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Association of cholesterol with hepatorenal markers and quality of life in diabetic patients before and after magnesium and potassium supplements

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ABSTRACT

Background: Magnesium and potassium are two critical minerals that have been linked to the treatment of diabetes and its consequences. A lack of magnesium has been linked to insulin resistance and diabetes, whereas potassium has been found to promote insulin sensitivity and glucose metabolism. The study aimed to determine the relationship between cholesterol, liver and kidney markers, and quality of life in diabetic patients before and after magnesium and potassium supplementation.

Methods: It was a single-blind randomized controlled study at Lahore Garrison University and Lahore Medical Research Centre (LMRC). The study included 200 diabetes participants. Four groups were made based on supplements. Blood samples of all diabetes patients were obtained to assess their quality of life before and after using Mg + and K + supplements, as well as the association between cholesterol, liver, and kidney markers.

Results: The participants' average age was 51.0 ± 11.08. 139 (69.5 %) of the 200 participants were female, whereas 26 (30.5 %) were male. There was no correlation between the quality of life measure and the patients' cholesterol levels before and after the magnesium and potassium supplementation. Furthermore, the kidney and liver indicators were not dependent on the diabetes individuals' cholesterol levels.

Conclusions: The study concluded that none of the four groups noticed a significant effect of magnesium and potassium therapies on the patient's quality of life or cholesterol levels. However, more research is needed to determine if liver and kidney problems are linked to cholesterol levels before and after medication, as the current study found no significant correlation between the two parameters.

1. Introduction

Diabetes impacts numerous organs, including the liver, which is essential for controlling the digestion of proteins, lipids, and carbohydrates (Bhatt and Smith, 2015). Liver enzymes including Alanine aminotransferase (ALT) and Aspartate Aminotransferase (AST) are considered substitute indicators and markers for testing the function of the liver (Agrawal et al., 2016). The bidirectional transamination of L-alanine and ketoglutarate to produce pyruvate and L-glutamate is catalyzed by ALT, which is crucial for gluconeogenesis and the metabolism of amino acids. The ALT enzyme is mainly active in the liver, but it is also present in other systems such as the muscle, heart, kidney, brain, and adipose tissue, albeit at much lesser levels (Sookoian and Pirola, 2012). Transamination reactions are catalyzed by AST. AST is

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most abundant in the heart when compared to other bodily parts like the liver, skeletal muscle, and kidney (Mauro and Renze, 2006). Several studies have linked diseases like Cardiovascular illnesses, metabolic syndrome (MetS) and Type 2 Diabetes Mellitus (T2DM) (Sattar et al., 2004; Vozarova et al., 2002; André et al., 2005). In a *meta*-analysis done in 2009, increased ALT was linked to a higher risk of T2DM (Fraser et al., 2009). Diabetes affects several organs including kidneys, lungs and liver. The kidney is a key component of the human body's homeostatic system. Urea, Uric acid and creatinine control mechanisms of various forms of filtering, reabsorption, and release and are responsible for controlling the body's electrolyte, protein, and metabolite equilibrium. Chronic Kidney Disease (CKD) is a frequently associated comorbidity with diabetes and there is a close relation between diabetes and renal disease (El Nahas and Bello, 2005). A useful biomarker of early-stage CKD is serum creatinine (Cr), which is a frequently used sign for identifying minor variations in glomerular filtration rate (GFR). Increased risk of cardiovascular diseases, fat, and hypertension was discovered to be related to raised Cr amounts in the blood (Joffe et al., 2010; Coresh et al., 2001; Muntner et al., 2002). Similar to this, increased amounts of serum uric acid (UA) have also been linked to CVD, hypertension, and reduced renal function (Feig, 2009; Mankovsky et al., 2010; Johnson et al., 2005). Studies have also shown that blood UA, by itself, is a powerful predictor of T2DM (Kodama et al., 2009). Magnesium and potassium are two essential minerals that have been shown to play a role in the management of diabetes and its associated complications. Magnesium deficiency has been associated with insulin resistance and diabetes, while potassium has been shown to improve insulin sensitivity and glucose metabolism (Volpe, 2013; Ekmekcioglu et al., 2016). This study aimed to investigate the association of cholesterol with liver and kidney markers in diabetic patients before and after magnesium and potassium intervention. The study also assessed the impact of the intervention on lipid profile, liver enzymes, and kidney function. This study may provide valuable insights into the potential benefits of magnesium and potassium supplementation in diabetic patients, particularly in those with liver and kidney dysfunction. Poor QoL has been linked to both diabetes and depression (Egede and Hernández-Tejada, 2013). The subjective assessment of one's physical and mental health is known as QoL. In contrast to doctor-ordered laboratory tests, measuring the QoL gives the clinician a subjective indication of how the condition is affecting the patient's ability to operate daily. The evaluation of a patient's psychological functioning, the identification of particular weaknesses, and the demands of patients at various phases of the disease are all made easier with the aid of studies on QoL. They aid in comparing the effects of various treatment plans on the satisfaction and well-being of patients (Snoek, 2000). In some situations, these findings from the research of QoL can aid a clinician's capacity to forecast treatment response and survival time (Acharya et al., 2014). This comparison research has given doctors crucial knowledge to support clinical judgment, taking into account both biological and psychosocial factors (Snoek, 2000).

