Hypertension in People Consuming Hard Water in Haji Samoa Goth Keti-Bundar Sindh.

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Abstract

Objective: The aim of our study was to compare the presence of hypertension in people consuming hard water or fresh water and level of hardness, in individual water resources in Haji Samoa village near Keti Bundar, Sindh, Pakistan.

Methods: A cross sectional study was conducted in Keti Bundar in September 2014. There are two sources of water supply in the area; rain water / hard water. 340 people were included. People > 18 years of age, living in Keti Bundar for > 5 years were included. People having chronic kidney disease, diabetes, or taking anti-hypertensive drugs/oral calcium supplements were excluded. Demographic features, Body Mass Index (BMI) and blood pressure were recorded. Water sample was checked for hardness. Hardness of > 180 ppm was considered to be very hard. Hypertension was compared between people consuming hard or fresh water. $p<0.05$ was considered statistically significant.

Result: Out of 340 people, 80 (23.5%) had hypertension; in people consuming hard water 38 (20%) were hypertensive while 42 (28%) people consuming fresh water were hypertensive. This difference was not found to be statistically significant. While testing the hardness of water resources, the level of hardness was found to be very high, 3 out of 4 reservoirs; which were not suitable for human consumption.

Conclusion: We conclude that hypertension is no more common in people taking fresh water than hard water; but the underground well water in area of Keti Bundar has high levels of hardness.

Keywords: fresh water, hypertension, prehypertension, underground water

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Introduction

Water is essential for hydration and therefore, for life. The safe drinking water supply has high impact on protecting human health. It is estimated that approximately 17% of the world's population uses water from the unprotected and remote sources, that means approximately, 884 million people lack access to safe water supplies; approximately one in eight people[1]. Among them large number of people consume hard water. Hard water is usually defined as underground water, which contains a high concentration of calcium and magnesium salts. However, several other dissolved metals can cause hardness; those forms divalent or multivalent cations, including aluminum, barium, strontium, iron, zinc, and manganese. Some impurities of underground water can be significant etiological factor for diseases such as gastrointestinal problems, reproductive failure, neural diseases, and renal dysfunction[2]. However some minerals especially high levels of calcium and magnesium salts in wa-

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ter have protective effect on hypertension and ischaemic heart disease[3,4]. It is thought that higher content of calcium and magnesium salts in hard water decreases vascular tone and thus protective against hypertension. Number of large-scale studies show protective effect of hardness of drinking-water on hypertension and cardiovascular disease[3-6]. However, no clear association has been found in some other studies[7,8]. The variability in the results is likely because of different ecological and geographical settings, having different forms and concentrations of minerals. Most of the studies available reflect European data; Asian and African data is very sparse. To date there is no study in Pakistan regarding protective effect of hard water on blood pressure. Since the results are highly variable with ecological environment, studies from local areas will be of great value to get the knowledge about, effects of using hard water on blood pressure levels.

The primary objective of our study was to compare the presence of hypertension in people consuming hard water or fresh water and secondarily measuring level of hardness, in individual water resources in Haji Samoa Village, Keti Bunder, Sindh Pakistan.

Subjects and Method

A cross sectional descriptive study was conducted at Haji Samoa village, rural area of Keti Bundar in September 2014. This village is 150 km away from metropolitan city Karachi, estimated population of the area is 2500; out of which 1500 are adults; the people of area mostly belong to low socio-economic class; farmers and laborers by profession; with low literacy rate, lack of health awareness and limited accessibility to healthcare facilities. The reason for selecting Keti Bundar area was, the population was using both hard and soft water, making comparison of hypertension easy. There are two main sources of water supply in Keti Bundar area; people living in Southern area of village mainly consume fresh water from small local reservoir i.e. rainwater; while in rest of the area relies on hard water from four hand pumps.

Our sample size was estimated to be 300 subjects (representing 20% of given population) on the basis of National Health Survey in Pakistan9 but 340 people approached us so we included all of them in study. Sampling technique was purposive non-probability sampling. Inclusion criteria comprised people >18 years of age, living in Keti Bundar for at least 5 years. People having chronic kidney disease, diabetes, or taking anti-hypertensive drugs/oral calcium supplements were excluded. Informed consent was taken before enrolling in the study, participants were reassured that their identification will not be disclosed and collected information will be used for research purpose only. We collected information regarding demographic features age, gender, risk factors for hypertension like, smoking, and family history of hypertension. We inquired about type of water being consumed (well water or fresh water), average daily intake of water (measured by number of glass/day); rough estimate of daily salt intake (high salt diet/pinches of table salt with meals). Body Mass Index (BMI) was measured. Blood pressure was recorded by an aneroid sphygmomanometer from right arm. Two readings were taken with interval of 5 minutes, taking the mean value as final reading. Hypertension was classified by Joint National Commission Report (JNC-7)10. Blood pressure of <120/80mmhg was considered normal, 120-139 mmHg systolic and 80-89 diastolic was considered pre-hypertension and > 140/90 mmHg was considered hypertension. Systolic blood pressure 140-159 mmHg and diastolic blood pressure of 90-99 mmHg was considered Stage 1, while values > 160/100 mmHg was considered as Stage 2 hypertension10. Water sample was taken from soft water reservoir as well as from four hard water hand pumps and tested for hardness, classification of water hardness was done on the basis of proposed classification[11]. Hardness of > 180 ppm (parts per million) was considered to be very hard and unsafe for human consumption.

