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EFFECT OF DIETARY CALCIUM AND MAGNESIUM ON OCCURRENCE OF CAD: ANALYSIS IN COMMUNITY OF ISLAMABAD

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All the authors contributed significantly to the research that resulted in the submitted manuscript.

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ABSTRACT

Objectives: To investigate potential association between serum and dietary Ca and Mg levels, with different risk factors and occurrence of CAD.

Methodology: It was a hospital based, case control study, conducted in Cardiology Department of Federal Government Polyclinic Hospital, Islamabad from 1st March 2013 to 30th September 2013. Study subjects were given specially designed FFQs and asked to bring drinking water samples for mineral analysis. Serum Ca and Mg levels were checked and daily intake of minerals was calculated, using USDA food composition table. Analysis was done using SPSS version 11. All participants were included after formal informed consent.

Results: A total of 600 individuals were studied, 280 cases of CAD and 320 with no history of CAD constituted the control group. About 69 % of cases and 53% of controls had low dietary Mg intake, indicating an association between Mg intake and occurrence of CAD ($p = 0.000$), where Ca levels showed none ($p > 0.05$). Hypertension, diabetes and hyperlipidemia showed better correlation with CAD ($p = 0.000$), smoking had relatively weak association ($p = 0.049$). Low dietary Mg showed association with hypertension, diabetes and smoking ($p < 0.05$). Ca levels in drinking water ranging between 04 - 22 mg /L, but at places, levels were as high as 160 mg /L, where Mg levels ranged between 8-22 mg/L, did not show marked variation. Fisher's test was applied for statistical inference ; F value for serum and dietary Mg levels were 34.61 and 38.57 respectively, with p value of 0.000.

Conclusion: Low dietary Mg may have a contributing role towards development of CAD.

Key Words: Atomic Absorption Spectro-Photometry, Calcium, Magnesium

INTRODUCTION

Both calcium and magnesium are essential to human health. Over 99% of total body calcium is found in bones and teeth, where as the remaining serves as a signal for vital physiological processes. Inadequate intake of calcium has been associated with increased risk of osteoporosis, kidney stones, colorectal cancer, hypertension, stroke, coronary artery disease, insulin resistance and obesity.[1-5] Although hypertension is multi factorial in origin, adequate calcium intake has been associated with lowered risk of elevated blood pressure.[6] Moreover if the mineral level of drinking water is low there is higher incidence of sudden cardiac death and acute cardiac arrest.[7] Similarly low magnesium status has been implicated in hypertension, coronary heart disease, type 2 diabetes mellitus and metabolic syndrome.[8] Evidence suggests that endothelial dysfunction may be the initiating event in the atherosclerotic process that subsequently leads to clinical CAD. Animal studies have documented an inverse (protective) relationship between magnesium intake and the rate or incidence of atherosclerosis.[9.10] Increased concentrations of extracellular magnesium cause vasodilation, improve blood flow, decrease vascular resistance, increase capacitance function of peripheral, coronary, renal and cerebral arteries and attenuate agonist-induced vasoconstriction, whereas decreased concentrations cause contraction, potentiate agonist-evoked vasoconstriction and increase vascular tone.[11,12]

In spite of known importance of calcium and magnesium in our diet, unfortunately less than 60% of adult men and women even in developed countries meet the adequate intake (AI) values for calcium and magnesium.[13] Recommended Dietary Allowances (RDAs) of Calcium for a healthy adult (19-50 years of age) should be at-least 1000 mg and for Magnesium between 310-420 mg.[14,15]

Coronary artery disease is one of the leading causes of death worldwide; its incidence is very high not only in West, but also in Asian countries. South Asia (India, Pakistan, Bangladesh, Sri Lanka, and Nepal) comprises 25% of the global population and contributes nearly 60% of the global cardiovascular disease burden.[16] We therefore conducted a small sized, hospital based, case control study, to find out the routine dietary intake of the Pakistani population for Ca and Mg, and to evaluate any significant relationship between dietary mineral levels and occurrence of CAD.

