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Impact of Water Filters and Consumption of Bottled Water on Fluoride Intake

(Kesan Penapisan Air dan Penggunaan Air yang Dibotolkan terhadap Pengambilan Fluorida)

B.S. TAN* & I.A. RAZAK

ABSTRACT

The objectives of this study were to assess the intake of fluoride among 4-5 year old children from drinking water (FH_20) and whether current practises of use of water filters and consumption of bottled water have any impact on fluoride intake. A questionnaire survey was conducted to elicit details of drinking water in 350 children aged 4-5 year old. The intake of fluoride from drinking water over a period of two days was biochemically determined in a subsample of 200 subjects. The majority of children (97.0%) had access to tap water, 23.1% to filtered tap water and 11.3% reported use of bottled water. The use of filters was found to be associated with ethnicity and socio-economic status ($p<0.00$)*. The mean fluoride concentration of unfiltered and filtered tap water were 0.541 ± 0.167 and 0.534 ± 0.192 ppm, respectively. The mean volume of water consumed was 1348.76 ± 482.70 mL/day while the mean FH_2O was 726.7 ± 357.5 ug/day. The use of filters and consumption of bottled water were sparse with no significant impact on FH_2O over a two-day study period.*

Keywords: Bottled water; fluoride intake; water filter

ABSTRAK

Tujuan kajian ini adalah untuk menilai pengambilan fluorida daripada air minuman (FH_2O) serta sama ada amalan penggunaan penapis air dan pengambilan air yang dibotolkan mempunyai kesan terhadap pengambilan fluorida. Satu tinjauan soal selidik telah dijalankan untuk mendapatkan butiran air minuman dalam kalangan 350 kanak-kanak berumur 4-5 tahun. Pengambilan fluorida daripada air minuman telah ditentukan secara biokimia selama dua hari dalam subsampel seramai 200 subjek. Majoriti kanak-kanak (97.0%) mempunyai akses kepada air paip, 23.1% kepada air paip yang ditapis dan 11.3% melaporkan penggunaan air yang dibotolkan. Penggunaan penapis air didapati mempunyai kaitan dengan status etnik dan sosio-ekonomi ($p< 0.00$)*. Kepekatan purata fluorida di dalam air paip tidak ditapis dan ditapis ialah 0.541 ± 0.167 dan 0.534 ± 0.192 ppm. Isi padu purata air yang diminum ialah 1348.76 ± 482.70 mL/hari manakala purata FH_2O yang diambil ialah 726.7 ± 357.5 ug/hari. Penggunaan penapis air dan pengambilan air yang dibotolkan jarang diamalkan dan tidak mempunyai kesan yang signifikan terhadap FH_2O sepanjang tempoh kajian selama dua hari.*

Kata kunci: Air yang dibotolkan; pengambilan fluorida; penapis air

INTRODUCTION

Fluoride is considered an essential trace element by the Committee on Dietary Allowances of the Food and Nutrition Board, National Research Council (National Research Council 1989) on the basis of its proven beneficial effects on dental caries. The sources of fluoride intake are the atmosphere, food, drinking water, beverages and fluoride containing dental and pharmaceutical products.

The inverse relationship between caries incidence and the concentration of fluoride that occurs naturally in water supplies, i.e. the anti-caries effect of fluoride is well known. The amount of fluoride ingested with water will be dependent on the fluoride content of the water and the amount of water consumed daily. It had been shown that drinking water can account for up to 50% of total fluoride intake during the period from birth to 12 years (Moller 1982).

It is fairly easy for fluoride content of water to be determined. Precise determination of the daily water intake is considerably more difficult (WHO 1970). Estimation of fluoride intake from drinking water is complicated by the use of water filters and bottled water. Filters of the osmosis (Jobson et al. 2000; Whitford 1994) and distillation (Jobson et al. 2000) types remove significant amounts of fluoride from water. The fluoride content of bottled water can have wide concentration ranges (Dabeka et al. 1992; Flaitz et al. 1989; Hargreaves & Chatha 1986; Nowak & Nowak 1989; Stannard et al. 1990). As most bottled water do not contain optimal levels of fluoride (ADA 2005; Whitford 1994), its consumption will reduce daily fluoride intake in fluoridated areas but not so much in non-fluoridated areas. Bottled water with fluoride concentrations higher than that available in tap water would increase the intake of fluoride (Whitford 1994). As about 60% of the total daily intake by 2-10 years old has been reported to be in the form of soft drinks, fruit juices or drinks (Pang et al. 1992), the impact of bottled water or drinks on optimal fluoride intake can be substantial.

