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A CROSS-SECTIONAL STUDY ON FLUORIDE IN DRINKING WATER AND URINE AMONG SECONDARY SCHOOL CHILDREN IN WILAYAH PERSEKUTUAN PUTRAJAYA

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ABSTRACT

Objective: This study aimed at determining the level of fluoride in drinking water and urine among secondary school children in Putrajaya and its relationship between both variables.
Method: A cross-sectional study has been conducted for selected secondary school children. A set of questionnaire has been given to the respondents. Also, samples of drinking water used at home and samples of urine has been taken from the respondents.
Result: A total of 67 respondents involved in this study and all of the respondents were 14 years old. A total of 36 of the respondents were male (53.7%) and 31 were female (46.7%). Based on the samples obtained, the reading of fluoride in drinking water was 0.423 ± 0.114 mg/L. For level of fluoride in urine, the reading obtained was 1.626 ± 0.222 mg/L. From the findings, there was no significant difference in urinary fluoride between gender as the p-value obtained was larger than 0.05. When compared the level of fluoride in drinking water with the National Standard for Drinking Water Quality (NSDWQ), which was from 0.4 mg/L – 0.6 mg/L, 36 samples (53.73%) were in the optimal range of fluoride in drinking water which was between 0.4 – 0.6 mg/L. About 5 samples (7.46%) exceed the 0.6 mg/L while 26 samples (38.8%) were lower than 0.4 mg/L. When compared the level of fluoride in urine with the National Institute of Occupational Safety and Health (NIOSH) standard, which was from 0.2 mg/L – 3.2 mg/L, all samples were in the optimal range of fluoride in urine. Lastly, there was no significant relationship between level of fluoride in drinking water and urinary fluoride, as the p-value obtained was 0.796 ($p > 0.05$).
Conclusion: The level of fluoride in drinking water for area of Putrajaya Presint 14 was still in optimal range but the authorities should monitored it regularly because there were some readings that lower or higher than the standard. All of the urine samples were in the optimal range as recommended by NIOSH. Next, the level of fluoride in urine was not related to gender. Besides, this study proved that level of fluoride in drinking water did not contributed to the level of fluoride in urine.

Keywords: *Fluoride, Drinking Water, Urinary Fluoride, School Children*

1. Introduction

Fluoride is a common element in the earth's crust and is highly soluble in water. It is a simplest anion of fluorine. It can be found in water, soil, air and even in food (Hui et al., 2013). There are high content of fluoride in tea and kombucha. Based on the USDA National Fluoride Database of Selected Beverage and Foods, it proved that tea has 5-10 time more fluoride contents than a can of soda (Michaels, 2017). Teflon or non-stick cookware means that it has some type of fluoride-impregnated coating that gives the slipperiness or non-stick condition. When the food is cook with this type of cookware, it will increase the fluoride in the food. In a study published in the Journal of Dental Research, it will increase the fluoride by three times (Mercola, 2015). Last but not least, fluoride are

added into drinking water and public water supplies to prevent any tooth decay from happening. This is called water fluoridation. In the water treatment process, fluoride is added before water enters the large finished water storage before being sent to the community (Mcintosh, 2016)

After fluoride had been ingested, some of the fluoride will be excreted and some of it will be retain in the body. There are several ways of excretion of fluoride such as urine and faeces. About 75 to 90% of fluoride that has been absorbed through duodenum and stomach, the fluoride will be excrete through urine (Maha et al., 2015). The unabsorbed fluoride from the gastrointestinal tract will be eliminated through faeces. The maximum faecal elimination can go up until 10% of the ingested fluoride (Haftenberger et al., 2001).

Retention of fluoride in human body can be affected by several factors. The factors are the amount of fluoride that is being ingested and the activity of the calcifying tissues. In general, the higher the amount of fluoride ingested, the higher the amount of it will be retained in our body. This will comply the law of mass action (Rapp, 2013). A storage depot for calcium in our body is called a calcified structure such as bone and tooth. While growing, the fluoride ion will goes into the crystalline structure of the calcified structure and because of that, it will retain more fluoride in the body. This is called an act of calcification. About 36% of fluoride ingested will be absorbed into the skeleton for adult while for children, the degree of retention is much higher around 55% (Buzalaf & Whitford, 2011). This is due to richer blood supply and larger surface area of bone crystallites.

In Malaysia, the fluoridation of water was started in 1972 in order to reduce dental caries. At average, 75.7 percent of our country's population which is around 20.7 million receives fluoridated water (Scott, 2017). The fluoridation of water is the addition of fluoride into the public water supplies in order to reduce cavities. Fluoride is added into the public water supplies with an average concentration of 1 ppm (part per million) but groundwater may contain much higher levels of fluoride (Main, 2015). Fluoride will bind to the tooth enamel and will make it more resistant to acid attack mainly from the bacteria. If the cavities that deposited at the tooth is still not untreated, it will lead to tooth decay (Peckham & Awofeso, 2014).

