

Factors Associated with Preferences for Safe Drinking Water among Outpatients at Hospital Universiti Sains Malaysia (HUSM), Kelantan, Malaysia

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ABSTRACT: Food and water borne diseases are resulted from consuming unsafe drinking water. However, a few states in Malaysia including Kelantan were reported to have low accessibility to treated water. The aim of this study was to assess the preference for safe drinking water and its associated factors among Hospital Universiti Sains Malaysia (HUSM) outpatient clinic attendees. A cross-sectional study was conducted from 1st February 2011 to 30th April 2011. A convenient sampling was applied and face to face interview was conducted by using a structured questionnaire. Those 18 years and above and literate were included as subjects. Results show that the proportion towards safe drinking water preferences was 30.4% (95% CI: 0.22, 0.39). Two significant associated factors for safe drinking water preferences were current used of drinking water source and household income status. People who currently used municipal water has 14.32 times odds to prefer safe drinking water than person who used other sources (95% CI: 4.08, 50.30, $p < 0.001$). Those at low and middle income level were 0.23 (95% CI: 0.06, 0.84, $p = 0.027$) and 0.11 (95% CI: 0.03, 0.47, $p = 0.003$) times odds to prefer safe drinking water than those below poverty line consecutively. In conclusion, the proportion of safe drinking water preference among HUSM outpatient clinic attendees was low and associated with current drinking water source and income level. An effective public awareness campaign is needed to convince public toward municipal water supply in order to help reducing the incidence of food and water borne diseases.

Keywords: Associated factors, drinking water preferences, safe drinking water

Introduction

Annually, 4.6 million children die from water-borne diseases caused by the lack of safe drinking water source and 90% of them are the children under-five from developing countries. Moreover, the annual four billion cases of diarrhea are responsible for 5.7% of the global burden of diseases (Barzilay *et al.*, 1999; Clasen, 2010; UN, 2005; WHO, 2002). According to World Health Organization (WHO), improved water sources include household pipe connection located inside the user's dwelling, public taps or standpipes, tube wells or borehole, protected dug wells, and protected springs or rain water collections. On the other hand, unimproved water sources refer to the unprotected dug wells, unprotected spring, cart with small tank/drum, surface water (river, dam, lake, pond, stream, canal, irrigation channels), and bottled water (WHO, 2008).

The main drinking water associated health risk is related to the microbiological aspects arise from fecal contamination that contaminates surface and ground water especially the poorly covered dug well or open well (WHO, 1997). Therefore, public drinking water supply

requires a careful evaluation, adequate and reliable treatment process at the treatment plant as well as adequate monitoring of water quality (Dufour *et al.*, 2003). However, sometimes consumers queried their municipal water in terms of aesthetics or safety (Mackey, 2004). It is the key factor by which public determines perception of quality, service satisfaction, selection of water sources and willingness to pay (Andria *et al.*, 2006; Doria, 2010; Jardine *et al.*, 1999). For these reasons, the consumption of bottled water is growing annually by 7-10% and Asia is potentially a large market for bottled water (Aini *et al.*, 2007 and Doria., 2010).

Malaysia is abundant with water resources especially from river. About 93% of the populations are supplied with municipal drinking water (urban areas 97%, rural areas 86%) (MWA, 200; Lee, 2005). Nevertheless, Malaysian Water Association reported that there were low accessibility to treated and piped water in state of Sabah, Terengganu, Kelantan and Kedah (MWA, 2004). In Kelantan, drinking water supply is privatized since 1996 and under the responsibility of Air Kelantan Sdn. Bhd. (AKSB). The main water source is from ground water. The coverage of municipal water supply in Kelantan is 50.3% compared to more than 90% for national coverage. Moreover, the use of dug wells in this state was 34.5% compared to 3.25% shown in national figure (MWA, 2004; Lee, 2005).

Malaysian consumes many types of drinking water. A survey conducted by Department of Statistics in 2005 indicated out that boiled and unfiltered tap water was consumed by 52.3% of population, filtered and boiled water was 25.6%, and bottled water was 6.2%. Malaysian household spent an average of RM16.97 per month for drinking water in which for urban communities spent RM14.30 while rural communities spent RM19.27. The average monthly water charges made up to 1.04% of the average monthly household expenses in Malaysia compared to 0.71% of that in European countries (Lee, 2005).

