Acta Ciencia Indica, Vol. XLIII C, No. 2, 273 (2017)

MAGNESIUM STATUS AND RISK OF HYPERTENSION IN ADULTS

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RECEIVED : 13, April 2017

INTRODUCTION

Hypertension is a major public health problem in India and elsewhere (1-3). It is a major cardiovascular risk factor (4-5) and contributes significantly to cardiovascular mortality (6). Cardiovascular diseases (CVD) are caused by abnormalities in the heart and blood vessels and mainly include conditions such as coronary heart disease, stroke, hypertension, peripheral vascular disease, rheumatic heart disease and heart failure (7).

The number of hypertension patients is steadily growing, and controlling high blood pressure and identifying its prevention factors are urgent tasks. Various dietary factors, such as obesity, aging, decreased physical activity and excessive sodium intake, are one of the causes of high blood pressure. Based on strong evidence, excessive sodium intake is a causal risk factor for hypertension, whereas a diet rich in fruit, vegetables, and low-fat dairy products and low in sodium and saturated fat has been recommended to prevent and reduce hypertension (8). It is reported that the consumption of plant foods, in particular, leads to a reduction in systolic blood pressure (9). Plant foods may confer beneficial effects on blood pressure control through their rich array of nutrients and constituents e.g., fiber, magnesium, potassium, and other food components magnesium is a major mineral that exists in the human body at a level of approximately 25 g. Magnesium, as a constituent of chlorophyll, is contained in large quantities of green leafy vegetables. In particular, magnesium given in conjunction with tourine lowers blood pressure, improves insulin resistance, retards artherogenesis, prevents arrhythmias, and stabilizes platelets (10). In addition, a previous study reported that with regard to CVD diseases, magnesium prevents calcification of atherosclerotic plaques, and self-reported magnesium intake has an inverse correlation with arterial calcification (11). Various epidemiologic, observational, and clinical trial data show that a diet high in magnesium (at least 500~1000 mg/day) lowers blood pressure; however, the conclusions are not consistent, and these studies are mostly conducted in Western countries, where plant food intake is not so popular (12,13).

Indians have kept their traditional diet pattern, which consists mostly of plant foods. Therefore, considering that magnesium is mainly supplied through plant food, magnesium deficiency has not been a concern. Although it is reported that magnesium, which is supplied primarily through plant food, is related to high blood pressure due to its metabolic function, there are not many comprehensive studies of magnesium's relation to high blood pressure in

Indians, who consume plant food in high quantities. Therefore, the present study was conducted to investigate the association between dietary magnesium intake and the high blood pressure risk. We hypothesized that lower dietary magnesium intake would correlate with a risk of high blood pressure in the general population.

SUBJECTS AND METHOD

The geographical area of research was Moradabad city. Moradabad city is considered urban with a population of roughly .56 million. One street of 560 household is selected. We randomly selected 466 adults based on voter list. Of 488 subjects contacted,18 were not available due to their absence and 36 refused for blood test and 30 were above 6 years of age which were excluded. Remaining 404 subjects (200 men and 204 women) between 25-64 years of age were included in this study.

The head of each family was personally contacted by researcher. At least 3 calls were made before any subject was declared non contacted or non responder; one of in the morning, one in the evening and last one on weekend. The interviews were performed with the help of a pretested and validated questionnaire to obtained detailed information on dietary intake, age, sex, socioeconomic status, occupation, education, physical activity and past family history of hypertention, diabetes, coronary artery disease, alcohol intake, smoking and chronic desease.

Detailed interviews were conducted with the person responsible for buying and preparing most of the food in the household. Dietary intake was obtained by 3 days diet diaries of all adult individuals in the household using food measures, food models and food portions. All subjects were asked to record all food taken at meals and between meals around the time of eating. Fruits, legumes and vegetable intake was weighed by all the subjects before recording.

The criteria of the diagnosis of risk factors and of coronary artery disease were based on World Health Organization (14). Essential hypertension was defined as the presence of systolic blood pressure 140 mmHg or more and diastolic blood pressure of 90 mmHg or more.

Nutrient intake were calculated per 24 hours by using Indian food composition table based on three day diet diaries and weight of fruits, vegetables and legume intake (15). Clinical data and drug intake were recorded in all subjects. Blood pressure(systolic and diastolic) were measured in right arm in sitting position. Body weight (in light underclothes) were measured to the nearest 0.1 kg. Waist and hips girth were measured in standing position.

RESULT

This study included 404 subjects (200 men, 204 women) between 25-64 years of age. Non responders (20%) were mainly those subjects who refuse to volunteer for blood test. The number of male non responders is more than the number of female non responders.

Clinical data and risk factors by sex are shown in table 1. Mean age, body weight body mass index,blood pressure showed no significant difference between two sexes. Alcohol intake was significantly more common among males compared to females. Dietary intake of minerals in different age group is shown in table 2 indicating that the intake of dietary calcium, magnesium, sodium, potassium was within normal limit.