The objectives of this study were to assess the intake of fluoride among 4-5 year old children from drinking water (FH_2O) and whether current practises of use of water filters and consumption of bottled water have any impact on fluoride intake.

MATERIALS AND METHODS

The study was conducted in Selangor, Malaysia. An analytical cross-sectional design was used. Self-administered questionnaire (QA) forms were given to the parents of 350 children, 4-5 year old to obtain socio demographic details of the subjects, oral hygiene practices as well as sources of drinking water at home. For determination of intake of fluoride, 200 children, 4-5 year old were subsampled and their parents were instructed to record their water consumption for the two-day study period. Samples of drinking water used by the subjects (tap water, filtered water and well water) were collected in 10 mL plastic screw capped tubes.

Fluoride content [F] in parts per million (ppm) and volumes (Vol) in millilitres (mL) were measured. Fluoride from drinking water (FH_2O) was calculated as follows:

$$FH_2O = \text{Vol Unfiltered} \times \text{Unfiltered [F]} + \text{Vol. Filtered} \times \text{Filtered [F]} + \text{Vol. School} \times \text{School [F]} + \text{Vol. Other} \times \text{Other[F]}.$$

All fluoride determinations were made with a direct read-out selective ion meter (EDT DR359) in conjunction with a fluoride ion electrode QSE333 from EDT Instruments. Plastic equipments were used. Double deionised water was used to prepare all solutions and samples, and for any rinsing and/or washing. Tisab (Part Number 30333) from EDT Instruments was added to dilute standards and samples before measurements. All samples were treated in the same way as the standards. The performance of the electrode was checked by first confirming that the mV/decade slope was within the theoretical value of 54-60 mV/decade. Recoveries were performed on the water specimens and values ranged from 88.2 to 105.6%. The mean was 95.4%.

QA survey data and laboratory data were analysed with the SPSSPC+ statistical package. Exploratory correlational analysis was conducted using the Bivariate correlation procedure with Pearson's coefficient. Categorical variables were cross-tabulated using the Chi Square test of association and Fisher Exact test when a cell contained an expected count of less than 5. The t-test and ANOVA were used to compare differences in means of variables between two and more groups, respectively. Paired t-test was used to compare differences between pipe and filtered water samples for subjects with water filters. The Levene's test was used to determine homogeneity of variances and the p values corresponding to the assumed equality or non-equality of the variances were then determined. Level of significance was set at $\alpha = 0.05$.

RESULTS

A total of 319 parents responded to the questionnaire survey. From the 200 subjects, 4-5 year old subsampled for biochemical determinations, 186 furnished records of their water consumption, 184 provided drinking water specimens for analysis of which 178 subjects provided both specimens and records.

A majority of the subjects had access to public water supply (96.9%). Of these, about a quarter (22.9%) filtered the tap water and 11.2% consumed bottled water. Well water was a source of water for 5.8% of respondents, whilst 0.9% reported use of river water for consumption.

