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Comparative Efficacy of Magnesium and Potassium Towards CKMB and Quality of Life in Type 2 Diabetes Mellitus Patients

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ABSTRACT

Cardiovascular diseases like myocardial infarction and acute coronary syndrome are common complications in diabetes that can be diagnosed by performing various lab tests, like the Creatine Kinase Myocardial Band (CKMB) test, which is used to evaluate the cardiovascular risks in patients. **Objectives:** To compare the effects of magnesium and potassium supplementation on CKMB levels and quality of life in type 2 diabetes mellitus patients, focusing on their role in electrolyte balance and cardiovascular risk reduction. **Methods:** A randomized controlled trial (single-blind) was conducted at Lahore Garrison University, Lahore. Additionally, parameters related to diabetes management, such as blood glucose levels, HbA1c levels, magnesium, and potassium, were also evaluated. The study comprised 80 patients asked to check the effect of magnesium and potassium before and after a two-month dose of two months. Four groups were formed named T1, T2, T3, and T4, which were given a placebo, magnesium, potassium, and a combination of magnesium-potassium, respectively. **Results:** The Mean age of the participants was 49.675 ± 10.8660. Out of 80 participants, 28 (35%) were female and 52 (65%) were male. Potassium supplements significantly lowered the CKMB value in Type 2 Diabetes Mellitus (T2DM) patients, with the largest decrease in the T3 group. Quality of life was also improved significantly after using supplementation. **Conclusions:** The treatment positively affected the level of CKMB in the T3 group, which was provided with potassium supplements, suggesting that potassium is effective for lowering the CKMB values. This means that this supplement minimizes the risk of cardiac problems in T2DM.

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is an international crisis of health concern, firmly concerned with severe complications. Diabetes is accompanied by multiple risks, including both small blood vessel and large blood vessel complications, such as cardiovascular disease. These complications are caused by high blood sugar levels and other factors, such as insulin resistance. Several environmental (poor eating habits, lack of exercise, obesity) and genetic factors contribute to this disease [1].

The body's ability to convert food to energy is affected by T2DM. More than 90% of all diabetes cases are caused by this type, in which IR and impaired insulin secretion are common. Insulin is a hormone that assists the body in utilizing glucose for energy demand. In T2DM, the body becomes resistant to insulin. This means that the cells do not normally respond to insulin. In this case, insulin-producing cells do not work so efficiently that they can normalize the sugar level in the body or reduce the

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concentration of overproduction of glucose. There is another condition that is not considered diabetes, in which sugar levels are so high, still it is still known as pre-diabetes. Although the glucose level in this situation is more than its normal value, but not enough to be called diabetes [2]. The primary cause of passing away or becoming disabled in adults who have diabetes is cardiovascular disease (CVD). People with diabetes have an amplified risk of developing CVD than patients with no diabetes [3]. Although the specific etiology of the elevated risk of CVD in people with diabetes is not known, it is supposed to be triggered by several factors, including high blood sugar, cholesterol, triglycerides, oxidative stress, and blood pressure levels that can be reduced by routine checkups, taking medicine, and changing lifestyle [4]. Diabetes mellitus does not directly cause CVD. However, it increases the chances of getting CVD by damaging and destroying the elasticity of vessels that transport blood to the heart or from the heart to the body. Once a person with diabetes develops cardiovascular disease (CVD), their risk of experiencing a myocardial infarction (MI) is higher compared to individuals without diabetes. This is because the damage to their blood vessels makes it more likely that a blood clot will form. An enzyme called Creatine kinase (CK), located in muscle tissue, is released into the bloodstream after the damage in tissue. An elevated CK level in the blood is a sign of muscle damage. CK can be used to diagnose various medical conditions [5]. A test for CKMB, a type of CK, can be used to help diagnose a heart attack. Troponin is another protein that is released from heart muscle cells when they are damaged. Troponin levels in the blood can also be utilized to assist in identifying a stroke. Early intervention can increase the possibility of recovery and lessen damage to the cardiac muscle [6]. By 2025, the World Health Organization (WHO) predicts that about 360 million people globally will have DM. Another biggest health risks to people in the twenty-first century is CVD. The prevalence and mortality of CVD continue to rise steadily. In China, 230 million individuals have a CVD, and 3 million people pass away from a CVD each year [7]. Electrolytes play a crucial role in this context. Potassium supplementation has been shown to benefit individuals with hypertension by lowering blood pressure and stroke risk [8]. Magnesium is vital for numerous bodily functions, including insulin secretion, glucose metabolism, and cardiovascular health, with its deficiency being linked to an increased risk of CVD and diabetes [9, 10].