METHODOLOGY

This hospital based case control study was conducted in Cardiology outpatient department, Federal Government Polyclinic Hospital (FGPC), Islamabad from 1st March 2013 to 30th September 2013. The subjects were included in the study after formal informed consent. Individuals from both the groups were assessed for presence or absence of major cardiac risk factors that were; hypertension, diabetes mellitus, hyperlipidemia, smoking and positive family history of ischemic heart disease. Cardiac patients were also asked about their drug history.

As the study subjects were evaluated by thorough clinical history, they were also provided with formal questionnaire for further clarification. The indivisulas under study were also advised to bring their past medical record like report of exercise tolerance test (ETT), nuclear scan or angiography, which ever was available. Patients with congenital heart disease or cardiomyopathy were not included in the study.

Assessment dietary calcium and magnesium intake:

All selected individuals (living in different sectors of Islamabad) were given specially prepared food frequency questionnaire (FFQ). The study tool used was already validated in one of the M Phil study, done in year 2006, in Allama Iqbal Open University, Islamabad. The FFQ contained questions on 35 food items, which were the most commonly consumed food items, in routine Pakistani diet. Frequency of consumption was reported according to 12 pre-defined categories, 1 time / week; 2 times / week; 3 times / week; 4 times/ week; 5 times / week; 6 times / week; 7 times / week; 1 time / day; 2 time / day; 3 times / day; Never; 1 time / month. In addition study subjects were also asked about intake of any Ca or Mg supplements.

Assessment of drinking water calcium and magnesium levels:

Each study subject was asked to bring his routine drinking water sample for mineral analysis, which was assessed by a special technique of Atomic Absorption Spectroscopy (AAS), in chemistry lab of AIOU, Islamabad. Every individual was asked about the source of water as there were 05 common sources; CDA supply, bore, well, filtration plant and packed mineral water bottles. They were also asked about the amount of water intake, according to 05 pre-defined categories, 3 glasses / day; 4 glasses / day; 5 glasses / day; 6 glasses / day; more than 6 glasses / day. Standard levels for Ca content in water samples are quite variable ranging from 1 to 240 mg/l and for Mg between 25-50 mg/l , for our convenience we have divided the Ca levels into two categories i.e. 50 mg /L or low and more than 50 mg /L[17] . For Mg 25 mg/l or low and more than 25 mg/l.

Calculation of total mineral dietary intake:

Intakes of calcium and magnesium were calculated by multiplying the frequency of consumption of each food item by the nutrient content, based on routine recipes used in Pakistani food, from U.S Department of Agriculture (USDA) food composition table.[18] As Recommended Dietary Allowances (RDAs) of Calcium for a healthy adult should be 700-1000 mg and for Magnesium between 310-420 mg.[14,15]

We divided the daily Calcium and Magnesium intakes of study subjects into 03 categories (Table 1)

Assessment of serum calcium and magnesium levels:

Serum calcium and magnesium levels of the study subjects were done using fully automated chemistry analyzer, SELECTRA, 11-7506 PRO-M, in Pathology laboratory of Federal Government Polyclinic Hospital, Islamabad. For detection of serum Ca levels MERCK and for Mg levels Fluitest MG XB kits were used. Depending on laboratory reference levels, normal serum Ca levels ranges between 8.5-10.5mg/dl and normal serum Mg levels ranges between 1.8-2.6 mg/dl.[19] We divided the serum Ca and Mg levels into 03 categories (Table 2)

Finally the data was tabulated; Pearson Correlation between different study variables was done and significance of the results was assessed at 95% confidence interval. All statistical analyses were performed with SPSS version 11. All reported p values were 2 sided; p values < 0.05 were considered statistically significant. Fisher's exact test was used for analysis of contingency tables.

RESULTS

The study population comprised of 600 subjects, out of which 320 included control group (those at risk of developing CAD, but healthy at present) with mean age of 52 $\pm$ 12 years and 280 were patients (cases) with established CAD with mean age of 57 $\pm$ 11 years. Total of 401 males and 199 females (N = 600) were studied, out of which 280 were cases of CAD (193 males and 87 females), and the remaining 320 (208 males and 112 females) had no history of CAD.