2. Material and methods

2.1. Study design

This study used a comprehensive and systematic approach to investigate the effects of magnesium and potassium supplements on cholesterol regulation in diabetic patients. A single-blind randomized and controlled trial was performed to ensure the validity and reliability of the study results.

2.2. Study setting

The trial was conducted at Lahore Garrison University and Lahore Medical Research Center over an intensive period of 9 months, covering the period from September 2022 to May 2023.

2.3. Ethical considerations

Before the initiation of the study, ethical approval was obtained from the Ethical Review Committee of Lahore Garrison University. Informed and voluntary consent was obtained from each participant before inclusion in the trial.

2.4. Recruitment and participants

A group of 200 diabetic patients receiving medical care from the Akhuwat Foundation, Lahore actively participated in the study. The study participants included all genders (males = 61, females = 139) with ages ranging from 26 to 80 years (Fig. 1) and ensured that they did not exhibit any contraindications such as pregnancy, diabetic nephropathy, or psychiatric conditions.

2.5. Sample collection and Grouping

Blood samples of 10 cc were collected from all participants by venipuncture using sterile syringes. These samples were carefully preserved in the Biology Research Laboratory at Lahore Garrison University. Subsequent experimental procedures were performed at the Lahore Medical Research Centre following scientific standards. To carefully evaluate the effects of magnesium and potassium supplements on cholesterol levels in diabetic patients, the participants were judiciously divided into four distinct groups (Table 1):

2.6. Intervention

For Placebo tablets starch (250 mg in each tablet) was used. For Mg tablets magnesium gluconate salt was used (each containing 414 mg magnesium gluconate as 250 mg elemental Mg^{+2}). For K^{+} tablets Potassium chloride salt was used. Child safe bottle packing (of 60 each) was used. Tablets were stored at cool dry place, and were provided to patients on monthly basis. In each group, 1 tablet was given in morning and evening for two months.

Cholesterol levels of all blood samples were assessed by a chemistry analyzer. Blood samples were taken on two different occasions; first before magnesium and potassium supplementation and second after 60 days of supplementation.

2.7. Data collection

A carefully designed questionnaire was used that covers details related to diabetes and QoL along with socio-demographic information. It ensures an overall assessment of the patient's well-being and its open-ended response format facilitates an accurate and individualized assessment of the quality of life. The World Health Organization Quality of Life Questionnaire, or WHOQOL, is used in this research to evaluate the quality of life for diabetic individuals who have cardiovascular

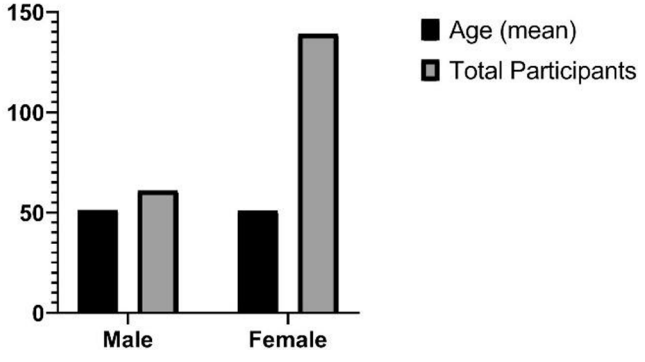

Fig. 1. Average age of the participants.

Table 1
Grouping of the study participants.

Group	T	Parameter
I	1	(Control or placebo group) This group received no supplement.
II	2	Participants in this group were given magnesium supplements.
III	3	This group received potassium supplements.
IV	4	Participants in this group were subjected to a combined treatment of magnesium and potassium supplements.

disease. The WHOQOL-BREF, a validated brief version of the questionnaire, is a cross-culturally applicable tool. The social, environmental, physical, and psychological domains—which include the whole spectrum of quality of life deficiencies—are assessed in this questionnaire in order to determine the overall quality of life. The straightforward style of the questionnaire allows for accurate differentiation of QoL between people. Face-to-face interviews with patients were done for this research after their agreement to participate. The participants were informed about the purpose and nature of the research prior to the interviews. All uncertainties were addressed. The manual's scoring rules were followed while scoring the WHOQOL-BREF component of the questionnaire.