This study aims to determine the effects of magnesium and potassium on CK-MB in diabetic patients and to check the quality of life, including physical functioning, mental health, social functioning, vitality, and overall well-being, before and after supplementation.

METHODS

This single-blind randomized controlled trial was conducted at Lahore Garrison University. The trial was registered at ClinicalTrials.gov (RCT No. NCT04642313), and ethical approval was obtained from the university's ethical committee (Ref. No. 003). All ethical guidelines set by the committee were strictly followed, and the rights of all research participants were respected. The study duration was six months (August 2022 to January 2023). Non-probability convenience sampling was used after obtaining written informed consent. 10cc blood from male and female genders with ages 26-80 years was collected in a gel blood tube using a BD sterilized syringe by venipuncture in Akhuwat Foundation. 80 patients with Type 2 Diabetes Mellitus (T2DM), aged 26-80 years, were selected based on demographic variables and Body Mass Index (BMI). Individuals were excluded if they had a history of alcohol consumption, smoking, nephropathy, chronic liver disease, were under 19 or over 85 years of age, or had taken any nutritional supplements or medications within the past 90 days. The sample size of 80 patients (20 per group) was adequate to detect meaningful differences in CKMB with 80% power. Baseline data on socioeconomic status, comorbidities, and diabetes duration were recorded to control for confounders. Confidentiality was maintained through de-identification and secure data storage. Diagnosis of Diabetes Mellitus was based on WHO criteria (random blood glucose ≥11.1 mmol/L). Blood samples were collected and processed; glucose was estimated in plasma, and electrolytes in serum. HbA1c was analyzed from whole blood, while blood glucose, magnesium, potassium, and CK-MB were measured using a Cobas 6000 Roche analyzer. Accuracy and precision were ensured by internal and external quality control measures. Patients were randomly divided into four groups: The placebo group (T1) received starch tablets (250 mg twice daily). The magnesium group (T2) was given magnesium supplements (Ostin, 250 mg twice daily). The potassium group (T3) received potassium supplements (Paravit, 250 mg twice daily). The combination group (T4) was administered both magnesium and potassium (Bionta, each at 250 mg twice daily). An 8-week supplementation period was chosen. Samples were taken before and after the 8-week supplementation. Data were analyzed using SPSS 25.0. Qualitative variables were presented by frequency and percentage, and quantitative variables by Mean and SD. Comparison among groups was conducted by applying the ANOVA test; a p-value<0.05 was considered significant. ANOVA was applied as it enables comparison of mean values across all four groups simultaneously, minimizing type I error compared to multiple t-tests.

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RESULTS

Results show descriptive statistics for the variable age. A total of 80 patients were included in the study. The minimum age value was 26, and the maximum age value was 80. The Mean age of the participants was 49.675 ± 10.8660 (Table 1).

Table 1: Descriptive Statistics of Age

Variables	Total	Minimum	Maximum	Mean ± SD
Age	80	26	80	49.675 ± 10.8660

Findings show the frequency % of participants. In the age group 26-40 years, there were 14(17.5%) participants. In the age group 41-55 years were 42 (52.5%). In the age group 56-80 years were 24 (30%). Additionally, out of 80 participants, 28 (35%) were female and 52 (65%) were male (Table 2).