Correlation pattern of different study variables with occurrence of CAD:

For having a comprehensive picture of the scenario, in addition to the dietary Ca and Mg intake, serum levels of the respective minerals and major risk factors for CAD were also included. Every study subject was evaluated for five major risk factors of CAD i.e. hypertension, diabetes, hyperlipidemia, smoking and family history. Correlation between different risk factors and their contribution towards development of CAD is shown in Table 4.

Table 1: Categorization of Mineral Dietary Levels in Study Subjects

Daily Dietary intake	Mineral Type	
	Calcium	Magnesium
Low Intake	< 700 mg	< 310 mg
Normal Intake	700-1000 mg	310-420 mg
High Intake	>1000 mg	> 420 mg

Table 2: Categorization of Mineral Serum Levels in Study Subjects

Serum Levels	Mineral Type	
	Calcium	Magnesium
Low	< 8.5 mg/dl	< 1.8 mg/dl
Normal	8.5-10.5 mg/dl	1.8-2.6 mg/dl
High	> 10.5 mg/dl	> 2.6 mg/dl

It was observed that 47.8 % of the controls and 63.2% of the cases were hypertensive. 20% of the controls and 35% of the cases were diabetics and for hyperlipidemia 21.6% of control group and 34% of the cases group had high cholesterol levels. Another observation was that 22% of the controls were smoker, compared with the other group i.e. cases, where 33% were either smokers or they had quitted smoking during last 05 years, indicating that all the four risk factors mentioned above had correlation with occurrence of CAD (p value < 0.05), (Table 4). No such correlation was seen with the positive family history of CAD.

Variation in mineral dietary intake among study subjects:

It was observed that 69 % of the cases and 53% of the controls had low dietary Mg intake, ($p = 0.000$) as shown in Table 5, where no such difference was observed for dietary Ca levels ($p > 0.05$).

Association of mineral levels with individual risk factors:

In this study we also tried to find out any association between serum and dietary Ca and Mg levels, and individual cardiac risk factors, contributing towards development of CAD. Study results showed that for the diabetics, 68% of the cases and 50% of the controls had low dietary Mg levels ($p = 0.000$). For hypertensive 55% of the study subjects from both the study groups had low Ca dietary intake, similarly for Mg levels 53% of the controls and 63.8% of the cases had low dietary Mg intake, suggesting that for both the mineral Ca and Mg, their low dietary levels, may have contribution towards development of hypertension ($p < 0.05$). For hyperlipidemia it was observed that 58% of the cases and 52.9% of the controls had low dietary Ca intake ($p = 0.04$). Smoking is another known risk factor for CAD. It was observed that 32.9% of the cases and only 7.1% of the controls had low serum magnesium levels, again indicating an association between low serum Mg level and smoking (p

Table 3: Demographic Characteristics of Study Subjects

Study Subjects	Study Cases		Study Controls	
	Male	Female	Male	Female
No. (%age)	193 (68.9%)	87 (31.07%)	208 (65%)	112 (35%)
Total No. (%age)	280 (46.66%)		320 (53.33%)	