2.8. Statistical analysis

A rigorous statistical analysis was performed on the collected data using Graph Pad Prism version 8.0.2. All the qualitative variables were presented by frequency and percentages and quantitative with mean ± SD. Comparison among groups were conducted by applying Chi Square and two way ANOVA test. P-Value < 0.05 was considered significant.

3. Results

3.1. QoL before and after intervention

Mean HbA1c of participants were 7.77 ± 2.10 while mean BMI of participants were 31.00 ± 23.68. As discussed earlier, there are 4 groups based on specific interventions. Pre QOL refers to the quality of life before any type of therapy while post QOL describes the quality of life after the intervention. Table 2 shows that the mean value of group T2 before receiving magnesium was 72.41 ± 7.55 and the mean value after magnesium intervention was 47.6 ± 4.8. P-values for all groups were calculated using a two-way ANOVA test. The p-value of T2 was 0.000 which means that magnesium therapy affects the quality of life of diabetic patients. For group T3, the mean value of potassium before receiving the intervention was 74.19 ± 7.16 and the mean value after therapy was 48.7 ± 4.69, indicating a significant effect ($p = 0.010$) of potassium on the quality of life of diabetic patients. Group T4 which received both magnesium and potassium treatment showed a mean value of 84.52 ± 4.81 with significance before and after intervention was 55.4 ± 8.55 ($p = 0.000$).

3.2. Cholesterol and physiological symptoms of QoL

In the age group 26–45 years, there was no male and female with normal as well as high range of cholesterol values in the physiological score range of 0–7 and 8–14. In the score range 15–21, two females were present with normal cholesterol range and for high cholesterol, there were 2 males and 6 females. In the score range 22–28, 10 males and 15 females had normal cholesterol levels and 14 males and 24 females had high cholesterol. In the score range 29–35 of the physiological symptoms, only 1 female was with normal cholesterol. There was no person with physiological symptoms ranges of 0–7 and 8–14 both for normal cholesterol as well as high cholesterol values. In the age group 46–65 years and with the range 15–21 physiological symptoms, there were 3 males and 14 females with normal cholesterol values and 4 males and 12 females with high cholesterol values. For the range 22–28 years, there were 11 males and 17 females with normal cholesterol and 12 males and 35 females with high cholesterol values. For the physiological symptoms range 29–35, there were 1 male and 1 female present with high cholesterol values, for the age group 66–80 years, there were 3 males and 1 female with range 15–21 and with normal cholesterol while 1 male and 3 females were with high cholesterol values. There were 2 females with normal cholesterol values and 3 males and 3 females with high cholesterol values and in the range of 22–28 physiological symptoms. The p-value was calculated as 0.7398 means that the physiological parameters of the quality of life were not affected by the cholesterol levels of the diabetic patients (Table 3).

Table 2
Pre-QOL and post-QOL values after magnesium and potassium intervention.

QOL	T1		T2		T3		T4	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Pre QOL	81.33	7.24	72.41	7.55	74.19	7.16	84.52	4.81
Post QOL	79.6	11.2	47.6	4.8	48.7	4.69	55.4	8.55
p-value	0.32		0.000		0.010		0.000	

3.3. Cholesterol and environmental symptoms of QoL

In the age group 26–45 years, there was no male and female with normal as well as high range of cholesterol values in the environmental symptoms score range of 0–8. In the score range 9–16, 1 female was present with a normal cholesterol range and for high cholesterol, there was also a single female. In the environmental symptoms score range 17–24, there were 7 males and 11 females with normal cholesterol levels and 9 males and 16 females with high cholesterol. In the score range, 25–32 of the environmental symptoms range, 6 males and 4 females with normal cholesterol values and 2 males and 16 females with high cholesterol values. For the range 33–40, only 1 female was with normal cholesterol. There was no person within the environmental symptoms range of 0–8 and 9–16 along with normal and high cholesterol in the age group 46–65 years. In the range 17–24, there were 11 males and 22 females with normal cholesterol values and 9 males and 31 females with high cholesterol values. In the same way, the range 25–32 consisted of 4 males and 4 females with normal cholesterol values and 7 males and 19 females with high levels of cholesterol values. The p-value was calculated as 0.7809 by 2-way ANOVA, which means that the environmental parameters also do not have any effect on the quality of life of diabetic patients (Table 4).