Data was analyzed in SPSS version 17. Quantitative variables; age, daily water intake and BMI was presented as mean. While qualitative variables; gender, smoking, family history of hypertension,

high salt intake and classification of hypertension was presented in frequency and percentages. To compare student t-test was applied on quantitative data while chi-square test was applied on qualitative data. $p<0.05$ were considered statistically significant.

Result

Total 340 people were included in the study; out of which 216 (64%) were male and 124 (36%) were female; mean age was 42.63 ± 12.2. 190 (56%) were using hard water; while 150 (44%) were using fresh water. In hard water group 60 (31.5%) were smokers while in fresh water group 62 (41.3%) were smokers (p=0.16). Mean BMI was 29.9 in hard water group while 27.52 in fresh water group (p=0.23). On comparing daily water consumption, there was significant difference in average daily water intake people taking fresh water were consuming average 1400 ml/day while people consuming hard water were consuming 900 ml/day (p=0.01). There was no significant difference between dietary salt intakes (p=0.457) as shown in (Table 1).

The results of average blood pressure readings shows that out of total 340 people; 80 (23.5%) had hypertension. In people consuming hard water 38 (20%) had hypertension, out of which 12% had pre-hypertension, 6% had stage I and 2% had stage II hypertension. From people consuming fresh water 42 (28%) people had hypertension, 17% had pre-hypertension,7% had stage 1 and 4% had stage 2 hypertension. Although hypertension was slightly more common in people taking soft water but the difference was not statistically significant (p=0.23). As shown in (Table 2.) and Fig. 1.

While testing the water resources, the level of hardness was found be very high, 3 out of 4 reservoirs; which were not suitable for human consumption. More importantly; nearly half 168 (49%) people were using the water from the unsafe reservoirs. The safe level of hardness (120-180 ppm) was found to be in fresh water reservoir and only one hand pump used by 172 (51%) people, as shown in (Table 3.).

Discussion

Safe and healthy water is basic right of every human being. It is estimated that only 51% people consume safe and protected water[12]. Hard water is defined as underground water rich in minerals especially calcium and magnesium salts. The high concentration of calcium and magnesium in water is crucial factor indicating the hardness although many other minerals are responsible for hardness like zinc, cadmium, sulphates and phosphates. Hardness generally enters groundwater as the water percolates through minerals containing calcium or magnesium. The most common sources of hardness are limestone (which introduces calcium into the water) and dolomite (which introduces magnesium)[13]. Number of studies have postulated that magnesium and calcium supplementation in water and diet is not only protective against cardiovascular disease and hypertension but also lower the blood pressure in people with pre-existing hypertension[14-16]. It has been thought that magnesium, as well as calcium, decrease in vascular smooth muscle tone, thus reducing risk of hypertension and coronary artery disease[14-16].

Protective role of hard water on blood pressure has been studied in few studies. Since the concentration and composition of hardness extremely varies in different ecological and geographical boundaries, that's why the results are also variable. In our study we observed that hypertension was slightly more common (28%) in people taking soft/ fresh water as compared to people taking hard water (20%) but statistically the difference was insignificant. Unfortunately there is paucity of national and international research on this topic. Kawano et al conducted a study on 67 people also concluded that protective effect of hard water was small and insignificant[15]. Momeni et al. conducted a study in Iran[17] and Rylander et al. conducted a study in Sweden[18] observed that hard water had favorable effects on cardiovascular disease and blood pressure.

Sauvant et al, Monarca et al., Lake et al. and Tubek et al. in quantitative reviews of several epidemiological as well as analytical studies observed

Table 1. General characteristics of individuals using fresh and hard water.

