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CORRELATION BETWEEN MAGNESIUM AND CALCIUM LEVELS ON HEALTH IN THE ELDERLY WITH DEGENERATIVE TYPE 2 DIABETES MELLITUS

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Keywords

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ABSTRACT

Diabetes Mellitus (DM) is a metabolic disorder characterized by elevated blood glucose levels due to decreased insulin secretion from pancreatic beta cells or insulin resistance. Magnesium and calcium are essential minerals that play crucial roles in various enzymatic activities, significantly influencing important biological functions, particularly in relation to metabolic syndrome. The purpose of the research is to investigate the correlation between magnesium and calcium levels in the serum of elderly individuals with type 2 diabetes mellitus. The study method is descriptive observation with cross-sectional studies. The examination sample used 25 serum samples of people with diabetes with age inclusion criteria over 50 years old without any other degenerative diseases. The analysis of the data from the results of the study was then carried out by the SpSS test of the relationship between magnesium levels and the condition of type 2 DM, especially in the context of aging and its impact on metabolic health. Based on the examination of magnesium levels using the xylidil blue method, 23 patients (92%) showed normal results, while 2 patients (8%) showed numbers above normal on average. There was no significant relationship between blood sugar and magnesium levels, blood sugar with calcium levels, and between magnesium with calcium with a significance of p 0.058, p 0.179, and p 0,114, respectively. The findings of this study could enhance the understanding of the complex interactions between these essential minerals and their potential roles in managing metabolic syndrome, ultimately contributing to better health outcomes for older adults with DM.

INTRODUCTION

Diabetes Mellitus (DM) is a metabolic disorder characterized by elevated blood glucose levels due to decreased insulin secretion from pancreatic beta cells or insulin resistance. The condition arises from impaired insulin production due to damage to these beta cells, often triggered by an autoimmune reaction that leads to inflammation and the formation of islet cell antibodies (ICA) that destroy beta cells. Additionally, DM can be caused by viral infections, including coxsackie virus, rubella, cytomegalovirus (CMV), and herpes (S. A. James & Joshua, 2024; Jeremiah et al., 2024; Smatti et al., 2019; Sundaresan et al., 2023; Thomas et al., 2022). Type 2 DM, also known as non-insulin-dependent or adult-onset diabetes, results from the body's ineffective use of insulin, influenced by a combination of genetic predisposition and environmental factors (Babu, 2023; Banwari et al., 2023; Bonnefond & Semple, 2022; Chandrasekaran & Weiskirchen, 2024; D. E. James et al., 2021).

People over the age of 50 are more susceptible to diabetes, this is because the aging process interferes with insulin secretion from cells in response to endogenous incretin (GIP) which is associated with a decrease in insulin sensitivity so that it triggers cell damage by inducing mitochondrial dysfunction. Impaired insulin sensitivity and insulin secretion gradually lead to impaired glucose tolerance into clinically manifested diabetes. The aging process in the elderly also causes chronic systemic inflammation, oxidative stress, DNA damage, decreased mitochondrial function, cellular aging, and tissue dysfunction, resulting in metabolic disorders (Aruan et al., 2023).

Fluid and electrolyte imbalances in the elderly are often caused by heart problems and kidney disorders, while activity greatly affects fluid and electrolyte needs. Body activity causes an increase in metabolic processes so that there is an increase in fluid production through sweat, thus the amount of fluid needed also increases (Périard et al., 2021; Zhong et al., 2022).

Magnesium is one of the six essential minerals contained in the human body, acting as a cofactor in more than 300 enzyme systems that regulate diverse biochemical reactions in the body, including DNA and protein synthesis, nerve and muscle function, regulating blood glucose levels, and regulating blood pressure. This mineral is most commonly found in bones, muscles, and tissues. Magnesium adequacy intake in DM patients is associated with homeostatic maintenance of blood sugar with the activation of factors that participate in the insulin sensitivity process. Lack of magnesium levels in the body can reduce the activity of tyrosine kinase in insulin receptors which will have an impact on decreasing insulin sensitivity (Amanda & Bening, 2019).

Calcium is an element that plays an important role not only in bone mineralization, but also has many different biological functions such as optimizing the transmission of nerve impulses, muscle contraction, blood clotting, hormone secretion, and intercellular adhesion. Calcium homeostasis disorders are common in diabetic patients with renal impairment or hypo/hyperparathyroidism, leading to calcium homeostasis disorders (Ahn et al., 2017). Insulin and glucagon secretion and insulin resistance are processes that depend on calcium homeostasis (Bartlett et al., 2014; Hughes et al., 2018).

Magnesium and calcium are essential minerals that play crucial roles in various enzymatic activities, significantly influencing important biological functions, particularly in relation to metabolic syndrome. These minerals contribute to the regulation of numerous physiological processes, including muscle contraction, nerve transmission, and the maintenance of bone health. Magnesium, for instance, is involved in over 300 enzymatic reactions, aiding in energy production and the synthesis of proteins and nucleic acids. Calcium, on the other hand, is vital for blood clotting, hormone secretion, and the functioning of cellular signaling pathways. The interplay between magnesium and calcium is particularly important in metabolic syndrome, where their adequate levels can help mitigate the risk factors associated with this condition, such as obesity, hypertension, and insulin resistance. Ensuring sufficient intake of these minerals may therefore be beneficial in managing and preventing metabolic syndrome and its associated complications.