3.4. Cholesterol and psychological symptoms of QoL

For the age group 26–45 years, there was no male and female with normal as well as high range of cholesterol values in the psychological symptoms score ranges of 0–6, 7–12. In the score range 13–18, there were 2 males and 3 females with normal cholesterol, and 4 males and 6 females with high cholesterol levels. In the psychological symptoms score range 19–24, there were 7 males and 12 females with normal cholesterol levels and 9 males and 17 females with high cholesterol. In the score range, 25–30 of the psychological symptoms range, 1 male and 3 females with normal cholesterol values and 3 males and 6 females with high cholesterol values. For the age group 46–65 years, there was 1 male with normal cholesterol value and 1 male with high cholesterol values within the range 0–6. In the range 7–12, there were 1 female with normal cholesterol value. For the range 13–18, there were 5 males and 9 females with normal cholesterol values and 1 male and 7 females with high cholesterol values. For the range 19–24, there were 7 males along with 16 females having normal cholesterol values and 12 males and 34 females having high cholesterol values. For the range 25–30, there was 1 male, 5 females with normal cholesterol values and 9 females with high levels of cholesterol. For the age group 66–80 years, there were 1 male and 1 female with normal levels of cholesterol and 2 females with high

Table 3
Association of cholesterol with QOL (Physical Symptoms).

QOL (Physiological symptoms)	Normal Cholesterol						High Cholesterol						p-value
	26–45 Y		46–65 Y		66–80 Y		26–45		46–65 Y		66–80 Y		0.7398
	M	F	M	F	M	F	M	F	M	F	M	F	
0–7	0	0	0	0	0	0	0	0	0	0	0	0	
8–14	0	0	0	0	0	1	0	0	0	0	0	0	
15–21	0	2	3	14	3	1	2	6	4	12	1	3	
22–28	10	15	11	17	0	2	14	24	12	35	3	3	
29–35	0	1	0	0	0	0	0	0	1	1	0	0	
Total	10	18	14	31	3	4	16	30	17	48	4	6	
	28		45		7		46		65		10		
	80						120						
	200												

Table 4
Association of cholesterol with QOL (Environmental Symptoms).

QOL (Environmental symptoms)	Normal level						High level						P-value
	26-45Y		46-65Y		66-80Y		26-45Y		46-65Y		66-80Y		0.7809
	M	F	M	F	M	F	M	F	M	F	M	F	
0–8	0	0	0	0	0	0	0	0	0	0	0	0	
9–16	0	1	0	0	0	0	0	1	0	0	0	0	
17–24	7	11	11	22	3	3	9	16	9	31	2	4	
25–32	6	4	4	4	0	1	2	16	7	19	2	2	
33–40	0	1	0	1	0	0	2	0	0	1	0	0	
Total	13	17	15	27	3	4	13	32	16	51	4	5	
	30		42		7		45		67		9		
	79						121						
	200												

levels of cholesterol within the range score of 13–18. For the score 19–24, there were 2 males and 3 females with normal cholesterol values and 3 males and 3 females with high levels of cholesterol. For the last range score 25–30, there were 1 male and 2 females with high levels of cholesterol. The p-value was calculated as 0.366 by 2-way ANOVA, which means that the psychological parameters also do not have any effect on the quality of life of diabetic patients (Table 5).

3.5. Cholesterol and social symptoms of QoL

For the age group 26–45 years, there was no male and female with normal as well as high range of cholesterol values in the social symptoms score ranges of 0–3. In the score range of 4–6, there was 1 male with normal cholesterol. In the social symptoms score range 7–9, there was 1 male and 3 females with normal cholesterol levels and 3 males and 8 females with high cholesterol. In the social symptoms score range 10–12, 7 males and 14 females with normal cholesterol values and 10 males and 18 females were present with high cholesterol values. In the score range 13–15, there was 1 male and 1 female with normal cholesterol value and 3 males and 4 females with high levels of cholesterol. For the age group 46–65 years, there was 1 male with a high cholesterol level within the range of 0–3. In the range 7–9, there was 1 male and 9 females with normal cholesterol value and 1 male and 7 females with high cholesterol value. For the range 10–12, there were 11 males and 16 females with normal cholesterol values and 14 males and 35 females with high cholesterol values. For the range 13–15, there were 2 males along with 6 females having normal cholesterol values and 1 male and 7 females having high cholesterol values. For the age group 66–80 years, there were 2 males and 1 female with normal levels of cholesterol and 1 male with high levels of cholesterol within the range score of 7–9. For the score 10–12, there was 1 male and 3 females with normal cholesterol values and 5 females with high levels of cholesterol. For the last range score 13–15, there was 1 male and 1 female with high levels of cholesterol. The p-value was calculated as 0.8179 by 2-way ANOVA, which means that the social parameters also do not have any effect on the quality of life of diabetic patients (Table 6).