Table 4: Correlation between different study variables and occurrence of CAD

	concas	HTN	D.M	HLP	Smoker	F/H	Serum Ca	Food Ca	Serum Mg	Food Mg
Study Population N	1 - 600	.156** .000 600	.184** .000 600	.124** .002 600	.080* .049 600	.050 .218 600	047 .255 600	.037 .362 600	.234** .000 600	.246** .000 600
HTN	.156** .000 600	1 - 600	.198** .000 600	.048 .237 600	.165** .000 600	.052 .203 600	.073 .074 600	.109** .007 600	.058 .153 600	.117* .004 600
D.M.	.184** .000 600	.198** .000 600	1 - 60	.073 .075 600	.078 .055 600	.045 .266 600	.110** .007 600	.052 .207 600	.015 .720 600	.044 .278 600
HLP	.124** .002 600	.048 .237 600	.073 .075 600	1 - 600	037 .360 600	.060 .141 600	044 .285 600	.082* .046 600	.041 .313 600	.041 .317 600
Smoking	.080* .049 600	.165** .000 600	.078 .055 600	.037 .360 600	1 - 600	.035 .396 600	.034 .407 600	.018 .668 600	.094* .021 600	.073 .075 600
F/H	.050 .218 600	.052 .203 600	.045 .266 600	.060 .141 600	.035 .396 600	1 - 600	.025 .533 600	.059 .146 600	.058 .153 600	.018 .655 600
Serum Ca	.047 .255 600	.073 .074 600	.110** .007 600	.044 .285 600	.034 .407 600	.025 .533 600	1 - 600	.375** .000 600	.049 .235 600	.208** .000 600
Food Ca	.037 .362 600	.109** .007 600	.052 .207 600	.082* .046 600	.018 .668 600	.059 .146 600	.375** .000 600	1 - 600	.192** .000 600	.429** .000 600
Serum Mg	.234** .000 600	.058 .153 600	.015 .720 600	.041 .313 600	.094* .021 600	.058 .153 600	.049 .235 600	.192** .000 600	1 - 600	.450** .000 600
Food Mg	.246** .000 600	.117* .004 600	.044 .278 600	.041 .317 600	.073 .075 600	.018 .655 600	.208** .000 600	.429** .000 600	.450** .000 600	1 - 600

** Correlation is significant at the 0.01 level (2-Tailed)
* Correlation is significant at the 0.05 level (2-Tailed)
HTN: hypertension, DM: diabetes Mellitus, HLP: hyperlipidemia, F/H: family history

= 0.02), leading to the development of CAD.

Use of mineral supplements:

In this study it was observed that a significant proportion of study population had low Ca intake i.e. 56 % of controls and 60.4 % of cases respectively and a small percentage i.e. 37 out of total 600 study subjects were taking Ca supplement as observed through our food frequency questionnaire (FFQ).

Talking of magnesium levels, it was observed that 60% of the total study subjects had low magnesium intake, that includes 53% of the total controls and 68.6% of the study cases, but none of the study subjects were taking Mg supplements.

Calcium and magnesium levels in drinking water:

Another important part of our study was to analyze calcium and magnesium levels in different water samples. As observed 86% of the study subjects had water calcium levels less than 50 mg/L, most of the water samples had Ca levels between 04 - 22 mg /L. Moreover water intake in 70% of the study population is not more than one litre per day. But

Table 5: Data showing variation in Dietary and Serum levels of Calcium and Magnesium among Study Population

	Serum Ca level No (% age)			Dietary (food) Ca level No (% age)			Dietary (Water) Ca No (% age)	
	Low	Normal	High	Low	Normal	High	Low	High
Cases								
Male (194) 69.2%	62 (31.9%)	125 (64.4%)	7 (3.6%)	115 (59.3%)	72 (37.1%)	7 (3.6%)	171 (88.1%)	23 (11.8%)
Female (86) 30.7%	39 (45.3%)	46 (53.5%)	1 (1.2%)	54 (62.7%)	32 (37.2%)	0 (0%)	75 (87.2%)	11 (12.7%)
Total cases (280)	101 (36.1%)	171 (61%)	8 (2.8%)	169 (60.4%)	103 (36.8%)	7 (2.5%)	246 (87.8%)	34 (12.1%)
Controls								
Male (209) 65.3%	64 (30.6%)	141 (67.4%)	4 (1.9%)	118 (56.4%)	84 (40.2%)	7 (3.3%)	179 (85.6%)	30 (14.3%)
Female (111) 34.6%	42 (37.8%)	68 (61.2%)	1 (0.9%)	61 (54.9%)	57 (51.3%)	2 (1.8%)	92 (82.8%)	19 (17.1%)
Total Controls (320)	106 (33.1%)	209 (65.3%)	5 (1.6%)	179 (55.9%)	141 (44%)	9 (2.8%)	271 (84.6%)	49 (15.3%)
Total (600)	207 (34.5%)	380 (63.3%)	13 (2.2%)	348 (58%)	244 (40.6%)	16 (2.6%)	517 (86.1%)	83 (13.8%)
	Serum Mg level No (% age)			Dietary (food) Mg level No (% age)			Dietary (Water) Mg No (% age)	
Cases								
Male (194) 69.2%	58 (29.9%)	136 (70.1%)	0 (0%)	132 (68.1%)	62 (31.9%)	0 (0%)	90 (46.4%)	104 (53.6%)
Female (86) 30.7%	19 (22.1%)	66 (76.7%)	1 (1.2%)	60 (69.8%)	26 (30.2%)	0 (0%)	39 (45.3%)	47 (54.6%)
Total cases (280)	77 (27.5%)	202 (72.1%)	1 (0.36%)	192 (68.6%)	88 (31.4%)	0 (0%)	129 (46.1%)	151 (53.9%)
Controls								
Male (209) 65.3%	21 (10%)	187 (89.5%)	1 (1.2%)	116 (55.5%)	93 (44.5%)	0 (0%)	101 (48.3%)	108 (51.6%)
Female (111) 34.6%	22 (19.8%)	86 (77.5%)	3 (2.7%)	53 (47.7%)	58 (52.2%)	0 (0%)	47 (42.3%)	64 (57.6%)
Total Controls (320)	43 (13.4%)	273 (85.3%)	4 (1.25%)	169 (52.8%)	151 (47.2%)	0 (0%)	148 (46.2%)	172 (53.7%)
Total Study Subjects (600)	120 (20%)	475 (79.2%)	5 (0.83%)	361 (60.2%)	239 (39.8%)	0 (0%)	277 (46.2%)	323 (53.8%)

