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Serum magnesium levels in patients suffering from cardiovascular diseases: A comparative study

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Abstract

Magnesium is a vital micronutrient for people because it helps to maintain normal cardiac function. It is a cofactor in several of the body's enzyme systems, and myocardial cells are one of its target tissues. The pathophysiology of cardiovascular diseases involves magnesium significantly. Estimating serum magnesium levels in people with cardiovascular disease is the goal of this study. The level of serum magnesium was measured in patients with cardiovascular disease who were hospitalized. Males with cardiovascular disease had a mean magnesium level of 1.14 ±0.103 mg/dl, while females had a level of 1.08 ±0.094 mg/dl. The mean magnesium level in healthy males and females (control) was 2.20 ±0.251 mg/dl and 2.15 ±0.163 mg/dl, respectively. Males and females with cardiovascular disease had significantly ($p< 0.05$) lower magnesium levels than healthy individuals (control). The highest mean magnesium level was 1.18 ±0.103 mg/dl in patients with cardiovascular diseases aged 35-50 years, and the lowest was 1.06 ±0.076 mg/dl in patients aged 61-75 years. The findings show that low magnesium levels in patients with cardiovascular disease rise with age, and patients with cardiovascular disease had significantly lower magnesium levels ($p< 0.05$) when compared to healthy people (control) in the same age group. In patients with cardiovascular disease, low magnesium levels are associated with poor outcomes.

Keywords: magnesium, cardiovascular disease, patients, hypomagnesemia, serum

Introduction

Cardiovascular disease has surpassed all other non-communicable diseases as the leading killer globally over the past 15 years. 15 million people perished from ischemic heart disease and stroke in 2015 (Aringazina *et al*., 2018). Although cardiovascular disease mortality has decreased in high-income nations, its prevalence is rising in low- and middle-income nations (Wuriea. and Cappuccioa, 2012). As a result, it's crucial to pinpoint potentially modifiable risk factors and put simple, affordable programs for health promotion.

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Magnesium is a necessary component of a healthy human body and is found in many foods naturally as well as dietary supplements. Nearly 24 g of magnesium are found in an adult's body, with 50-60% of that amount being found in bones and the remaining portion in soft tissues. Less than 1% of the body's total magnesium is represented in the serum magnesium level (Romani, 2013). More than 300 enzymatic processes, including those in charge of lipid peroxidation, blood pressure regulation, and glycemic control, require magnesium as a cofactor (Kebir and Zahzeh, 2022). Its potential target of action includes myocardial cells, smooth muscles, and platelets. DiNicolantonio *et al*. (2018) reported that because magnesium is a necessary cofactor for many enzymes, changes in intracellular and extracellular concentrations could affect a variety of metabolic pathways. This is especially true because magnesium is required for energy-dependent (adenosine triphosphate [ATP]) reactions.

Although serum magnesium levels may not accurately reflect intracellular magnesium, abnormal serum levels can cause pathology, particularly cardiovascular disease. A growing body of research indicates that low dietary magnesium intake increases the risk of cardiovascular disease and that higher magnesium intake enhances cardiovascular disease prevention and treatment (Geiger and Wanner *et al*., 2012). A mild-to-moderate magnesium deficiency increases the risk of abnormal cardiac excitation, atherosclerosis, ischemic heart disease, and congestive heart failure, whereas a severe magnesium deficiency increases the risk of ventricular dysrhythmias and sudden cardiac death. The cardiovascular system therefore depends on it (DiNicolantonio *et al*., 2018).

The maintenance of electrochemical gradients across cytoplasmic membranes is another important function of magnesium, which means that variations in magnesium concentration have an impact on membrane potentials and ion transport (Tan *et al*., 2021). Magnesium retention is a risk factor for magnesium imbalances in patients with kidney disease, and chronic hypomagnesemia can result from a variety of disorders of kidney tubular magnesium handling. Hypomagnesemia is a side effect of medications like chemotherapeutic agents and diuretics that is becoming more common (Geiger and Wanner *et al*., 2012). In addition, gastrointestinal losses from proton pump inhibitors may exacerbate magnesium imbalances and raise the risk of cardiovascular complications (Romani, 2013). Therefore, this study was conducted to evaluate the serum magnesium levels in male and female patients with cardiovascular diseases and of different ages.

Methodology

This study was conducted in 2023 over a six-month period on male (33) and female (27) patients (60) of various ages [35-50 (9), 51-65 (20), and 61-75 (31) years] suffering from cardiovascular diseases and 40 controls (20 male and 20 female) in a hospital in Basrah Governorate. Patients with hypokalemia and those who did not meet the diagnostic criteria for cardiovascular disease were excluded. Prior to participating in the study, all patients provided written consent after being informed of the potential benefits. The study was carried out with

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the approval of the Basrah Health Department, the hospital where the study was carried out, and the College of Health and Medical Technologies in Basrah, Southern Technical University.

Patients who were admitted to the hospital with cardiovascular disease had the appropriate history, physical examinations, and biochemical analysis as part of their evaluation routine. Full blood counts, urine tests, blood sugar, blood urea, serum creatinine, fasting lipid profiles, cardiac enzymes, and ECGS were all performed on all patients. The magnesium level in the blood was estimated after acceptance.

Participants' 5 ml venous blood samples were drawn under aseptic conditions in order to estimate the participants' serum magnesium levels. The blood samples were then centrifuged for 10 minutes at 3000 rpm, and the magnesium levels were determined using the magnesium kit (Biolabo, France).

The data were statistically analyzed using IBM-USA's statistics package for social sciences (SPSS), version 28 for Windows. The variables were expressed as mean standard deviation (SD).

