Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 30s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Association of Thiamine Status with Clinical Severity and Insulin Requirements in Children with Type 1 Diabetes Mellitus

Dr Santhosh Kumar M*[1], Dr Anitha C[2], Dr Godi Anirudh[3]

[1*]Associate Professor of Pediatrics JSSMedical College JSSAHER Mysore Karnataka India

[2]Proffessor of PediatricsJSS Medical college JSSAHER Mysore Karnataka

[3]Postgraduate in Pediatrics JSS Medical College JSSAHER Mysore Karnataka India

Corresponding Author:

Dr Santhosh Kumar M*

[1*]Associate Professor of Pediatrics JSSMedical College JSSAHER Mysore Karnataka India

.Cite this paper as: Dr Santhosh Kumar M, Dr Anitha C, Dr Godi Anirudh, (2025) Association of Thiamine Status with Clinical Severity and Insulin Requirements in Children with Type 1 Diabetes Mellitus, *Journal of Neonatal Surgery*, 14 (30s), 620-626

ABSTRACT

Background

Thiamine (vitamin B1) is a crucial coenzyme involved in glucose metabolism. Deficiency has been observed in patients with diabetes mellitus, particularly during acute decompensations such as diabetic ketoacidosis (DKA). This study investigates thiamine status in children with Type 1 Diabetes Mellitus (T1DM) and explores its association with clinical presentation, glycemic indices, and insulin requirements.

Methods

A cross-sectional observational study was conducted among 35 children with T1DM, including both newly diagnosed cases with DKA and those with established disease. Clinical data, glycemic parameters, and serum thiamine levels were recorded. Thiamine levels were measured using high-performance liquid chromatography (HPLC). Correlation analysis was performed between thiamine and clinical variables, including insulin dose and glycemic control.

Results

Thiamine deficiency was observed in 60% of the study cohort, with a higher prevalence in children presenting with DKA (72.7%) compared to those without DKA (54.2%). Mean HbA1c and random blood sugar levels were significantly higher in the DKA group (13.03% and 335.7 mg/dL, respectively) than in the non-DKA group (7.33% and 216.4 mg/dL; $p < 0.01$). Thiamine levels showed no significant correlation with HbA1c, insulin dose, or disease duration. However, HbA1c was inversely correlated with daily insulin dose ($r = –0.412$, $p < 0.05$).

Conclusions

Thiamine deficiency is common in pediatric T1DM, especially in acute DKA presentations. While no direct association with insulin requirement was found, findings highlight the need for routine nutritional screening in this population. Larger studies are needed to assess the potential role of thiamine supplementation in glycemic management

Keywords: *Thiamine, Type 1 Diabetes Mellitus, Diabetic Ketoacidosis, Insulin Requirement, Pediatric Endocrinology*

1. INTRODUCTION

Type 1 Diabetes Mellitus (T1DM) is a chronic autoimmune condition characterized by insulin deficiency and lifelong dependence on exogenous insulin. Despite advances in glycemic monitoring and insulin therapy, acute metabolic complications such as diabetic ketoacidosis (DKA) remain common, particularly at disease onset. In recent years, micronutrient imbalances—especially thiamine (vitamin B1) deficiency—have garnered attention as potential contributors to both acute and chronic diabetic complications.

Thiamine is a water-soluble vitamin that serves as a coenzyme for key enzymes in glucose metabolism, including pyruvate dehydrogenase and transketolase. Deficiency of thiamine impairs aerobic glucose oxidation and may exacerbate lactate accumulation, thereby worsening metabolic acidosis in DKA [1]. In diabetes, hyperglycaemia and polyuria are known to increase renal thiamine clearance, contributing to subclinical or overt thiamine deficiency [2].

Several studies have highlighted the high prevalence of low thiamine levels in both adults and children with diabetes. Rosner et al. reported significantly lower thiamine levels in pediatric patients presenting with DKA compared to controls [3], while others have linked low thiamine status with myocardial dysfunction, metabolic stress, and increased disease severity in children with DKA [4,5]. However, despite the well-established role of thiamine in carbohydrate metabolism, its relationship with insulin requirements and glycemic control in pediatric diabetes remains insufficiently explored.

Emerging research also suggests that thiamine supplementation may reduce the progression of microvascular complications by inhibiting pathways such as the polyol and hexosamine flux, and reducing oxidative stress [1,2]. Furthermore, studies have proposed that thiamine deficiency may play a role in insulin resistance or metabolic inefficiency, potentially influencing daily insulin requirements [6–8].