in few areas, which were generally slightly hilly areas, water Ca levels were as high as 160 mg/L.

Magnesium levels had no marked variation in different water sources, generally the magnesium levels ranged between 8-22 mg/L, in different water samples, collected from different areas of Islamabad.

Fisher's test was applied for statistical inference, F values for serum and dietary Mg levels came out to be 34.61 and 38.57 respectively, where no such association was seen for dietary and serum calcium levels. F value for Serum Ca was 1.3 and for food Ca 0.83, as shown in Table 6.

DISCUSSION

Both calcium and magnesium are essential to human health. Over 99% of total body calcium is found in bones and teeth, where the remaining serves as a signal for vital physiological processes. Deficiency of calcium is not only associated with increased risks of osteoporosis, kidney stones and colorectal cancer, but also hypertension, stroke and coronary artery disease. [1-4] It is also studied that if the mineral level of drinking water is low there is higher incidence of sudden cardiac death and acute cardiac arrest.[7] Low magnesium status has been implicated in hypertension, coronary heart disease, type 2 diabetes mellitus and metabolic syndrome and also associated with increased rate or incidence of atherosclerosis.[8-10]

In spite of known importance of calcium and magnesium in our diet, a very small percentage i.e. less than 60% of adult men and women meet the adequate intake (AI) values for the said minerals.[13] Already available data regarding mineral composition of typical Pakistani diet and daily dietary intake of calcium and magnesium in Pakistani population is quite deficient. This study was specifically planned because since last few years Pakistani population have shown definite change in their eating habits and they have started eating more of fast food / occidental "American diet" which is

Table 6: Statistical Inference Drawn by Applying Fisher's Test

		Sum of Squares	df	Mean Square	F	Sig.
Serum Ca	between groups	1.112	1	1.112	1.301	.255
	within groups	511.294	598	.855		
	total	512.406	599			
Food Ca	between groups	14116.059	1	14116.059	.832	.362
	within groups	10145465	598	16965.661		
	total	10159581	599			
Food Mg	between groups	38116.606	1	38116.606	38.571	.000
	within groups	590961.2	598	988.229		
	total	629077.8	599			
Serum Mg	between groups	2.532	1	2.532	34.616	.000
	within groups	43.748	598	.073		
	total	46.280	599			

relatively deficient in magnesium, as compared to original Pakistani / Oriental diet, which is characterized by a greater intake of fruits and vegetables, that is rich in magnesium.[24] We believed that in this scenario a thorough review of pupil's dietary intake was mandatory.