In view of the high proportion of Malaysian communities consumed water from untreated water sources, it is necessary to assess the community preference toward safe drinking water and factors associated with it, and to help the responsible authorities to determine the gap in practice and enable to launch effective programs to reduce the health risk related to consumption from unsafe drinking water. Our finding may also stimulate further studies such as those that are related to chemical contamination, microbiological parameters and health effects among tap water, bottled water and home purifying systems.

Materials and Methods

This cross-sectional study was conducted at Outpatient Clinic of HUSM, Kota Bharu, Kelantan, Malaysia from 1st February 2011 to 30th April 2011. Subjects were recruited by using a convenient sampling. Several inclusion criteria were used i.e: subjects were adult 18 years and above, literate and able to choose drinking water source at their home independently. Subjects were excluded if they have mental disorder and if their family member had been already recruited as participant. A total of 115 subjects were included in this study.

A structured questionnaires form was used. The instrument comprised of five sections. Section one was about personal information. Section two was on current drinking water source and preferences. Section three was pertaining to perception on quality and safe drinking water source. Section four was on the measures taken to improve drinking water quality at home and Section five consisted of ten questions on knowledge towards drinking water and health. Seven statements were used to assess the perception on safe drinking water

source under the section three in which only one statement was true (municipal water source). For the Section five, there were three responses provided; 'yes', 'no' and 'don't know'. A correct response was given '2' marks, an incorrect response was given '0' mark and a don't know response was given '1' mark. The sum of the score for all statements was then classified as poor (score <50%), moderate (score between 50% and less than 80%) and good (score \geq 80%).

The content of the questionnaire was validated by four experts in related fields: two experts represent Environmental Health Unit from Community Medicine Department of USM Health Campus; one expert from Drinking Water Quality Control Division; and the other one from Food Safety and Quality Division of Kelantan State Health Department. The questionnaire was also tested for face validity among ten people with different background; two of them were professional group; two from Food Safety and Quality Division of Kelantan State Health Department; two from support group; and the remaining four were recruited from outpatient clinic attendees in the nearby Kedai Lalat Health Clinic. A few changes and language used problem were then done. The data were gathered through face to face interview.

Sample size was calculated for each objective. By using a single proportion formula and the prevalence of community in Kelantan using municipal water according to NHMS III (2006) was 50.3%, with confidence interval of 95.0% and 0.10% precision and considering 20% drop out, the total subjects required in this study was 115. Another sample size calculation was done using a power and sample size calculation software (version 3.0.43, Dupont and Plummer, 1997).

The involved parameters are as follow:

$\alpha=0.05$, $\beta=80\%$,

$m=1$ and;

$P_0= 60\%$, the proportion of those with good education preferred unsustainable safe drinking water source (Sobsey *et al.*, 2008)

$P_1= 30\%$, the estimated proportion of those with good education using sustainable safe drinking water source

Total subjects required was 51 (considering 20% drop out)

Data were analyzed using Statistical Package for the Social Sciences Version 18.0 (SPSS 18.0). A simple and multiple logistic regressions were used to examine the factors associated with preferences for safe drinking water. The results were presented with odds ratio (OR) and adjusted OR with 95% Confidence Interval (CI) and *p*-value with significance level set at 0.05. Ethical approval was granted by the research committee of Universiti Sains Malaysia (Reference No: USMKK/PPP/JEPeM [235.4. (1.4)]). Written informed consent was obtained from the participants prior to the study.

Results

General characteristics of the subjects

Of the total subjects ($n=115$), 67.0% were female and majority of them were Malay (96.5%). Mean age of the subjects was 37.2 [standard deviation (sd) 14.6] years. The mean for number of family members and number of children under 12 year-old were 5.75 (sd 2.36) and 1.4 (sd 1.5), respectively. Educational status of subjects showed that almost one third had education up to tertiary level (30.4%), 54.8% up to secondary school and the remaining only up to

primary school. Only 34.8% of subjects were unemployed and more than half (57.4%) working either at private sectors or as government servants. Subjects with household income below poverty line (<RM676) constituted 26.1%, between RM676 and RM1500 comprised 30.4%, above RM1500 but below RM3500 accounted for 33.0% and the balance 10.4% were those with monthly household income of RM3500 and more.

