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Kertas Asli/*Original Articles*

Knowledge and Perception of Fluoride in Drinking Water among Residents of Precinct 9, Putrajaya, Malaysia

(Pengetahuan dan Persepsi Fluorida dalam Air Minuman dalam Kalangan Penduduk Presint 9, Putrajaya, Malaysia)

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ABSTRACT

The knowledge and beliefs on the presence of fluoride in drinking water, its purpose and the associated health risks aids in equate water fluoridation and effective prevention programs. Water fluoridation is a safe, effective, and necessary method where adequate doses of fluoride is added into drinking water supplies with the target of assisting in tooth restoration and preventing tooth decay and dental caries. Therefore, this study identifies the level of knowledge and perception of fluoride in drinking water among residents living in Precinct 9, Putrajaya Methods: A cross-sectional, self-administered online questionnaire was used to examine knowledge and perception of fluoride in drinking water of 240 Precinct 9 residents. Descriptive analysis was applied for socio-demographic data and Chi-square was used to compare discrete data. All data obtained were further analyzed using SPSS Version 23.0. Results: The highest frequency (percentage) of residents were 213 (88.8%), aged 18-64 years old, 141 (58.8%) female, 214 (89.2%) with tertiary education background and 125 (51.1%) of them lived in Precinct 9 for more than 10 years. Of all participants, 137 (57.1%) and 83 (34.6%) have poor knowledge and medium perception regarding fluoride in drinking water respectively. There was a significant association between those with higher education level with knowledge (p=0.02) and perception (p=0.005) where they were more likely to know about overall fluoride in drinking water. Conclusion: Most participants had limited knowledge and negative perception of fluoride beyond a general sense it was beneficial. It appears that in moving forward to receive the water fluoridation support will need to attend to the challenge of anti-fluoride sentiment influence.

Keywords: Knowledge; perception; fluoride; drinking water; Putrajaya

ABSTRAK

Pengetahuan dan kepercayaan kepada kehadiran fluorida dalam air minuman, tujuan dan kesan berkaitan risiko kesihatan membantu dalam fluoridasi air secukupnya dan program pencegahan yang berkesan. Fluoridasi air adalah selamat, efektif dan merupakan kaedah yang penting di mana dos fluorida mencukupi ditambahkan ke dalam bekalan air minuman dengan bertujuan membantu pemulihan gigi dan pencegahan pereputan gigi serta karies gigi. Oleh itu, kajian ini mengenalpasti tahap pengetahuan dan persepsi terhadap kandungan fluorida dalam air minuman dalam kalangan penduduk yang menetap di Presint 9, Putrajaya. Kaedah: Suatu kajian keratan rentas dalam talian yang diisi secara sendiri telah digunakan untuk mengkaji tahap pengetahuan dan persepsi terhadap fluorida dalam air minuman dalam kalangan 240 orang penduduk di Presint 9, Putrajaya. Analisis secara diskriptif ini telah diaplikasikan bagi data sosio-demografik manakala 'Chi-square' digunakan untuk membandingkan data diskrit. Semua data yang diperolehi dianalisa secara lanjut menggunakan SPSS Versi 23.0. Keputusan: Frekuensi tertinggi (peratus) penduduk adalah seramai 213 (88.8%) yang berumur dari 18 hingga 64 tahun, 141 (58.8%) perempuan, 214 (89.2%) berlatar belakang pendidikan tinggi dan 125 (51.1%) daripada mereka tinggal di Presint 9, Putrajaya lebih daripada 10 tahun. Daripada jumlah peserta, 137 (57.1%) dan 83 (34.6%) mempunyai tahap pengetahuan yang rendah dan persepsi sederhana berkenaan fluorida dalam air minuman. Terdapat perkaitan yang signifikan di antara mereka yang mempunyai latar belakang pendidikan yang lebih tinggi dengan pengetahuan (p=0.02) dan persepsi (p=0.005) di mana mereka lebih mengetahui secara menyeluruh tentang fluorida dalam air minuman. Kesimpulan: Kebanyakan peserta mempunyai

tahap pengetahuan yang terhad dan persepsi negatif terhadap fluorida menandingi pemahaman umum tentang kebaikannya. Demi bergerak ke hadapan untuk menerima sokongan fluoridasi air, cabaran daripada pengaruh sentimen anti-fluorida perlu ditangani.

