RISK FACTORS ASSOCIATED WITH TEETH DISCOLORATION IN MALAKAND DISTRICT, PAKISTAN

Nawsherwan,[a]* R Kaur Chawla,[a] Muhammad Arif,[a] M Nauman Ahmad,[b] Humaira Wasila,[a] Ijaz Ulhaq,[c] Abbas Khan,[a] Afia Zia,[a] A Ahmad Mian,[c] R Ullah Shah,[c] Imran Khan[d]

Malakand, Pakistan

ABSTRACT: A community-based cross-sectional study was conducted to determine the risk factors associated with teeth discoloration in Malakand District, Pakistan. A total of 200 subjects, 50 from each of 4 villages, aged 6–60 yr, were interviewed for data collection using a questionnaire. Twenty water samples were collected from the drinking sources in each village and the fluoride levels measured using a T60 V spectrophotometer. More teeth discoloration was found in those with a middle range of family monthly income (12,000–25,000 Pakistan rupees, p<0.05). Teeth discoloration was significantly related to the mean drinking water fluoride level. The overall prevalence of teeth discoloration was 48.5% with the prevalence being highest in Barh (72%, drinking water fluoride 1.8 mg F/L) and lowest in Selaipaty (16%, drinking water fluoride 0.5 mg F/L). Among subjects with teeth discoloration, 88% had yellow teeth color, 82% had internal teeth defect, and 82% had dental fluorosis. Both the subjects with normal teeth color and discolored teeth had poor oral hygiene practices. Cigarette smoking was significantly associated with discolored teeth (p<0.05). It was recommended that the government should provide safe drinking water supply schemes, with proper maintenance, in all the high-fluoride drinking water areas to prevent the occurrence of dental and other forms of fluorosis.

Keywords: Fluoride in drinking water; Dental fluorosis; Malakand; Pakistan; Teeth discoloration.

INTRODUCTION

Although the essentiality of fluoride for humans has not been demonstrated unequivocally, low concentrations of fluoride, with a minimum value of 0.5 mg F/L, have been considered to provide protection against dental caries in both children and adults.[1, 2] However, it is now considered that any action that fluoride has in preventing dental caries occurs predominantly after the eruption of the teeth into the mouth and it is primarily topical, for both adults and children, via inhibiting demineralization, enhancing remineralization, and inhibiting bacterial action in dental plaque.[3] Various topical delivery methods for fluoride have been developed.[3] The long-term consumption of drinking water containing more than 1 mg F/L may cause various adverse health effects ranging from mild dental fluorosis to crippling skeletal fluorosis depending on the fluoride level.[1, 2]

Teeth discoloration is one of the most prominent abnormalities in the human dentition and is a frequent dental finding associated with clinical and aesthetic problems.[4] Teeth discoloration can be classified as intrinsic and extrinsic and can be caused by the deposition of pigments in internal and external structure of the teeth. Intrinsic discoloration can be caused by exposure to a high drinking water level of fluoride (>1.5 mg F/L), tetracycline, and other drugs.[5] Extrinsic

[a]Department of Human Nutrition, The University of Agriculture, Peshawar, Pakistan; [b]Department of Agricultural Chemistry, The University of Agriculture, Peshawar, Pakistan. [c]Institute of Biotechnology and Genetical Engineering (IBGE), The University of Agriculture, Peshawar, Pakistan; [d]Centre for Interdisciplinary Research in Basic Sciences (CIRBS), International Islamic University, Islamabad, Pakistan; *For correspondence: Nawsherwan, Department of Human Nutrition, The University of Agriculture, Peshawar, Pakistan; Email: Nawshermkd@gmail.com.

discoloration is located on the outer surface of the teeth and usually caused by beverages such as tea and coffee, the deposition of dental plaque, cigarette smoking, and antibacterial agents such as chlorhexidine.[6]