Current drinking water sources and preferences

Majority of subjects (34.8%) currently used dug well as their drinking water source whereas only 29.2% used water from municipal water supply. The other sources used by the subjects were tube well (13.9%), treated drinking water by Ministry of Health (0.96%) and used from two sources (20.8%). For drinking water preferences, our results showed that only 30.4% (95% CI: 0.22, 0.39) of subjects prefer safe water. Avoidance measures taken by subjects to improve drinking water quality at home revealed that 96.5% boiled water prior drinking; 55.7% filtered water; 23.5% purchased big bottled water; 29.6% purchased mineral water; and 13.0% purchased water from vendor machine.

Knowledge towards drinking water and health

Table 1 shows that the overall knowledge score towards drinking water and health of the subjects was moderate in most of them (72.2%). Almost two-third of subjects knew polluted water consumption can cause cholera and food poisoning and more than half of the subjects correctly answered dysentery and typhoid fever as related to consuming polluted water. Conversely, less than half of them knew cancer is one of the disease related to drinking of polluted water and very a few of the respondents knew the relationship of polluted drinking water with diabetes mellitus. The table also illustrates that less than half of the subjects correctly answered that water from municipal water supply is safe.

Table 1: Percentage of correct answer on knowledge towards drinking water and health (n =115)

Variable	Frequency	Percentage
Disease caused by polluted water		
Cholera	89	77.4
Typhoid fever	61	53.0
Food poisoning	84	73.0
Dysentery	77	67.0
Cancer	46	40.0
Diabetes mellitus [‡]	12	10.4
Water from Municipal water not safe [‡]	52	45.2
Bottled water is safe [‡]	38	33.0
Water from vendor machine is safe [‡]	39	33.9
Domestic home filter produces better water quality [‡] than municipal water [‡]	30	26.1
Knowledge level on drinking water and health*		
Poor	6	5.2

Moderate	83	72.2
Good	26	22.6

*Poor: <50 %, Moderate: 50 - < 80%, Good: ≥ 80%

‡Negative questions

Factors associated with safe drinking water preferences

Table 2 shows that the significant associated factors with safe drinking water preferences were low monthly income level and currently used municipal water as their drinking water source. Socio-demography and knowledge level towards drinking water and health were found to be not significant.

Table 2: Factors associated with safe drinking water preferences among HUSM outpatient clinic attendees by using simple logistic regression analysis (n=115)

Variables	Drinking water preference		Crude OR ^a (95% CI ^b)	p-value
	Safe Freq (%)	Unsafe Freq (%)		
Subject's age	39.63 ^c (16.11) ^d	36.13 ^c (13.89) ^d	1.07 (0.99,1.04)	0.238
No of family members	5.51 ^c (2.22) ^d	5.85 ^c (2.50) ^d	0.94 (0.80,1.12)	0.481
Number of children under 12 years old in the family	1.51 ^c (1.48) ^d	1.35 ^c (1.52) ^d	1.07 (0.83,1.40)	0.590
Gender				
Female	27 (35.1)	50 (64.9)	1	
Male	8 (21.1)	30 (78.9)	2.03 (0.82,5.03)	0.128
Education level				
Up to primary	8 (47.1)	9 (52.9)	1	
Secondary	16 (25.4)	47 (74.6)	0.38 (0.13,1.16)	0.090
Tertiary	11 (31.4)	24 (68.6)	0.52 (0.16,1.70)	0.275
Employment				
Unemployment	15 (37.5)	25 (62.5)	1	
Self employed	1 (12.5)	7 (87.5)	0.24 (0.03,2.13)	0.199
Private/government servant	18 (27.3)	48 (72.7)	0.63 (0.27,1.45)	0.272
Income status				
<RM676	13 (43.3)	17 (56.7)	1	
RM676-1500	6 (17.1)	29 (82.9)	0.27 (0.09,0.84)	0.024
>RM1500-<3500	9 (23.7)	29 (76.3)	0.41 (0.14,1.15)	0.089
RM3500 and above	7 (58.3)	5 (41.7)	1.83 (0.47,7.10)	0.382

