Effect of Drinking Desalinated Fluoride Free Water on children's Bone Mineral Density

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Abstract

Objectives was to assess the effect of drinking desalinated fluoride free water on children's Bone Mineral Density in the Arabian Gulf area.

Methodology:

The study included 129 child aging 8 to 12 years from both sexes who were divided into 3 groups. first group: children who drank desalinated water (containing no fluoride) since birth. Second group: children who drank fluoridated bottled water. Third group: Children who drank mixed water. The children were examined for the BUA (Broadband ultrasound attenuation) of the calcaneus bone of both feet by the use of a quantitative ultrasound machine (QUS).

Results:

BUA was significantly higher in first group than second group regarding: all children eight to ten years old (mean was 51.13 in first group and 60.74 in the second group), and girls only ten to twelve years old (mean was 55.75 in the first group and 73.40 in the second group).

Conclusion: There may be a probable advantage for drinking bottled water containing fluoride over desalinated fluoride free water, regarding the bone mineral density of children.

Keywords:

Fluoride, desalinated water, bone mineral density.

Introduction:

Desalination of seawater is widely practiced and rapidly growing as the principal source of new fresh water in the world (WHO, 2004).

It is anticipated that by the year 2025 water resources of Egypt will drop approaching the water poverty limit. The future strategy is based on enhancing the use of non-conventional sources including desalination (El- Kady and El-Shibini, 2001).

Desalinated seawater is the major water supply for Kuwait (Darwish and Al Najem, 2005), the

United Arab Emirates (Sommariva and Syambabu, 2001), Bahrain (Hashim and Hajjaj, 2005), and counts for at least half of the supplies in Saudi Arabia (Dawoud, 2005).

Desalinated water is produced mainly by distillation, deionisation and membrane filtration (Reverse Osmosis Or Nanofiltration) (Kozisek, 2004).

Distillation filters remove all fluoride (Hobson et al., 2007). Since the addition of fluoride to public water supplies was initiated in 1945, exposure to fluoridation continues as a persistent public health issue (PHS, 2000). The effect of fluoridation on bone mineral density and rates of fractures is inconsistent (Phipps, 2000).

Although there are a large number of epidemiological studies available, the data are such that it is difficult to determine a clear exposure-response relationship. One possible feature of fluorosis is bone fracture, although some studies have reported a protective effect of fluoride on fracture (WHO, 2006).

Prospective studies have shown that calcaneal quantitative ultrasound can predict future fracture risk nearly as well as DXA (Khaw et al., 2004).

Quantitative ultrasound has several potential advantages over DXA: It is less expensive, is portable, does not involve ionizing radiation, and does not require specially trained personnel (Marı´n et al., 2004).

Aim Of The Study:

The aim of the present study was to assess the effect of drinking desalinated fluoride free water on children's bone mineral density, through examining BUA (Broadband ultrasound attenuation) of the calcaneus bone of both feet, by the use of a Quantitative Ultrasound Machine (QUS).

Subject And Method:

The present study was conducted during the period of September to November 2010 on children living in an accommodation compound on the Arabian Gulf.

This accommodation compound is supplied by pure desalinated seawater not mixed with any other water, But not all the people living in the compound drink desalinated water, some people prefer to buy and drink other types of commercially available bottled water.

The children were divided into three groups according to the following inclusion criteria:

- First group: Children from 8 to 12 years old of both sex who used desalinated seawater only since birth (n=67 child).
- Second group: Children from 8 to 12 years old of both sex who didn't use desalinated seawater at all since birth, they have drank only commercially produced bottled water available in the markets (n=38 child).
- Third group: Children from 8 to 12 years old of both sex who used both types of water at the same time or used desalinated water for some periods of their life and used bottled water for other periods (n=24 child).

We excluded children who have any of the following:

1. Children having any chronic disease (endocrinal disorders, marrow disorders, connective tissue and skeletal disorders, inborn errors of metabolism, renal troubles, malignancy and other diseases).
2. Patients receiving or who was receiving any medication regularly (esp. glucocorticoids, anticonvulsants, thyroxin, cyclosporine and chemotherapy).
3. Prematurely Delivered.
4. Children with manifestations of malnutrition.
5. Short stature (below tenth percentile) or obesity (body mass index above 95th percentile).

6. Acute diseases either febrile or not at the time of investigation.

Methods:

Children of the sample were subjected to:

1. Full medical history: Data was collected through a pre-designed questionnaire including:
   a. Personal history: name, birth date, sex, phone number.
   b. Type of water the child is drinking currently.
   c. Type of water drank by the child since birth.
   d. History of bone fractures, Low back pain or leg pain or skeletal pain elsewhere.
   e. Medical conditions: endocrinopathy, nephropathy, gastrointestinal diseases and malabsorption, blood diseases and bone marrow disorders, connective tissue and skeletal disorders, inborn errors of metabolism, malignancy, Prolonged immobility period, Infestations and any other diseases.
   f. Medications: Glucocorticoids, Anti-convulsants, Thyroxin, Cyclosporine, chemotherapy and other medications.
2. Thorough Clinical Examination
   a. General Examination: For signs of diseases mentioned in the (exclusion criteria).
   b. Essential Anthropometric Measurements: Height, weight and body mass index were plotted against CDC growth charts for girls and boys (2- 20 years).
3. Assessment of bone mineral density by using the quantitative ultrasound device called (CUBA clinical measurement device, by McCue corporation) to check the parameter BUA (Broadband Ultreasound Attenuation) of the Calcaneus bone of the foot, expressed in dB/MHz.