Fluorosis, dental and/or skeletal, induced by exposure to naturally occurring high fluoride levels in drinking water is quite widespread in many countries in the world, including Argentina, Brazil, Canada, China, Eritrea, Ethiopia, Germany, India, Indonesia, Israel, Japan, Kenya, Mexico, Niger, Nigeria, Norway, Pakistan, Saudi Arabia, Senegal, South Africa, Spain, Sri Lanka, Sudan, Thailand, Turkey, Uganda, United Republic of Tanzania, and the USA.[7] It is now becoming a public health problem and an increasing disease burden worldwide, especially for the developing countries, such as Pakistan.[8] Globally, the frequency of dental fluorosis varies between regions,[9] e.g. 8.53% in southern Brazil with a drinking water F level of 0.6–0.9 mg F/L and with the dental fluorosis being associated with a higher frequency of tooth brushing and the initial use of fluoride toothpaste at the emergence of the first tooth,[10] 69.84% in Udaipur, Rajasthan, India, with a drinking water F level of 0.8–4.1 mg F/L, [11] and 99% in the Rift Valley, Ethiopia, with a drinking water F level of 3.5–12.4 mg F/L.[12] A high prevalence of dental fluorosis has been observed in certain regions of Pakistan, e.g., 53.3% in school children in Karachi,[9] 60% in Quetta District, Balochistan, [13] 85% in Mianwali,[14] and 98% in Mardan,[14] with greater tea consumption being seen as an risk factor in addition to the high groundwater fluoride levels for the latter two locations.[9]

A high level of fluoride in drinking water is a well-known risk factor of dental fluorosis.[15] Although the World Health Organization set, in 1984 and reaffirmed in 1993, a guideline of 1.5 mg F/L (1.5 ppm) as a “desirable” upper limit, it also allows countries to set country standards, their own national standards or local guidelines.[16,17] The limit of 1.5 mg F/L has been seen to be unsuitable in some countries and lower country standards have been set of 1 mg F/L in India and 0.6 mg F/L in Senegal, West Africa.[17,18] A rider to the Indian limit is that the “lesser the fluoride the better, as fluoride is injurious to health.”[17,18] Consumption of drinking water having a fluoride concentration beyond the country standard level will increase the risk of developing dental fluorosis. Young children are most vulnerable to dental fluorosis because dental enamel formation is most active at this stage. Drinking water is usually the principal source of fluoride intake, but other sources such as dietary sources with high level of fluoride, vegetables grown in locations with a high level of naturally occurring fluoride, fluoride containing spices, e.g., rock salt (fluorite, CaF_2), and tea with elevated fluoride levels, e.g. brick tea, can also be significant sources of exposure to high levels of fluoride.[15,19] The present study attempts to assess the prevalence of dental fluorosis in some developing communities of Pakistan. The data may be utilized by the government and non-government organizations for further studies and for developing strategies to effectively combat the occurrence of dental fluorosis.

MATERIALS AND METHODS

A community-based cross-sectional study was conducted on a convenient sample to determine the risk factors associated with teeth discoloration in residents of Malakand District, Pakistan. For this purpose, two union councils (Selaipaty

and Kot) were selected, and then, from each union council, two villages were randomly selected. From each village, 25 households were randomly selected and two subjects were interviewed from each household. A total of 200 subjects, aged 6–60 yr, were interviewed for data collection using a questionnaire. The subjects were life-long residents of four villages of similar population size which differed in the fluoride content of the drinking water. A total of 80 bottles (250 mL each) of water samples, 20 bottles from each of the four villages, were collected from the drinking sources for fluoride determination by standard methods for the examination of water and wastewater using a T60 V spectrophotometer.[20]A range of questions on socio-demographic status, health status, water source, and oral hygiene practices were asked. Information on the dietary intake pattern was collected using a 24 hr dietary recall method and data from food composition tables for Pakistan.[21] All data was entered into the Statistical Package for Social Sciences.[22] Descriptive statistics (e.g., frequency, mean) were used to analyze the data distribution and any possible errors. The tests used were: Chi-square test for categorical data in order to establish the relationship between the risk factors and teeth discoloration; Independent T-test to compare the means between cases and controls for the 24 hr dietary recall; and One-way ANOVA to compare the means of the drinking water fluoride levels in the four villages.