Kata kunci: Pengetahuan; persepsi; fluoride; air minuman; Putrajaya=

INTRODUCTION

Fluoride is an inorganic anion of fluorine found in the natural environment (Thippeswamy et al. 2021). Fluoride is highly present in granitic terrains causing adverse health effects over a long term consumption through water supply (Adimalla & Venkatayogi 2017). It is very common for fluoride to be found in drinking water (Aoun et al. 2018), an important dietary source in human daily life.

Globally, the majority of 200 million people living in developing countries are thought to be drinking water with fluoride levels exceeding the limit value that has been suggested by World Health Organization (WHO) guidelines at 1.5 mg/L (World Health Organization 2011). On the other hand, in Malaysia, the standard fluoride level in drinking water is set to be in the range of 0.4 - 0.6 mg/L which is in line with the National Standard for Drinking water Quality (NSDWQ) (Ministry of Health Malaysia, 2019).

It is widely known that fluoride possesses both beneficial and detrimental effects on the consumers' health through drinking water in-take and other sources (Kimambo et al. 2019). Water fluoridation is the most effective way to ensure the healthy dental health of the community (Goodarzi at al. 2016) and is useful in decontaminating water and preventing tooth decay (U.S. Centers for Disease Control and Prevention 2021) in both children and adults (American Dental Association Division of Government and Public Affairs 2017).

Fluoridation of community water supply is unreservedly endorsed by the American Dental Association (ADA) as a safe, effective, and essential method (U.S. Centers for Disease Control and Prevention, Water Fluoridation Basics 2019). Nevertheless, excessive fluoride consumption dominantly through fluoridated drinking water leads to different types of fluorosis. Fluorosis is a group of disease due to excess fluoride content in regular drinking water consumption (Kashyap, Sankannavar & Madhu 2021). Fluorosis affects teeth and bones (World Health Organization 2018). Fluorosis and fluoride consumption has a dose-response relationship; as fluoride intake increases, so does the prevalence and severity of fluorosis (Bhagavatula et al. 2017). The prevalence of dental fluorosis in the high-fluoride exposure group was significantly greater than in the normal-fluoride exposure group (Yu et al. 2018). Elevated exposure to fluoride over a long period may cause immense health problem, from losing teeth to debilitating pain (Ramadan & Ghandourb 2016).

Apart from that, fluoride intake in low doses is commonly linked with dental caries (TenCate & Buzalaf 2019). Fluoride exposure might also be neurotoxic to fetus development (Grandjean & Landrigan 2015). A study in Iran reported that <0.5 mg/L dose of fluoride impacts the human thyroid hormones activity (KheradPisheh et al. 2018). It has also been suggested in another study that a relationship exists between lower intelligence levels in children's and high levels of fluoride in water (Duan at al., 2018). Almost all studies originated from different countries, however, found a negative association between fluoride levels in the water and Intellectual Quotient (IQ) deficits or learning disorders (Till et al. 2020; Wang et al. 2020). There was a proportional variability of the mental output based on the varied fluoride level in the water being consumed upon comparing the IQ scores among the respondents living in low, medium and high fluoride area, (Razdan et al. 2017). However, this study also revealed that there were many multi-factorial variable on the IQ development apart from the consumption of high-fluoride source including the education of the parents, parental education or care, nutritional status and many others.

In Malaysia, there have been no studies done that relate socio-demographic characteristics among urban residents with knowledge and perception level regarding fluoride in drinking water. Therefore, studying the knowledge and perception on drinking water fluoridation and its association with socio-demographic is crucial for education program surveillance and preventive programs to avoid many questionable perceived health risks across age groups that might arise from fluoride exposure. This is to ensure a comprehensive understanding of the fluoride presence, its optimal concentration, advantages, and detrimental effects that greatly potentiate the use of fluoride by reducing the health risks.

MATERIALS AND METHODS

This study was approved by The University Ethics Committee involving Human Subjects of Universiti Putra Malaysia (Reff: JKEUPM-2021-739). This qualitative study employed a cross-sectional design. The research was

conducted in Precinct 9, Putrajaya. Baseline measures included a 21-item survey reproduced questions based on similar published literature on knowledge and perception towards the addition of fluoride into drinking water supplies. Based on the reliability analysis, the Cronbach's alpha value was 0.771 which falls on a good scale of internal consistency. This online questionnaire was adapted and modified according to the study setting from (Wilger et al. 2004; Quinonez & Locker 2009; Environmental Health Directorate 2012; Whyman, Mahoney & Borsting 2016; Sabti et al. 2019).