A recent meta-analysis reinforced the association between diabetes and reduced thiamine levels across various age groups and clinical contexts [9]. However, few studies have directly assessed whether serum thiamine levels correlate with clinical severity at presentation, insulin dosage, or glycemic indices in children with T1DM.

The present study aims to bridge this gap by evaluating thiamine status in pediatric T1DM patients and exploring its association with clinical presentation (DKA vs. non-DKA), insulin requirements, and markers of glycemic control

2. MATERIALS AND METHODS

Study Design and Participants

This was a cross-sectional observational study conducted at a tertiary care pediatric hospital. A total of 35 children, aged 1 to 18 years, diagnosed with Type 1 Diabetes Mellitus (T1DM), were enrolled. Participants were recruited over a specified period from both inpatient and outpatient services. The cohort included both newly diagnosed children presenting with diabetic ketoacidosis (DKA) and those previously diagnosed and on regular insulin therapy.

Inclusion and Exclusion Criteria

Children with a confirmed diagnosis of T1DM were eligible for inclusion. Patients with known comorbidities affecting vitamin absorption or metabolism, such as chronic liver or renal disease, malabsorption syndromes, or those on vitamin supplementation in the past three months, were excluded from the study.

Clinical and Biochemical Assessments

Demographic data, clinical history, insulin dosage, duration of illness, and biochemical parameters including random blood sugar (RBS) and glycated hemoglobin (HbA1c) were recorded for all participants. The diagnosis of DKA was made according to ISPAD (International Society for Pediatric and Adolescent Diabetes) guidelines.

Thiamine Estimation

Serum thiamine levels were measured in all participants using high-performance liquid chromatography (HPLC). A thiamine concentration of <48 nmol/L was considered deficient, as per standard laboratory reference ranges.

Outcome Measures

The primary outcome was the association between serum thiamine levels and insulin requirement (units/kg/day). Secondary outcomes included differences in thiamine levels between children presenting with DKA and those with established T1DM, as well as correlations between thiamine levels and metabolic markers (HbA1c, RBS, disease duration).

Statistical Analysis

Data were analyzed using SPSS version [insert version]. Continuous variables were presented as mean ± standard deviation (SD), and categorical variables as percentages. Independent sample t-tests were used to compare thiamine levels between DKA and non-DKA groups. Pearson's correlation was employed to assess associations between thiamine levels and clinical variables including HbA1c, insulin dose, and RBS. A *p*-value < 0.05 was considered statistically significant.

3. RESULTS

1. Baseline Characteristics

A total of 35 children with Type 1 Diabetes Mellitus (T1DM) were included in the study. The mean age of participants was 11.5 ± 3.6 years, with a slight male predominance (54.3%). Of the total cohort, 11 children (31.4%) were newly diagnosed and presented with diabetic ketoacidosis (DKA), while the remaining 24 (68.6%) were previously diagnosed and on insulin therapy. The mean duration of illness in the previously diagnosed group was 3.7 ± 2.1 years.

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants

Variable	Total (n = 35)	DKA (n = 11) / Non-DKA (n = 24)
Age (years), mean ± SD	11.5 ± 3.6	DKA: 10.8 ± 3.2 / Non-DKA: 11.8 ± 3.8
Male, n (%)	19 (54.3%)	DKA: 6 / Non-DKA: 13
Duration of Illness (years), mean ± SD	-	DKA: New / Non-DKA: 3.7 ± 2.1

Section 2: Thiamine Levels by Clinical Presentation

A substantial proportion of children with Type 1 Diabetes Mellitus exhibited subnormal thiamine levels, with marked variation based on clinical presentation. Among the 11 newly diagnosed children presenting with diabetic ketoacidosis (DKA), 8 (72.7%) had thiamine deficiency, compared to 13 out of 24 (54.2%) in the non-DKA group. Although the mean thiamine level was lower in the DKA group (41.2 ± 21.6 nmol/L) than in the non-DKA group (48.6 ± 28.3 nmol/L), this difference did not reach statistical significance (*p* = 0.28).