Table 2: Frequency of Age in T2DM and Descriptive Statistics of Gender

Variables		n (%)
Age (Years)	26-40	14 (17.5%)
	41-55	42 (52.5%)
	56-80	24 (30%)
Gender	Female	28 (35%)
	Male	52 (65%)
	Total	80 (100%)

The mean values for random blood sugar levels (BS/R) Pre-treatment were 241.7 ± 72.3 in T1, 241.3 ± 72.1 in T2, 220.8 ± 97.1 in T3, and 227.9 ± 91.6 in T4. Post-treatment mean values of BS/R were 170.75 ± 40.74 in T1, 171.85 ± 34.82 in T2, 147.05 ± 37.77 in T3 and 165.50 ± 57.55 in T4. Further, The Pre-treatment mean values for Mg+ were relatively consistent across all groups, i.e., 2.1 ± 0.4 in T1, 1.8 ± 0.4 in T2, 2.0 ± 0.2 in T3, and 2.2 ± 0.3 in T4. Post-treatment means values of Mg+ were 2.1 ± 0.3 in T1, 22.1 ± 0.2 in T2, 2.1 ± 0.2 in T3 and 2.2 ± 0.3 in T4. The Pre-treatment mean values for K+ were 2.6 ± 0.9 in T1, 4.7 ± 0.6 in T2, 4.2 ± 0.5 in T3, and 4.1 ± 0.4 in T4. The Post-treatment mean values for K+ were 5.4 ± 1.8 in T1, 4.9 ± 1.7 in T2, 4.5 ± 0.8 in T3, and 4.6 ± 0.6 in T4. The Pre-treatment mean values for HbA1c were 10.2 ± 0.6 in T1, 9.2 ± 1.1 in T2, 9.5 ± 1.5 in T3, and 9.9 ± 1.7 in T4. The Post-treatment mean values for HbA1c were 8.54 ± 1.43 in T1, 8.24 ± 0.98 in T2, 7.86 ± 1.12 in T3 and 8.41 ± 1.72 in T4. The mean values for CK-MB before treatment were 16.5 ± 3.7 in T1, 23.7 ± 5.1 in T2, 30.4 ± 14.8 in T3 and 23.9 ± 6.2 in T4. The mean values for CKMB after treatment were 25.4 ± 5.6 in T1, 21.7 ± 6.7 in T2, 26.4 ± 20.2 in T3, and 20.9 ± 6.7 in T4 (Table 3).

Table 3: Mean Values of Pre and Post Treatment BS/R Levels, Mg+ Levels, K+ Levels, HbA1c Levels and CKMB Levels

Group	Pre-Treatment Mean ± SD	Post-Treatment Mean ± SD
T1 (Placebo)	241.7 ± 72.3	170.8 ± 40.7
T2 (Magnesium)	241.3 ± 72.7	171.9 ± 34.8
T3 (Potassium)	220.8 ± 97.1	147.1 ± 37.8
T4 (Magnesium + Potassium)	227.9 ± 91.6	165.5 ± 57.6
T1 (Placebo)	2.1 ± 0.4	2.1 ± 0.3
T2 (Magnesium)	1.8 ± 0.4	2.1 ± 0.2
T3 (Potassium)	2.0 ± 0.2	2.1 ± 0.2
T4 (Magnesium + Potassium)	2.2 ± 0.3	2.2 ± 0.3
T1 (Placebo)	2.6 ± 0.9	5.4 ± 1.8
T2 (Magnesium)	4.7 ± 0.6	4.9 ± 1.7
T3 (Potassium)	4.2 ± 0.5	4.5 ± 0.8
T4 (Magnesium + Potassium)	4.1 ± 0.4	4.6 ± 0.6
T1 (Placebo)	10.2 ± 0.6	8.54 ± 1.43
T2 (Magnesium)	9.2 ± 1.1	8.24 ± 0.98
T3 (Potassium)	9.5 ± 1.5	7.86 ± 1.12
T4 (Magnesium + Potassium)	9.9 ± 1.7	8.41 ± 1.72
T1 (Placebo)	16.5 ± 3.7	25.4 ± 5.6
T2 (Magnesium)	23.7 ± 5.1	21.7 ± 6.7
T3 (Potassium)	30.4 ± 14.8	26.4 ± 20.2
T4 (Magnesium + Potassium)	23.9 ± 6.2	20.9 ± 6.7