RESULTS

Analysis of the demographic and socioeconomic factors for the 200 subjects showed no significant relationship ($p>0.05$) between the presence of discolored teeth and age, gender, occupation, and education (Table 1). In contrast, a significant difference ($p<0.05$) was found between the presence of discolored teeth and the family monthly income with more teeth discoloration in the middle income group (12,000–25,000 Pakistan rupees).

The prevalence of teeth discoloration was highest in Barh (72% of the 50 persons examined in the village) followed by Mena (58%), Totai (48%) and Selaipaty (16%, Table 2 and Figure). The mean drinking water fluoride levels in the four villages ranged from the highest value in Barh (1.8 mg F/L) to the lowest in Selaipaty (0.5 mg F/L). The mean drinking water fluoride level in Totai (1.4±0.5 mg F/L) was significantly different ($p<0.05$) from the levels in Selaipaty (0.5±0.4 mg F/L) and Barh (1.8±0.6 mg F/L) but not significantly different ($p>0.62$) from that in Mena (1.0±0.8 mg F/L). The mean drinking water fluoride levels in Selaipaty, Mena, and Barh were significantly different ($p<0.05$) from each other.

The age of onset of teeth discoloration was less than 10 yr in 88.5% of the subjects and 10 or more yr in 11.5% (Table 3). The commonest discoloration color was yellow (87.5%) followed by black (6.1%), brown (2.2%), and white with spotting (4.2%). Internal acquired teeth defect was present in 82% and external deficit in 18%. Discoloration was due to dental fluorosis in 82%, dental carries in 1%, and dental plaque in 16%. Most of the subjects had no missing teeth (83%), no teeth ache (67%), no sensitivity to heat or cold (62%), and no sensitivity to sweets (69%). Only 7% of the subjects with discolored teeth had visited to the dentist because of lack of dentists in the area.

Table 1. Teeth color and socio-demographic variables in the four studied villages (n=200)

Variables		Persons with normal teeth (%)	Persons with discolored teeth (%)	Total	p-value
Age (yr)	< 18	44 (47.3)	49 (52.7)	93	0.269
	≥ 18	59 (55.2)	48 (44.8)	107	
Gender	Male	85 (51.2)	81 (48.8)	166	0.854
	Female	18 (53)	16 (47)	34	
Family type	Joint	74 (56)	59 (44)	133	0.099
	Nuclear	29 (43.3)	38 (56.7)	67	
Family size (number of members)	< 5	6 (66.7)	3 (33.3)	9	0.352
	≥ 5	97 (50.8)	94 (49.2)	191	
Subject's occupation	Government job	12 (52.2)	11 (47.8)	23	0.921
	Private job	24 (49)	25 (51)	49	
	None	67 (52.4)	61 (47.6)	128	
Subject's education	Illiterate	18 (62)	11 (38)	29	0.086
	≤ Metric	79 (49.6)	80 (50.4)	159	
	≥ Intermediate	6 (50)	6 (50)	12	
Family monthly income (Pakistani rupee)	< 12,000	13 (65)	7 (35)	20	0.021
	12,000–25,000	53 (42.7)	71 (57.3)	124	
	> 25,000	37 (66)	19 (34)	56	

Table 2. Comparison of the number of persons with normal and discolored teeth and the mean water fluoride levels in the four villages.

(50 persons were examined in each village, total number of persons examined in the 4 villages n=200 persons. Values for drinking water fluoride level, mg/L, are mean±SD, 20 water samples were collected from each of the four villages, total number of water samples n=80.)

Villages	Normal teeth (%)*	Discolored teeth (%)*	Fluoride level (mg F/L)
Totai	26 (52)	24 (48)	1.4±0.5[a]
Selaipaty	42 (84)	8 (16)	0.5±0.4[b]
Mena	21 (42)	29 (58)	1.0±0.8[ca]
Barh	14 (28)	36 (72)	1.8±0.6[d]
Total for the 4 villages	103	97	

[abcd]Comparing the mean fluoride content in the water samples from the four villages, by ANOVA-1, any groups not sharing a common lower case alphabet superscript differed significantly from each other at $p<0.05$; *% of persons in each village with normal or discolored teeth