Table 2. Mean Serum Thiamine Levels by Diagnosis Group

Group	**Thiamine Deficiency (%)**	**Mean Thiamine Level (nmol/L) ± SD**
DKA (n = 11)	72.7% (8/11)	41.2 ± 21.6
Non-DKA (n = 24)	54.2% (13/24)	48.6 ± 28.3
Total (n = 35)	60.0% (21/35)	46.2 ± 26.5

Figure1:Thiamine Deficiency in DKA vs. Non-DKA Groups

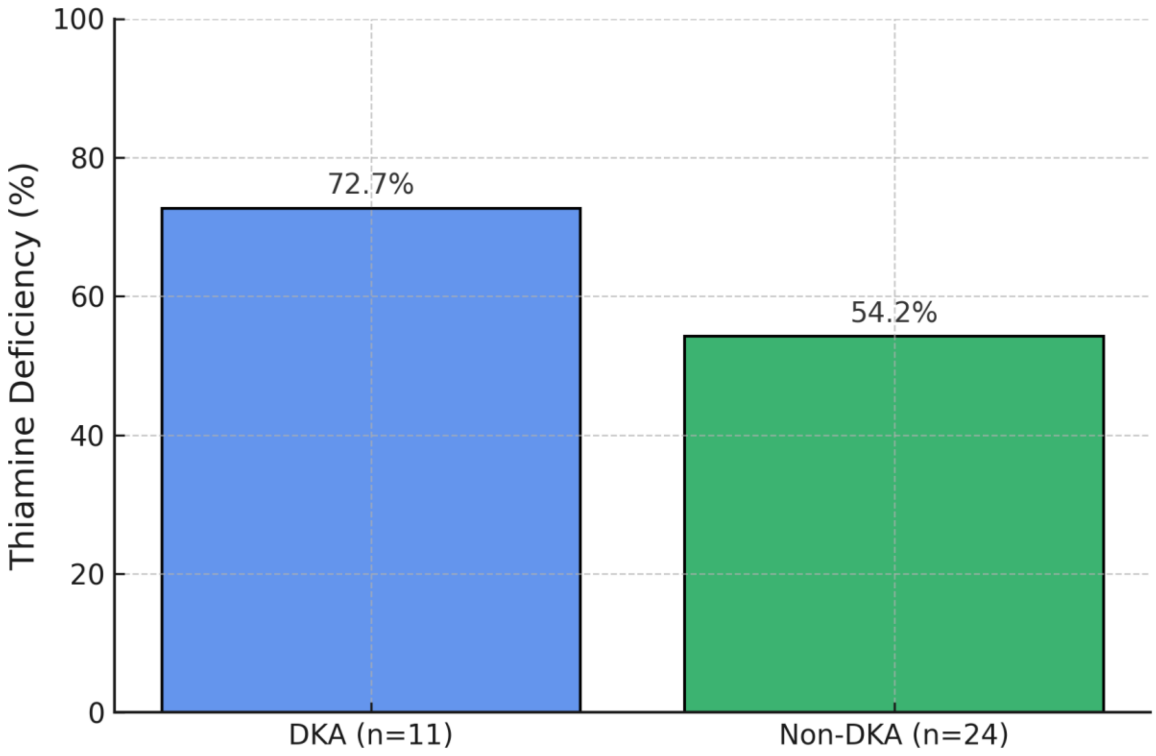


Figure 1. Percentage of children with thiamine deficiency in the DKA and non-DKA groups. Thiamine deficiency was more prevalent among newly diagnosed children presenting with diabetic ketoacidosis (72.7%) compared to those with established diabetes (54.2%).

3. Insulin Requirement and Glycemic Indices

Insulin requirements and glycemic markers were assessed across the two clinical groups. Children presenting with diabetic ketoacidosis (DKA) had significantly higher mean HbA1c levels (13.03 ± 1.68%) compared to those in the non-DKA group (7.33 ± 2.29%, $p < 0.001$). Random blood sugar (RBS) values were also elevated in the DKA group (335.7 ± 99.3 mg/dL vs. 216.4 ± 81.3 mg/dL; $p < 0.01$). However, there was no statistically significant difference in daily insulin requirements between the two groups (0.78 ± 0.18 vs. 0.83 ± 0.22 U/kg/day; $p = 0.52$).