Our prime aim while conducting the study was to find out whether there is any relationship between dietary calcium and magnesium intake and occurrence of CAD. South Asians have higher rates, higher associated mortality, and earlier onset of CAD, due to genetic predisposition and lifestyle factors. Nine modifiable risk factors (Smoking, DM, lipids, central obesity, hypertension, diet, physical activity, alcohol consumption, psychosocial factors) account for over 90% of CAD in all populations.[26] In this study all the study subjects were evaluated for five major risk factors of CAD i.e. hypertension, diabetes, hyperlipidemia, smoking and family history.

About 63.2% of the cases, as compared to 47.8% of controls were hypertensive (p value 0.000) as shown in Table 4. The INTERHEART study showed that 22% of heart attacks in Western Europe were due to a history of high blood pressure and those with hypertension had almost twice the risk of a heart attack.[27]

Study results showed that 35% of the cases and 20% of controls were diabetics (p value 0.000), Garcia in 1974 showed that men with type 2 diabetes had 2 to 4 times greater annual risk of CAD where women had 3 to 5 times greater risk.[28]

The INTERHEART study suggested that 45% of heart attacks in Western Europe were due to abnormal blood lipids.[27] About 34% of cases as compared to 21.6% of control group were hyperlipidemic; p value came out to be 0.002, supporting the evidence suggested by the above mentioned study. Table 4 indicates that smoking showed weak correlation with CAD ($p = 0.049$) and positive family history failed to show any ($P > 0.05$).

It was observed that there was no significant match between dietary and serum levels of the two minerals ($p > 0.05$). Such problem was also experienced in previous studies, where it was noted that individuals with a serum magnesium concentration within the reference interval had total body deficit for magnesium. It was especially likely when an individual had a chronic, marginally negative magnesium balance, as the serum concentration may be supported by magnesium from other tissue pools, particularly bone.[12]

It was also observed that larger proportion of the cases group had lower dietary Mg intake, as compared to the control group i.e. 69 % and 53 % respectively as shown in Table 5, ($p = 0.000$). Earlier it has been shown that there is a significant association between Mg^{+2} and cardiac functional capacity in stable CAD patients.[30] A study was conducted in Heart Research Laboratory, Medical Hospital and Research Center, Moradabad, India, in 1997 showed that lower magnesium status was inversely associated with risk of CAD in both rural and urban subjects in both sexes.[31]

In the study we also tried to find out any relationship between Ca and Mg levels and individual cardiac risk factors, contributing towards development of CAD. It was observed that low dietary and serum Ca levels had some association with diabetes mellitus ($p = 0.007$),as shown in Table 4. Though too much evidence is not there but few studies have shown that low calcium levels are somehow related to insulin resistance and obesity.[2,3]

Another finding in this study was that more of the diabetics have low Mg levels as shown in Table 4, ($p = 0.000$), indicating a relationship between low dietary Mg and development of CAD. Whether low intracellular magnesium content is secondary to or precedes insulin resistance is unclear; however, recent evidence suggests that subclinical magnesium deficiency may precipitate a diabetic state.[12]

Second important risk factor that we considered in this study was hypertension. It was observed that 55% of the study subjects from both the study groups had low Ca dietary intake, showing that majority of the hypertensive from both the groups had low dietary Ca intake, which may be a contributing factor toward development of hypertension ($p = 0.007$). Although hypertension is multi factorial in origin, adequate calcium intake has been associated with lowered risk of elevated blood pressure.[32]

Similarly low Mg intake was also predominant among hypertension ($p = 0.004$). Magnesium deficiency has been implicated in the pathogenesis of hypertension, demonstrating a negative correlation between blood pressure and serum magnesium levels. Small changes in extracellular Mg^{+2} levels (Mg^{+2}) and/or intracellular free Mg^{+2} concentrations (Mg^{+2}) have significant effects on cardiac excitability and on vascular tone, contractility, reactivity and growth.[11,12]

Table 4 shows that high cholesterol levels and low dietary Ca levels have some association ($p= 0.04$), where for magnesium levels have better association, ($p = 0.002$). So the combined effect of lower mineral levels and the risk factor itself may have stronger contribution towards development of CAD.