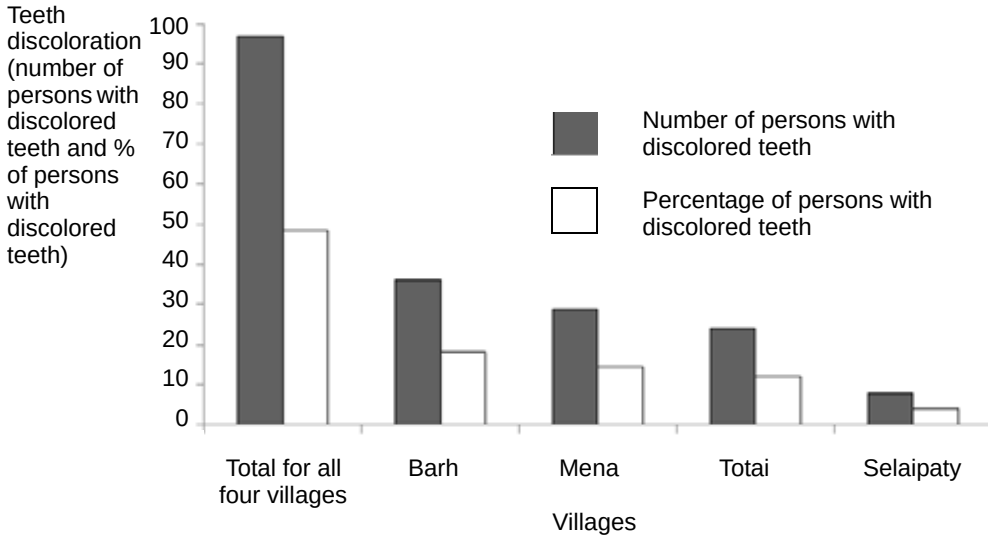

Figure. Number of persons with teeth discoloration and prevalence (%) of teeth discoloration in the villages of Barh, Mena, Totai, and Selaipaty in Malakand District, Pakistan.

Table 3. The health status of the subjects with teeth discoloration (n=97)

Variables		Frequency (%)	Total
Age of person at time of onset of teeth discoloration	< 10 years	86 (88.5)	97
	≥ 10 years	11 (11.5)	
Color of teeth	Yellow	85 (87.5)	97
	Brown	2 (2.2)	
	Black	6 (6.1)	
	White spotting	4 (4.2)	
Teeth defect	Internal	80 (82)	97
	External	17 (18)	
Type of teeth discoloration	Fluorosis	80 (82)	97
	Dental carries	1 (1)	
	Other/plaque	16 (17)	
Gums bleeding	Yes	29 (30)	97
	No	68 (70)	
Unpleasant taste	Yes	29 (30)	97
	No	68 (70)	
Missing teeth	Yes	16 (17)	97
	No	81 (83)	
Pain in jaws	Yes	29 (30)	97
	No	68 (70)	
Teeth ache	Yes	32 (33)	97
	No	65 (67)	
Sensitivity to heat/cold	Yes	37 (38)	97
	No	60 (62)	
Sensitivity to sweets	Yes	30 (31)	97
	No	67 (69)	
Visit to dentist	Yes	7 (7)	97
	No	90 (93)	
Medical problem	Yes	6 (6)	97
	No	91 (94)	
Kind of medical problem	Stomach	6 (6)	97
	None	91 (94)	
Use of medicine	Yes	1 (1)	97
	No	96 (99)	

No significant difference was found between subjects with normal teeth and those discolored teeth in the teeth brushing frequency, the teeth cleaning material, or the type of tooth paste used (Table 4). Tooth discoloration was commoner in those who smoked cigarettes and increased as the level of smoking increased ($p<0.05$).