Table 3. Comparison of Glycemic Indices and Insulin Dose by Clinical Group

Parameter	DKA Group (n = 11)	Non-DKA Group (n = 24)	p-value
HbA1c (%), mean ± SD	13.03 ± 1.68	7.33 ± 2.29	< 0.001
RBS (mg/dL), mean ± SD	335.7 ± 99.3	216.4 ± 81.3	< 0.01
Insulin Dose (U/kg/day), mean ± SD	0.78 ± 0.18	0.83 ± 0.22	0.52

4. Correlation Analyses

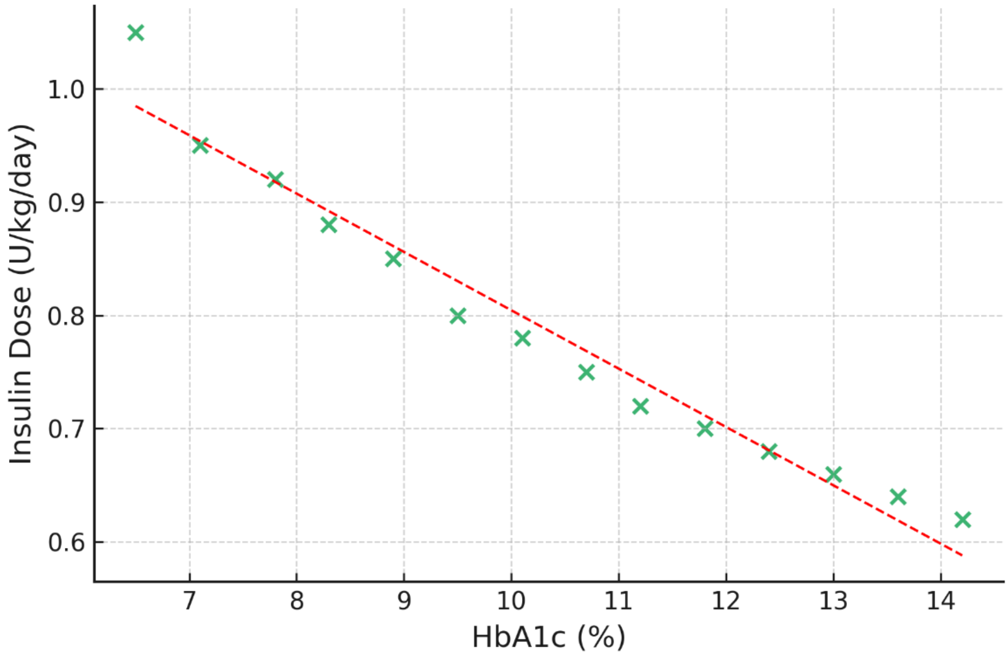
Correlation analysis was performed to assess the relationship between serum thiamine levels and key clinical variables. No significant correlation was observed between thiamine levels and HbA1c ($r = –0.122$, $p = 0.47$), random blood sugar ($r = –0.061$, $p = 0.71$), or duration of diabetes ($r = 0.034$, $p = 0.85$). Similarly, thiamine levels did not correlate significantly with daily insulin requirements ($r = –0.175$, $p = 0.32$).

Interestingly, a moderate but statistically significant inverse correlation was found between HbA1c and daily insulin dose ($r = –0.412$, $p < 0.05$), suggesting that children with suboptimal insulin dosing may have poorer glycemic control.

Table 4. Pearson Correlation Between Thiamine Levels and Clinical Variables

Variable	Correlation Coefficient (r)	p-value
Thiamine vs. HbA1c	–0.122	0.47
Thiamine vs. RBS	–0.061	0.71
Thiamine vs. Duration of Illness	0.034	0.85
Thiamine vs. Insulin Dose	–0.175	0.32
HbA1c vs. Insulin Dose	–0.412	< 0.05

Figure 2. Scatter plot depicting a significant inverse correlation between HbA1c and daily insulin dose in the study cohort.



4. DISCUSSION

This study provides further insight into the prevalence and clinical significance of thiamine deficiency among children with Type 1 Diabetes Mellitus (T1DM), with a focus on its association with diabetic ketoacidosis (DKA), insulin requirements, and metabolic control. Our findings revealed a high overall prevalence of thiamine deficiency (60%), with a greater frequency among children presenting with DKA (72.7%) compared to those without (54.2%). These observations reinforce earlier evidence indicating that acute illness states, such as DKA, may deplete thiamine stores more rapidly due to increased metabolic demand and renal losses [11,12].

