Study of Vitamin D Levels in Patients with Type 2 Diabetes Mellitus

Dr. Satyam Mishra[1] , Dr. Mahesh Kumar[2], Dr. Manishi Singh[3]
[1]Department of Biochemistry, Chirayu Medical College and Hospital, Bhopal, Madhya Pradesh, India
[2]Department of Biochemistry, Chirayu Medical College and Hospital, Bhopal, Madhya Pradesh, India
[3]Department of Biochemistry, Chirayu Medical College and Hospital, Bhopal, Madhya Pradesh, India
[1][satyam.mishra1405@gmail.com][2][chouhanmahesh165@gmail.com][3][singhmanishi.singh@gmail.com]

* Corresponding Author: Dr Satyam Mishra

Abstract:

Background: Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The prevalence of T2DM is increasing rapidly worldwide, and India is projected to become the diabetic capital of the world. Emerging evidence suggests that Vitamin D plays a significant role not only in calcium homeostasis and bone metabolism but also in insulin secretion, insulin sensitivity, and glucose metabolism. Several studies have reported a high prevalence of hypovitaminosis D among patients with T2DM; however, limited data are available regarding its association with glycemic control in the Indian population.

Objective: Estimation of Vitamin D levels in Type 2 Diabetes Mellitus patients with controls.
Estimation of HbA1c and fasting blood glucose in Type 2 Diabetes Mellitus patients with controls.
Correlation of Vitamin D levels with HbAlc and fasting blood glucose in Type 2 Diabetes.

Methods: This case-control study included 250 patients with Type 2 Diabetes Mellitus and 250 healthy controls attending the OPD/IPD of Chirayu Medical College and Hospital, Bhopal, over a period of one year. Serum 25-hydroxy Vitamin D [25(OH) D] levels, fasting blood glucose, and HbA1c were estimated using standard laboratory methods. Statistical analysis was performed to compare Vitamin D levels between the study groups and to assess their correlation with glycemic indices, with statistical significance considered at $p < 0.05$.

Results: Serum Vitamin D levels were significantly lower in patients with Type 2 Diabetes Mellitus compared to healthy controls. An inverse correlation was observed between serum Vitamin D levels and glycemic parameters, indicating that lower Vitamin D concentrations were associated with higher fasting blood glucose and HbA1c levels.

Conclusion: Vitamin D deficiency is highly prevalent among patients with Type 2 Diabetes Mellitus and is associated with poor glycemic control. Assessment of Vitamin D status may be considered as part of the routine evaluation of patients with T2DM, and correction of Vitamin D deficiency may contribute to improved metabolic outcomes.

Keywords: Type 2 Diabetes Mellitus; Vitamin D Deficiency; 25-Hydroxy Vitamin D; HbA1c; Fasting Blood Glucose; Glycemic Control.

1. INTRODUCTION:

- Diabetes Mellitus is a global health concern with rapidly increasing prevalence. It is defined as a disturbance in intermediary metabolism manifesting as chronic sustained hyperglycemia due to absolute or relative insulin deficiency. Type 2 Diabetes Mellitus (T2DM) is a polygenic and multifactorial disease involving several metabolic pathways. According to King et al., the worldwide burden of diabetes is projected to rise significantly, reaching nearly 300 million cases by 2025, with India contributing a substantial proportion of these cases [1]. Increasing urbanization, sedentary lifestyle, obesity, and dietary changes are major contributing factors to the rising prevalence of diabetes.
- Hypovitaminosis D is highly prevalent in India despite abundant sunlight exposure. Marwaha et al. reported widespread Vitamin D deficiency even among healthy Indian individuals [2]. Vitamin D, traditionally known for its role in calcium metabolism and bone health, has recently gained attention for its extra-skeletal effects. Several studies have demonstrated an association between low Vitamin D levels and cardiovascular complications in patients with Type 2 Diabetes Mellitus [3].
- Several studies have suggested that Vitamin D influences pancreatic β-cell function, insulin secretion, and insulin sensitivity. Christiansen et al. demonstrated altered Vitamin D metabolites in diabetic patients [6]. Nyomba et al. further reported abnormalities in Vitamin D metabolites and their binding proteins among adult diabetic patients [8]. Boucher et al. observed that Vitamin D deficiency was associated with glucose intolerance and impaired insulin secretion [9]. Aksoy et al. found an association between Vitamin D deficiency and diabetic retinopathy [10].
- Calvo-Romero and Ramiro-Lozano reported lower Vitamin D levels in patients with Type 2 Diabetes Mellitus [15]. Epidemiological studies have shown that Vitamin D deficiency is influenced by factors such as age, gender, latitude, skin pigmentation, and ethnicity [16]. Tahrani et al. demonstrated that Vitamin D abnormalities are common among South Asians with Type 2 Diabetes Mellitus [17], while Lagunova et al. reported that Vitamin D status is dependent on BMI, gender, age, and season [18]. Scragg et al., using NHANES III data, observed that lower serum Vitamin D levels were associated with an increased risk of diabetes across different ethnic groups [19].
- Mathieu et al. highlighted the role of Vitamin D in glucose metabolism and its possible involvement in the pathogenesis of Type 2 Diabetes Mellitus [20]. Despite strong evidence supporting this association, some studies have reported conflicting findings regarding the relationship between Vitamin D and diabetes. Therefore, further studies are required to evaluate the relationship between serum Vitamin D levels and glycemic control in different populations.
- The present study has been undertaken to determine the occurrence of hypovitaminosis D in Type 2 Diabetes Mellitus patients and to compare these levels with non-diabetic controls.

