Does Water Hardness Have Preventive Effect on Cardiovascular Disease?

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ABSTRACT

Background: The aim of this study is to investigate the association of calcium and magnesium concentration of drinking water with cardiovascular disease (CVDs) in urban and rural areas of a city in Iran.

Methods: This case-control study was conducted in 2012 in Khansar County in Isfahan province, Iran. We used the official data of the Provincial health center regarding the chemical analysis data of urban and rural areas including the hardness, calcium and magnesium content of drinking water. Data of patients hospitalized for CVD in the only specialty hospital of the city was gathered for the years of 2010 and 2011.

Results: In 2010, water calcium content above 72 mg/L was associated with reduced number of CVDs in 1000 population; whereas in 2011 this decrease in CVDs was observed for calcium levels of more than 75 mg/L. In 2010, the level of water Mg content ranged from 23 to 57 mg/L. By increasing Mg hardness level above 31 mg/L in 2010 and above 26 mg/L in 2011 were associated with decreased number of CVDs in 1000 people. decrease.

Conclusions: Our study suggests favorable protective effects of water hardness, mainly water magnesium content, on CVDs. Water hardness, as well as calcium and magnesium content of drinking water may have a protective role against CVDs. Further experimental studies are necessary to determine the underlying mechanisms and longitudinal studies are required to study the clinical impacts of the current findings.

Keywords: Calcium, cardiovascular disease, Iran, magnesium, water hardness

Original Article

INTRODUCTION

The association of drinking water hardness and cardiovascular diseases (CVDs) has been studied since more than five decades ago.[1] A study in England and Wales showed that cardiovascular death-rates had a favorable effect in towns with harder water and had an adverse effect in towns with softer water.[2] Another studies showed that high levels of drinking water hardness can be protective against CVD.[3,4]

However, a review of ecological studies showed that the results are inconsistent between studies. A meta-analysis revealed

a negative association between concentration of magnesium in water and CVD mortality.[5]

Moreover, another review showed protective role of magnesium concentration in water against CVD in some case-control studies and one cohort study, but the analytical studies showed little evidence about the association of calcium and magnesium levels in drinking water and CVD risk.[6]

Water hardness may be also associated with CVD risk factors, for instance positive correlations of water magnesium and calcium with blood pressure is documented.[7]

In the Netherlands, another study found no overall association between calcium, magnesium or total hardness and ischemic heart disease or stroke mortality.[8]

Water hardness may be also associated with CVD risk factors, for instance positive correlations of water magnesium and calcium with blood pressure is documented.[7]

Case-control and cohort studies are more useful than ecological epidemiologicalstudies for investigating cause- and-effect relationships. The guidelines for drinking-water quality of the World Health Organization in 2011 reported that one of the case-control studies addressed the association between calcium and acute myocardial infarction and three reported the association between calcium and death from CVDs. None found a positive or inverse correlation between calcium and either morbidity or mortality.

The aim of this study is to investigate the association of calcium and magnesium concentration of drinking water with CVDs in urban and rural areas of a city in Iran.

METHODS

This case-control study was conducted in 2012 in Khansar County in Isfahan province, Iran. Khansar is a mountainous county about 2300 meters above sea level. 33°15′N 50°20′E. Its area is 900 km² and it includes 18 towns, 3 villages and one central city. This city is located to the northwest of Isfahan.

We used the official data of the Provincial health center regarding the chemical analysis data of urban and rural areas including the hardness, calcium and magnesium content of drinking water.

Data of patients hospitalized for CVD in the only specialty hospital of the city was gathered. By using the population of these areas, we calculated the relative frequency of CVD in urban and rural areas.

Statistical analysis

We compared the frequency and relative frequency of CVDs in the population studied according to the concentrations of Ca and Mg hardness in drinking water in 2010 and 2011.

The analysis was performed by using SPSS software (SPSS, Chicago, IL., USA, version 20.0).

RESULTS

The findings of the study in 2010 and 2011 are reported in Table 1. In 2010, the increase in the calcium hardness above 72 mg/L, the prevalence of

Table 1: Characteristics of variables studied in 2010 and 2011

Area	Area population (*n*)	Water Mg content (mg/L)	Water Ca content (mg/L)	Cardiovascular disease (*n*)	Relative frequency (%)	Relative frequency percentage	Cardiovascular patients in 1000 people (*n*)
2010							
1	20000	31.2	71	350	0.0175	1.75	17.5
2	2950	36.48	80.3	32	0.0108	1.08	10.84
3	2725	23.84	61	70	0.0256	2.56	25.68
4	2390	24.8	66	38	0.0158	1.58	15.89
5	4190	57.6	62.4	46	0.0109	1.09	10.97
2011							
1	20146	23.75	59.9	370	0.0183	1.8	18.3
2	3606	35.5	94.8	35	0.0097	0.97	9.7
3	2742	26.2	74	67	0.0244	2.44	24.4
4	2407	25	59.2	40	0.0166	1.66	16.6
5	4199	30.56	59.46	50	0.0119	1.19	11.9

CVDs in 1000 population decreased [Figure 1a]; in 2011 this decrease in CVDs was observed for calcium hardness of more than 75 mg/L [Figure 1b].

