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The interplay of blood electrolytes and triglycerides in type 2 diabetes mellitus

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Abstract

Type 2 diabetes mellitus is a major global health issue, especially in areas that are going through rapid urbanization and demographic changes. The objective of this study was to examine the correlation between blood electrolytes (potassium and sodium) and triglycerides in individuals who have been diagnosed with type 2 diabetes in Basrah City, Iraq. A cohort of 100 participants, consisting of a diabetic group (n = 50) and a control group (n = 50), underwent blood analysis. Noticeable differences were observed in the fasting glucose, potassium, sodium, and triglyceride levels between the diabetic and control groups. A significant variation in triglyceride levels was observed in the diabetic group, suggesting a diverse range of metabolic characteristics among patients. Gender-based analysis revealed that there were no significant differences between the genders within each group. Correlation analysis showed that blood electrolytes (potassium and sodium) and glucose levels were associated in individuals diagnosed with type 2 diabetes. Additionally, a significant relationship was found between triglyceride levels and age in the diabetic group. These results underline the complex relationship between metabolic factors in the progression of type 2 diabetes and demonstrate the significance of personalized interventions in controlling this condition.

1. Introduction

Type 2 diabetes mellitus is a widespread metabolic disorder that involves insulin resistance and disrupted glucose regulation, resulting in high blood sugar levels [1]. Given the evolving lifestyles, rapid urbanization, and the increasing number of elderly individuals, type 2 diabetes has become a significant global health issue [2]. It has a global impact, affecting millions of people, especially in low- and middle-income countries [3]. The impact of type 2 diabetes goes far beyond its direct health effects, playing a major role in morbidity, mortality, and healthcare costs [4]. Efforts to tackle type 2 diabetes on a global scale require a comprehensive approach that includes prevention, early detection, lifestyle changes, and effective management strategies [5]. Despite the progress made in understanding and treating type 2 diabetes, the increasing number of cases highlights the importance of ongoing research, policy efforts, and public health interventions to reduce its impact and enhance the well-being of those affected worldwide.

The increasing prevalence of Type 2 diabetes in Iraq presents a significant health challenge [6]. The rising prevalence of type 2 diabetes in the Iraqi population can be attributed to various factors, including genetic predisposition, sedentary lifestyles, dietary habits, and limited access to healthcare services. The healthcare infrastructure has been under strain due to conflict and political instability, which has had a negative impact on diabetes management and worsened the complications associated with the disease [7]. Despite these challenges, there are ongoing efforts to improve diabetes prevention, education, and care services in Iraq in order to enhance outcomes and lessen the socioeconomic burden linked to type 2 diabetes.

The correlation between blood cations, particularly potassium (K^+) and sodium (Na^+), along with triglycerides (TG) in type 2 diabetes patients highlights the intricate interaction of metabolic factors involved in the development of the disease. Previous research has established a connection between higher sodium levels and negative effects on insulin

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sensitivity and the body's ability to process glucose, which can play a role in the development of type 2 diabetes [8]. On the other hand, potassium plays a vital role in insulin secretion and sensitivity. When serum levels of potassium are low, there is a higher risk of developing type 2 diabetes [9]. Elevated levels of triglycerides are commonly observed in individuals with insulin resistance and type 2 diabetes. These elevated levels contribute to dyslipidemia and increase the risk of cardiovascular complications [10]. The complex interplay of these biochemical parameters emphasizes the multifaceted nature of type 2 diabetes and emphasizes the significance of thorough metabolic profiling in its treatment and prevention.

In light of the increasing prevalence of type 2 diabetes in Iraq, this study sought to examine the relationship between blood cations (K^+ and Na^+), and triglyceride levels, with the severity of type 2 diabetes in patients from Basrah City, Iraq.

2. Materials and Methods

2.1. Study sample

A sample of one hundred participants (58 males and 42 females) were selected for this study. Subjects were attendants of diagnostic facilities at Alsadr Teaching Hospital in Basrah City, Iraq, for routine blood tests between October and April 20021-2022. Out of the participants, 50 individuals (29 males and 21 females) were diagnosed with type 2 diabetes (having a fasting glucose level ≥7 mmol/L) for more than one year and were considered the diabetic group. The participants in this group ranged in age between 33 and 70 years. The other half of the sample (29 males and 21 females) represented the control group with normal fasting glucose levels and an age range of 22 to 70 years. None of the participants were taking any medications that could have affected their lipid or electrolyte metabolism and had no other chronic diseases.