Drinking water currently used				
Other sources	15 (18.5)	66 (81.5)	1	
Municipal water	20(58.8)	14 (41.2)	6.28 (2.60,15.21)	<0.001
Knowledge on drinking water and health				
Poor	1 (16.7)	5 (83.3)	1	
Moderate	19 (22.9)	64 (77.1)	1.48 (0.16,13.49)	0.730
Good	15 (57.7)	11 (42.3)	6.81 (0.69,66.90)	0.100

^aOR= Odds Ratio, ^bCI= Confidence Interval, ^cmean, ^dSD= Standard Deviation

Results from multiple logistic regression demonstrated that the significant factors contributing to safe drinking water preferences were drinking water currently used and household income status as shown in **Table 3**. Those who currently used municipal water had 14.32 times odds for safe drinking water preferences than those who used other sources (95% CI: 4.08, 50.30, $p < 0.001$). On the other hand, those with income between RM676 - RM1500 had 0.023 (95% CI: 0.06, 0.84, $p = 0.027$) times odds for safe drinking water preferences than those with income of less than RM676. Finally, those with income more than RM1500 but less RM3500 had 0.011 (95 % CI: 0.03, 0.47, $p = 0.003$) times odds for safe drinking water preferences than those with income less than RM676.

Table 3: Associated Factors for safe drinking water preferences among HUSM outpatient clinic attendees by using multiple logistic regression analysis (n=115)

Variables	B	Adjusted OR (95 % CI)	p-value
Household income			
<RM676		1	
RM676-1500	-1.478	0.23 (0.06,0.84)	0.027
>RM1500-<3500	-2.228	0.11 (0.03,0.47)	0.003
RM3500 and above	0.411	1.51 (0.33.6.97)	0.598
Drinking water currently used			
Other sources		1	
Municipal supply	2.66	14.32 (4.08,50.30)	<0.001

^aB = Regression coefficient, ^bOR = Odds Ratio, ^cCI = Confidence Interval

No multicollinearity problem between the independent variables

No interaction between the significant independent variables.

Model fitness:

Hosmer and Lemeshow test for fitness of model is not significant with p-value 0.703

Classification table: overall percentage was 79.1%

ROC (Area under the curve) is 0.788 (95% CI: 0.694, 0.883)

The model can accurately discriminate 78.8% of the cases

There was no multicollinearity problem between the independent variables. Hosmer and Lemeshow test for fitness of final model was not significant with p -value of 0.703, which shows that the model is fit. The fitness of this model was also supported by classification table and receiver operating characteristics (ROC) curve. The classification table showed that the

overall percentage was 79.1% and area under the curve was 0.788 (95% CI 0.694, 0.883). Finally, this model can accurately discriminate 78.8% of the cases.

Discussion

The present finding among outpatients' attendees at HUSM clearly demonstrates the lack of knowledge on the effects of consuming polluted water to cancer, safety of municipal water, bottled water, water from vendor machine and domestic water filter. At the same time, the subjects have misconception about relationship of diabetes and polluted water consumption. The relationship of drinking water with high nitrate level and cancer incidence has been reported by a few studies (Weyer *et al.*, 2001; Ward, 2005). Nitrate contamination in drinking water had been shown to have positive associations with the incidence of bladder and ovarian cancer. This is because nitrate is endogenously reduced to nitrite and subsequent nitrosation reactions give rise to N-nitroso compounds which highly carcinogenic and can act systemically.

