 μg F/g of ash. Their results showed lower concentrations of F in deciduous teeth.[20]

In our study, mean of a total number of carious permanent teeth for 157 students is 1.87 and the mean of a total number of carious primary teeth for 157 students is 2.35. In a study done in Brazil, among 12-year-old schoolchildren, the DMFT and SiC indices (Significant Caries Index) were 0.85 ± 1.54 and 2.52 ± 1.72. Fluorosis prevalence was 29.42%.[21] In the present study, among the permanent teeth, mandibular molars are commonly affected with dental caries. The overall high prevalence of dental caries could be attributed to low level of fluoride in drinking water. A study from Nalgonda district of Andhra Pradesh, India (endemic fluoride belt), showed that the average prevalence of dental caries among children was 56.3% with the highest in below optimal fluoride area (71.3%) and lowest in optimal fluoride area (24.3%).[22]

The American Academy of Pediatric Dentistry recommends to consider fluoride supplements for all children consuming

fluoride-deficient (<0.6 ppm) water. The daily fluoride supplement dosage can be assessed using the dietary fluoride supplementation schedule. It can be formulated by determining the fluoride level of water supply through public health officials and evaluating other dietary sources of fluoride and assessing the risk of caries in children.[23,24]

CONCLUSION

The recommended level of fluoride in water for warm countries like Saudi Arabia should be 0.6–0.8 ppm slightly lesser than the normal recommended level, due to the larger amount of water consumption in the hot climate compared to the moderate or cool temperate countries. Despite the low level of fluoride in drinking water, some of the children are affected by fluorosis in primary or permanent dentition. The cause of such condition may be due to the other sources such as fluoridate toothpaste, milk, bread, and chewing gum. Further studies have to be carried out in large scale by taking all fluoridated products into account to set a normal level of fluoride consumption in Saudi Arabia to prevent dental caries and fluorosis.

ACKNOWLEDGMENT

We like to thank our Dean Dr. Abdulrahman A. Al-Atram, Vice Dean Academics Dr. Mohammed A. Alsakran Altamimi and Dr Mousa Abu Fadaleh, Assistant Professor, Head of Research Unit, College of Dentistry, Majmaah University, Saudi Arabia for their cooperation and support extended to this study.

REFERENCES

1. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. Bull World Health Organ 2005;83:661-9.
2. Petersen PE, Lennon MA. Effective use of fluorides for the prevention of dental caries in the 21st century: The WHO approach. Community Dent Oral Epidemiol 2004;32:319-21.
3. Hellwig E, Lennon AM. Systemic versus topical fluoride. Caries Res 2004;38:258-62.
4. Robinson C, Connell S, Kirkham J, Brookes SJ, Shore RC, Smith AM, *et al.* The effect of fluoride on the developing tooth. Caries Res 2004;38:268-76.
5. Hiremath SS. Fluorides. Text Book of Preventive and Community Dentistry. 2nd ed. New Delhi: Reed Elsevier India Private Ltd.; 2011. p. 370-402.
6. Rozier RG. Epidemiologic indices for measuring the clinical manifestations of dental fluorosis: Overview and critique. Adv Dent Res 1994;8:39-55.
7. Tenuta LM, Chedid SJ, Cury JA. In: Maio LC, Primo LG, editors. Uso de Fluoretosemodontopediatria: Mitos e Evidências. São Paulo: Santos: Odontopediatria Clínica Integral.; 2012. p. 153-77.
8. Aoba T, Fejerskov O. Dental fluorosis: Chemistry and biology. Crit Rev Oral Biol Med 2002;13:155-70.
9. Fawell J, Bailey K, Chilton J, Dahi E, Fewtrell L, Magara Y. Fluoride in Drinking-Water. London: World Health Organization (WHO); 2006. Available from: http://www.apps.who.int/iris/bitstream/10665/43514/1/9241563192_eng.pdf. [Last accessed on 2015 Mar 16].
10. Aldrees AM, Al-Manea SM. Fluoride content of bottled drinking waters available in Riyadh, Saudi Arabia. Saudi Dent J 2010;22:189-93.
11. American Dental Association. American Dental Association Statement on Water Fluoridation Efficacy and Safety. Available from: http://www.ada.org/prof/resources/positions/statements/fluoride2.asp. [Last accessed on 2009 Aug 29; Last updated on 2002 Jun 5].
12. Aldosari AM, Akpata ES, Khan N, Wyne AH, Al-Meheithif A. Fluoride levels in drinking water in the central province of Saudi Arabia. Ann Saudi Med 2003;23:20-3.
13. Zohouri FV, Maguire A, Moynihan PJ. Sources of dietary fluoride intake in 6-7-year-old English children receiving optimally, sub-optimally, and non-fluoridated water. J Public Health Dent 2006;66:227-34.
14. Mackay TD, Thomson WM. Enamel defects and dental caries among southland children. N Z Dent J 2005;101:35-43.
15. Balmer RC, Laskey D, Mahoney E, Toumba KJ. Prevalence of enamel defects and MIH in non-fluoridated and fluoridated communities. Eur J Paediatr Dent 2005;6:209-12.
16. Wong HM, McGrath C, Lo EC, King NM. Association between developmental defects of enamel and different concentrations of fluoride in the public water supply. Caries Res 2006;40:481-6.
17. Mehta DN, Shah J. Reversal of dental fluorosis: A clinical study. J Nat Sci Biol Med 2013;4:138-44.
18. Khan SQ, Moheet IA, Farooqi FA, ArRejaie AS, Al Abbad MA, Khabeer A. Prevalence of dental fluorosis in school going children of Dammam, Saudi Arabia. J Dent Allied Sci 2015;4:69-72.
19. Warren JJ, Levy SM, Kanellis MJ. Prevalence of dental fluorosis in the primary dentition. J Public Health Dent 2001;61:87-91.
20. Stiefel A, Cobet U, Binus W. Electron probe microanalysis of fluorine content in deciduous and permanent teeth from an area with a fluoride-deficient (0,3% mg/l) water supply. Dtsch Stomatol 1991;41:451-4.
21. Benazzi AS, da Silva RP, de Meneghim M, Ambrosano GM, Pereira AC. Dental caries and fluorosis prevalence and their relationship with socioeconomic and behavioural variables among 12-year-old schoolchildren. Oral Health Prev Dent 2012;10:65-73.
22. Shekar C, Cheluvaiah MB, Namile D. Prevalence of dental caries and dental fluorosis among 12 and 15 years old school children in relation to fluoride concentration in drinking water in an endemic fluoride belt of Andhra Pradesh. Indian J Public Health 2012;56:122-8.
23. Burt BA. The changing patterns of systemic fluoride intake. J Dent Res 1992;71:1228-37.
24. Levy SM, Kiritsy MC, Warren JJ. Sources of fluoride intake in children. J Public Health Dent 1995;55:39-52.

How to cite this Article: Alanazi AH, Alsaab FA, Alatallah SS, Alfahaid SF, Alharbi AS, Almutairi BS, Kanna ... Fluoride level in drinking water and prevalence of dental fluorosis and dental caries among the school children: A descriptive cross-sectional study. Asian Pac. J. Health Sci., 2017; 4(4):155-159.

Source of Support: Nil, **Conflict of Interest:** None declared.