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Effectiveness of Health Education on Knowledge of Groundwater-dependent Rural Residents Regarding Arsenic-contaminated Water at Kyonpyaw Township

Ohnmar Myint[1*] *& Nang Htawn Hla*[2]

[1]Military Institute of Nursing and Paramedical Sciences
[2]University of Nursing

Arsenic contamination of groundwater is one of the naturally occurring problems in Myanmar. This non-equivalent control group study was conducted to evaluate the effectiveness of health education on the knowledge status of groundwater-dependent rural residents regarding arsenic-contaminated water at Kyonpyaw Township in 2014. Each of 135 adult household members who were continuously living in the study areas at least 7 years for study and control groups were selected by using simple random sampling. Face-to-face interview was done with pretested structured questionnaire for quantitative and in-depth interviewing for qualitative data. This study found that 18.8% from study and 22.5% from control groups did not remember whether their tubewells were tested or not. The qualitative findings highlighted that misunderstandings about arsenic with iron in water was widely acknowledged among the respondents from both groups. Before intervention, most of respondents in both groups had low scores. One month after health education, mean knowledge score of study group was considerably higher than that of control group (29.93±2.62 *vs.* 14.24±3.42). Independent t-test result showed that there was statistically significant difference in mean knowledge scores between two groups after intervention at p=<0.001. It could be concluded that the increase in knowledge status of study group was likely to be the effect of health education. It was recommended that further research studies should be carried out with larger sample sizes and longer follow-up periods to assess the effectiveness of health education.

Key words: Arsenic, Groundwater, Knowledge, Health education

INTRODUCTION

Nowadays, concern of safe and improved drinking water has become an important issue worldwide. Currently, over one tenth of the global populations (about 884 million) still rely on unimproved drinking water sources.[1] Ninety-nine percent of the world's water supply is unsafe or unavailable to drink yet.[2] As increase in groundwater usage for domestic consumption, chemical contamination problem rather than bacteriological contamination problem becomes more prominent. The chemical contamination specifically the arsenic pollution in groundwater sources occurs in almost every region in the world: Asia, the Americas, Europe, and Australia. About 130 million people across the world have been exposed to arsenic from drinking water that exceeds the WHO recommended limit of 10 ppb.[3]

Long-term exposure to arsenic in drinking water can cause serious health problems, including skin lesions and cancers.[4] In Myanmar, the estimated number of arsenic exposed population, about 2.5 million out of a population of 50 million, are potentially at risk of arsenic poisoning from drinking water sources.[5] Arsenic

*To whom correspondence should be addressed.
Tel: +95-9254131377
E-mail: ohmarmyintminp@gmail.com

above the national standard of 50 ppb has been found in 8 percent of the approximately 250,000 water sources tested to date and an estimated 300,000 people are exposed to arsenic in drinking water.[6] The highest arsenic contamination is found in river valleys and delta regions.[7]

In Ayeyawady Region, the highest arsenic affected townships were Kyonpyaw, Kyaungone, Pantanaw, Hinthada and Zalun, from which 35.9% of 19301 tested samples in Kyonpyaw were above 10 ppb.[8] To prevent from effect of contaminated drinking water, the public need to have awareness relating to this poisonous element. The majorities (68.64%) of total 236 respondents from four villages of Kyaungone Township did not have knowledge on safe drinking water and only 30.51% knew arsenic.[9] Moreover, the effectiveness of previous arsenic mitigation program for arsenic exposure from drinking water has received little attention in Myanmar. To enhance arsenic-safe water use practices, providing appropriate health education (HE) needs to be carried out in arsenic-affected communities.

The findings greatly help the public which need urgent intervention to prevent arsenic exposure and to benefit from future technical development.

MATERIALS AND METHODS

This quantitative and qualitative combined study was conducted at Zinpyunekone and Mannkyar villages, Kyonpyaw Township in 2014. These two villages were selected randomly among total 47 villages which were known as high arsenic-contaminated above Myanmar national standard of 50 ppb. Inclusion criteria included the villages must have similar access to health care facilities; the villages assigned for study and control must be reasonable access within the study period; two test villages must be located at reasonable distance away but far enough from each other; similar interventional study or awareness raising program should not be implemented in the study villages within the study period. Then, each of 135 rural residents for study and control groups, respectively, were selected from an accessible population of that villages by using simple random sampling. The selection criteria used were adult household members (aged 18 and above) who were knowledgeable about sources of drinking-water and household water-usage, villager who owned arsenic tested tubewell (test done in 2005), the household members who were continuously living in the study areas at least for 7 years and the person willing to participate in the present study. For qualitative method, ten participants each for study and control group, respectively, were purposively selected from respondents of quantitative samples based on their willingness.