Table 4. Oral hygiene practices of the subjects and teeth coloration (n =200)

Variables		Normal (n=103) Frequency (%)	Discolored (n=97) Frequency (%)	Total	p value
Brushing teeth	Yes	40 (39)	42 (43)	82	0.762
	No	63 (61)	55 (57)	118	
Frequency of brushing teeth per day	Once a day	30 (29)	26 (27)	56	0.538
	Occasionally	8 (8)	16 (16)	24	
	None	65 (63)	55 (57)	120	
Time of teeth brushing	In the morning	36 (35)	37 (38)	73	0.760
	After eating meals	2 (2)	5 (5)	7	
	None	65 (63)	55 (57)	120	
Gargling mouth	Yes	98 (95)	93 (96)	191	0.120
	No	5 (5)	4 (4)	9	
Last brushing of teeth	Today	21 (20)	11 (11)	32	0.122
	Yesterday	10 (10)	14 (14)	24	
	Day before yesterday	8 (7)	15 (16)	23	
	Never	64 (63)	57 (59)	121	
Teeth cleaning material	Miswak	17 (17)	13 (13)	30	0.079
	Brush and teeth past	39 (38)	39 (40)	78	
	With finger	17 (17)	27 (28)	44	
	Other	22 (21)	12 (13)	34	
Type of tooth paste	None	8 (7)	6 (6)	14	0.176
	Fluoridated	21 (20)	29 (30)	50	
	Non-fluoridated	16 (15)	13 (13)	29	
	None	66 (65)	55 (57)	121	
Duration of brushing teeth	>3 minutes	33 (32)	34 (35)	67	0.804
	Don't know	7 (7)	10 (10)	17	
	None	63 (61)	53 (55)	116	
Reasons for brushing teeth	For cleanness	39 (38)	42 (43)	81	0.908
	None	64 (62)	55 (57)	119	
Knowledge about the cause of teeth discoloration	Don't brush the teeth after eating food	37 (36)	37 (38)	74	0.587
	Don't know	66 (64)	60 (62)	126	
Smoking	Yes	10 (10)	25 (26)	35	0.018
	No	93 (90)	72 (74)	165	
Smoking per day	< 5 times	3 (3)	3 (3)	6	0.042
	> 5 times	7 (7)	22 (22)	29	
	None	93 (90)	72 (75)	165	

No significant differences were present between those with normal and discolored teeth in the mean 24 hr dietary intake of carbohydrates, protein, fats, and iron or in the mean daily energy in the food consumed (Table 5).

Table 5. Daily dietary intake and teeth coloration (Values are mean±SD, n=200)

Variables	Normal teeth	Discolored teeth	p value
Age (yr)	23±12	20±9	0.870
Carbohydrates (g/day)	307±91	307±69	0.974
Proteins (g/day)	78±20	77±17	0.771
Fats (g/day)	66±20	68±18	0.338
Energy (Kcal/day)	2138±582	2168±496	0.703

DISCUSSION

The current study is the first to explore the risk factors associated with teeth discoloration in various areas of Malakand District, Khyber Pukhtunkhwa, Pakistan. We found that teeth discoloration had it onset more often before the age of 10 yr (88.5%) than at 10 yr or later (11.5%). Younger children are more vulnerable to dental fluorosis because dental enamel formation is most active during childhood.[15] Teeth discoloration increases naturally with increasing age because of the incorporation of extrinsic stains and secondary dentin formation.[23-25] Because of cultural constraints, fewer females (n=34) than males (n=166) were interviewed in the present study, but no significant gender difference in teeth discoloration was found. Alkhatib et al. found teeth discoloration commoner in males than females[23] while Ghalayani and Alizadah found no significant gender difference in teeth discoloration in high school students.[26]

In the present study, more teeth discoloration was found in the middle income group (12,000–25,000 Pakistan rupees). Alkhatib et al. found that teeth discoloration was more prevalent in a low income group.[23] Income may affect the predisposing factors for teeth discoloration through an influence on life style, diet, and oral hygiene practices.[25] In contrast, Xiao et al. reported that income had no significant effect on teeth discoloration[24] and Shanthi et al. found that socioeconomic status had no significant effect on the prevalence of dental fluorosis.[27]

The number of subjects with discolored teeth increased with the increasing mean drinking water fluoride levels. The use of drinking water with fluoride levels greater than 1 ppm may result in dental fluorosis.[4] Teeth discoloration increases with higher drinking water fluoride levels.[15,28] In addition, the findings of the present study are consistent with the report of Szpunar and Burt who found that the prevalence of dental fluorosis increased with increases in the drinking water fluoride level ($p<0.01$).[29] However, within the drinking water fluoride range of