DATA COLLECTION

A pre-test questionnaire session was conducted among 10% of the sample size before data collection to ensure the effectiveness and identify any misinterpretations. Then, the data was collected by means of an online questionnaire to obtain information on socio-demographic characteristics, knowledge of fluoride in drinking water and perception of fluoride in drinking water.

DATA ANALYSIS

Statistical analysis was performed using Statistical Package for the Social Sciences version 23.0 (SPSS 23.0). Descriptive statistics was performed and data analysis was presented in the form of frequency distribution tables and percentages. Statistical test of Fischer Exact Test was applied to compare the socio-demographic characteristics and knowledge and perception level.

RESULTS AND DISCUSSION

This study was conducted among residents of Precinct 9, Putrajaya. A total of 240 participants completed the questionnaire, giving a response rate of 100%. The distribution of the study sample was summarized in Table 1. Of 240 participants, 213 (99.9%) were in the 18 to 64 age category, 141 (58.8%) were female, 214 (89.2%) were tertiary education graduates, and a total of 125 (52.1%) residents have lived in the study area for more than 10 years (Table 1).

TABLE 1. Characteristics of Participants

Socio-demographic Characteristics	Frequency, n (%)
Age group	
18-64 years old	213 (88.8)
Above 64 years old	27 (11.2)
Gender	
Male	99 (41.2)
Female	141 (58.8)
Educational level	
No formal education	2 (0.8)
Primary education	0 (0.0)
Secondary education	24 (10.0)
Tertiary education	214 (89.2)
Residential Duration	
Less than a year	29 (12.1)
1-5 years	34 (14.2)
5-10 years	52 (21.7)
More than 10 years	125 (52.1)

From 240 data collected, more than half of the respondents had poor knowledge level, amounting to 137 (57.1%) with 77 (32.1%) respondents had moderate knowledge level with only 26 (10.8%) had good knowledge level regarding fluoride and its purpose, benefits and risks following the addition into the public drinking water supply (Table 2).

In this study, the number of participants that were aged 18 to 64 years old, female, have finished tertiary education and lived in Precinct 9, Putrajaya for more than 10 years dominated the percentage in their respective sociodemographic characteristics. According to the Department of Statistics Malaysia, 22.7 million (69.6%) of Malaysians were categorized under 18 to 64 years old

with another 2.4 million (7.4%) of those more than 64 years old (Vanaja et al., 2016). Previous study highlighted that 85% of female residents dominated their survey participation with only 15% male which was not balanced in terms of the gender proportion (Department of Statistics Malaysia Official Portal 2021). However, a recent study found that there was no substantial improvement from the fresh graduates and batch of tertiary education regarding the knowledge on fluoride (Muralidharan, Pocha & Paul 2018).

TABLE 2. Knowledge of Fluoride in Drinking Water of Respondents Living in Precinct 9, Putrajaya

Knowledge Level	Frequency, n	Percentage (%)
Poor (<50%)	137	57.1
Moderate (51-75%)	77	31.2
Good (76-100%)	26	10.8

Based on Table 3, the proportion of having general knowledge on the presence of fluoride in drinking water were at 149 (62.1%) with only 104 (43.4%) participants who were aware of its purpose. As many as 127 (52.9%) and 140 (58.3%) participants knew that adverse health problems may arise from lack and excessive fluoride intake respectively.

The information on the public awareness level was extracted using a scoring system from a questionnaire survey filled by the Precinct 9, Putrajaya (Malaysia) residents. The scoring system results indicated that participants were generally not familiar with fluoride with a very low knowledge level on the overall fluoride presence and purpose through its addition into the drinking water. Consistently, the most recent community-based cross-sectional study among the community of Ethiopia reported a total of 348 (85.9%) of the interviewed household who had good knowledge (Almebo et al. 2021).

The former study identified that knowledge of fluoride use in preventing dental caries and preserve oral health was not high. This was possible because community knowledge of interventions related to oral health, including the addition of fluoride into drinking water, was a major public health objective (U.S. Department of Health and Human Services, 2020). Furthermore, the American Dental Association (ADA) and the National Institute of Health and Care Excellence (NICE) put a great emphasis on dental caries detection and prevention in any healthcare program as the most essential elements (American Dental Association Department of Scientific Information 2021).