Face-to-face interviews with pretested, structured questionnaires for quantitative data were conducted by two trained health staff for about over 30 minutes for qualitative data, ten participants from each village were interviewed in-depth with guided questions by the interviewer, for about 45 minutes to one hour. Supple-mentary interviews were done until there was no new data coming out.

After collecting the data, the statistical analysis were done to identify what factors would be further needed to add to the HE intervention activities. To prevent the researcher biases, choosing the study and control groups was done after the pre-intervention data collection. Zinpyunekone Village was the study group and Mannkyar Village was the control group by simple random sampling. HE session was conducted in the Monastery Hall for the study group because of wide space and easy to arrange for audio-visual materials.

Moreover, presence of one pond and two arsenic-safe deep tubewells in its compound aided to indicate easily those safe sources. It was lasted for one and half hours: 45 minutes for providing HE, 15 minutes for announcing the average amount of arsenic in the respondents' tubewells, and 30 minutes for discussion. Lecture notes and leaflets designed by CHEB regarding arsenic were supplied for every attendee. Poster, Econo Quick Arsenic Test Kit and GIS based map showing the distribution of arsenic rich water sources in Kyonpyaw Township provided by WRUD as visual aids were also used.

By providing the information about arsenic-affected wells, the respondents had the opportunity to switch from an arsenic-contaminated well to a nearby safe well HE was also stressed on the incorrect and misconceptions about arsenic and unsafe drinking water that had been reflected from pre-intervention results. According to the literatures, different points were assigned for total 19 questions on assessing the knowledge on arsenic-contaminated water. Maximum total score (40) was given for all corrected answers.

Analysis

SPSS 20.0 version Software System was used to perform data entry, processing and analysis. To compare the baseline characteristics of the respondents between two groups, application of cross tabulation and Chi-square test was used. Independent *t*-test was used to compare the mean between two different groups in pre-intervention, and one month after intervention. One year after intervention, reassessment was also made to know the sustainability and effectiveness of HE, however, it was not presented in the paper. Qualitative data was analyzed by content analysis.

Ethical consideration

Approval from the Research Ethics Committee of Military Institute of Nursing and Paramedical Sciences and informed consents were obtained. Aiming to be relevant with ethic, the rural residents of control group were provided with interventional HE after completing one month of post-intervention assessment.

RESULTS

One hundred and thirty-five respondents from study and control areas participated in the present study and 117 eligible respondents for the former and 120 for the latter groups were included in the analysis stage after removing the list of attrition and data cleaning. The respondents of study group were ages between 22 to 88 years with mean age of 48.37±12.91. Similarly, the respondents of control group were ages between 22 to 83 years with the average age of 50.92±15.07. Chi-square values highlighted that the two study sites did not differ significantly with respect to age structure, education facilities, residential status and residential period as described in Table 1.

Table 1. Comparison of baseline socio-demographic characteristics between groups

Variables	Study group (n=117)		Control group (n=120)		Significance	
	No.	%	No.	%	X^2	P value
Age (years)						
21-40	38	55.1	31	44.9	1.411	0.494
41-60	58	47.9	63	52.1		
>60	21	44.7	26	55.3		
Education						
Low	57	45.6	68	54.4	1.664	0.435
Middle	38	55.1	31	44.9		
High	22	51.2	21	48.8		
Residential status						
Indigenous	106	50.0	106	50.0	1.77	0.556
Migrated	11	44.0	14	56.0		
Duration of residence (year)						
<21	15	57.7	11	42.3	2.708	0.447
21-40	34	53.9	29	46.1		
41-60	52	48.1	56	51.9		
>60	16	40.0	24	60.0		

This study found that 18.8% from study and 22.5% from control groups did not remember whether their tubewells were tested or not. The percentage of correct responses were not much different between groups on pre-intervention assessment as shown in Table 2.