	Patient's using hard water n=190	Patient's using fresh water n=150	p-values
Age(Mean±SD)	44.2±12	47.4±6	
Male	114(60%)	102(68%)	0.126
Female	76(40%)	48(32%)	0.023
Smokers	60(31.5%)	62(41.3%)	0.167
Family having hypertension	27(14.2%)	35(23%)	0.347
Body Mass Index (BMI)	29.9	27.52	0.235
Average daily water intake(ml)	900±3.2	1400±6.7	0.012
High salt intake(approx)	16(8.4%)	22(14.6%)	0.457

Table 2. Hypertension in people taking hard/fresh water

	People taking hard water n=190	People taking fresh water n=150	p-values
Normal blood pressure <120/80	152(80%)	108(72%)	-
Pre-hypertension: 120-139(systolic), 80-89(diastolic)	23(12%)	26(17%)	0.213
Stage 1 Hypertension: 140-154(systolic), 90-99(diastolic)	12(6%)	10(7%)	0.475
Stage 2 Hypertension: >160/100	3(2%)	6(4%)	0.547

Table 3: Analysis of water samples from all Sources

Reservoirs	Level of hardness (ppm)	Safe levels	No. of people consuming water
Fresh water reservoir	120	Satisfactory	150(44%)
Hand Pump 1	450	Unsatisfactory	78(23%)
Hand Pump 2	340	Unsatisfactory	56(16%)
Hand Pump 3	320	Unsatisfactory	34(10%)
Hand Pump 4	160	Satisfactory	22(7%)

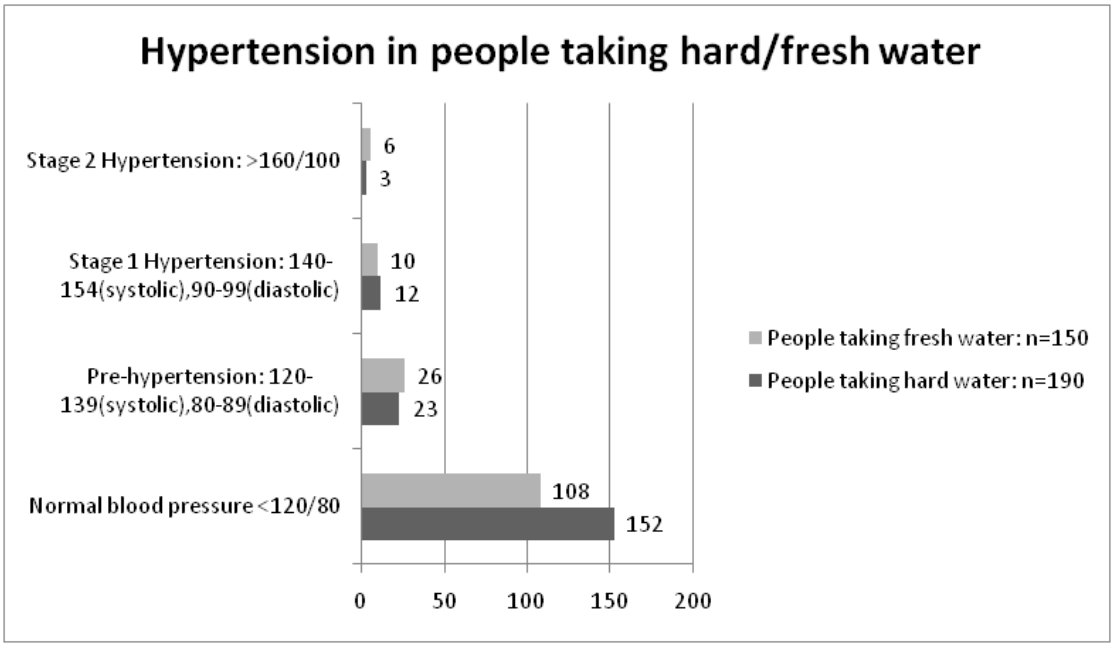

Fig. 1. Frequency of Hypertension in people taking fresh and hard water

the benefits effect of calcium and magnesium contents in water on cardiovascular mortality as well as hypertension.[19-22]. However Morris et al conducted a study in 2008 also found no benefit association between hypertension and hardness of water[23].

In our study we also observed that people taking hard water were taking considerable less amount of water than daily recommended largely because of altered taste and remote accessibility, so they are at risk of developing dehydration, low blood pressure and renal stones. During analysis of water from different sources, we observed that out of four hand pumps; only one hand pump was supplying water with safer levels of hardness. Hard water has no serious adverse health effects except for bad taste and gastrointestinal symptoms like diarrhoea. A WHO report says in 2008 Geneva Conference[1] but the knowledge of individual electrolytes responsible for hardness is important; especially harmful like cadmium, arsenic, lead levels need to be known if using underground well water. Unfortunately because of lack of financial resources we were not able to measure the levels of individual electrolytes in water supplies

By conducting this study we addressed the topic first time in Pakistan and it will draw attention of local researchers in same and related objectives. In future, further studied should be designed in different geographical settings with adequate resources and measurement of toxic minerals like arsenic, lead etc., moreover the use of bottled mineral water and its effect on blood pressure also need to be studied.

Conclusion

We conclude that hypertension is no more common in people taking fresh water than hard water; in area of Keti Bundar, but the level of hardness is inappropriately high in most water resources.

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Conflict of interest

Author has no conflict of interest and no funding/grant from any organization.

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