Table 5
Association of cholesterol with QOL (Psychological Symptoms).

QOL (Psychological symptoms)	Normal level						High level						P-value
	26-45Y		46-65Y		66-80Y		26-45Y		46-65Y		66-80Y		0.7366
	M	F	M	F	M	F	M	F	M	F	M	F	
0–6	0	0	1	0	0	0	0	0	1	0	0	0	
7–12	0	0	0	1	0	0	0	0	0	0	0	0	
13–18	2	3	5	9	1	1	4	6	1	7	0	2	
19–24	7	12	7	16	2	3	9	17	12	34	3	3	
25–30	1	3	1	5	0	0	3	6	0	9	1	2	
Total	10	18	14	31	3	4	16	29	14	50	4	7	
	28		45		7		45		64		11		
	80						120						
	200												

Table 6
Association of cholesterol with QOL (Social Symptoms).

QOL (Social symptoms)	Normal level						High level						P-value
	26-45Y		46-65Y		66-80Y		26-45Y		46-65Y		66-80Y		0.8179
	M	F	M	F	M	F	M	F	M	F	M	F	
0–3	0	0	0	0	0	0	0	0	1	0	0	0	
4–6	1	0	0	0	0	0	0	0	0	0	0	0	
7–9	1	3	1	9	2	1	3	8	1	7	1	0	
10–12	7	14	11	16	1	3	10	18	14	35	0	5	
13–15	1	1	2	6	0	0	3	4	1	7	1	1	
Total	10	18	14	31	3	4	16	30	17	49	2	6	
	28		45		7		46		66		8		
	80						120						
	200												

3.6. Cholesterol and overall QoL scoring

For the age group 26–45 years, there was no male and female with normal as well as high range of cholesterol values in the social symptoms score ranges of 0–24, 24–48. In the score range 49–72, there were 1 male and 2 females with normal cholesterol and 3 males and 7 females with high levels of cholesterol. For the overall score range 73–96, there were 9 males and 16 females with normal cholesterol levels and 13 males and 22 females with high cholesterol. For the age group 46–65 years, there were 4 males and 11 females with normal cholesterol and 3 males and 10 females had high cholesterol levels in the range 49–72. In the range 73–96, there were 10 males and 10 females with normal cholesterol values and 13 males and 40 females with high cholesterol values. For the range 97–120, there was 1 male with a high cholesterol value. For the age group 66–80 years, there were 3 males and 3 females with normal levels of cholesterol and 1 female with high levels of cholesterol within the range score of 49–72. For the score 73–96, there were 4 males and 7 females with normal cholesterol values and 4 males with 5 females with high levels of cholesterol. The p-value was calculated as 0.3078 by 2-way ANOVA, which means that overall, all the parameters also do not have any effect on the quality of life of the diabetic patients (Table 7).

3.7. Association of cholesterol with ALT

ALT values were taken before and after magnesium and potassium intervention. Among 200 patients, there was no patient with low ALT levels and with normal, and high cholesterol values before and after magnesium and potassium intervention. Before magnesium and potassium intervention, 129 patients had normal ALT as well as cholesterol values. Similarly, 6 patients have normal cholesterol as well as high ALT values. After interventional therapy, 173 patients had normal ALT and cholesterol values while 13 had elevated ALT. Now for high cholesterol value, 61 were showing normal, 4 with high ALT before interventions. After therapy, there were 14 with normal ALT. The p-value 0.6521 showed that there is no significant relationship between ALT values and cholesterol levels and hence the results are interpreted as non-significant (Table 8).

3.8. Association of cholesterol with AST

Along with ALT values, AST values were also taken before and after magnesium and potassium intervention. Among 200 patients, there was no patient with low AST levels and with normal, and high cholesterol values before and after magnesium and potassium intervention. Before magnesium and potassium intervention, 135 patients had normal AST as well as cholesterol values. After interventional therapy, 185 patients had normal AST and cholesterol values while 4 had elevated ALT. After therapy, there were 185 patients with normal AST and 4 with higher AST values. Now for high cholesterol value, 65 were showing normal AST before interventions. After therapy, there were 10 with normal AST and 1 with high AST. The p-value 0.6604 showed that there is no significant relationship between AST values and cholesterol levels and hence the results are interpreted as non-significant (Table 9).