Qualitative findings also revealed that most of the participants from both groups did not have enough information about arsenic chemical. A male participant aged seventy-nine disclosed as:

Table 2. Comparison of correct responses on the knowledge questions regarding arsenic contaminated water between groups before intervention

Knowledge questions Items	Study group (n=117)		Control group (n=120)	
	Frequency	(%)	Frequency	(%)
Naturally, what chemicals are contaminated in groundwater? (Multiple responses)				
Arsenic	93	(79.5)	99	(82.5)
Fluoride	1	(0.9)	4	(3.33)
Iron	40	(34.2)	52	(44.4)
Calcium	15	(12.8)	15	(12.5)
Have you heard about arsenic -contamination in water?	109	(93.2)	111	(92.5)
If "YES", how long ago did you first heard about it?				
Less than one year ago	5	(4.3)	15	(12.5)
Within 1-5 years ago	39	(33.3)	38	(31.7)
More than 5 years ago	65	(55.5)	58	(48.3)
If "YES", can you know arsenic in water by using some senses like taste, smell and eyesight?	24	(20.5)	26	(21.7)
Do you know non-dangerous level of arsenic content in water?	6	(5.1)	10	(8.3)
The arsenic-contaminated water can be used for bathing, cleaning and washing purposes	68	(58.1)	65	(54.2)
Where does arsenic in groundwater in your village (tubewells) come from?				
From human activities (industry, agriculture)	11	(9.4)	12	(10.0)
It exists in groundwater naturally in the soil and rock.	40	(34.2)	44	(36.7)
What is the cause(s) of arsenic poisoning?				
Drinking and cooking of an arsenic-contaminated water	31	(26.5)	30	(25.0)
Bathing and washing of an arsenic-contaminated water	11	(9.4)	10	(8.3)
Can people die if they drink arsenic contaminated water?	39	(33.3)	43	(35.8)
Tell me all visible symptoms of arsenic poisoning as many as you can. (Multiple responses)				
Skin changes	29	(24.8)	43	(35.8)
Headache	9	(7.7)	5	(4.2)
Peripheral neuropathy	19	(16.2)	14	(11.2)
How long does arsenic poisoning take to develop visible symptoms?				
<1 year	2	(1.7)	5	(4.2)
1-5 years	2	(1.7)	5	(4.2)
>5years	26	(22.2)	35	(29.2)
List all diseases that can be caused by arsenic poisoning as many as you can. (Multiple responses)				
Skin disease	30	(25.6)	42	(35.0)
Peripheral vascular disease	5	(4.3)	10	(8.3)
Nerve damage	7	(6.0)	7	(5.8)
Hypertension, heart, lung, diabetes diseases	5	(4.3)	7	(5.8)
Bladder, kidney, liver cancer	15	(12.8)	13	(10.8)
How long does it take for arsenic poisoning to cause the diseases you mentioned (in question 12)?				
1-5 years	2	(1.7)	5	(4.2)
6-10 years	5	(4.3)	9	(7.5)
≥10 years	26	(22.2)	33	(27.5)
Whether symptoms will go away if respondent stops using arsenic water?	34	(29.1)	36	(30.0)
It is necessary to take medical checkup for symptoms of arsenic poisoning.	100	(85.5)	104	(86.7)
Can arsenic be filtered from water?	54	(46.2)	54	(45.0)
*Can someone spread arsenicosis to another person?**	38	(32.5)	44	(36.7)
List the possible ways for arsenic safe drinking water as you know.				
One way	60	(51.3)	30	(25.0)
Two ways	10	(8.5)	10	(8.3)
Three ways	3	(2.6)	-	-
What does a red mark on a tubewell mean?	67	(57.3)	57	(47.5)

"Adding dry tea leaves and changing color of the water is because of the arsenic containing in it which cannot be seen with naked eye."

Moreover, some participants did not perceive that arsenic as a problem because using arsenic was long-existing routine for the villagers from both study areas. A female daily wage earner aged forty-five expressed that:

"*Some know it is deadly but they continue using it without dread as it is an age-old custom here."*

Moreover, a 52-year-old male farmer revealed that:

"*It has been like that since the moment it was dug. Until now our household suffers no illness; everyone is healthy. It can be used for every purpose."*

After adding total knowledge score, low level of knowledge about arsenic-contaminated water was found in 27.5% of the respondents from study group and 26.5% of those from control. And minimum scores of the respondents in both groups were 6 out of maximum possible highest score of 40. It highlighted that HE was essential for the groundwater-dependent rural population in the present study.