2.2. Ethical approach

The approval to conduct this research (No. 123) was granted by the Ethical Committee for Human and Animal Model Research Subjects, College of Pharmacy at Basrah University. The participants were selected after obtaining an informed consent to participate in this research. Every participant in the study received a thorough explanation of the study's purpose and patient anonymity was preserved.

2.3. Blood sample collection

Blood samples of 3 ml were collected by venipuncture from each individual. Following a 10-minute centrifugation at 3000 rpm, the blood was allowed to coagulate. The acquired serum was pipetted into a clean bottle and tested for glucose levels immediately. The leftover volume was stored at -4 °C for the remainder of the analysis.

2.4. Analytical methods

Serum analysis for fasting glucose, Na^+, and K^+ were performed by the UV-visible spectrophotometer Model DU-8200, China, and kits were purchased from HUMAN Diagnostics, Germany. Triglycerides levels were estimated enzymatically using GPO-PAP method.

2.5. Statistical analysis

Statistical analyses were done using Minitab 19 software. Data was presented as means±standard deviation (Mean±SD) for all quantitative values. The studied blood characteristics were compared between diabetic and control groups using t-test. Furthermore, the means of both genders of each group were compared using one-way analysis of variance (ANOVA) and Tukey's test. Additionally, Pearson's correlation coefficient between fasting glucose, Na^+, K^+, and triglycerides levels was calculated in diabetic and control groups.

3. Results

There were significant discrepancies ($p<0.001$) in the blood characteristics between the diabetic and control groups. The levels of fasting glucose, potassium (K^+), sodium (Na^+), and triglycerides were found to be significantly higher in the diabetic group when compared to the control group, as determined by a *t*-test. In the diabetic group, the levels of fasting glucose varied from 130 to 314 mg/dl, whereas in the control group, the range was 65 to 106 mg/dl. Similarly, potassium levels ranged from 6 to 7 meq/L in the diabetic group, whereas in the control group, it ranged from 3 to 5 meq/L. For sodium, the range in the diabetic group was 156 to 172 meq/L, compared to 125 to 148 meq/L in the control group. Additionally, the range of triglyceride levels in the diabetic group was 41 to 414 mg/dl, whereas in the control group, the range was 80 to 145 mg/dl (Fig. 1). It is important to mention that while triglyceride levels were generally higher in the diabetic group, there were a few cases where individuals had normal triglyceride levels similar to those in the control group, and some even had lower triglyceride levels.

There were no significant differences found between males and females within each group, as indicated by Tukey's test. However, significant differences were observed between the diabetic and control groups for both male and female participants (Fig. 2).

In terms of correlations in the diabetic group, significant positive correlations were found between potassium and fasting blood glucose (r = 0.29, $p<0.05$), sodium and fasting blood glucose (r = 0.6, $p<0.01$), in addition to triglycerides and age (r = 0.41, $p<0.01$) (Fig. 3 A). These correlations suggest potential associations between these blood characteristics in individuals with type 2 diabetes. However, in the control group, no significant correlation coefficients were observed, indicating a lack of strong relationships between the blood characteristics in individuals without diabetes (Fig.3 B).

4. Discussion

The present findings indicate markedly increased levels of fasting glucose, potassium (K^+), sodium (Na^+), and triglycerides in people diagnosed with type 2 diabetes in comparison to the control group. These findings are consistent with the metabolic dysfunction that is typical of diabetes, where decreased insulin action results in abnormal glucose metabolism and consequent changes in electrolyte and lipid balance [11].