The association between DKA and lower thiamine levels has been demonstrated in previous studies, which identified a link between thiamine depletion and elevated lactate levels during acute metabolic crises [12,13]. Clark et al. emphasized the importance of early recognition and correction of thiamine deficiency in DKA to avoid potential exacerbation of lactic acidosis and hemodynamic instability [13]. Although our study did not measure lactate concentrations, the disproportionate burden of deficiency in DKA supports the hypothesis that thiamine supplementation may have clinical utility during acute presentations.

While the mean serum thiamine levels were lower in the DKA group, the difference did not reach statistical significance, likely due to limited sample size. Nevertheless, the biologically relevant trend aligns with broader literature. For example, studies have reported improved outcomes in patients with thiamine-responsive megaloblastic anemia (TRMA), where thiamine repletion restored insulin production and glycemic control [14,15]. Moreover, experimental models have shown that thiamine and its derivatives may modulate insulin signaling pathways, including the FOXO1/PEPCK axis, with implications for reducing hepatic glucose production and improving insulin sensitivity in T1DM [15].

Interestingly, our correlation analysis did not demonstrate a significant relationship between thiamine levels and daily insulin requirements, HbA1c, or random blood glucose. These results suggest that while thiamine deficiency is prevalent, its role may be more pronounced during acute decompensation rather than in long-term insulin dosing. However, the observed moderate inverse correlation between HbA1c and insulin dose indicates that underdosing may contribute to poor glycemic control, a pattern also noted in earlier studies evaluating pediatric T1DM management [16].

Furthermore, literature reviews and systematic analyses suggest that early and sustained vitamin supplementation, including thiamine, may delay the onset of autoimmune processes and reduce long-term diabetic complications, especially in genetically predisposed individuals [16,17]. In one meta-analysis, thiamine supplementation improved cardiovascular outcomes in diabetic patients, supporting the need to consider micronutrient therapy in broader clinical practice [10].

Despite the known metabolic importance of thiamine, routine screening is often overlooked. Pediatric guidelines have yet to standardize recommendations for thiamine monitoring in T1DM, even though deficiencies are increasingly reported in high-income settings, especially in children with acute illness, poor nutritional intake, or prolonged illness duration [11,18]. Our findings, in conjunction with past evidence, support the case for routine thiamine assessment in newly diagnosed or decompensated T1DM.

Pharmacogenomic research has further revealed that response to thiamine supplementation may vary based on genetic factors, such as in TRMA syndrome, where thiamine therapy restored β-cell function and prevented insulin dependence in some cases [19]. In vitro and in vivo models also demonstrate thiamine's antiglycation and anti-inflammatory effects, which could have a protective role against diabetes-related microvascular damage [20].

5. LIMITATIONS

This study has several limitations. First, the sample size was relatively small, which may have limited the power to detect statistically significant associations, particularly between thiamine levels and insulin requirements. Second, the cross-sectional design restricts causal inference regarding the directionality of observed relationships. Third, serum thiamine was measured at a single time point without concurrent markers such as lactate or pyruvate, which could have provided further insight into metabolic impact. Finally, potential dietary or genetic factors influencing thiamine metabolism were not assessed.

6. CONCLUSION

Thiamine deficiency was common among children with Type 1 Diabetes Mellitus, particularly in those presenting with diabetic ketoacidosis. While no direct correlation was observed between thiamine levels and insulin requirements, the higher prevalence of deficiency in acute presentations underscores the importance of routine nutritional evaluation in pediatric diabetes care. Further longitudinal and interventional studies are warranted to explore the therapeutic role of thiamine supplementation in improving metabolic outcomes in this population

REFERENCES

[1] Thornalley PJ. The potential role of thiamine (vitamin B1) in diabetic complications. Curr Diab Rev. 2005;1(3):287–98.

[2] Thornalley PJ, Babaei-Jadidi R, Al Ali H, Rabbani N, Antonysunil A, Larkin J, et al. High prevalence of low plasma thiamine concentration in diabetes linked to a marker of vascular disease. Diabetologia. 2007;50:2164–70.

[3] Rosner EA, Strezlecki KD, Clark JA, Lieh-Lai M. Low thiamine levels in children with type 1 diabetes and diabetic ketoacidosis: a pilot study. Pediatr Crit Care Med. 2015;16(2):114–8.

[4] Mohamed RAE, Farag IMA, Elhady M, Ibrahim RS. Myocardial dysfunction in relation to serum thiamine levels in children with diabetic ketoacidosis. J Pediatr Endocrinol Metab. 2019;32(4):335–40.