The information on the knowledge regarding insufficient fluoride leading to tooth decay formation is higher than weakness in bone structure was most probably because the National Health and Medical Research Council has widely outlined the use of fluoride in the prevention of tooth decay by protecting against damage and helping with the repair (National Health and Medical Research Council of Australia 2017).

Next, taking excessive amounts of fluoride from unregulated or untested sources can lead to dental fluorosis (Nurul et al. 2017). In alignment, the present study revealed that more than 60% of participants acknowledged dental fluorosis as a health issue arising from excessive fluoride intake from fluoridated drinking water consumption.

TABLE 3. Knowledge Items

Knowledge items	Frequency, n (%)
Knowledge on understanding of fluoride	169 (70.4)
Knowledge on the presence of fluoride	194 (80.8)
Knowledge on fluoride addition into drinking water	149 (62.1)
Knowledge on purpose of fluoride addition into drinking water	104 (43.3)
1. Prevent dental caries	107 (44.6)
2. Preserve oral health	103 (42.9)
3. Strengthening bones	55 (22.9)
Source of information of the presence of fluoride in drinking water	
Print media	59 (24.6)
Electronic media	162 (67.5)
Educational institution	130 (54.2)
Friends	46 (19.2)
Others	7 (2.9)
Knowledge on the optimal level of fluoride addition in drinking water by the NSDWQ*	26 (10.8)

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Knowledge on staidness of lack of fluoride	127 (52.9)
1. Tooth decay	174 (72.5)
2. Weakness in bone structure	89 (37.1)
Knowledge on staidness of excessive of fluoride	140 (58.3)
1. Dental fluorosis	150 (62.5)
2. Skeletal fluorosis	108 (45.0)
3. Insulin secretion problem	58 (24.2)
4. Neural development problem	59 (24.6)
5. Thyroid gland problem	52 (21.7)

*National Standard for Drinking Water Quality

Despite multiple scientific research had been conducted to prove how effective fluoride was in preventing oral and skeletal-related diseases through its addition into the drinking water system, there were still, many antagonistic beliefs on water fluoridation.

There has been an increase in anti-fluoridators who opted for the removal of fluoride from their drinking water (Seymour et al. 2015). Fluoride Action Network (FAN) was among many groups actively going against the idea of adding fluoride into the drinking water (Fluoride Action Network 2021). In alignment with the previous study, in 2013, Florida county needed to reverse its decision to remove fluoridation entirely and fluoridate them again due to public opposition to fluoridation back in 2011 (Pinellas County Utilities 2017). In this study, a total of 162 (67.5%) participants obtained fluoride-related information mainly from electronic media. This was because, electronic media has become quick, cheap and easier to access for any information (Shearer & Mitchell 2021).

In the present group of participants, some information were received from educational institutions, printed media and friends. A total of 283 (37%) out of 761 participants had read about fluoridation from local newspapers, and a minority believed that their water supply had been fluoridated (Lowry, Brophy & Lennon 2021). On the other hand, people rely on salesperson from a department store regarding household water filters (Sarkar, Krishnapillai & Valcour 2012). Other sources of information the participants stated include dentists. Correspondingly, communities who did not visit the dentist could miss the important exposure about community water fluoridation (CWF) (Barker et al. 2016).

TABLE 4. Perception of Fluoride in Drinking Water of Respondents Living in Precinct 9, Putrajaya

Perception Level	Frequency, n	Percentage (%)
Very low (10-20%)	0	0.0
Low (21-35%)	70	29.2
Medium (61-85%)	83	34.6
High (61-85%)	69	28.8
Very high (86-100%)	18	7.5

The results tabulated in Table 4 shows that the highest frequency of the participants was categorized as having a medium perception level towards the fluoride in the drinking water at 83 (34.6%), followed by 70 (29.2%) and 69 (28.8%) participants who have low and high perception level respectively. Meanwhile, a minority of 18 (7.5%) participants were very highly perceived fluoride positively, with none participants having a very low perception level towards fluoride in drinking water.