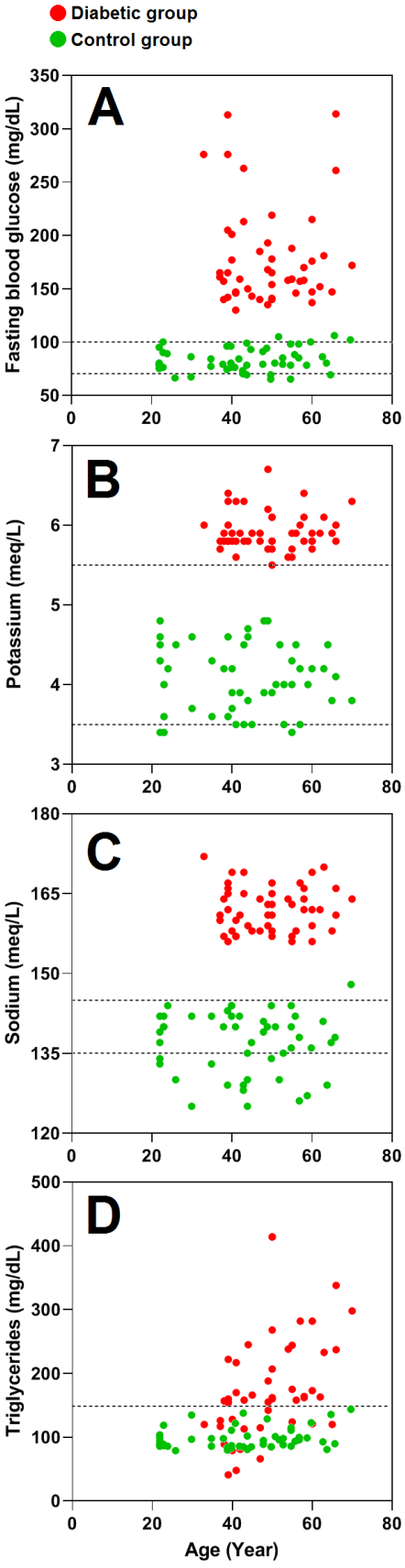

Figure 1. Scatter plots for fasting blood glucose (A), potassium (B), sodium (C), and triglycerides (D) levels in the diabetic and control groups based on the age of the participants. The dotted lines represent the normal limits or ranges in each measured blood characteristic.

It is important to mention that the diabetic group has a wide range of values for all measured characteristics, which highlights heterogeneity of type 2 diabetes. This variability is due to differences in the severity of the disease and how it is managed by the participants. The heterogeneity observed in this context can be attributed to variations in genetic predisposition, lifestyle factors, and adherence to therapy [12]. Notably, although triglyceride levels were generally elevated in the diabetic group, the fact that some people had normal or lower triglyceride levels indicates possible differences in lipid metabolism within the diabetic population. The presence of such diversity highlights the significance of tailoring diabetes care strategies to individual needs, taking into account specific metabolic profiles and risk factors [13].

Furthermore, the study demonstrated that there were no notable gender-related distinctions within any group. This conclusion aligns with prior research where no correlation between the severity of type 2 diabetes and gender was found [14]. Nevertheless, notable discrepancies were noted between the diabetes and control groups among both male and female subjects. These findings highlight the systemic influence of diabetes on blood chemistry, regardless of gender.

Correlational investigation conducted among individuals with diabetes revealed noteworthy positive correlations between potassium and fasting glucose levels, sodium and fasting glucose levels, and triglycerides and age. The strong association between each of Na^+ and K^+ with blood sugar levels reveals the complex connections between type 2 diabetes and imbalances in electrolytes. Indeed, this correlation has been extensively examined in literature, as instances of dysnatremia (hyponatremia and hypernatremia) and dyskalemia (hypokalemia and hyperkalemia) are frequently observed in individuals with diabetes [15]. It is crucial to acknowledge that the intricate treatment regimens in diabetes patients may be a primary cause of electrolyte abnormalities. Hence, regular monitoring of electrolyte levels in individuals with type 2 diabetes may highlight the necessity of modifying some medications to achieve a more optimal electrolyte balance and mitigate the potential consequences associated with electrolyte imbalances.