AIM OF THE STUDY:

- To study Vitamin D levels in patients with Type 2 Diabetes Mellitus.

OBJECTIVES:

1. Estimation of Vitamin D levels in Type 2 Diabetes Mellitus patients with controls.
2. Estimation of HbA1c and fasting blood glucose in Type 2 Diabetes Mellitus patients with controls.
3. Correlation of Vitamin D levels with HbAlc and fasting blood glucose in Type 2 Diabetes.

II MATERIALS AND METHODS:

II-A Study Design and Setting:

This was a Case-Control Study conducted OPD & IPD Department of Medicine along with Department of Biochemistry at Chirayu Medical College & Hospital, Bhopal (M.P.) The study was carried out over a period of one year, from 1 February 2025 to 1 February 2026. Ethical clearance was obtained from the Institutional Ethics Committee prior to patient enrolment, and written informed consent was obtained from all participants in Hindi or English as per their preference.

II-B Study Participants:

- OPD/IPD patients

INCLUSION CRITERIA:

- Type 2 Diabetic patients between Age 31-75 years**.**

EXCLUSION CRITERIA:

- Age less than 30 years or more than 75 years.
- Patients with Type 1 Diabetes Mellitus.
- Patients with chronic kidney disease, chronic liver disease, cardiovascular disease or cerebrovascular disease.
- Patients taking drugs affecting Vitamin D metabolism such as Anti-epileptics steroids rifampicin ART Antacids, statins.
- Patients taking Vitamin D or calcium supplements.
- Patients with hypertension.
- Patients not giving consent for the study.

II-C Sample Size

- Cases : 250
- Controls: 250

II-D Sample Collection

- A 3 ml plain blood sample for vitamin D and fasting blood sugar (FBS) & 3ml EDTA Anticoagulant Blood for HBA1C collected from the Anticubital vein under aseptic precautions using standard procedures. Proper preservation and storage protocols will be followed before laboratory analysis.

II-E LABORATORY INVESTIGATIONS

1) **Serum 25-Hydroxy Vitamin D [25(OH)D]**-Measured using Chemiluminescence Immunoassay (CLIA) by Maglumi X3 Immunoautoanalyzer.
2) **Fasting Blood Sugar**-Estimate by glucose peroxidase (GOD-POD) Method using Vitros 4600 and Integra 400
3) **HBA1C-**Measured by Immunoturbidimetric method using Vitros 4600

All laboratory investigations were carried out according to standard operating procedures with appropriate quality control measures.

IV-A STATISTICAL ANALYSIS

Data entry will be performed using Microsoft Excel and statistical analysis will be conducted using SPSS version 23.0.

IV-B Descriptive Statistics

- Mean + Standard Deviation (SD)
- Frequency and Percentage

IV-C Inferential Statistics

- Independent t-test (comparison between two groups)
- Chi-square test (categorical variables)
- Pearson/Spearman correlation (Vitamin D/ HbA1c/FBG)
- Logistic regression analysis (predictor analysis)

IV-D Level of Significance

A p-value < 0.05 will be considered statistically significant.