The differences across ethnic groups and SES in their use of water filters were statistically significant ($p = 0.000$) as seen in Table 1. Use of filters however was highest among Chinese (53.2%) followed by Malays (14.7%) and

TABLE 1. Distribution of use of bottled water and water filters by social-economic status and race

SES*	I	II	III	Total responses	*p* value
Bottled water					
No	88.5%	90.7%	91.2%	89.6%	
Yes	11.5%	9.3%	8.8%	10.4%	0.89**
Water filter					
No	84.2%	74.1%	50%	76.7%	
Yes	15.8%	25.9%	50%	23.3%	0.00**
Ethnic group	Malay	Chinese	Indian+Others	Total responses	*p* value
Bottled water					
No	89.6%	89.4%	84.9%	88.8%	
Yes	9.4%	9.6%	5.1%	11.2%	0.99
Water filter					
No	79.6%	46.8%	92.6%	77.0%	
Yes	20.4%	53.2%	8.4%	23.0%	0.00

*SES- Socio-economic status. I to III=low to high
**Chi square for linear trend

those of Indian and other ethnic origin (7.7%). There was also higher proportion of use of filters in groups of higher socio economic status (SES). Use of bottled water showed no differences across racial and socio economic groups.

Results from analysis of drinking water specimens and water consumptions of the 4-5 year old subjects are tabulated in Table 2. The mean daily amount of fluoride derived from drinking water was 726.7 ± 357.5 µg (SEM = 26.8). Male subjects had higher fluoride intake from water (1514.49 ug) than females (1379.85 ug) but these differences were not of statistical significance ($p = 0.255$; Levene's test for homogeneity of variances $p<0.05$, assumption of non-homogeneity applied). Differences between racial groups were also not of statistical significance ($p = 0.14$) (Malay = 1396.54, Chinese = 1627.94, Indian = 1414.94, Others = 197.23 ug).

Table 3 shows the details of consumption recorded over the two-days study, including concentrations, volumes, fluoride exposures of the subjects who had no water filters ($n = 134$) and for those who had filters, the fluoride exposure in the hypothetical situation for them if the water consumed had not been filtered.

The mean volume of water consumed per 24 h was 1348.76 ± 482.7 mL and the mean F concentration of drinking waters were 0.531 ± 0.168 ppm (sem = 0.013). The mean F intake from consumption of water per 24 h was 726.69 ± 357.49 ug (sem = 26.8) with no significant differences between subjects drinking filtered (701.9±331.6 [sem = 28.7] and unfiltered drinking water (757.5±438.3 [sem = 66.1], $p = 0.4$).

Figures 1 and 2 show the plots of the fluoride concentration of the unfiltered pipe water and filtered pipe water of subjects who reported use of water filters at their homes (differences in fluoride concentration being shown by the lengths of the bars between each of the matched 'filtered and unfiltered' samples from each of the subjects with filters). Use of water filters had reduced the fluoride content of the water (unfiltered pipe water: 0.572 ppm vs 0.534 ppm after being filtered; paired mean difference = 0.038, $p = 0.087$) and the fluoride intake from drinking water but differences were not of statistical significance (813 ug/day if unfiltered pipe water had been consumed compared with 767.7 ug/day due to consumption of filtered water, paired t-test $p = 0.17$).

TABLE 2. F intake from drinking water

Parameter	n	Overall Mean	Median	SD	SEM
Tap - Unfiltered [F]	184	0.541	0.539	0.167	0.012
Volume (mL)	144	2588.3	2500.0	932.567	77.71
Tap - Filtered [F]	44	0.534	0.574	0.192	0.029
Volume (mL)	44	2776.02	2750.00	1165.20	175.66
School - [F]	182	0.593	0.549	0.211	0.0157
Volume (mL)	7	803.571	750.00	366.978	138.705
Other - [F]	11	0.526	0.576	0.164	0.0496
Volumes (mL)	2	625.00	625.00	530.33	375.00
Total 48 h volumes	186	2697.51	2750.0	965.40	70.79
Mean water [F]	178	0.531	0.537	0.168	0.013
F H_2O over 48 h	178	1431.28	1303.0	720.64	54.01
Volume / day		1348.76	1375.0	482.70	35.40
F H_2O /day		726.69	656.5	357.49	27.0

TABLE 3. Comparison of parameters resulting from use of water filters

Subjects	[F]ppm Pipe	[F] Filtered	Volume mL	F H_2O	Hypothetical F H_2O *
Overall, n=178	0.541	-	1348.76	726.7	-
No filters, n=134	0.531	-	1324.53	701.9	-
With Filters, n=44	0.572	0.534	1427.78	757.5	Pipe = 813.75 Filtered = 767.7
p values	0.154	-	0.215	0.444	0.173