0.5–1.5 mg F/L, Rango et al. found no correlation between fluoride content and dental fluorosis.[19] The precise threshold level for fluoride to cause dental fluorosis has not been established.[30]

The significant difference ($p<0.05$) found in the habit and frequency of cigarette smoking between subjects with normal teeth color and those with discolored teeth indicates that smoking contributes to teeth discoloration. Smoking can cause tooth discoloration due to various components in cigarette smoke such as tar, a viscous, black residue capable of becoming impregnated in the teeth surface.[31] Alkhatib et al. found that smokers had moderate and severe levels of teeth discoloration when compared to non-smokers.[32] Xiao et al.[24] and Odioso et al.[33] also found that smoking had significant effect on teeth discoloration ($p<0.05$) while no association was found between oral hygiene measures and dental fluorosis.[27] All of the subjects, in the present study, had the same pattern of diet and, consequently, no significant difference was found in the mean intake of carbohydrates, protein, fats, energy, and iron between those with a normal teeth color and those with discolored teeth.

CONCLUSIONS

From the present study, we found that increased teeth discoloration was associated with drinking water fluoride levels above 0.5 mg F/L, cigarette smoking, and a middle level of family monthly income (12,500–25,000 Pakistan rupees) but not with any dietary differences. Poor oral hygiene practices were found in subjects with both normal and discolored teeth. It is recommended that the government should provide safe drinking water supply schemes, with proper maintenance, in all the high-fluoride drinking water areas to prevent the occurrence of dental and other forms of fluorosis.

REFERENCES

1 Jha SK, Mishra VK, Sharma DK. Fluoride in the environment and its metabolism in humans. Rev Environ Contam Toxicol 2011;211:121-42.
2 World Health Organization. Guidelines for drinking-water quality. 4th ed. Geneva: WHO; 2011.
3 Ullah R, Zafar MS. Oral and dental delivery of fluoride: a review. Fluoride 2015;48(3):195-204.
4 Khozeimeh F, Khademi H, Ghalayani P. The prevalence of etiological factors for teeth discoloration in female students in Isfahan High Schools. Dental Res J 2008;95:13-6.
5 Garcia-Lopez M, Martinez-Blanco M, Martinez-Mir I, Palop V. Amoxycillin-clavulanic acid–related teeth discoloration in children. Pediatrics 2001;108:819.
6 Ibiyemi O, Taiwo JO. Psychosocial aspect of anterior teeth discoloration among adolescents in IBGO-ORA, Southwestern Nigeria. Annals of Ibadan Postgraduate Medicine 2011;9:94-9.
7 Fawell J, Bailey K, Chilton J, Dahi E, Fewtrell L, Magara Y. Fluoride in drinking-water. London: IWA Publishing on behalf of the World Health Organization; 2006.
8 Fewtrell L, Smith S, Kay D. An attempt to estimate the global burden of disease due to fluoride in drinking water. J Water Health 2006;4:533-42.
9 Mohsin A, Hakeem S, Arain AH, Ali T, Mirza D. Frequency and severity of dental fluorosis among school children in Gadap town, Karachi. J Pak Oral Dental 2014;34:684-7.
10 Azevedo MS, Goettems ML, Torriani DD, Demarco FF. Factors associated with dental fluorosis in school children in southern Brazil: a cross-sectional study. Brazilian Oral Research 2014;28(1):1-7.
11 Sarvaiya BU, Bhayya D, Arora R, Mehta DN. Prevalence of dental fluorosis in relation with different fluoride levels in drinking water among school going children in Sarada tehsil of Udaipur district, Rajasthan. Journal of Indian Society of Pedontics and Preventive Dentistry 2012, 30(4):317-22.