When blood glucose levels increase, glucose is transported into the cell with the help of the GLUT-4 transporter, subsequently glucose is converted to glucose-6-phosphate with the help of glucokinase, oxidized to produce ATP which causes depolarization of the cell membrane due to the closure of potassium channels. This depolarization causes an increase in calcium flux through calcium channels leading to docking, insulin-containing vesicles fusing with cell membranes. The insulin is then secreted by exocytosis.

Increased intracellular calcium levels have been shown to reduce the effects of insulin in adipocytes due to reduced glucose transporter count (GLUT-4) and decreased insulin receptor

activity. Decreased expression of the GLUT-4 transporter resulting in reduced glucose absorption resulting in an increase in glucose concentration in plasma (Becerra-Tomás et al., 2014).

The primary purpose of the research is to investigate the correlation between magnesium and calcium levels in the serum of elderly individuals with type 2 diabetes mellitus (DM). The study aims to understand whether there is a significant relationship between these mineral levels and the condition of type 2 DM, particularly in the context of aging and its impact on metabolic health. This research contributes to the existing body of knowledge by highlighting the lack of correlation between magnesium and calcium levels in the elderly with type 2 DM, suggesting that these minerals may not directly influence each other in this population. Additionally, it underscores the need for further investigation by recommending an increase in sample size and the inclusion of additional parameters such as the calcium/magnesium (Ca/Mg) ratio and vitamin D levels. This could enhance the understanding of the complex interactions between these essential minerals and their potential roles in managing metabolic syndrome, ultimately contributing to better health outcomes for older adults with type 2 diabetes.

METHODS

The research method is descriptive observation with cross-sectional studies. The examination sample used 25 serum samples of people with diabetes mellitus with age inclusion criteria over 50 years old without any other degenerative diseases. The principle of magnesium serum examination based on the xylidyl blue test in an alkaline atmosphere forms a complex color that can be read on a spectrophotometry, while the calcium level examination uses the principle of O-cresolphthalein complex in an alkaline atmosphere to form a purple complex color and the intensity of the color formed is directly proportional to the calcium content and measured at a wavelength of 578 nm. The analysis of the data from the results of the study was then carried out by the SpSS test of the relationship between magnesium and calcium levels in the elderly with DMT2 cases.

RESULTS

The results of the descriptive test were obtained that the average blood sugar level in the 25 samples obtained was 221 mg/dl, the average calcium level in the blood was 13.92 mg/dl and the average magnesium level was 2.23 mg/dl. Normal blood sugar values 70-100 mg/dl, magnesium 1.9-2.5 mg/dl, calcium 8.1-10.4 mg/dl. The results of the spearman correlation analysis test found that there was no significance of the relationship between blood sugar and magnesium levels, blood sugar and calcium levels and between magnesium and calcium levels with a significance of p 0.058, p 0.179 and p 0.114, respectively.