*Hypothetical FH_2O; Pipe= if all drinking water is from unfiltered pipe water
Filtered= if all drinking water is filtered

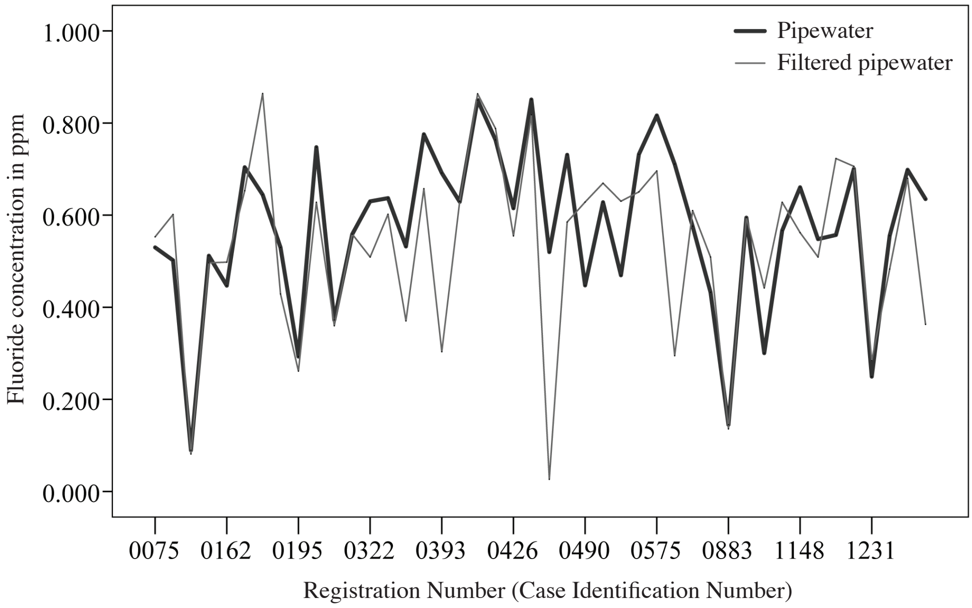

FIGURE 1. Fluoride concentrations of pipewater and filtered pipewater of subjects with water filters at their homes (n=44)

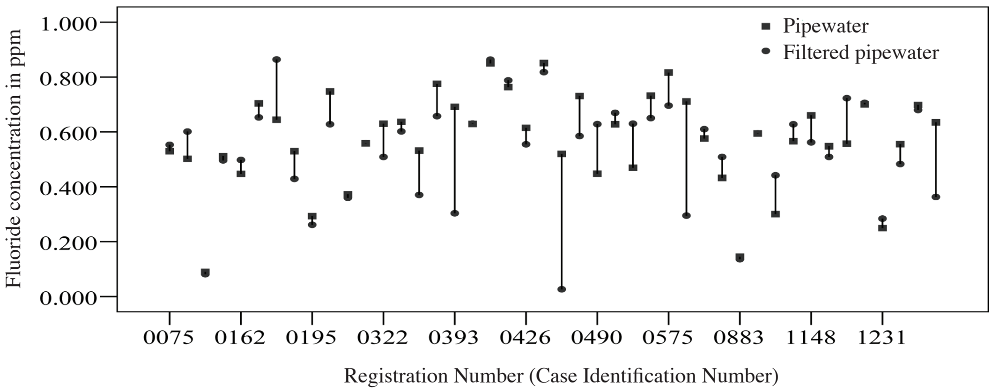

FIGURE 2. Differences in fluoride concentrations (indicated by lines) between pipe and filtered pipe water of subjects with water filters at their homes (n=44)

Discussion

Determination of the fluoride content of drinking water is straightforward but determination of water consumption is more complex and subsequently more problematic. This was not the only study that had utilised the drink diary technique. Numerous other workers had relied on records of water consumption over 2-3 day study (Clovis & Hargreaves 1988; Heintze et al. 1998; Pang et al. 1992; Rwenyonyi et al. 1999). It had been reported that 1-3 day record are sufficient for group means and that with 7-day records, validity declined by the 5th, 6th and 7th day (Gersovitz et al. 1978). Clovis and Hargreaves (1988) considered a 3-day record most valid. It was felt that the 2-day record utilised in this study was acceptable.