This survey demonstrated that 50.4% of participants used tap water at home, which was slightly lower than a study among Pennsylvania community where 60% of the public consumed tap water (Leavy et al. 2012). Almost one-third (32.5%) of the participants from the former study consumed store-bought water bottled while only a minority (16.7%) used a filtration system. On the other hand, a previous study reported that 48% of the public living in Western Newfoundland, Canada used a water filter at home (Ochoo, Valcour & Sarkar 2017). These filtered water treated the municipal water using reverse osmosis, so any naturally occurring or added fluoride in the water was removed. The study participants' preferences were in line with a cross-sectional study at Hamad Medical Corporation (HMC) among parents where more than two-thirds of

parents chose bottled water as the best water choice for their children whereas 33% answered likely yes and yes with another 32% answered no and definitely no for the consumption of tap water as the drinking water source for their children (Hendaus et al. 2019).

TABLE 5. Perception Items

	Perception items	Frequency, n (%)
	The most common source of drinking water	
	1. Tap water	121 (50.4)
	2. Store bought bottled water	78 (32.5)
	3. Others (eg: water filter)	40 (16.7)
	Reason(s) of choice of drinking water source	
	1. The taste, smell and colour of the drinking water	143 (59.6)
	2. Save money and time	137 (57.1)
	3. Guarantee safety of the drinking water	168 (70.0)
	Perception on the safety of fluoride addition into drinking water	123 (40.1)
	Perception on the effectiveness of fluoride addition into drinking water	85 (27.7)
	Perception on the usefulness of fluoride addition in drinking water to prevent tooth decay	134 (43.6)
Agreement on the addition of fluoride in drinking water		123 (40.1)

Table 5 reported that half of the population in Precinct 9, n=121 (50.4%) commonly use tap water as their primary source of drinking water, followed by store-bought bottled water (78; 32.5%) and lastly, other sources of drinking water (40; 16.7%) including filtered water. Considering the perception on the choice of drinking water sources, "Guarantee safety of drinking water" was the most frequently cited reason by approximately 168 (70.0%) participants. Other reasons were "taste, smell and colour of the drinking water" (143; 59.6%) and "save money and time" (137; 57.1%).

Fluoridated drinking water was extremely safe in terms of acute fluoride toxicity it may provide (Cury et al. 2019). This study's finding was also concurrent with the most recent evidence suggesting the perception of safe fluoridated drinking water as the majority of respondents agreed that drinking safe and sufficient water can avoid waterborne diseases in the Tigray area of northern Ethiopia (Berhe et al. 2020). These findings were quite similar to the present findings, where respondents made choices of their drinking water supply as it guaranteed them safety from uneasy taste and appearance of drinking water.

Several participants explicitly said they preferred getting water supply from tap water due to the safety it provides. Boiled water increases the fluoride level through evaporation whereas filtered water has no effect of increasing or decreasing the fluoride level from the tap water. Nevertheless, the participants believed that either directly consuming the boiled tap water or the tap water itself, it contains no or low fluoride. From this study, the results of questions on perceptions regarding the use of fluoride and its safety highlighted as many as 123 (40.1%) of participants perceived the fluoride addition into drinking water as safe to be consumed. This corresponded well with a recent Canada-wide water attitude study showing that 90% of Canadians are very or somewhat confident about the safety and quality of the water in their homes (GlobeScan 2017).

Next, this study found that slightly more than half of the participants made choices for their drinking water source according to the taste, smell and colour of the drinking water itself. Likewise, the public perceived the quality of public drinking water in Newfoundland by physical properties such as colour, clarity, odour, taste, and smell rather than microbiological or chemical composition (Butt 2010). The study also established that when the public loses trust in water quality, they turned to bottled water, wayside springs, and at-home treatment methods. Nevertheless, water with a foul odour did not always meant it was harmful to drink, and clear water with a pleasant taste did not always meant it was safe (Napier & Kodner 2008). However, among Malaysians, other important parameters to ensure good water quality such as the concentration of fluoride in drinking water was more

emphasized than the physical properties of the drinking water such as the taste, smell and clarity (Bahari et al. 2018).

The present study also revealed that 137 (57.1%) participants preferred fluoride to be available through cheap and time-saving drinking water sources rather than other means. This study results were quite similar to a previous literature, which pointed out that there was a lack of understanding of fluorides' main mechanism of action, which could lead to inappropriate judgement on the effectiveness of its use in different age groups (Bansal et al. 2012). In contrast, during a 2010 referendum, there was an overturned of water fluoridation (Perrella & Kiss 2015). Their experiments showed that participants who knew about water fluoridation opposition by a national advocacy group had a lower perception level than those who are told that the government and WHO supported fluoridation.