Mean knowledge scores were not much different between groups (13.68±3.66 *vs.* 13.93±3.45) in pre-intervention. An independent-samples *t*-test showed no statistical significant difference between mean knowledge scores regarding arsenic-contaminated water of control group and that of study group at p=0.589. One month after intervention, mean score in study group was considerably higher than that of control group. Mean knowledge scores of study group was 29.93±2.62 and that of control group was 14.24±3.42. There was statistically significant difference in mean scores between two groups on one month after intervention at p=<0.001 (two-tailed).

DISCUSSION

This study found that two groups were comparable in most respects including age, education, and residential period. It might be due to selecting the study villages by setting criteria. Thus, the findings of the effects of interventional HE on the awareness of the respondents living in arsenic-contaminated area regarding unsafe water might be clearly verified. Although this study used the nonequivalent control group design, their strategy of statistically controlling a number of background characteristics strengthened the internal validity of the study.[10]

When comparing the current results with previous studies done in other arsenic risky countries, most respondents (87%) from Bangladesh were aware of the problem. [11] Similarly, one study done in Cambodia revealed that all respondents have heard of arsenic.[12] Hearing about "arsenic" might depend on the severity of the problem. One survey data stated that 9.83% of respondents who were living in the low arsenic risk region had never heard of the groundwater arsenic contamination problem while all respondents in the medium risk region had knowledge of the problem. This difference in arsenic-related knowledge between respondents of two regions was not unexpected.[13]

Although the study areas were high arsenic regions, there were some people who did not know arsenic in both study and control groups. Even if they have not seen or heard arsenicosis sufferers in Myanmar, it should not be undermined and awareness raising regarding arsenic should also be accelerated. This study intended to find out whether the respondents understood that people could die if they drunk arsenic-contaminated water. It emphasized the severity of the ingestion of arsenic-contaminated water. In pre-intervention assessment, only one-third of each in both groups had correct knowledge that it could lead to death. However, some participants in this study did not concern that could lead to death because of longevity of their parents. In Bangladesh study, respondents were more knowledgeable by 69.5%of them correctly answered that people could die from continued use of arsenic-contaminated water.[14] In contrast, it was worse in one study done in Bangladesh which found that only 12.9% were aware that arsenic could result in death.[15]

They falsely aware that changing colour by adding green tea leaves and usual habit of testing water with guava leaves were due to arsenic. Actually, it might be due to iron in that water. By understanding the health impacts of consuming arsenic-rich water, they might switch to safe wells which prevent the potential health consequences for those risky populations. Therefore, it was stressed in HE session for the study group. Based on the results, health care personnel needed to concern addressing HE in health impact of arsenic poisoning to each and every person.

When comparing the mean baseline knowledge scores regarding arsenic-contaminated water, mean knowledge scores of study group was nearly the same as that of control. The pre-intervention total knowledge scores of study group were, therefore, comparable to those of control group. However, it was noteworthy that pre-intervention mean total knowledge scores in both groups were far lower than half of the possible highest total scores.

Thus, the need for provision of HE to mitigate the arsenic exposure from highly contaminated groundwater was acknowledged in both areas. In addition to the similar knowledge status, comparable socio-demographic characteristics of two groups could distinctly point out the extent of effectiveness of educational intervention on arsenic-contaminated groundwater of rural residents in this study.

One month after intervention, mean knowledge score of study group was as much twice as control and their knowledge scores were statistically significant different. This improvement of knowledge status in study group approved that provision of HE is a sufficient reason for increasing knowledge status of the respondents living in arsenic risk area towards unsafe water. This current study only evaluated the effectiveness of HE in one month after intervention. To be sustainable knowledge status, repeated HE session and evaluation will be needed for those people with larger sample sizes. The results highlighted that provision of HE is the valuable intervention for the vulnerable consumers of unsafe water to get the advantages of timely intervention and sustainable preventive practices.

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