More than one third of subjects currently used dug well (34.8%) compared to municipal water (29.6%). The findings was hampered by the big proportion of subjects who preferred unsafe drinking water sources (69.6%) rather than the safe sources. According to WHO, only municipal water supply complies with drinking water requirement standards and categorized as safe drinking water source (WHO, 1997). This suggests that there is a lack of public trust towards the government body who manages the drinking water supply as supported by Johnson (2003). Moreover, there was lack of information delivered to public regarding water safety as shown by knowledge level in Table 1. As reported by Aini *et al.* (2007), the common public complaints about municipal water were regarding the colour, floating debris, odor and taste. The other problems related to municipal water supply was on health risks concern as reported by Turgeon *et al.* (2003) and organoleptics reasons (Levallois *et al.*, 1999; Jardine *et al.*, 1999). According to Koren (2005), organoleptics perception is related to the sensorial information obtained from taste, odor, colour and turbidity of water. The substances that impart odor and taste to water can be inorganic compounds, organic compounds, biological sources or waste water discharges which can be one of health hazards, but it still depending on the noticeable features, threshold level, palatability and strength of the substances (Doria, 2010)

Consuming contaminated drinking water would pose increase risk for food and water borne diseases (Motarjemi and Käferstein, 1999; Solomon *et al.*, 2002; Kirby *et al.*, 2003). Current study revealed 96.5% of subjects boiled water prior drinking as the preventive measures for food and water borne diseases. This finding is in agreement with Psutka *et al.* (2011), however, the authors reported that there were over-reporting of boiling and inconsistent compliance among the households. Additionally, they claimed that though boiling the water improves microbiological quality of water but it can be deteriorated by unsafe storage and handling of the boiled water.

Current source of drinking water, moderate and low household income were significantly associated with safe drinking water preferences. Those who currently used municipal water as their drinking water source was 14.32 times odds to prefer safe drinking water source. Municipal water users might already gain the information and believe that this water follows WHO guidelines, and is safer for their family. Study conducted among Victoria University's students toward local tap water showed 90% of subjects categorised it as safe drinking water preferences due to its stringent treatment processes (Belanger *et al.*, 2011).

Moderate (RM1500 to RM 3500) to low income status (RM676 to RM1500) were significantly associated with less probability to prefer safe drinking water compared to those with household income less than RM676, which is below the poverty line. Different results were reported by previous studies. Study among Latino individuals in Arizona showed those with low income and education preferred safe drinking water source compared to bottled water (York *et al.*, 2011). Individual with high income status also reported to invest more money to improve or gain safer water source and indeed they may prefer to use bottled water for their family (Larson and Gnedenko, 1999; Um *et al.*, 2002; Aini, 2007). Talatala (2008) also pointed out that household with greater income consumed more unsafe drinking water. Therefore, it is believed that people with low and moderate income level still have a few options to choose their drinking water sources compared to the poorer group. They may have certain limit of purchase power such as using bottled water or spending money to build up a tube well or dug well instead of paying to set up a domestic pipe line system for municipal water which is rather more expensive.

Conclusion

In conclusion, this study shows a high proportion of the respondents used and preferred to use unsafe drinking water source. Besides many public still lack of knowledge on safe drinking water source and certain area on health risk related to polluted water consumption especially on cancer and diabetes mellitus. In addition, we found two significant factors associated with safe drinking water preferences. Those who were currently used municipal water have 14.32 times odds for safe drinking water preferences compared to those who used other drinking water sources ($p < 0.001$, 95% CI : 4.08, 50.30). Meanwhile, those with low (RM676 and RM1500) and moderate (RM1500 and RM3500) household income were 0.23 ($p = 0.027$, 95% CI: 0.06, 0.84) and 0.11 ($p=0.003$, 95% CI: 0.03, 0.47) times odds for safe drinking water preferences compared to those with monthly household income less than RM676 respectively.

Continuous intervention and health promotion could be planned for the communities to instill the knowledge on safe drinking water source and health risk related to polluted water consumption and therefore to increase the proportion of safe drinking water preferences and users. Since the consumption of water from dug wells is high, responsible agencies especially ministry of health is suggested to adopt regular drinking water chlorination and deliver education towards a good and sanitary dug well as a preventive measure to reduce possible adverse health effects from unsafe drinking water. It would be beneficial if local government (AKSB) could expand their water supply coverage in this community. Further studies are desirable possibly the laboratory test on drinking water sources used by community to expand the information on quality standard of drinking water currently consumed by public.

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