TABLE 6. Association between Socio-demographic Characteristics with Knowledge of Fluoride in Drinking Water

Socio-demographic characteristics Poor (N = 137)		Knowledge level, N = 240 (%)			Expected count, x^2	p-value (p<0.05)
		Moderate (N = 77)	Good (N = 26)			
Age	18-64 years old	122 (89.1%)	70 (90.9%)	21 (80.77%)		0.341[a]
	Above 64 years old	15 (10.9%)	7 (5.1%)	5 (19.2%)		
Gender	Male	58 (42.3%)	31 (40.3%)	10 (38.5%)		0.926[a]
	Female	79 (57.7%)	46 (59.7%)	16 (61.5%)		
Educational level	Primary education	0 (0.0%)	0 (0.0%)	0 (0.0%)		0.002[a]
	Secondary education	22 (16.1%)	2 (2.6%)	0 (0.0%)		
	Tertiary education	114 (83.2%)	74 (96.1%)	26 (100%)		
	No formal education	1 (0.7%)	1 (1.3%)	0 (0.0%)		
Residential duration	Less than 1 year	16 (11.7%)	10 (13.0%)	3 (11.5%)		0.655[a]
	1-5 years	21 (15.3%)	7 (9.1%)	6 (23.1%)		
	6-10 years	30 (21.9%)	16 (20.8%)	6 (23.1%)		
	More than 10 years	70 (51.1%)	44 (57.1%)	11 (42.3%)		

a = Fischer Exact Test, **p-value is significant at p<0.05**

Based on Table 6, p-value = 0.02 (p<0.05) obtained from Fischer Exact Test showed a significant difference between respondents' educational level and knowledge level. However, age, gender and duration of residency were not significantly associated with the knowledge level of fluoride in drinking water among residents of Precinct 9, Putrajaya.

Nearly half (114; 83.2%) of tertiary education graduates were categorized as having poor knowledge levels on fluoride in drinking water as compared to 22 (16.1%) secondary education graduates and 1 (0.7%) with no formal education. 74 (96.1%) of the tertiary education graduates had moderate knowledge level, followed by 2 (2.6%) secondary education graduates and 1 (1.3%) respondents who did not received any formal education. There were 26 participants with good knowledge level who entirely graduated from tertiary education with no representative from graduates of other educational levels (Table 6).

In this study, there was a significant association between the educational status with the knowledge level.. Findings from this study also indicated that, there was no statistically significant association between the other categories of each socio-demographic characteristic (age, gender and residential duration) with knowledge level of residents of Precinct 9, Putrajaya.

A query was set up to investigate which of the participants' educational level, given high knowledge as evidence, know well about overall fluoride. Of the surveyed residents, 100% of tertiary education graduates fall under the good knowledge category with 96.1% and 83.2% of them fall under moderate and poor knowledge levels respectively (p=0.002). Fathers (84%) and mothers (88%) with a higher education level were aware of the advantages,

and 37% were in favour of fluoride consumption through drinking water (Blumer et al. 2018).). Furthermore, there was a need for early intervention to increase awareness among children about oral health and mandate educated parents' involvement throughout the prevention process (Alkhtib & Morawala, 2018; Mamat 2018).

TABLE 7. Association between Socio-demographic Characteristics with Perception of Fluoride in Drinking Water

Socio-demographic characteristics Very low		Perception level (%) N = 240					Expected count, x^2	p-value ($p<0.05$)
		Low	Medium	High	Very high			
Age	18-64 years old	0 (0.0%)	67 (95.7%)	71 (85.5%)	59 (85.5%)	16 (88.9%)		0.122[a]
	Above 64 years old	0 (0.0%)	3 (4.3%)	12 (14.5%)	10 (14.5%)	2 (11.1%)		
Gender	Male	0 (0.0%)	30 (42.9%)	37 (44.6%)	27 (39.1%)	5 (27.8%)		0.605[a]
	Female	0 (0.0%)	40 (57.1%)	46 (55.4%)	42 (60.9%)	13 (72.2%)		
Educatio-nal level	No formal education	0 (0.0%)	1 (1.4%)	0 (0.0%)	1 (1.4%)	0 (0.0%)		0.005[a]
	Primary education	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
	Secondary education	0 (0.0%)	15 (21.4%)	6 (7.3%)	3 (4.3%)	0 (0.0%)		
	Tertiary education	0 (0.0%)	54 (77.1%)	77 (92.8%)	65 (94.2%)	18 (100.0%)		
Residen-tial duration	Less than 1 year	0 (0.0%)	6 (8.6%)	11 (13.3%)	9 (13.0%)	3 (16.7%)		0.893[a]
	1-5 years	0 (0.0%)	12 (17.1%)	10 (12.0%)	10 (14.5%)	2 (11.1%)		
	6-10 years	0 (0.0%)	18 (25.7%)	19 (22.9%)	11 (15.9%)	4 (22.2%)		
	More than 10 years	0 (0.0%)	34 (48.6%)	43 (51.8%)	39 (56.5%)	9 (50%)		