3.9. Association of cholesterol with urea levels

Urea values of all the diabetic patients were taken before and after magnesium and potassium intervention. Among 200 patients, there was no patient with low urea levels and with normal, and high cholesterol values before and after magnesium and potassium intervention. Before magnesium and potassium intervention, 124 patients had normal urea as well as cholesterol values. There were 11 patients with high levels of urea before the magnesium and potassium intervention. After interventional therapy, 176 patients had normal urea levels and cholesterol values while 10 had elevated urea levels. Now for high cholesterol values, 60 were showing normal, 5 with high urea levels before interventions. After therapy, there were 12 patients with normal urea levels and 2 were with higher levels of urea. The p-value 0.6502 showed that there is no significant relationship between urea values and cholesterol levels and hence the results are interpreted as non-significant (Table 10).

Table 7
Association of Cholesterol with Overall QOL Score.

QOL (Overall score)	Normal level						High level						P-value
	26-45Y		46-65Y		66-80Y		26-45Y		46-65Y		66-80Y		0.3078
	M	F	M	F	M	F	M	F	M	F	M	F	
0–24	0	0	0	0	0	0	0	0	0	0	0	0	
25–48	0	0	0	0	0	0	0	0	0	0	0	0	
49–72	1	2	4	11	3	3	3	7	3	10	0	1	
73–96	9	16	10	10	4	7	13	22	13	40	4	5	
97–120	0	0	0	0	0	0	0	0	1	0	0	0	
Total	10	18	14	21	7	10	16	29	17	50	4	4	
	28		35		17		45		67		8		
	80						120						
	200												

Table 8
Association of cholesterol with ALT Score before and after the magnesium and potassium intervention.

	ALT before treatment			ALT after treatment			p-value
Cholesterol	Low	Normal	High	Low	Normal	High	
Normal	0	129	6	0	173	13	0.6521
High	0	61	4	0	14	0	
Total	200			200			

Table 9
Association of cholesterol with AST Score before and after the magnesium and potassium intervention.

	AST before treatment			AST after treatment			p-value
Cholesterol	Low	Normal	High	Low	Normal	High	
Normal	0	135	0	0	185	4	0.6604
High	0	65	0	0	10	1	
Total	200			200			

Table 10
Association of cholesterol with urea levels before and after the magnesium and potassium intervention.

	Urea before treatment			Urea after treatment			p-value
Cholesterol	Low	Normal	High	Low	Normal	High	
Normal	0	124	11	0	176	10	0.6502
High	0	60	5	0	12	2	
Total	200			200			

3.10. Association of cholesterol with urea level

Creatinine values of all the diabetic patients were taken before and after magnesium and potassium intervention. Among 200 patients, there was no patient with low creatinine levels and with normal, and high cholesterol values before and after magnesium and potassium intervention. Before magnesium and potassium intervention, 120 patients had normal creatinine as well as cholesterol values. Similarly, 15 patients have normal cholesterol as well as high creatinine levels. After interventional therapy, 146 patients had normal creatinine levels and cholesterol values while 40 had elevated cholesterol levels. Now for high cholesterol value, 57 were showing normal creatinine levels in the blood, 8 with high creatinine levels before interventions. After therapy, there were 9 patients with normal creatinine levels and 5 had higher levels of urea. The p-value 0.5888 showed that there is no significant relationship between creatinine values and cholesterol levels and hence the results are interpreted as non-significant (Table 11).

3.11. Liver and kidney markers before and after intervention

Figs. 2 and 3 shows association of cholesterol with liver and kidney markers before and after intervention. Cholesterol can be seen significantly decreased and more in normal range after intervention in relation to all liver and kidney markers. However, ALT, AST, urea and Creatinine does not differ significantly before and after intervention.

4. Discussion

In the current study, the impact of magnesium and potassium on cholesterol level was studied and quality of life among diabetic patients were considered. Magnesium is essential for the health of the bones, neuromuscular transmission, muscle contraction, vasomotor tone, normal blood pressure, neurotransmitter and insulin metabolism, and cardiac excitability. Some metabolic studies showed that Mg + 2 supplementation has a positive impact on the action of insulin and the metabolism of glucose (Aswathy, 2015; Takaya et al., 2003). If potassium levels are too low, the body may make less insulin. For all cells to operate normally, potassium is required. It keeps the heartbeat in check, ensures that the muscles and nerves are functioning properly, and is essential for protein synthesis and carbohydrate metabolism. Magnesium serves as a major intracellular cation in numerous enzyme systems, including those involved in lipid metabolism. It has been shown that alterations in the lipid profile are caused by both magnesium deficit and supplementation. It has been seen that diabetic patients usually have high levels of cholesterol. This study was designed to see if potassium and magnesium supplement helps to decrease cholesterol level in diabetic patients. The present study includes descriptive statistics for various variables including age, gender, and biomarkers such as ALT, AST, Urea, Creatinine and Cholesterol levels before and after treatment. The study included 200 patients, with a minimum age of 26 and maximum age of 80, and a mean age of 51.0 ± 11.08. Out of the 200 patients, 139 (69.5 %) were female and 27 (30.5 %) were male. The treatment had a major impact on cholesterol levels in all four groups. Specifically, there was a decrease in mean cholesterol levels in all groups after the treatment, with the largest reduction seen in the T4 group, which received both potassium and magnesium supplements. Similar results were found in another study by ELDerawi et al., who studied the effect of ascorbic acid and magnesium supplements in 56 diabetic