Cups of known capacities were provided to the children and it was explained how volumes were to be recorded to the nearest quarter cup (relatively simpler, compared with reading of exact volumes in some chosen units) to garner better compliance, before the actual study days. We had also conducted post-study-days interviews to confirm descriptions of intakes as recorded. These pre- and post-study-days interviews and use of common measure (the cup provided) have been reported to enhance the accuracy of recall (Clovis & Hargreaves 1988) even for children aged 5-14 years (Frank et al.1977).

Alternative to the drink diary mentioned above, many researchers (Guha-Chowdhury et al. 1996; Kimura et al. 2001; Rojas-Sanchez et al. 1999) have employed a duplicate technique similar to the duplicate diet technique where all water and beverages consumed were duplicated and the F content of the pooled fluids subsequently analysed. This method was however felt to be impractical and too cumbersome for this study.

The finding that almost all (96.9%) subjects reported drinking pipe water, 22.9% drank filtered pipe water and the infrequent use of alternative sources and bottled water was consistent with the fact that the study area was fully fluoridated with a community water supply that is well in place.

Fluoridation levels are targeted at the 'existing optimum' of 0.7 ppm. However, variations of fluoride levels in the reticulation systems have been documented (Awang et al. 1984; Larsen et al. 1989; Williams & Zwemer 1990) and are attributed to reasons such as the mixing of water from different reticulation systems whose sources had different fluoride content (Awang et al. 1984), seasonal variations (Larsen et al. 1989; Nanda & Zipkin 1974; Williams & Zwemer 1990) and a lack of control system, personnel and money (Heintze et al. 1998). Inconsistencies of fluoride levels of water samples could also occur due to complexing with other ions and subsequent decomplexing liberating F ions during determination or evaporation of water samples resulting in higher [F] obtained. It is however, not known for certain, if and to what extent day-to-day variations occurred and if these had confounded our measurements of fluoride.

There are many types and brands of filters available. It has been documented that only the reverse osmosis (Whitford 1994) and the distillation types (ADA 2003) remove significant amounts of fluoride. The effect of the filter on fluoride content of the water depends on the type, quality, status and age of the filter (ADA 2003).

Pang et al. (1992) in North Carolina reported the total liquid consumption was contributed 36-40% by milk and water and 60% by common beverages and 1.0-1.5% by less common beverages. Consumption of beverages increased fluoride intake in non-fluoridated communities particularly if manufactured in a fluoridated area. In a mainly fluoridated country such as Malaysia and with industries mainly in fluoridated areas, the consumption of beverages will not have that pronounced effect. Moreover, the consumption of processed beverages is quite minimal with only about 11% respondents reporting having drunk processed beverages; but very rarely as shown by the drinking record over the two study days.

Table 4 shows the findings on F exposures from drinking water of several studies. Daily water consumption was consistent with those of Clovis and Hargreaves (1988) and Pang et al. (1992). The fluoride intake from drinking water in this study were however higher than that of North Carolina (Pang et al. 1992) and Camrose (Clovis & Hargreaves 1988) probably due to differences in fluoridation status.

Fluoride intake derived from drinking water in this study was higher than in most other studies except the maximum seen in the fluoridated area of Canada, Wetaskiwin (Clovis & Hargreaves 1988) in which the fluoride level is higher.

Several studies on fluoride intake determined simultaneously intake from food and water (Burt 1992; Guha-Chowdhury et al. 1996; Haftenberger et al. 2001; Kimura et al. 2001). Comparisons with these are difficult as intakes from food and water were not reported separately.