The p-value of 0.253 sugar level indicates that there is no significant difference in blood sugar levels between different groups. A p-value of 0.674 Mg+ levels indicates no significant difference in magnesium levels between different groups. A p-value of 0.183 for K+ levels indicated no significant difference in potassium levels between different groups. The p-value of HbA1c levels was 0.407, indicating no significant difference in HbA1c levels between different groups. A p-value of CK-MB levels was 0.347, indicating that no significant difference in CK-MB levels between different groups (Table 4).

Table 4: Descriptive Statistics of BS, Mg, K, HbA1c, and CK-MB in T2DM Patients

Variable		Mean ± SD	95% Confidence Interval for Mean		Min	Max	p-Value
			Lower Bound	Upper Bound			
After-BS	T1	170.7500 ± 40.73906	151.6835	189.8165	108.00	248.00	0.253
	T2	171.8500 ± 34.82479	155.5515	188.1485	110.00	248.00	
	T3	147.0500 ± 37.77283	129.3718	164.7282	87.00	242.00	
	T4	165.5000 ± 57.55135	138.5651	192.4349	.00	265.00	
	Total	163.7875 ± 43.94291	154.0085	173.5665	.00	265.00	

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After-Mg	T1	2.06 ± 0.3050	1.917	2.203	1.7	3.0	0.674
	T2	2.140 ± 0.2186	2.038	2.242	1.8	2.6	
	T3	2.145 ± 0.2481	2.029	2.261	1.7	2.6	
	T4	2.155±.3103	2.010	2.300	1.7	3.0	
	Total	2.125 ± 0.2707	2.065	2.185	1.7	3.0	
After-K	T1	5.355 ± 1.7557	4.533	6.177	4.1	9.3	0.183
	T2	4.875 ± 1.6667	4.095	5.655	3.6	9.3	
	T3	4.520 ± 0.8082	4.142	4.898	3.5	6.7	
	T4	4.590 ± 0.6431	4.289	4.891	3.6	5.8	
	Total	4.835 ± 1.3324	4.538	5.132	3.5	9.3	
After HbA1c	T1	8.5385 ± 1.42857	7.8699	9.2071	5.20	10.60	0.407
	T2	8.2440 ± 0.97914	7.7857	8.7023	7.00	9.60	
	T3	7.8555 ± 1.11525	7.3335	8.3775	5.40	9.36	
	T4	8.4135 ± 1.72357	7.6068	9.2202	5.20	11.40	
	Total	8.2629 ± 1.34242	7.9641	8.5616	5.20	11.40	
After CK-MB	T1	25.425 ± 5.5829	22.812	28.038	16.0	36.0	0.347
	T2	21.665 ± 6.6777	18.540	24.790	9.9	30.3	
	T3	26.400 ± 20.1532	16.968	35.832	9.9	89.0	
	T4	20.925 ± 6.6958	17.791	24.059	9.9	36.0	
	Total	23.604 ± 11.5010	21.044	26.163	9.9	89.0	

This study shows the results of potassium and magnesium before and after treatment on the quality of life among patients with T2DM. In QOL before treatment Mean ± SD value for T1 was 59.4 ± 5.87. Mean ± SD value for T2 was 65.1 ± 10.1. Mean ± SD value for T3 was 63.2 ± 6.96. Mean ± SD value for T4 was 60.7 ± 5.44. In QOL after treatment Mean ± SD value for T1 was 55.6 ± 11.2. Mean ± SD value for T2 was 55.9 ± 9.18. Mean ± SD value for T3 was 69.9 ± 6.91. Mean ± SD value for T4 was 55.0 ± 8.39. A p-value of T1 was 0.237, T2 was 0.011, T3 was 0.010, and T4 was 0.030. Significant difference in the QOL score was seen among T2, T3, and T4 (Table 5).