Table 11
Association of cholesterol with creatinine levels before and after the magnesium and potassium intervention

	Creatinine before treatment			Creatinine after treatment			p-value
Cholesterol	Low	Normal	High	Low	Normal	High	
Normal	0	120	15	0	146	40	0.5888
High	0	57	8	0	9	5	
Total	200			200			

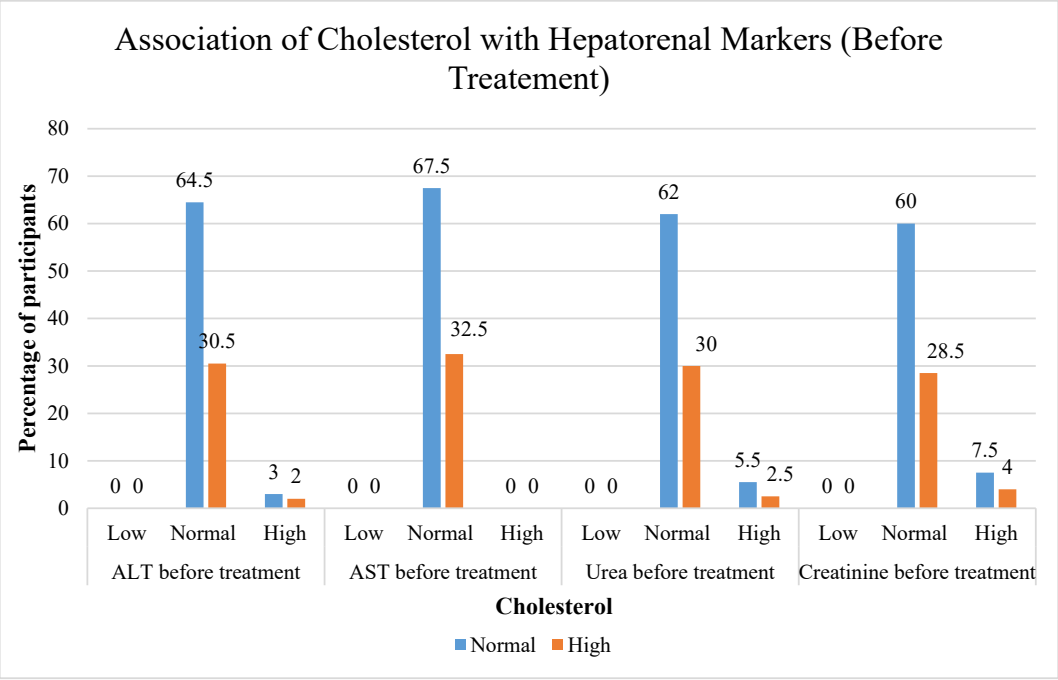

Fig. 2. Association of Cholesterol with Hepatorenal Markers (Before Treatment), *ALT and AST Unit: U/L. Urea and Creatinine Unit: mg/dl.