The optimal range of fluoride intake, estimated by Burt (1992) was 0.05-0.07 mg/kg bw/day. The threshold limit of intake above which there is observable adverse effect of fluorosis is 0.1 mg/kg bw (Burt 1992). The average weight of 4-5 year old children is 16-18 kg (Fluoride Action Network 2005). Taking the average weight of 4-5 year olds, the mean fluoride intake per kg bw of subjects was

TABLE 4. Fluoride intake from drinking water- various studies

Study, location, *n*, age	F level, ppm	Vol (mL/24 h)	F H_2O (ug/24 h)
Clovis & Hargreaves 1988; Canada; Grade 6;			
Wetaskiwin; *n*=94	1.08	1189.33 ± 351.3	400-2450
Camrose; *n*=119	0.23	1223.33 ± 392.67	20-820
Rojas-Sanchez et al. 1999; *n* = 54, 16-40 months			
San Juan, Puerto Rico; *n* = 11	non-F	-	103 ± 22*
Connersville, Indiana; *n* = 14	non-F	-	257 ± 59*
Indianapolis, Indiana; *n* = 29	optimal	-	396 ± 52*
Villa et al. 2000; Chile; *n* = 20; 3-5	0.5-0.6	-	415 ± 60
Pang et al. 1992; North Carolina; *n* = 79; 2-10 yrs		1048 ± 372.7	540 ± 520
This study; *n* = 178; 4-5 yrs	0.7	1348.8 ±35.4	726.7 ± 26.8
Haftenberger et al. 2001; *n* = 11; 3-6 years	0.25	-	167.3 ± 148.2

* SEM instead of SD given; **based on estimates

0.02-0.06 mgF/kg bw. Fluoride intake from drinking water in this study is thus on average lower than the threshold limit for fluorosis according to Burt (1992) and did not pose risk of fluorosis.

CONCLUSION

Only a low proportion of total drinking water was in the form of bottled water as usage during the two study days were sparse. For subjects who had water filters at home (n = 44), the use of filters had reduced the fluoride content of the water, (paired mean difference = 0.038, $p = 0.087$) as well as fluoride consumption from drinking water (paired t-test; $p = 0.173$). Overall, the use of water filters had no significant effect on fluoride intake from drinking water over a two-day study period. However, some water filters could reduce the F content of the water drastically and these individuals could be losing the decay preventive effects of optimally fluoridated water.

Thus, the long term impact of the use of filters on fluoride exposures, caries prevention and fluorosis should be the subject of future research to verify the preliminary information provided by this study on the lack of impact of consuming bottled water and use of filters over a 2-day study period.

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REFERENCES

ADA. 2005. Fluoridation Facts. http://www.ada.org/sections/professionalResources/pdfs/fluoridation_facts.pdf. Accessed 4th July 2012.

Awang, A.R., Razak, I.A. & Jalalludin, R.L.R. 1984. Variations in fluoride levels within the reticulation system. *Dent. J. Malaysia*. 7: 53-56.

Burt, B.A. 1992. The changing patterns of systematic fluoride intake. *J. Dent. Res*. 71(5): 1228-1237.

Clovis, J. & Hargreaves, J.A. 1988. Fluoride intake from beverage consumption. *Community Dent. Oral Epidemiol* 16: 11-15.

Dabeka, R.W., Conacher, H.B.S., Salminen, J., Nixon, G.R., Riedel, G., Crocker, R. & Duke, G. 1992. Survey of bottled drinking water sold in Canada. Part 1. Lead, cadmium, arsenic, aluminium, and fluoride. *J. AOAC Int*. 75: 949-953.

Flaitz, C.M., Hill, E.M. & Hicks, M.J. 1989. A survey of bottled water usage by patients; Implications for dental health. *Quintessence Int*. 20: 847-852.

Fluoride Action Network. 2005. *Why Is There a Poison Warning on Toothpaste?* Available from http://www. fluoride alert.org./toothpaste.html. Accessed 31st December 2011.

Frank, G.C., Berenson, G.S., Schilling, P.E. & Moore, M.C. 1977. Adopting the 24-hour recall for epidemiological studies of schoolchildren *J. Am. Dietetic Association*. 71(1): 26-31.