Based on the National Standard for Drinking Water Quality (NSDWQ), the standard level of fluoride in drinking water in Malaysia is 0.4 – 0.6 mg/L (Engineering Services Division, Ministry of Health Malaysia, 2010). This is lower than the standard that had been released by World Health Organization (WHO) which is 1.5mg/L (Thakre et al., 2009).

There is a need to provide a baseline data of fluoride in drinking water and urine among school children in order to compare it to existing standards. This is to ensure school children were not subjected to unacceptable level of fluoride exposures that have been linked to deleterious health effects such as dental fluorosis (Shaharuddin et al., 2010).

2. Materials and Method

Students of SMK Putrajaya Presint 14 (1) were selected as the respondents of this study. The name list was obtained from the Student Affairs department of the school. There were several inclusive and exclusive criteria that needed to be followed in order to choose the respondents. The inclusive criteria were aged 14 years old (Form 2), live in the study area for at least 6 years, respondents used tap water as a source of drinking water and free from any kidney disease. The exclusive criteria were respondents used any water filter system at home and respondents that participated during this study are relocated to a new place.

There were 2 methods of data collection, which was by questionnaires and samples obtained from the respondents. There are 3 sections in the questionnaire, which were socio-demographic data, health status and types of water supply used. There were 2 samples taken from the respondents, drinking water and urine sample. Drinking water sample was taken from the tap water. The respondents were asked to collect the urine sample that had been excreted the first in the morning. The urine that collected from that time, will give the most accurate readings of the fluoride in it. Drinking water samples were collected using cleaned HDPE bottles and urine were collected using cleaned urine sample bottles for 3 consecutive days and were analyzed using the SPADNS method on a direct reading spectrophotometry HACH Brand model DR1900.

3. Results

This study involved 67 respondents and all of them were Form 2 students (14 years old). Out of this, 36 (53.7%) were male and 31 (46.7%) were female. The range and mean of fluoride in drinking water and

urine can be seen in Table 1. The analysis of fluoride between gender are presented in Table 2. The comparison of level of fluoride in drinking water with NSDWQ standards was shown in Table 3 and Table 4. Table 5 and 6 shows the comparison of level of fluoride in urine with NIOSH standards. Table 7 shows that association between level of fluoride in drinking water and urine.

Table 1: The range and mean of fluoride in drinking water and urine

	N = 67		
Parameters	**Range**	**Mean (mg/L)**	**SD (±)**
Fluoride in drinking water	0.15 – 0.71	0.4236	0.1146
Urinary fluoride	1.18 – 1.96	1.6267	0.2222

Table 2: Comparison of urinary fluoride between gender

Variables	**Mean (SD)**		**p-value**
	Male	**Female**	
Urinary Fluoride Level	1.6514 (0.22435)	1.5981 (0.21985)	0.331

Table 3: Comparison of level of fluoride in drinking water with NSDWQ standards (0.4 mg/L)

Variables	**Mean (SD)**	**p-value**
Fluoride in Drinking Water	0.4236 (0.1146)	0.097

** p is significant when <0.05*

Table 4: Comparison of level of fluoride in drinking water with NSDWQ standards (0.6 mg/L)

** p is significant when <0.05*

Variables	**Mean (SD)**	**p-value**
Fluoride in Drinking Water	0.4236 (0.1146)	<0.001

Table 5: Comparison of level of fluoride in urine with NIOSH standards (0.2 mg/L)

Variables	**Mean (SD)**	**p-value**
Fluoride in Urine	1.6267 (0.2222)	<0.001

** p is significant when <0.05*

Table 6: Comparison of level of fluoride in urine with NIOSH standards (3.2 mg/L)

Variables	**Mean (SD)**	**p-value**
Fluoride in Urine	1.6267 (0.2222)	<0.001

** p is significant when <0.05*

Table 7: The association between level of fluoride in drinking water and urine

	Urinary fluoride	
	Coefficient correlation, *r*	**p-value**
Level of Fluoride in Drinking Water	-0.032	0.796

** p is significant when <0.05*

4. Discussion

The general objective in this study was to determine the level of fluoride in drinking water and urinary fluoride among secondary school children. The mean obtained from the level of fluoride in drinking water was 0.423 mg/L with standard deviation of ±0.114 mg/L. The highest reading for fluoride in drinking water

was 0.71 mg/L while the lowest was 0.15 mg/L. This findings are the same with a study conducted in 2016. A systematic review had been conducted that analysed the prevalence of dental fluorosis and exposure to fluoride in drinking water. It concludes that the children age 6 – 18 years old, exposed to fluoride in drinking water that was less than 0.7 mg/L (Goodarzi et al., 2016). In another study conducted in Hormozgan, Iran, it showed that the mean concentration of fluoride in drinking water was 0.82 mg/L (Dindarloo et al., 2016). The researcher also concluded that it has been proved that drinking water can be considered as one of the source of fluoride for children.