Results

Table (1) shows the magnesium levels in male and female patients with cardiovascular disease as well as control groups. The mean magnesium level in males with cardiovascular disease was 1.14 ±0.103 mg/dl, while it was 1.08 ±0.094 mg/dl in females. The mean magnesium level in healthy males (control) was 2.20 ±0.251 mg/dl, while it was 2.15 ±0.163 mg/dl in healthy females. The results show that males and females with cardiovascular disease have lower magnesium levels than healthy males and females (control). The statistical analysis revealed that this decrease was significant at ($P< 0.05$).

Table (1): Magnesium level (mg/dl) in male and female cardiovascular patients and control groups.

Group	Gender	Mean	±SD	P value
Patients	Males	1.14	0.103	0.100*
	Females	1.08	0.094	
Control	Males	2.20	0.251	0.400*
	Females	2.15	0.163	

Table 2 shows the magnesium levels in patients with cardiovascular disease of various ages as well as control groups. The highest mean level of magnesium in patients with cardiovascular diseases aged 35-50 years was 1.18 ±0.103 mg/dl, while the lowest mean level of magnesium was 1.06 ±0.076 mg/dl in patients with cardiovascular diseases aged 61-75 years. The mean magnesium level in healthy individuals (control) ranged from 2.37 ±0.144

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mg/dl in the 35-50 year age group to 2.06 ±0.233 mg/dl in the 61-75 year age group. According to the findings, low magnesium levels in patients with cardiovascular disease increase with age (insignificantly at $p > 0.05$). The findings also revealed that patients with cardiovascular diseases had significantly lower magnesium levels ($p < 0.05$) when compared to healthy people (control) in the same age group.

Table (2): Magnesium level (mg/dl) in cardiovascular patients of different ages and control groups.

Group	Ages (years)	Mean	±SD	P value
Patients	35-50	1.18	0.103	0.020*
	51-65	1.16	0.100	
	61-75	1.06	0.076	
Control	35-50	2.37	0.144	0.001*
	51-65	2.11	0.133	
	61-75	2.06	0.233	

Discussion

Magnesium deficiency is a problem for people who have cardiovascular disease (Lal and Murmu, 2016). As a result, the purpose of this study was to assess serum magnesium levels in patients with cardiovascular disease and how they relate to heart problems.

According to the current study, patients with cardiovascular diseases have low magnesium levels (hypomagnesemia). There were no significant ($p > 0.05$) differences between males and females with cardiovascular disease, but there were significant ($p < 0.05$) differences between males and females with cardiovascular disease and healthy males and females. The study also found that magnesium levels in cardiovascular patients decline with age, with a non-significant result ($p > 0.05$). While there are significant differences ($p < 0.05$) between patients with cardiovascular disease and healthy people in all age groups studied.

A comparison of serum magnesium levels between the control group and the group of patients with cardiovascular disease in an Indian study revealed that the mean serum magnesium level among the patients was 1.01 mEq/l, with a range of 0.42-1.56 mEq/l, and was significantly lower. ($p < 0.01$) versus the control group (2.2 mEq/l) (Lal and Murmu, 2016). This is consistent with the findings of the current study.

A previous study revealed that serum magnesium was lower in cardiac patients than in controls (Subramanyam and Vakrani, 2015). Another study in cardiac patients showed that there were 16% and 34% of patients who had serum magnesium levels of less than 1.6 and 1.6-2.4 mg/dl, respectively (Akila *et al*., 2017). Our findings revealed that all participating patients

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with cardiovascular disease showed lower serum levels of magnesium compared to healthy individuals.

Low magnesium levels can be caused by a number of factors, including insufficient magnesium intake, chronic stress, malabsorption, and medications like diuretics (Romani, 2013). This was consistent with our findings, which revealed that when their medical history was reviewed, a higher proportion of cardiovascular disease patients were receiving diuretics.

A study divided 465 patients with cardiovascular disease into two groups based on serum magnesium levels. More patients with a serum magnesium level of ≤ 2.3 mg/dl had dyslipidemia, higher hemoglobin levels, and lower serum sodium, and were more likely to be given beta-blockers, angiotensin converting enzyme inhibitors or angiotensin receptor blockers, calcium channel blockers, and statins after admission (Mizuguchi *et al*., 2021). These findings were consistent with ours.

According to Masuda *et al*. (2016), people who received intravenous magnesium after an infarction had a significantly lower risk of passing away from complications associated with ischemic heart disease. Additionally, patients with low magnesium levels were more likely to develop arrhythmia, according to a study by Akila *et al*. (2017) conducted on a samples of patients.

According to a study done on 9005 cardiovascular disease patients, serum magnesium levels between 2.2 and 2.4 mg/dl and higher than 2.4 mg/dl were both highly significant predictors of all-cause in-hospital mortality. Additionally, a serum magnesium level of 2.2 to 2.4 mg/dl demonstrated a higher risk of in-hospital mortality compared to a level of more than 2.4 mg/dl (Tan *et al*., 2021). According to one study of Subramanyam and Vakrani, (2015), serum magnesium levels were lower in cardiovascular disease patients with complications than in those without complications. This was consistent with the findings of the current study.

The study's limitations include the fact that it was conducted at only one hospital, and we did not use a multivariate analysis to assess low magnesium levels as a risk factor for adverse outcomes. The study's strength was that it was a simple study with clear results.

Patients with cardiovascular disease have low serum magnesium levels. The development of other complications is associated with a low serum magnesium level. Future implications of the study include highlighting the significance of measuring serum magnesium levels in patients with cardiovascular disease. This could imply that serum magnesium levels can be used to predict whether cardiovascular disease will have a good or bad outcome. This could also be evidence that magnesium is useful in the treatment of cardiovascular disease. This, however, necessitates further investigation. More research on this topic is recommended.

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