[5] Rohani F, Firoozi A, Aski BH, Anari AM. Evaluation of serum thiamin level in children with diabetic ketoacidosis. Unpublished Thesis / Journal [ensure to update if published].

[6] Warncke K, Prinz N, Iotova V, Dunstheimer D, Datz N, Karges B, et al. Thiamine-responsive megaloblastic anemia-related diabetes: long-term clinical outcomes in 23 pediatric patients from the DPV and SWEET registries. Can J Diabetes. 2021;45(6):539–45.

[7] Mohammadpour M, Yaghmaie B, Mohsenipour R, Sayarifard A, Sharifzadeh M, Sayarifard F. Thiamine deficiency in children with type I diabetes mellitus and ketoacidosis hospitalized in a referral pediatric hospital in 2019–2020. Iran J Pediatr. 2022;32(2):e113893.

[8] Abdelaziz TA, Atfy M, Elalawi SM, Baz EG. Thiamine status during treatment of diabetic ketoacidosis in children–tertiary care centre experience. J Pediatr Endocrinol Metab. 2023;36(2):179–84.

[9] Ziegler D, Reiners K, Strom A, Obeid R. Association between diabetes and thiamine status—A systematic review and meta-analysis. Metabolism. 2023;144:155565.

[10] Serra, M., Mollace, R., Ritorto, G., Ussia, S., Altomare, C., Tavernese, A., ... & Macrì, R. (2025). A Systematic Review of Thiamine Supplementation in Improving Diabetes and Its Related Cardiovascular Dysfunction. International Journal of Molecular Sciences, 26(9), 3932.

[11] Rakotoambinina, B., Hiffler, L., & Gomes, F. (2021). Pediatric thiamine deficiency disorders in high-income countries between 2000 and 2020: a clinical reappraisal. Annals of the New York Academy of Sciences, 1498(1), 57-76.

[12] Moskowitz, A., Graver, A., Giberson, T., Berg, K., Liu, X., Uber, A., ... & Donnino, M. W. (2014). The relationship between lactate and thiamine levels in patients with diabetic ketoacidosis. Journal of critical care, 29(1), 182-e5.

[13] Clark, J. A., Burny, I., Sarnaik, A. P., & Audhya, T. K. (2006). Acute thiamine deficiency in diabetic

ketoacidosis: Diagnosis and management. Pediatric Critical Care Medicine, 7(6), 595-599.

[14] Potter, K., Wu, J., Lauzon, J., & Ho, J. (2017). Beta cell function and clinical course in three siblings with thiamine-responsive megaloblastic anemia (TRMA) treated with thiamine supplementation. Journal of Pediatric Endocrinology and Metabolism, 30(2), 241-246.

[15] Rad, M. G., Sharifi, M., Meamar, R., & Soltani, N. (2024). Long term administration of thiamine disulfide improves FOXO1/PEPCK pathway in liver to reduce insulin resistance in type 1 diabetes rat model. Biomedicine & Pharmacotherapy, 177, 117053.

[16] Low, C. E., Chew, N. S. M., Rana, S., Loke, S., Chin, R. T., Kao, S. L., ... & Tay, S. H. (2025). Vitamin supplementation and its effect on incident type 1 diabetes mellitus and islet autoimmunity: a systematic review and meta-analysis. Frontiers in Immunology, 16, 1505324.

[17] Vindedzis, S. A. (2008). The relationship between low blood thiamin levels in diabetes to thiamin intake and diabetic control (Doctoral dissertation, Curtin University).

[18] vinh quoc Luong, K., & Nguyen, L. T. H. (2012). The impact of thiamine treatment in the diabetes mellitus. Journal of Clinical Medicine Research, 4(3), 153.

[19] Habeb, A. M., Flanagan, S. E., Zulali, M. A., Abdullah, M. A., Pomahačová, R., Boyadzhiev, V., ... & De Franco, E. (2018). Pharmacogenomics in diabetes: outcomes of thiamine therapy in TRMA syndrome. Diabetologia, 61, 1027-1036.

[20] Abdullah, K. M., Arefeen, A., Shamsi, A., Alhumaydhi, F. A., & Naseem, I. (2021). Insight into the In vitro antiglycation and in vivo antidiabetic effects of thiamine: Implications of vitamin B1 in controlling diabetes. ACS omega, 6(19), 12605-12614...