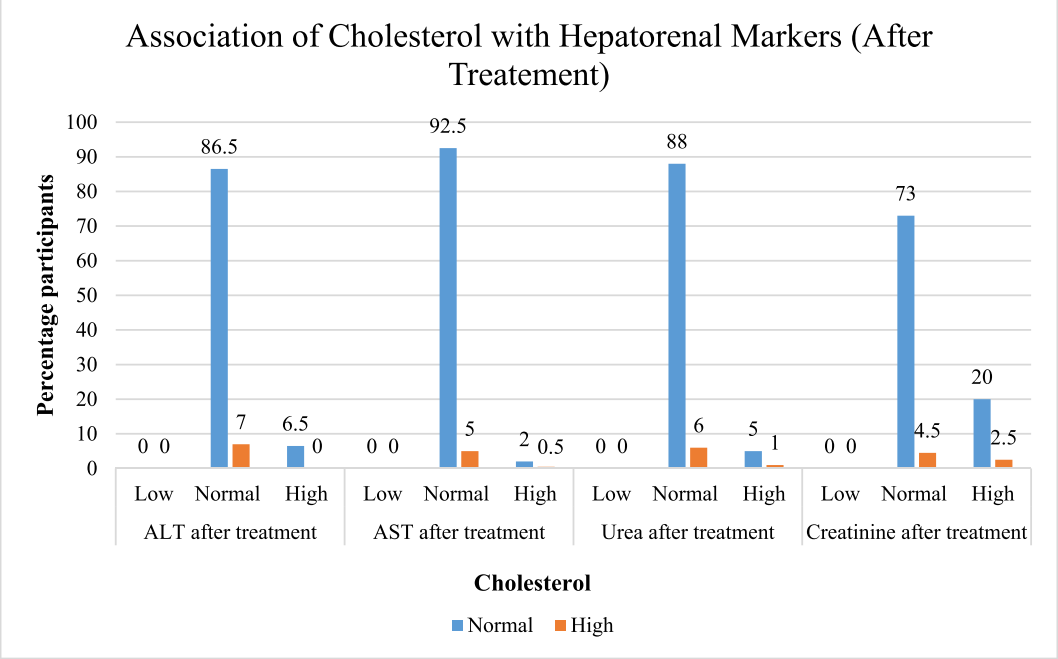

Fig. 3. Association of Cholesterol with Hepatorenal Markers (After Treatment). *ALT and AST Unit: U/L. Urea and Creatinine Unit: mg/dl.

patients. They observed the beneficial effects of the above-mentioned supplements on triglycerides and cholesterol levels ($p < 0.05$) of diabetic patients (ELDerawi et al., 2018). Whang and Sims presented a similar hypothesis. As there is frequent deficiency of magnesium and potassium in diabetic patients, Mg + 2 and K + supplementation can prevent the effects of vascular diabetic disease (Whang and Sims, 2000). Complaints relating to diabetes the QoL scores are considerably lowered by weariness, sleep issues, polyurea, issues with work life, decreased energy, hypoglycemia symptoms, tingling or numbness, issues with social life, trouble walking, swelling in limbs, pain in limbs, and delayed wound healing (Prajapati et al., 2018). Taking into consideration the fatty liver diseases that are associated with cholesterol, a recent study has shown that when the cholesterol levels are higher there is a 29 % prevalence of non-alcoholic fatty liver disease (Jimba et al., 2005). However, our study has shown that after the magnesium and potassium interventions, there is no association between the cholesterol and values of ALT, AST, urea and creatinine, so the liver and kidney diseases are not dependent. Several causes might account for this lack of impact. These might include the precise doses employed, the length of the intervention, the heterogeneity of the diabetic community, or the existence of confounding factors that the research did not control for. Furthermore, the clinical ramifications of these findings for diabetes patients must be

investigated. Understanding the possible benefits, if any, on blood pressure, glycemic control, or other diabetic-related health factors is critical for clinicians and patients to make educated decisions about supplementation as an adjunct to standard care, even though the study's results may not have demonstrated a direct benefit in quality of life or hepatorenal markers.

There are various limitations for this study which should be considered while doing further researches. Individual differences in response limit generalizability, adherence and compliance issues, safety concerns related to high-dose supplementation, interactions with medications, uncertainties about optimal dosage, dietary confounders, the need to consider both short-term and long-term effects, and a relatively small sample size are among them. This study topic is further complicated by ethical concerns, expenses, placebo effects, and publication bias. Addressing these issues is critical for generating effective and ethical diabetic guidelines.

For future investigations, the fundamental processes by which magnesium and potassium regulate cholesterol levels and diabetes outcomes should be investigated. Understanding the physiological mechanisms involved may lead to new treatment targets. Larger and longer-term longitudinal studies on the effects of magnesium and potassium supplementation on cholesterol levels and diabetes outcomes should be done to further demonstrate the causality and long-term benefits of these nutrients. This would assist to corroborate the present study's results and give more strong proof. Regional and cultural differences in dietary patterns, as well as their effect on magnesium and potassium consumption, should be investigated since they may alter the study's results' application in diverse groups.

5. Conclusions

In conclusion, there is an impact of magnesium and potassium supplements on cholesterol levels but there is no impact of these interventions on the liver and kidney markers. All four groups experienced a decrease in blood sugar levels after treatment. The result findings suggested that magnesium and potassium supplements may be beneficial in improving the lipid profile but liver and kidney diseases are not related to it. However, further research is needed to determine the long-term effects of these supplements and their optimal dosages.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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