At the end we want to discuss certain special aspects of our study, which are in fact the ultimate effects and outcomes of low calcium and magnesium levels in the study subjects. It was observed that a significantly high percentage in both control and cases group had low Ca intake i.e. 56 % and 60.4 % respectively. Prescribing calcium supplements, especially to females with post menopausal osteoporosis, is a common practice. In this study it was observed that 37 out of total 600 study subjects were taking Ca supplements. A recent meta-analysis from around 12,000 participants involved in 11 randomized controlled trials (RCTs) demonstrated a 30% increase in the incidence of myocardial infarction with calcium supplementation, more than 500 mg/day.[28] So unnecessary prescription of Ca supplements should be avoided.

Lu Wang and his co workers in 2012 reported a significantly increased risk of CAD, among users of calcium supplements versus non-users. It was suggested in the study that some people remained deficient despite additional calcium intake, while others ended up with calcium overload, leading to calcification of arteries and other soft tissue.[25]

Now coming to the magnesium levels, in this study we observed that even in our control group 53% had low magnesium intake (Table 5). One of the recent studies showed a beneficial role for oral magnesium as a regulator of platelet dependent thromboses (PDT) and it was observed that PDT was reduced by 35% in patients who received oral magnesium supplementation, indicating a definite protective role in prevention and acute management of myocardial infarction.[30] So if Mg has such a protective role then low Mg intake in control group should be a concern.

A randomized, prospective, double-blind study was conducted in Cedars-Sinai Medical Center which showed that an oral magnesium intervention for 6 months in CAD patients results in significant improvement in brachial artery endothelial function and exercise tolerance.[31] But in our study we observed that none of the study subjects were taking Mg supplement.

Management of the complications of CAD is also one aspect of management that cannot be ignored. It was observed that more than 60% of the cases group had low magnesium levels, both dietary and serum (Table 5). Studies have shown that patients with acute myocardial infarction who even have mild hypomagnesaemia appear to have a two- to threefold increase in the frequency of ventricular arrhythmias, in the first 24 hours when compared with those with normal magnesium levels.[34] Uncontrolled studies suggest that the administration of intravenous magnesium at this time can reduce the frequency of potentially fatal ventricular arrhythmias.[35]

Last but not the least another essential part of our study was to analyze calcium and magnesium levels in different water samples. Although the samples were obtained from a small district Islamabad, even than marked variation in Ca levels was observed. In the study it was observed that in 86% of the study subjects, the calcium levels in drinking water were less than 50 mg/L, mostly between 04 - 22 mg /L, a level very small to have any significant contribution towards total dietary intake. Study conducted by Chen and Gao showed that the intake of calcium either from diet or water among Asians are known to be low because of soft water supply, dietary habits and cost.[36] But in few areas, which were generally slightly hilly areas, water Ca levels were as high as 160 mg /L. In these areas water does have a contribution towards total dietary intake.

No marked variation was noticed in the Mg levels from different water sources. The magnesium levels ranged between 8-22 mg/L in different water samples, though contribution towards total dietary intake was low, but in the scenario where 60% of the study subjects (Table 5) were having low dietary Mg intake as shown in Table 5, even that small contribution is worth mentioning. It is true that the contribution of magnesium in water to the total intake may be small, compared to the amount ingested in food, but due to high bioavailability from water that available fraction is significant.[37] Because of this the magnesium supplementation of drinking water has been suggested to reduce the incidence of some types of cardiovascular diseases.[38]

Fissure test applied (Table 6), it was observed that F value for serum Ca came out to be 1.30 and for food Ca 0.83. Both not significant (p value > 0.05). But for Mg^{+2} serum and dietary levels the F values were 34.61 and 38.57 respectively, showing that the results cannot be obtained per chance.

CONCLUSION

For Ca^{+2} levels we couldn't reject the null hypothesis, but for Mg^{+2} we had to reject the null hypothesis, concluding that

there is definite relationship between dietary and serum Mg^{+2} levels and occurrence of CAD, ($p = 0.000$), Correlation matrix showed negative correlation between dietary and serum Mg^{+2} and CAD, indicating that lower the level, higher would be the incidence of CAD. So importance must be given to Mg^{+2} levels in serum, improve dietary intake of Mg^{+2} so as to reduce CAD events.

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