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RESEARCH ARTICLE

Serum magnesium in relation with obesity

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ABSTRACT

Background: Obesity is the leading public health crisis of our time. A chronic imbalance between energy intake and energy expenditure will eventually lead to obesity. Several micronutrients are found to be involved in the development of obesity. Magnesium is found to have some role in the development of obesity. **Aims and Objective:** Objective of this study was to evaluate the correlation of serum magnesium with different parameters of obesity such as body weight, basal metabolic rate, waist circumference (WC), and waist-hip ratio on the basis of the hypothesis that subjects with hypomagnesemia are more prone to develop obesity. **Materials and Methods:** This is a population-based cross-sectional study. A total of 130 apparently healthy adults of age between 25 and 65 years, were recruited with prior ethical approval and written informed consent. **Results:** Serum magnesium was found to have significant negative correlation with body weight ($r = -0.30$, $P = 0.003$) and WC ($r = -0.21$, $P = 0.03$). Correlation with rest of the parameters was not significant. **Conclusion:** On the basis of results it is concluded that hypomagnesemia can be proved to be one of the important predictors of obesity.

KEY WORDS: Serum Magnesium; Obesity; Body Weight; Basal Metabolic Rate; Waist Circumference and Waist-hip Ratio

INTRODUCTION

Obesity is a growing epidemic which places the individual at high risk for cardiovascular disease. The pathophysiology of obesity is complex and poorly understood, but includes social, nutritional, physiologic, psychological, and genetic factors. Environmental factors such as a sedentary lifestyle and chronic ingestion of excess calories can cause obesity. Adipose tissue secretes hundreds of adipokines that regulate important biological processes. Inflammatory adipokines serve as the cellular mediators of metabolic syndrome and endothelial dysfunction.[1] Excess adipose tissue, especially intra-abdominal, predisposes to type 2 diabetes, hypertension, dyslipidemia, and metabolic syndrome largely through increased lipolysis that raises the production of free fatty acids and adipokines. The excess fatty acids interfere with insulin receptor signaling and lead to decreased glucose transport, often referred to as lipotoxicity. They also activate protein kinase C. Protein kinase C phosphorylates insulin receptors by interfering with insulin signal transduction.[2] Serum magnesium is found to have a negative correlation with fasting blood sugar, systolic blood pressure (BP), diastolic BP, triglyceride levels, and positive correlation high-density lipoprotein levels.[3] Serum magnesium was found to have a significant negative correlation with triglyceride and very low-density lipoprotein.[4]

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Magnesium and Obesity

Magnesium is second most abundant (after potassium) intracellular cation and is a fourth most abundant cation of the human body. Approximately half of the magnesium is found in the bones and half in the soft tissue. <1% of the total body magnesium is found in the blood.[5]

Normal serum magnesium level is 1.5–2.3 mg/dl or 0.62–0.95 mmol/L.[6] Magnesium exists in the serum in the three states. About one-third of serum magnesium is bound to proteins, 25% with the albumin and 8% with the globulin. For the remaining two-third of serum magnesium 92% is free, and 8% is complexed with phosphate, citrate, and other compounds.[7] Recommended dietary allowance of the magnesium is 420 mg per day for adult male and 320 mg per day for an adult female.[8] Hypomagnesemia was defined as serum magnesium concentrations ≤ 1.8 mg/dL (≤0.74 mmol/L).[9] The major dietary sources of mg intake include whole grains, legumes, nuts, and green leafy vegetables.[10] Magnesium intake is falling due to increased consumption of processed and fast food. Thus, the incidence of chronic magnesium deficiency is probably increasing with possible health hazards but is not recognized because of the diagnostic limitations of magnesium status.[5,11]

Serum magnesium is found to have correlation with obesity in several studies. Hypomagnesemia is found to be associated with metabolically obese normal weight rather than metabolically healthy obese phenotypes.[12] Overweight children were found to have significantly lower serum magnesium level compared to the children of normal weight group in spite of high dietary intake. Besides this, serum magnesium levels were inversely correlated with body mass index, systolic BP, diastolic BP, waist circumference (WC), and fasting insulin level.[13]

The possible underlying mechanism behind lower serum magnesium levels in the overweight group may be as follows. Low serum magnesium in overweight individuals might be due to either decreased absorption or increased excretion of magnesium.[13] Increase consumption of fast food and decreased intake of fibers, whole grains, and green leafy vegetables is associated with both obesity and hypomagnesemia. It was hypothesized that magnesium may have an anti-obesity effect because of its capability of forming soaps with fatty acids in the intestine and thus reducing absorption of fat from the diet. Nevertheless, intake of whole grain, nuts, and fruits, and vegetables, which are the major foods contributing to magnesium intake, have been shown to be inversely related to body weight.[14] Epinephrine, a hormone secreted from adrenal medulla, has a role in the development of obesity.[15] Magnesium plays a role in secretion of epinephrine.[16] With obesity and adipocyte enlargement, blood supply to the adipocyte may compromise with resultant hypoxia. Hypoxia has been proposed to induce production of biologically active metabolites - adipocytokines which include C-reactive protein, plasminogen activator inhibitor-1, and proinflammatory mediators (tumor necrosis factor-α, interleukin-6 (IL-6).[17] Serum magnesium is found to be inversely related to IL-6 and high sensitivity C-reactive protein.[18]

Evidence that magnesium is directly involved in body weight regulation is lacking. The mechanisms for an inverse association between magnesium intake and abdominal obesity are unclear. The objective of this study was to evaluate the correlation of serum magnesium with anthropometric parameters (weight, WC, hip circumference, Basal metabolic index [BMI], and waist-hip ratio [WHR]) of the subjects on the basis of the hypothesis that subjects with hypomagnesemia are more prone to develop obesity.