Total number of children checked was 129 child, we checked both left foot and right foot and considered the higher reading of both feet.

Results:

Table (1): Comparison of the ion composition of desalinated water and the bottled water available in the city

	Calcium (Mg/L.)	Magnesium (Mg/L.)	Fluoride (Mg/L.)
Desalinated Water	17.09	2.16	0.00
Hayat	10	3	0.85
Ynabeea	15	3	0.85
Nova	10	4.45	0.8
Pure	19	4	1
Nestle	36	4.7	0.9
Hada	13	4	0.8
Safa (Makka)	19	3	1
Hana	12	3.7	0.85
Qasim	12	3.7	0.85

The main difference between desalinated water and bottled water is the absence of fluoride in desalinated water, while all types of bottled water contain at least 0.8 mg/l of fluoride. The amount of magnesium and calcium in desalinated water is slightly different from different types of bottled water.

Statistical analysis of the results of the present study are shown in tables (2) to (8).

Table (2): Distribution of BUA for all children according to type of water

	Group 1	Group 2	Group 3
No.	67	38	24
Mean	59.01	62.37	61.83
S.D	12.32	12.73	18.21
Minimum	37	38	36
Maximum	110	101	117
F- Test	0.86, P=0.43		

There was a non-significant statistical difference between the three groups as regards the BUA.

Table (3): Distribution of BUA for children 8 to 10 years according to type of water

	Group 1	Group 2	Group 3
No.	24	17	9
Mean	51.13	60.74	58.11
S.D	9.70	12.09	12.8
Minimum	43	45	45
Maximum	75	87	89
F- Test	3.98, P=0.03		
G1 & G2	t= 2.82, P=0.007		
G1 & G3	t= 1.89, P=0.102		

There was a significant statistical difference between the three groups (P=0.03) as regards the BUA, and a significant statistical difference (P=0.007) between group 1 (Desalinated water) and group 2 (bottled water). There was a non-significant statistical difference between group 2 and group 3.

Table (4): Distribution of BUA for children 10 to 12 years according to type of water

	Group 1	Group 2	Group 3
No.	42	21	15
Mean	60.24	63.67	64.07
S.D	13.67	13.38	20.90
Minimum	37	38	36
Maximum	110	101	117
F- Test	0.54, P=0.58		

There was a non-significant statistical difference between the three groups as regards the BUA.

Table (5): Distribution of BUA for boys only 8 to 10 years according to type of water

	Group 1	Group 2	Group 3
No.	17	10	6
Mean	56.06	56.50	61.17
S.D	8.79	10.21	15.03
Minimum	43	45	45
Maximum	72	78	89
F- Test	0.55, P=0.58		

There was a non-significant statistical difference between the three groups as regards the BUA.

Table (6): Distribution of BUA for boys only 10 to 12 years according to type of water

	Group 1	Group 2	Group 3
No.	30	16	13
Mean	62.03	60.63	64.77
S.D	14.57	10.15	22.41
Minimum	40	38	36
Maximum	110	77	117
F- Test	0.26, P=0.77		

There was a non-significant statistical difference between the three groups as regards the BUA.

Table (7): Distribution of BUA for girls (8 to 10 years) according to type of water (group 3 neglected because number of girls less than 5).

	Group 1	Group 2
No.	7	7
Mean	58.71	66.86
S.D	11.97	12.64
Minimum	43	52
Maximum	75	87
T- Test	1.09, P=0.30	

There was a non-significant statistical difference between the two groups as regards the BUA.

Table (8): Distribution of BUA for girls (10 to 12 years) according to type of water (group 3 neglected because number of girls less than 5).

	Group 1	Group 2
No.	12	5
Mean	55.75	73.40
S.D	10.30	18.80
Minimum	37	50
Maximum	71	101
T- Test	2.53, P=0.023	

There was a significant statistical difference (P=0.023) between the two groups as regards the BUA.

Discussion:

The previous results can be interpreted as: children 8 to 10 years old either male or female and girls 10 to 12 years old who drank desalinated fluoride free seawater have bone mineral density statistically lower than children who drank water containing between 0.8 and 1 mg/L. of fluoride.

Steven et al. (2009) stated that: relatively few studies have assessed bone development in children, and these studies generally had small numbers of subjects at any specific age and related outcomes to a small number of variables.. little is known of fluoride's effects, if any, on normal childhood bone development at lower levels, including from community water fluoridation.

Keele and Vose 1969, Keele and Vose 1971, Wenzel et al., 1982, Alarcón-Herrera et al., 2001 and Arnold et al., 1997, suggested that fluoride may slightly increase BMD, but the evidence is relatively weak and somewhat conflicting.