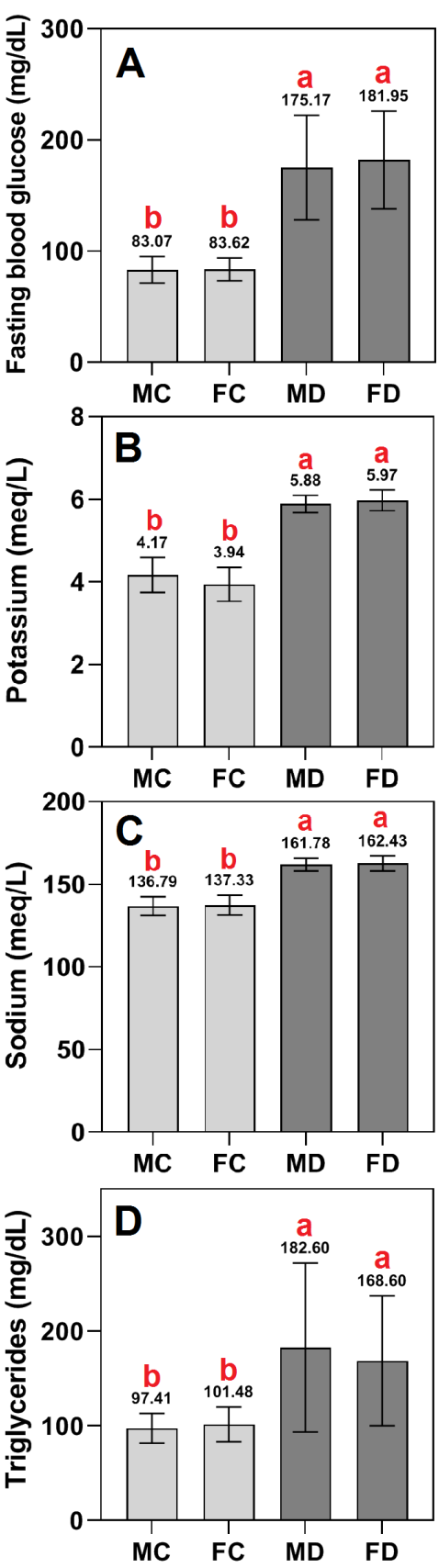

Figure 2. Fasting blood glucose (A), potassium (B), sodium (C), and triglycerides (D) levels in control (MC and FC) and diabetic (MD and FD) groups. The means were compared between the two genders, where MC and MD refer to male participants, while FC and FD refer to female participants. The results are presented as means±SD and different annotations (letters above the columns) refer to the presence of significant differences (*p<0.05*) between the means of the compared groups according to Tukey's test.

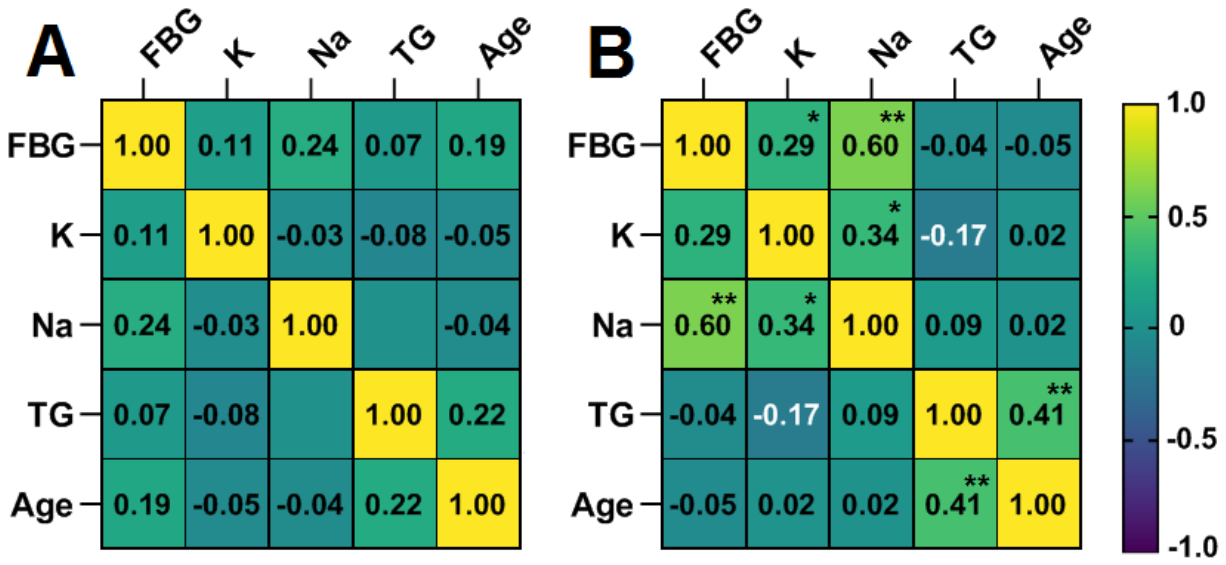

Figure 3. Pearson's correlation coefficients between the measured blood characteristics and the age of participants in control (A) and diabetic (B) groups. FBS (Fasting blood glucose), K (Potassium), Na (Sodium), TG (Triglycerides). * and ** refer to significant correlations at 0.05 and 0.01 levels of significance.

The correlation between triglycerides and diabetes was previously examined [16]. Triglycerides were regarded as a prognosticator for type 2 diabetes in middle-aged and elderly individuals. The current findings revealed a remarkably strong association between triglyceride levels and age in the diabetic group. Triglycerides might be regarded as a significant marker that should be closely watched in older individuals who are more prone to developing type 2 diabetes. On the other hand, the control group did not show any significant correlations, which suggests that there are no strong connections between the studied blood parameters in individuals without diabetes. This emphasizes that the associations found in the diabetic group are specific to diabetic pathology, as there were no other underlying diseases present in any of the studied groups.

5. Conclusion

This study provides comprehensive insights into the blood characteristics associated with type 2 diabetes, highlighting the multifaceted nature of metabolic dysregulation in diabetes. Further research is warranted to elucidate the mechanistic underpinnings of these associations and explore their implications for personalized diabetes management strategies.

Conflict of interest statement

The authors declared no conflict of interest.

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Data availability statement

The authors declared that all related data are included in the article.

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