Gersovitz, M., Madden, J.P. & Smiciklas-Wright, H. 1978. Validity of the 24-hr dietary recall and seven-day record for group comparisons. *J. Am. Dietetic Assoc*. 73(1): 48-55.

Guha-Chowdhury, N., Drummond, B.K. & Smilie. 1996. Total fluoride intake in children aged 3 to 4 years: A longitudinal study. *J. Dent. Res*. 75(7): 1451-1457.

Haftenberger, M., Viergutz, G., Neumeister, V. & Hetzer, G. 2001. Total fluoride intake and urinary excretion in German children aged 3-6 years. *Caries Res*. 35: 451-457.

Hargreaves, J.A. & Chatha, K. 1986. Fluoride level of mineral water available for consumption in western Canada. *J. Dent. Res*. 65: 531-535.

Heintze, S.D., Bastos, J.R.M. & Bastos, R. 1998. Urinary fluoride levels and prevalence of dental fluorosis in three Brazillian cities with different fluoride concentrations in the drinking water. *Community Dent. Oral Epidemiol* 26: 316-323.

Jobson, M.D., Grimm, S.E., Banks, K. & Henley, G. 2000. The effects of water filtration systems on fluoride: Washington, D.C. metropolitan area. *ASDC J. Dent. Child*. 67(5): 302-304.

Kimura, T., Morita, M., Kinoshita, T., Tsuneishi, M., Akagi, T., Yanashita, F. & Watanabe, T. 2001. Fluoride intake from food and drink in Japanese children aged 1-6 years. *Caries Res*. 35: 47-49.

Larsen, M.J., Fejerskov, O., Bojen, O. & Senderowitz, F. 1989. Fluctuation of fluoride concentrations in drinking waters: A collaborative study. *Int. Dent. J*. 39: 140-146.

Moller, I.J. 1982. Fluoride and dental fluorosis. *Int. Dent. J*. 32: 135-147.

Nanda, R.S. & Zipkin, I. 1974. Factors affecting the prevalence of dental fluorosis in Lucknow India. *Archs. Oral Biol*. 19: 781-792.

National Research Council. 1989. *Trace Elements. Recommended Dietary Allowances: 10th Ed*. Washington, D.C.: The National Academies Press.

Nowak, A. & Nowak, M.W. 1989. Fluoride concentration of bottled and processed waters. *Iowa Dent. J*. 7(4): 28.

Pang, D.T.Y., Phillips, C.L. & Bawden, J.W. 1992. Fluoride intake from beverage consumption in a sample of north Carolina children. *J. Dent. Res*. 71(7): 1382-1388.

Rojas-Sanchez, F., Kelly, S.A., Drake, K.M., Eckert, G.J., Stookey, G.K. & Dunipace, A.J. 1999. Fluoride intake from foods, beverages and dentifrices by young children in communities with negligibly and optimally fluoridated water: A pilot study. *Community Dent. Oral Epidemiol*. 27: 288-297.

Rwenyonyi, C., Bjorvatn, K., Birkeland, J. & Haugejorden, O. 1999. Altitude as a risk indicator of dental fluorosis in children residing in areas with 0.5 and 2.5 mg fluoride per litre in drinking water. *Caries Res*. 33(4): 267-274.

Stannard, J., Rovero, J., Tsamtsouris, A. & Garvis, V. 1990. Fluoride content of some bottled waters and recommendations for fluoride supplementation. *J. Pedodont*. 14(2): 103-107.

Villa, A.E., Anabalon, M. & Cabezes, L. 2000. The fractional urinary fluoride excretion in young children under stable fluoride intake conditions. *Community Dent. Oral Epidemiol*. 28: 344-355.

Whitford, G.M. 1994. Intake and metabolism of fluoride. *Adv. Dent. Res.* 8(1): 5-14.

WHO. Fluorides and human health. 1970. Geneva: *WHO Monograph series* No. 59.

Williams, J.E. & Zwemer, J.D. 1990. Community water fluoride levels, preschool dietary patterns and occurrence of fluoride enamel opacities. *J. Public Health Dent.* 50: 276-281.

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