Next, for the urinary fluoride, the mean obtained was 1.626 mg/L with standard deviation of ±0.222 mg/L. The highest reading obtained was 2.23 mg/L and the lowest was 1.18 mg/L. This findings are similar with a study that was conducted in India on 2016, the level of fluoride in urine that had been analysed was 0.86 mg/L (Kousik & Naba, 2016). About 80% of fluoride ingested will be excreted mainly through urine, whereas the remainder will be absorbed into body tissue. A study conducted in San Luis Potosi, Mexico that chose 180 school children as respondents. This study was about the association between urine fluoride and dental fluorosis. The researcher concluded that, the range of fluoride in urine was 1.1 to 5.9 mg/L, with a mean of 3.14 ± 1.09 mg/L (Lizet et al., 2015). The reasons why the fluoride levels in urine was quite high because of the community in that area received drinking water that had 4.13 mg/L of fluoride levels in it.

There was no significant difference between male and female urinary fluoride levels since the p-value obtained was larger than 0.05. The Thar Desert areas of Sindh province in Pakistan are one of the area that the groundwater contains fluoride that can go until 9.76 mg/L. The average values of urinary fluoride for residents in this places are higher from any other parts of the world. Still, there was no significant difference in fluoride levels of serum, urine and plasma between gender (Rafique et al., 2015). In another study conducted in Texas showed that there was no significant difference when compares between male and females. This study includes respondents from age 0 – 19 years old that lived in sub-optimal, optimal and above-optimal fluoridated area (Natalie et al., 2016).

When One Sample T-test was conducted using 0.4 mg/L as known value, the p-value obtained was 0.097 (>0.05), thus there was no significant difference between level of fluoride in drinking water with NSDWQ standard. When using 0.6 mg/L as known value, the p-value obtained was <0.001, thus there was a significant difference between level of fluoride in drinking water with NSDWQ standard. In a study conducted on 2013 in Selangor, Malaysia which showed that the fluoride levels in unfiltered tap water was 0.541 mg/L (Tan & Razak, 2013). This proved that the level of fluoride in drinking water at Selangor was in the optimal range. Another study conducted on 2010 in Malaysia shows that Seri Serdang has the highest mean fluoride levels, at 0.71 mg/L while Kota Kinabalu has the lowest mean fluoride levels, at 0.08 mg/L. The reason why Kota Kinabalu has the lowest mean of fluoride levels was because of the non-fluoridation of drinking water in Sabah (Shaharuddin et al., 2010).

Based on the data analysis, all the 67 samples had the optimal range of fluoride in urine which was between 0.2 – 3.2 mg/L. When comparing the level of fluoride in urine with NIOSH standard (0.2 mg/L), the p-value obtained was <0.001, thus there was a significant difference between level of fluoride in urine with NIOSH standard. Next, when 3.2 mg/L was used as known value, the p-value obtained was <0.001, thus there was a significant difference. This proved that the level of fluoride in urine among the respondents are still in the optimal range and none of them were in the alert state. Based on a study conducted in China on 2016, it showed that the mean fluoride levels in urine of children were 1.39 mg/L for village Warmiao and 1.30 mg/L for village Xinhuai. This is due to the higher concentration of fluoride in drinking water at village Warmiao than village Xinhuai (Xiang et al., 2016). In a study conducted in Mexico, the mean concentration of fluoride in urine for children was 0.82 mg/L. This study analysed regarding level of fluoride in urine with the cognitive functions. The researcher concluded that with higher level of fluoride exposure leads to lower scores on tests of cognitive functions (Morteza et al., 2017).

The statistical analysis used in this study was Pearson Correlation test. Since the p-value obtained was p=0.796 (p>0.05), there was no significant association between the level of fluoride in drinking water and urinary fluoride. . This finding is consistent with a study conducted at Iran. It studies about the fluoride concentration in drinking water and the prevalence of dental fluorosis. The results was, there was no significant association between concentration of fluoride in drinking water and urine. They concluded that there were other fluoride sources such as tea, foodstuff and toothpaste (Azami et al., 2013). Besides, a study conducted in China on 2015 showed that there was also no significant association between fluoride in urine and in drinking water. In this study, 51 children

that lived in Mianning County were being chosen as respondents. When comparing the level of fluoride in urine and water, there were not significant relationship. They also concluded that the children's urinary fluoride levels may also be affected by the amount of water that the children drank (Anna et al., 2015).

5. Conclusion

In conclusion, 53.73% of the respondents received treated water that contain fluoride that are within the permissible range 0.4 – 0.6 mg/L. For urinary fluoride levels, all the respondents are in the optimal range of 0.2 – 3.2 mg/L. The level of fluoride in urine was not related to gender. Lastly, there was no significant relationship between the level of fluoride in drinking water and urinary fluoride. There were other sources of fluoride such as fluoride dentifrice, mouth rinses, foodstuff and tea that were not taking into account in this study

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