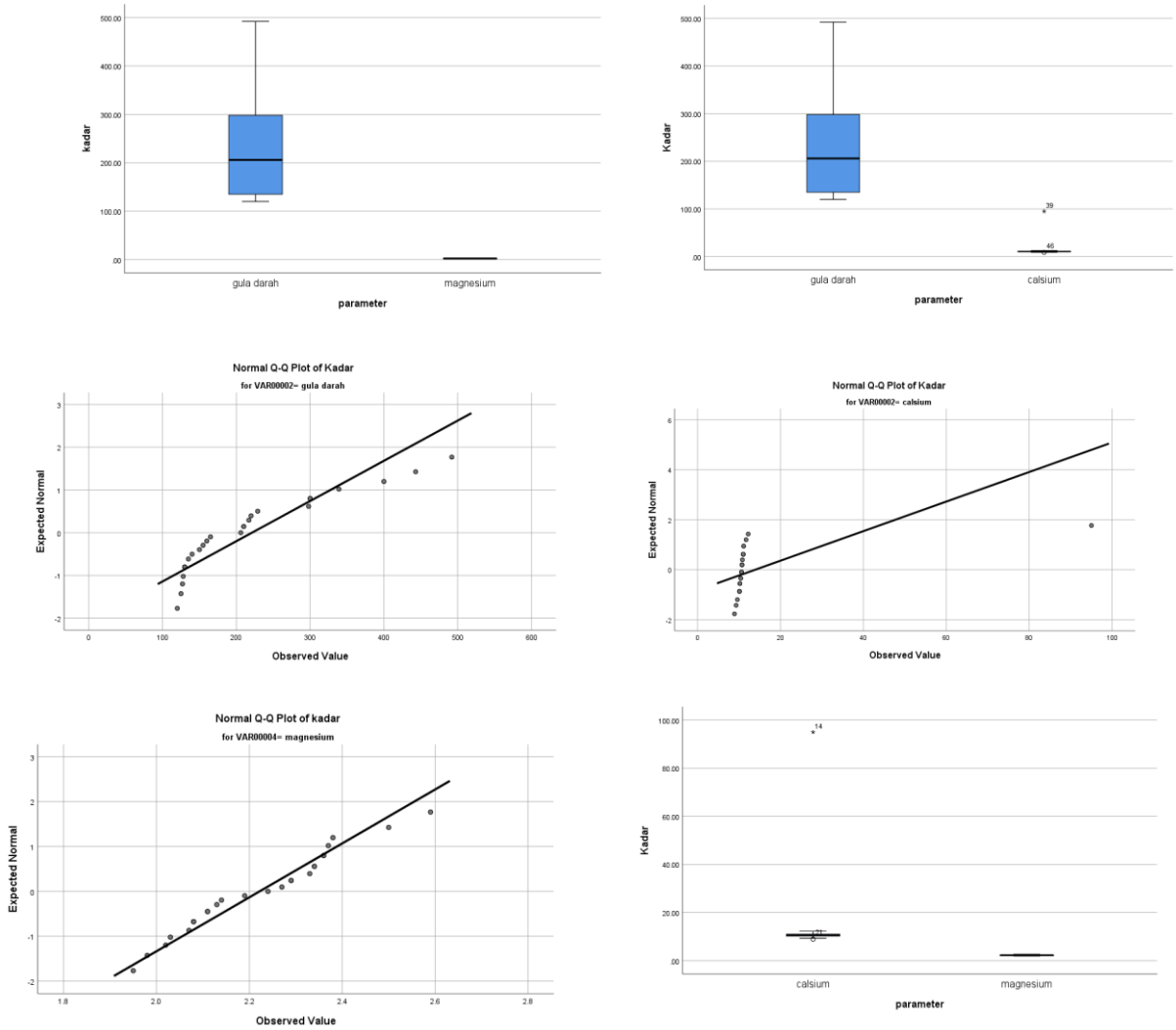

Figure 1. Test Results

Based on the examination of magnesium levels using the xylidil blue method in the serum samples of 25 patients with diabetes mellitus, 23 patients (92%) showed normal results, while the results of the examination of 2 patients (8%) showed numbers above normal.

The results obtained above are in accordance with the theory that the age variable over 55 years can increase the incidence of diabetes mellitus due to aging which causes a decrease in the sensitivity of the hormone insulin so that blood glucose levels that should enter the blood seem to remain in the bloodstream and cause blood glucose levels to increase. More than 80% of the 184 million people with diabetes are in the age range of 40-59 years. In older individuals, there is a decrease in mitochondrial activity in muscle cell cells by 35%. This is related to an increase in fat levels in muscles by 30% and triggers insulin resistance. The mechanism of magnesium deficiency in diabetic patients is still unclear, but diabetes is considered a triggering factor for increased urinary magnesium excretion. Some diseases related to the high incidence of hypermagnesemia are kidney failure. In addition, hypermagnesemia in this study may be caused by drug overdose treatment with magnesium-containing catharsis.

Judging from the distribution of data, there is a tendency that the higher the magnesium intake, the lower the blood glucose level. There is a relationship between magnesium intake and blood glucose levels. The higher the magnesium intake, the lower the blood glucose level, other researchers stated that magnesium as a micromineral plays an important role in glucose homeostasis and the action of the hormone insulin (Becerra-Tomás et al., 2014). The results of the study showed that

elderly patients with high sugar levels had calcium levels more than normal on average. This result is in accordance with research conducted by Cho et al. (2011) and Becerra-Tomás et al. (2014) which stated that the results of high calcium levels in hyperglycemia.

Diabetic patients should be evaluated for hypercalcemia given that untreated hyperparathyroidism is associated with hypertension. Dehydration is probably the most important contributing factor to hypercalcemia in this case. Decreased bone formation due to metabolic acidosis and increased bone mineral dissolution and resorption due to severe insulin deficiency. Inhibition of bone mineralization mediated by hyperglycemia, hypophosphatemia and immobilization are also among the factors that have the potential to contribute to hypercalcemia. In addition, diabetic patients who use thiazide diuretics are more prone to hypercalcemia.

The absence of a significant relationship between magnesium and calcium levels is according to a study conducted by Moia et al. (2024). Research has found that magnesium is an antagonist to the physiological of calcium. Research has also found that calcium directly or indirectly competes with magnesium for intestinal absorption and transport, this can happen because magnesium is thought to share ion channels with calcium.

CONCLUSION

The study found no relationship between magnesium and calcium levels in the elderly with type 2 diabetes mellitus, suggesting a need for further exploration. Future research should focus on expanding the sample size to improve statistical power and include additional parameters such as the calcium/magnesium (Ca/Mg) ratio and vitamin D levels. This approach could enhance the understanding of the complex interactions between these minerals and their roles in metabolic health. By investigating these factors in a larger and more diverse population, researchers may clarify subtle relationships and gain insights into how magnesium and calcium levels influence the management of type 2 diabetes in older adults.

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