12 Olsson B. Dental findings in high-fluoride areas in Ethiopia. Community Dent Oral Epidemiol 1978;7:51-6.
13 Ahmed A, Naseer H, Baloch M. Prevalence of fluorosis among children aged 12 years living in urban and peri urban areas of Quetta District, Balochistan, Medical Forum Monthly 2013;24(6):86-8.
14 Siddiq K, Dost S, Naseem A, Arshad A, Attaullah. Prevalence of dental fluorosis in Mianwali and Mardan. JCDSA 2011;1:106-9.
15 Kravchenko J, Rango T, Akushevich I, Atlaw B, McCornica PG, Merola RB, et al. The effect of non-fluoride factors on risk of dental fluorosis: evidence from rural populations of the Main Ethiopian Rift. Sci Total Environ 2014;488-489:595-606.
16 WHO. Fluoride in drinking-water: background document for development of WHO Guidelines for drinking-water quality. WHO/SDE/WSH/03.04.96, English only. Geneva: WHO; 2004. Available from: http://www.who.int/water_sanitation_health/dwq/chemicals/fluoride.pdf
17 Spittle B. A step in the right direction [editorial]. Fluoride 2015;48(2):91-2.
18 Susheela AK. A treatise on fluorosis. 3rd ed. Delhi: Fluorosis Research and Rural Development Foundation; 2007. pp. 15-6.
19 Rango T, Kravchenko J, Atlaw B, McCornico PG, Jeuland M, Merola B, et al. Ground water quality and its health impact: an assessment of dental fluorosis in rural inhabitants of the Main Ethopian Rift. Environment Int 2012;43:37-47.
20 Clesceri LS, Greenberg AE, Eaton AD, editors. Standard Methods for the Examination of Water and Wastewater. 20th ed. 1998. Method 4500 FD, 20th ed. American Public Health Association, Washington, DC: American Public Health Association, American Water Works Association, Water Environment Federation (APHA-AWWA-WEF); 1998.
21 Hussain T: Food composition tables for Pakistan. Peshawar Pakistan: Planning and Development Division, Ministry of Planning and Development, Department of Agricultural Chemistry and Human Nutrition, NWFP, Agricultural University, Peshawar Pakistan; 1985.
22 Statistical Package for Social Sciences (SPSS) Inc. SPSS for Windows. Version 16. Chicago: SPSS Inc.; 2007.
23 Alkhatib MN, Holt R, Bedi R. Prevalence of self-assessed teeth discoloration in the United Kingdom. J Dent 2004;32:561-6.
24 Xiao J, Zhou XD, Zhu WC, Zhang B, Li JY, Xu X. The prevalence of teeth discoloration and the self-satisfaction with teeth color in a Chinese urban population. J Oral Rehabilitation 2007;34:351-60.
25 Watts A, Addy M. Teeth discolouration and staining: a review of the literature. Br Dent J 2001;190: 309-16.
26 Ghalayani P, Alizadeh A. The prevalence and etiology of teeth discoloration among 14-18 year old Isfahan boy students (Iran) Dental School of Isfahan. Uni Med Sci 2001;15:15-20.
27 Shanthi M, Reddy BV, Venkataramana VV, Gowrisankar S, Reddy BVT, Chennupati S. Relationship between drinking water fluoride level, dental fluorosis, dental carries and associated risk factors in 9-12 years old school children of Nelakondapally Mandal of Khammam district, Andhrapardesh, India. J Inter Oral Health 2014;6:106-10.
28 Harrison PTC. Fluoride in water. J Fluorine Chem 2005;126:1448-56.
29 Szpunar SM, Burt BA. Dental carries, fluorosis and fluoride exposure in Michigan school children. J Dent Res 1988;67:802-6.
30 Sohn W, Noh H, Burt BA. Fluoride ingestion is related to fluoride consumption patterns. J Public Health Dent 2009;69:267-75.
31 Wasilewski Mde S, Takahushi MK, Kirsten GA, de Souza EM. Effect of cigarette smoke and whiskey on the color stability of dental composites. Am J Dent 2010:23:4-8.
32 Alkhatib MN, Holt RD, Bedi R. Smoking and teeth discoloration: findings from a national cross-sectional study. BMC Public Health; 2005;5:27.
33 Odioso LL, Gibb RD, Gerlach RW. Impact of demographic, behavioural, and dental care utilization parameters on teeth colour and personal satisfaction. Compend Contin Educ Dent Suppl. 2000;21:35-41.