MATERIALS AND METHODS

Subject Recruitment

This is a cross-sectional study conducted in north Indian apparently healthy adults irrespective of sex with age between 25 and 65 years. We enrolled 130 apparently healthy adults for this study, of which 67 (51.5%) were males and 63 (48.5%) were females.

Subjects with pregnancy, history of alcohol consumption or cigarette smoking, history of any known cardiovascular disease, diabetes mellitus type 1 and 2, other endocrinal disorders, metabolic disorders, hypertension, renal diseases, chronic disorders of joint and connective tissue, psychosomatic disorder neurological disorders, history of intake of lipid-lowering drugs, diuretics, cisplatin, or any other medication which affect magnesium absorption, metabolism, or excretion were excluded from study. All samples were collected from Lucknow and nearby areas.

Ethical Statement

This study was approved by the ethical committee of our institute and "we certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research." Written informed consent was obtained from all the volunteers.

Anthropometric Assessment

1. Weight measured on calibrated balance scale (within 100 g) without heavy clothing.
2. Height measured by rigid stadiometer to the nearest centimeter while barefoot.
3. BMI was calculated according to formulae.
   $$BMI = \text{Weight in kg}/(\text{height in mt.})^2$$
4. WC was measured with a flexible and inelastic measuring tape whereas taking the necessary care not to compress tissue. WC was measured according to the WHO's recommendation with the patient standing, after a regular expiration, midway between lowest portion of rib cage and superior border of iliac crest.

5. Hip circumference measured at the widest part of the hip.
6. WHR was calculated:

$$\text{WHR}=\frac{\text{Waist circumference at umbilicus}}{\text{Hip circumference at greater trochanter}}$$

WHR more than 0.90 in males and more 0.80 in females are indicative of central obesity (Asia Pacific perspective redefining obesity and it is treatment) Table 1.

Biochemical Assessment

Blood samples for estimation of serum magnesium were collected from subjects in the morning having 12 hours of the overnight fast.

Estimation of serum magnesium level: The VITRIOS mg Slide method was used. Test type was colorimetric using vitros 250 fully autoanalyzer.

Statistical Analysis

All the clinical data and anthropometric values are presented as a mean ± standard deviation. All the analysis was carried out using SPSS 16.0 version (Chicago, Inc., USA). The Pearson correlation coefficient was calculated to find the direction of the association between two continuous parameters. The linear regression analysis was applied to find the strength of the associations. For all analyses, $P < 0.05$ was considered as statistically significant.

RESULT

This study was performed in 130 apparently healthy adults between age 25 and 65 years, in which males were 51.5% (n = 67) and females were 48.5% (n = 63). Table 2 shows the distribution of the anthropometric parameters of the subjects.

Table 3 shows a correlation of serum mg with anthropometric parameters of the subjects. Serum magnesium was found to have significant negative correlation with body weight (r = −0.30, P = 0.003) and WC (r = −0.21, P = 0.03). Correlation with rest of the parameters was not significant.

DISCUSSION

In this study serum magnesium was found to have negative correlation with weight (r = 0.30, P = 0.003*) and WC (r = 0.21, P = 0.03*). However, relation with rest of the anthropometric parameters (BMI and WHR) was not significant.

One of the studies has found that consuming less than the estimated average requirement for magnesium was associated with a significantly higher BMI.[19] The mean of intra mononuclear magnesium was lower in patients with obesity (P = 0.04*).[20] Serum magnesium also found to be negatively correlated with obesity.[21] Magnesium intake was inversely correlated with WC, body fat percent and body mass index (P < 0.005*) in a cross-sectional study involved 210 type 2 diabetes patients aged 65 years and above.[20] Serum magnesium is found to be significantly lower in obese children in comparison to lean children.[22] Results of these studies were inconsistent with our study.

Table 1: Differences in the cut points for obesity and abdominal obesity for Asian Indians/South Asians and Europids

Generalized obesity	Asian Indians/South Asians	Europids
Normal weight	BMI 18–22.9	BMI 18.5–24.9
Overweight	BMI 23–24.9	BMI 25–29.9
Obesity	BMI≥25	BMI≥30
Abdominal obesity		
Men	WC≥90 cm	WC≥102 cm
Women	WC≥80 cm	WC≥88 cm

WHO/ASO/ITO Asia Pacific perspective redefining obesity and it is treatment, WHO, Western Pacific Region, 2000, BMI: Basal metabolic index, WC: Waist circumference

Table 2: Distribution of anthropometric parameters

Anthropometric parameters	Male (n=51), mean±SD	Female (n=49), mean±SD
Weight (kg)	73.76±13.24	62.65±13.94
BMI (kg/m^2)	26.29±4.36	26.44±5.52
Waist-circumference (cm)	97.74±13.85	92.94±15.09
WHR	0.97±0.07	0.91±0.09

*Significant (P<0.05). SD: Standard deviation, WHR: Waist-hip ratio

Table 3: Correlation of serum mg with anthropometric parameters of the subjects

Anthropometric parameters	Serum magnesium	
	Correlation coefficient (r[1])	P-value
Weight	−0.30	0.003*
BMI	−0.13	0.20
WC	−0.21	0.03*
WHR	−0.16	0.11

[1]Spearman correlation. *Significant (P<0.05). WHR: Waist-hip ratio, WC: Waist circumference, BMI: Basal metabolic index

Limitation of Study

This study was performed in apparently healthy adults, and so the result does not present the whole population which includes diseased individuals too. Measurement of intracellular magnesium is lacking in this study.

CONCLUSION

The result of this study suggests that a significant negative correlation exists between serum magnesium level and some of the anthropometric parameters (body weight and WC). We look forward to additional large studies examining the same relationships in a large population including diseased individuals also acquiring about dietary magnesium intake.

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