Table-1 : Clinical data and risk factors by sex

Clinical data	Male (n=200)	mean(SD	Female(n=204)
Age	41.02 (12.9)		39.09 (11.5)
Body weight	59.84 (6.12)		52.19 (6.59)
Body mass index (kg/m^2)	22.48 (2.19)		22.23 (2.36)
Waist- hip ratio	0.88 (0.04)		0.83 (0.04)
Blood pressure (mmHg)			
Systolic	132.87 (20.91)		132.60 (19.57)
Diastolic	85.22 (7.39)		84.30 (6.97)
Risk factors	**No.**	**%**	**No.** **%**
Obesity (BMI>25Kg/M2)	28	14	30 15
Alcohol intake(>once/month)	40	20	10 05
Excess salt intake (>5g/day)	80	40	90 45
Sedentary behavior	60	30	70 35
Mental stress	100	50	80 40
Diabetes mellitus	12	06	11 05
Prevalence of diseases	**No.**	**%**	**No.** **%**
Coronary artery disease	15	7.5*	06 03
Hypertension			
(WHO > 160/95)	28	14	26 13
(JNC > 140/90)	60	30	57 28
Isolated systolic			
Hypertension (>140)	60	30	57 28

Values are mean (standard Deviation) and number %. P values was obtained by Chi square test *=P<0.01

Table 2: Dietary intake of magnesium and other electrolyte in different age group

Age group	No.	Sodium	Potassium	Calcium	Magnesium
		(mg/day)	(mg/day)	(mg/day)	(mg/day)
			Mean(SD)		
25-34	140	3413(554)	1253(248)	421 (136)	351(98)
35-44	126	3358(541)	1216(229)	402 (141)	334(91)
45-54	100	3292(548)	1193(219)	394 (134)	315(88)
55-64	38	3154(521)**	1125(201)**	371 (116)*	294(86)***

*=p <0.05, **=p<.01,***=p <.001, p values are obtained by comparion of younger age group (25-34) with other groups by student t-test.

It is found that serum calcium decreases with age in both men and women except in the age of 45-54 in women(table 3). Table 4 shows the serum concentration of calcium in relation to blood pressure. There is a increase in blood pressure with the decrease in serum calcium.

Table 3 : Serum concentration of magnesium in different age groups by sex

Age group	No.	magnesium (mg/dl)
men		mean (SD)
25-34	76	1.8(0.24)

35-44	70	1.9(0.26)
45-54	42	1.7(0.23)
55-64	12	1.6(0.21)*
Women		
25-34	64	1.8(0.24)
35-44	56	1.7(0.21)
45-54	58	1.6(0.21)*
55-64	26	1.6(0.22)*

Values are mean (SD) *=P value were obtained by student's t test. P<0.02

Table 4 : Serum concentration of magnesium in relation to blood pressure

		Serum magnesium	Systolic BP	Diastolic BP
Age group	No.	(mg/dl)	(mmHg)	(mmHg)
Men				
25-34	76	1.8 (0.24)	128.8 ±11.4	72.6±9.4
35-44	70	1.9 (0.26)	129.9 ±13.3	77.9±10.4
45-54	42	1.7 (0.23)	134.8 ±16.8	81.6±11.0
55-64	12	1.6 (0.21)*	143.1 ±20.9*	83.3±12.0*
Women				
25-34	64	1.8 (0.24)	117.3 ±11.2	68.3±9.3
35-44	56	1.7 (0.21)	121.6 ±14.5	72.6±10.3
45-54	58	1.6 (0.21)	131.6 ±19.1	77.6±11.8
55-64	26	1.6(0.21)*	143.8 ±22.2*	80.0±12.8*

Values are mean(SD) * = P < 0.02, values are obtained by student's t test by comparison of values of younger age group with higher age group.

Discussion

Until late 1970s and 1980s, the strongest evidence pointed to a positive relationship between raised serum Mg and blood pressure. Recent studies also strongly favour a significant relationship between raised serum Mg and high blood pressure (16, 17). The present study also indicate that Mg intake was lower in hypertensive patients. Mg is rich in unpolished grains, fruits and vegetables and the CARDIAC study indicated that Mg intake was greatly beneficial in lowering blood pressure levels (18). Low Mg intake in hypertensive patients should therefore be considered a dietary risk for causing hypertension, CHD and stroke as previously reported (19)

Many studies report that a high magnesium intake ranging from 500 to 1000 mg/day may reduce blood pressure (12,13,20). It is known that magnesium lowers blood pressure by functioning as a calcium channel blocker. In other words, magnesium competes with the sodium binding site of smooth muscle cells, increases prostaglandin E, interacts with potassium, induces vasodilation, reduces intra-cell calcium and sodium contents and decreases blood pressure (21, 22). The negative relationship between magnesium intake and blood pressure is reported in epidemiological studies and observational studies. Song et al. (23)

examined 28,349 middle-aged women in a follow-up observational study over a 10-year period and reported that the highest quartile of magnesium intake (434 mg/day) showed significantly lower hypertension risk than the lowest quartile (356 mg/day), which indicated that magnesium intake had a significant negative correlation with hypertension prevalence. In this study, women's magnesium intake was inversely related to the risk of high blood pressure. However, after adjusting for several confounding factors, the result was attenuated. Especially when potassium intake, one of the confounding factors, was adjusted, the inverse relationship of magnesium intake and the risk of high blood pressure did not appear. Green leafy vegetables richly contain magnesium and trace amounts of potassium. This seems to affect potassium intake, which in turn affects the relationship between magnesium intake and the risk of high blood pressure.

Conclusion

In conclusion, we found that increased magnesium intake was possibly associated with a modestly lower risk of hypertensionn. Whether this represents a causal effect of magnesium is not certain. Nevertheless, there is sufficient reason to encourage a balanced diet rich in magnesium sources, such as whole grains, fruits and vegetables to lower the risk of hypertension.

Acknowledgment

To International College of Nutrition for providing support to do the laboratory analysis of magnesium

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