In 2010, the level of Mg hardness in water ranged from 23 to 57 mg/L. By increasing Mg hardness level above 31 mg/L in 2010 [Figure 2a] and above 26 mg/L in 2011 [Figure 2b], the number of CVD in 1000 people decrease.

DISCUSSION

Our study suggests favorable protective effects of water hardness, mainly water magnesium content, on CVDs. Water quality and content have important health effects. Several epidemiological studies have confirmed a negative association between water hardness and CVD among adults.[5-9] However, some other studies did not confirm such relationship Controversial results exist on the association of water hardness with CVD and their risk factors among the adult population.

The health effects of hard water are mainly considered to be because of the effects of its dissolved salts, primarily Ca and Mg. Hard water may be a good source for the intake of these elements. Some studies documented that the softer the water, the higher the CVD death-rates and suggested that water Ca may have such protective role.[8-10]

Most previous studies showed a significant inverse association between mortality from CVD and water levels of Mg, but not Ca levels. A review of the current literature reported that 10 of the 19 geographical studies published since 1979, found a significant association, but two geographical studies from Sweden, reported no association. Moreover, one of the six case-control studies that

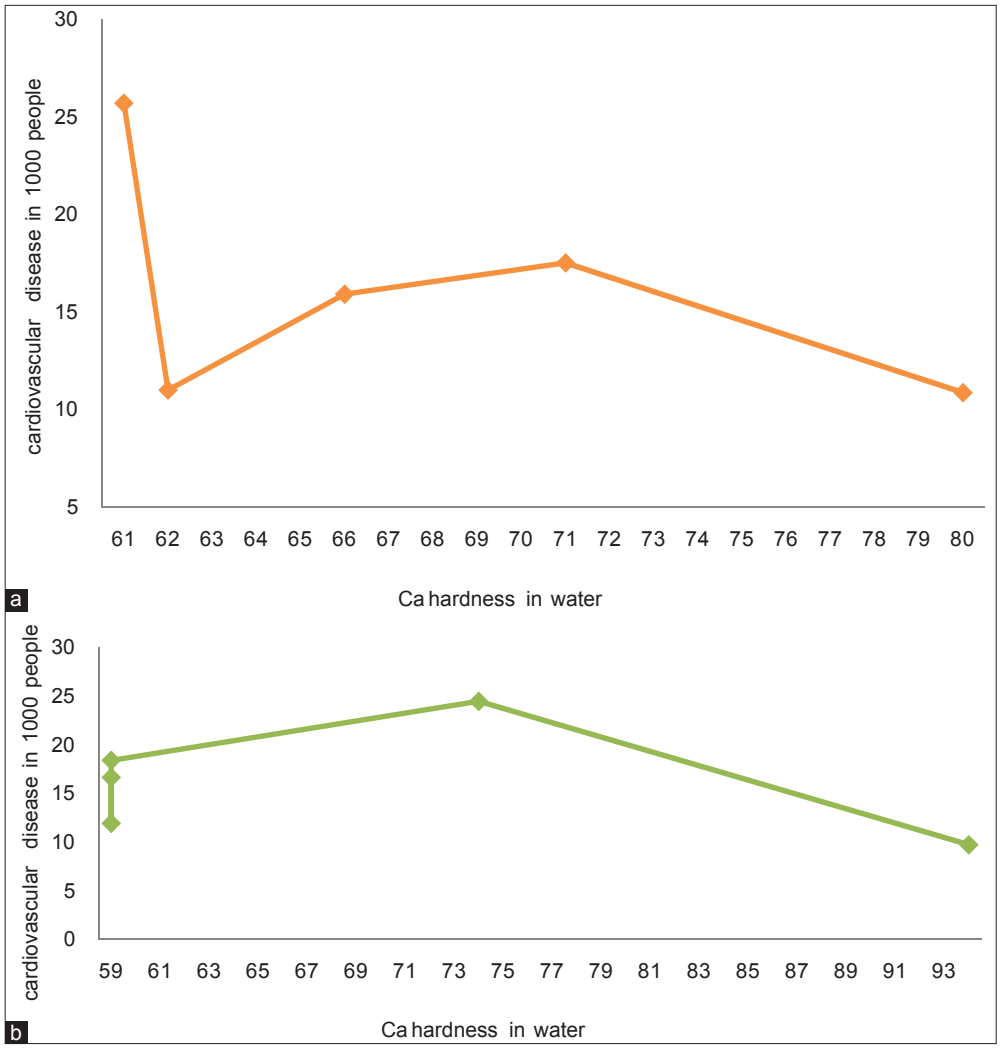

Figure 1: Cardiovascular patients in 1000 people according to the calcium hardness in water in (a) 2010 and (b) 2011

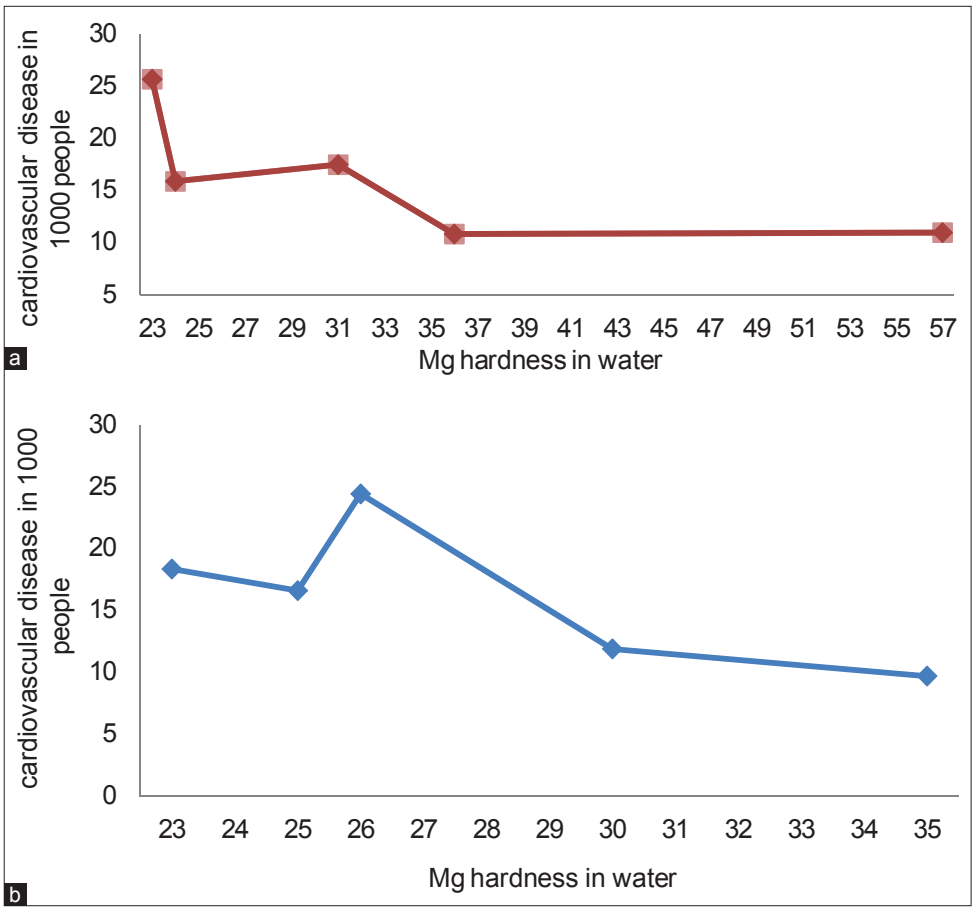

Figure 2: Cardiovascular patients in 1000 people according to the magnesium hardness in water in (a) 2010 and (b) 2011

considered Ca, found significant protective effect of high Ca levels (>70 mg/L) in drinking water. Mg is a protective element against soft-tissue calcification and has a role in prevention from myocardial infarction. Many, but not all, of the geographical correlation, cohort and case-control studies suggested that a high Mg water concentration protects against CVD mortality.[11-13]

Likewise, a recent review confirmed the protective effects of water hardness, notably its Ca level against many chronic diseases including CVDs.[14]

Study limitations and strengths

The main limitation of the current study is its cross-sectional nature, thus the associations documented in this study should be considered with caution.

CONCLUSIONS

Water hardness, as well as calcium and magnesium content of drinking water may have a protective role against CVDs. Further experimental studies are necessary to determine the underlying mechanisms and longitudinal studies are required to study the clinical impacts of the current findings.

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