a = Fischer Exact Test, p-value is significant at $p<0.05$

Based on Table 7, the p-value is 0.005 ($p<0.05$) indicating that there was a significant association between the socio-demographic background, specifically the educational level with the perception level among respondents. However, there was no significant association between each level of socio-demographic characteristics and knowledge level of fluoride in drinking water. For low perception level, 54 (77.1%) tertiary education graduates were the highest category. Meanwhile, the medium perception level was the highest among 77 (92.8%) tertiary education graduates. Based on the tabulated data on the high perception level, those who graduated at tertiary education level also have the highest total of participants with 65 (94.2%). Only the participants from tertiary education level have scored a very high perception level at 18 (100.0%) with none (0.0%) from other educational levels.

The present study found a significant association between the educational status with the perception level towards fluoride and its addition into the drinking water among residents of Precinct 9, Putrajaya. Overall, the majority of the tertiary education graduates who participated in the study perceived that it was appropriate to add fluoride into drinking water ($p=0.005$, Fischer Exact Test). Similar findings were also reported in a previous study, where college graduates (67.9%) had higher odds of perceiving community water fluoridation (CWF) as safe (Mork & Griffin 2015). This discovery was also concordance with a previous study among higher educated respondents who perceived their water supplies as satisfying (completely satisfied/very satisfied) (Ochoo, Valcour & Sarkar 2017). Other independent variables aside from educational level showed no association with both knowledge and perception level most probably because the respondents may not be aware enough of the fluoride addition into the public's drinking water system, which made them unable to clarify their opinions regarding this subject through this research.

This study presents several limitations. First, this study is limited by its small sample with a single urban location. It may not be representative since its focus is on urban residents, just one region in the Putrajaya compared with the general population of Putrajaya. Second, there is a lack of detailed questions as we had little scope to explore the possible reasonings for each answers chosen. Therefore,

further studies are required to diversify the socio-demographic background towards the public awareness and satisfaction level towards fluoride in their water supply. Another limitation was that this study does not include public knowledge baseline of fluoride from multiple sources. It only focuses on the awareness and beliefs regarding the presence of fluoride in the drinking water. The participants might misinterpret the possible effects from lack or excessive intake of fluoride from other sources, such as food and dental products.

For the next similar study, caution must be taken when making generalizations especially to other urban populations, other socio-demographic strata, or different geographic regions of fluoridated drinking water to ensure that the study are reasonably representative. In this study, no other groups of primary education graduates were found eligible to become respondents. We only obtained responses from few individuals with no formal education and many with a secondary and tertiary education background.

Therefore, having a balanced number of participation from individuals with different educational statuses in the study would yield the most accurate level of knowledge and perception towards fluoride in drinking water. In the long run, to improve both public knowledge related to fluoride in drinking water and perception towards its addition into the drinking water supply among the general public, various relevant agencies should draw attention to implement awareness programmes at the grassroots level.

CONCLUSION

Education plays a huge role in knowledge enhancement and perception. Despite the participants being in favour of water fluoridation and believing in its safety, certain barriers were apparent such as knowledge deficiencies on the purpose, benefits and risks of fluoride addition into drinking water and lack of positive perception in its safety and effectiveness. Therefore, the provincial government, local authorities and municipalities should disseminate a comprehensive information on water fluoridation to citizens across the regions through many kind of approaches. Lastly, further in-depth study required to assess the knowledge and perception on the benefits and risks of the presence of multiple sources of fluoride aside from fluoride level in drinking water.

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