Table 5: Quality of Life in Pre and Post Treatment of Potassium and Magnesium Supplements in T2DM Patients

Variables	T1	T2	T3	T4
		Mean ± SD		
Pre-QOL	59.4 ± 5.87	65.1 ± 10.1	63.2 ± 6.96	60.7 ± 5.44
Post-QOL	55.6 ± 11.2	55.9 ± 9.18	69.9 ± 6.91	55.0 ± 8.39
p-Value	0.237	0.011	0.010	0.030

DISCUSSION

This research investigates the effects of Magnesium (Mg) and Potassium (K) in diabetic patients. Potassium is crucial for heart rate regulation, and its imbalance can cause severe cardiac and muscular issues, with levels being affected by heart attacks and kidney function [11]. A strong link exists between diabetes and heart disease, with glucose control being vital for reducing cardiovascular disease (CVD) risk [12, 13]. Furthermore, elevated CK-MB levels after procedures like percutaneous coronary intervention (PCI) indicate a higher risk of cardiac death [14]. Magnesium deficiency can lead to oxidative stress and impair nitric oxide release, increasing CVD risk by causing blood vessel narrowing [15]. The present study of 80 patients showed post-treatment decreases in blood sugar (BS/R) across all groups, with the greatest reduction in the potassium group (T3). Previous research aligns with the benefits of magnesium supplementation for diabetic patients with heart disease [16]. Research on potassium in diabetics is limited. While past studies on hypokalemia [17] and muscle damage show that potassium supplementation normalizes serum levels, similar to the current findings, they did not focus on supplements in diabetics. HbA1c levels decreased in all groups post-treatment, underscoring the role of micronutrients in glycemic control and highlighting a gap in research on minerals like K+ and Mg+ in Type 2 Diabetes Mellitus (T2DM) [18]. CKMB levels were significantly affected by treatment. The potassium group (T3) showed a decrease from the highest pre-treatment level, while the placebo group (T1) saw an increase. An electrolyte imbalance, particularly low potassium, can raise CKMB, suggesting a role in heart disease [19]. The participants of another study were 93 (32.1) male and 197 (67.9) female. Based on the analysis, it was found that the treatment groups were significantly associated with ISI after the trial (post-trial), p=0.0001. It was found that pre- and post-serum cortisol levels of groups 2, 3, and 4 (T2, T3, and T4) have a significant association, as the p-values are 0.001, 0.001, and 0.001, respectively. The same was also found in serum melatonin [20]. The mean value of the participants was 51.0139 females (69.5%) and 26 males (30.5%). The quality of life measure did not correlate with the pre- and post-magnesium and potassium supplementation levels of

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cholesterol in the patients. In addition, the kidney and liver pointers were independent of the cholesterol levels of the diabetic individuals[21].

CONCLUSIONS

The association of T2DM and serum electrolytes was crucial for maintaining the CKMB. Serum electrolytes such as Mg+ and K+ were found to be pivotal in maintaining, stabilizing, and reducing the risk of CKMB in T2DM patients. The study demonstrated that treatment with supplements resulted in a decrease in HbA1c levels across all four groups. This study also concluded that the poor quality of life among diabetic patients had a detrimental effect on CKMB levels, as well as magnesium and potassium levels in the body.

Authors Contribution

Conceptualization: MA
Methodology: MA
Formal analysis: MA, UR, SK, NI, RHU
Writing review and editing: MA, UR, SH, AZ

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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