The results of the present study may agree with such studies regarding the increase in BMD in children receiving water containing fluoride by comparison to those receiving fluoride free water.

In that study done by (Steven et al., 2009) Subjects have been participating in the ongoing Iowa Fluoride Study/Iowa Bone development Study. Mothers were recruited postpartum during 1992-1995 from eight Iowa hospitals, and detailed fluoride questionnaires were sent every 1.5- 6 months. From these, combined fluoride intakes from water sources (Home, Childcare, Filtered, Bottled), other beverages, selected foods, dietary fluoride supplements, and dentifrice were estimated at individual points and cumulatively (with area under the curve). Subjects received dual energy x-ray absorptiometry (DXA) scans of proximal femur (hip), lumbar spine and whole body (Hologic QDR 4500A). DXA results (bone mineral content- BMC; bone mineral density- BMD) were related to fluoride intake.

Boys' associations were consistently positive, while girls' unadjusted associations were generally positive and adjusted ones were generally negative. However, after adjustment, no girls' or boys' bone outcomes were statistically significantly related to any of the period-specific fluoride intake measures.

They concluded that Longitudinal fluoride intake at levels of intake typical in the United States (from 0.7 to 1.2 mg/L milligrams per liter, equivalent to parts per million), is only weakly associated with BMD in boys and girls at age 11 and Additional research is warranted to better understand possible gender and age specific effects of fluoride intake on bone development.

McNally (2000) stated that: The contradicting results of studies done on adults increased the controversy of water fluoridation.

Although there are a large number of epidemiological studies available, the data are such that it is difficult to determine a clear exposure-response relationship. One possible feature of fluorosis is bone fracture, although some studies have reported a protective effect of fluoride on fracture (WHO, 2006).

The present study does not agree with the study done by Lehmann et al., 1998. They analyzed the influence of drinking water fluoridation on the bone mineral density (BMD) in two different communities in eastern Germany: in Chemnitz, drinking water was fluoridated (1 mg/L) over a period of 30 years; in Halle, the water was not fluoridated. BMD was measured in healthy hospital employees aged 20- 60 years. No correlation was found between fluoride exposure and age adjusted BMD. They found no significant difference in spinal or femoral BMD between subjects living in Halle and Chemnitz. In conclusion, their study suggests that optimal drinking water fluoridation (1 mg/L), which is advocated for prevention of dental caries, does not influence peak bone density.

Ecological studies that compare rates of fracture specific for age and sex between fluoridated and non fluoridated communities have variously found that exposure to fluoridated water increases the risk of

hip fracture (Jacobson, 1992), Increases the risk of proximal humerus and distal forearm fracture (Karagas, 1996), has no effect on fracture risk (Avorn J., 1986) and decreases the risk of hip fracture (Jacobsen, 1993).

In an epidemiological study in China done by Li et al., 2001 the relationship between fluoride intake via drinking-water and all other sources, and all fractures, followed a U shaped dose response with higher rates of fracture at very low intakes below 0.34 mg/l and high intakes above 4.32 mg/l (total intake 14 mg per day).

Conclusion:

There is a significant statistical difference between children drinking fluoridated water and those drinking non fluoridated water regarding the mean of BUA in the age groups; eight to ten (including boys and girls) and girls ten to twelve years old. This results may refer to a probable advantage for drinking fluoride-containing bottled water by children over desalinated (fluoride free) water.

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الملخص

أثر شرب مياه البحر المحلاه الخالية من الفلورايد على كثافة عظام الأطفال

الهدف هو دراسة تأثير شرب المياه الخالية من مادة الفلورايد على كثافة العظام لدى الأطفال.

العينة:

١٢٩ طفلاً من الذكور والإناث من عمر ٨ سنوات إلى ١٢ سنة.

الإجراءات:

تم تقييم حالة كثافة العظام لعظمة عقب القدم لديهم باستخدام جهاز الموجات الصوتية الكمى الذى يقيس مقدار التوهين (BUA) الذى يعكس كثافة العظام.

وقد انقسم هؤلاء الأطفال إلى ثلاثة مجموعات هى:

- المجموعة الأولى تشمل الأطفال الذين شربوا منذ الولادة المياه المحلاة الخالية من الفلورايد ولم يستعملوا أى مياه أخرى.
- المجموعة الثانية تشمل الأطفال الذين استعملوا منذ ولادتهم المياه المعبأة فى زجاجات والمحتوية على الفلورايد بنسبة تتراوح بين ٠.٨ إلى ١ مج/ لتر.
- المجموعة الثالثة استخدموا النوعين السابقين فى فترات مختلفة من حياتهم.

النتائج:

تلاحظ وجود اختلافاً إحصائيا معتبراً فى كثافة العظام بالنسبة للأطفال من سن ثمانية إلى عشرة سنوات والبنات من سن عشرة إلى اثنا عشرة سنة. حيث زاد متوسط الوهين (BUA) لدى الأطفال الذين يشربون المياه المحتوية على الفلورايد عنه فى الأطفال الذين يشربون المياه الخالية من الفلورايد، مما قد يشير إلى احتمال التأثير الإيجابى لفلورة المياه على كثافة العظام لدى الأطفال.