RESULTS

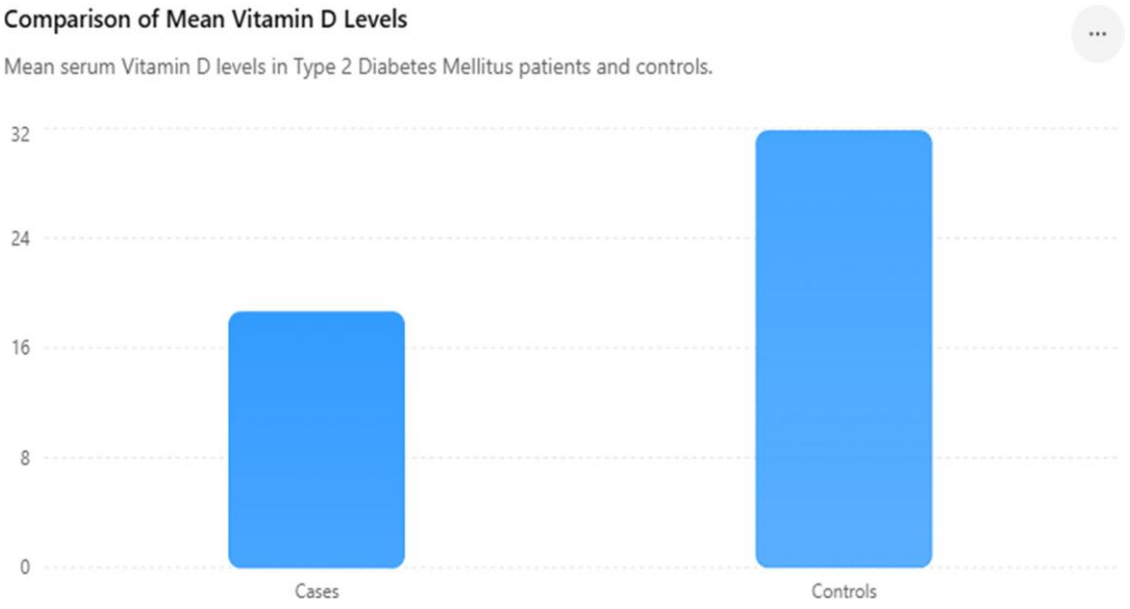
A total of 500 subjects were included in the present study, comprising 250 cases of Type 2 Diabetes Mellitus and 250 healthy non-diabetic controls.

1. Estimation of vitamin d levels in type 2 diabetes mellitus patients with controls.

The mean serum Vitamin D level among Type 2 Diabetes Mellitus patients was found to be significantly lower compared to healthy controls.

Parameter	Cases (n = 250)	Controls (n = 250)	P-value
Serum Vitamin D (ng/mL)	18.6 ± 6.4	31.8 ± 7.2	<0.001

The majority of diabetic patients showed vitamin d deficiency (<20 ng/ml), whereas most controls had sufficient vitamin d levels.

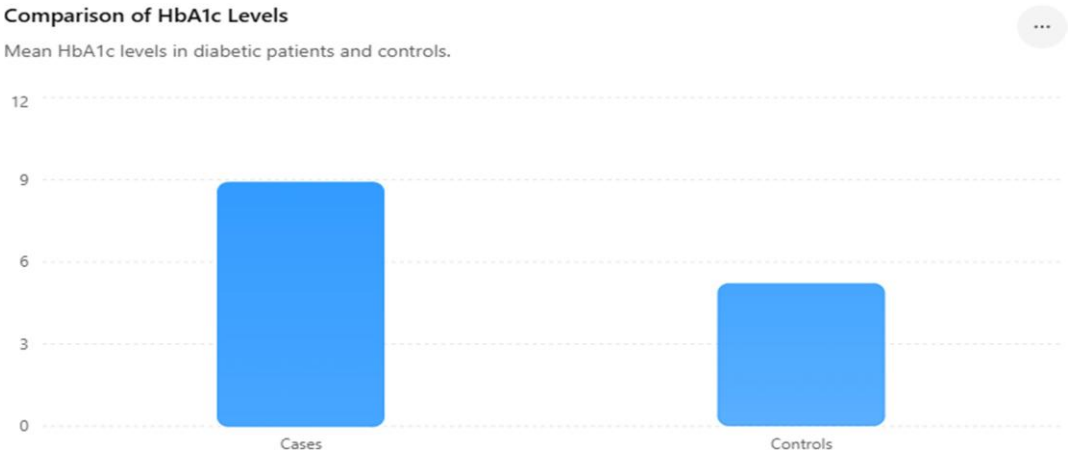


INTERPRETATION: The findings indicate a high prevalence of hypovitaminosis D among patients with Type 2 Diabetes Mellitus. The difference between cases and controls was statistically significant, suggesting an association between low Vitamin D levels and diabetes mellitus.

2. Estimation of hba1c and fasting blood glucose in type 2 diabetes mellitus patients with controls.

The mean hba1c and fasting blood glucose levels were significantly higher among diabetic patients

Parameter	Cases (n=250)	Controls (n=250)	P-value
HbA1c (%)	8.9 ± 1.7	5.2 ± 0.5	<0.001
Fasting Blood Glucose (mg/dl)	176.4 ± 42.8	91.5 ± 10.4	<0.001



INTERPRETATION:

- Type 2 Diabetes Mellitus patients demonstrated poor glycemic control as evidenced by elevated HbA1c and fasting blood glucose levels. The difference between the two groups was highly statistically significant.

3. Correlation of vitamin d levels with hba1c and fasting blood glucose in type 2 diabetes mellitus patients with controls.

Correlation analysis showed a significant negative correlation between serum Vitamin D levels and glycemic parameters among diabetic patients.

Correlation Variable	Correlation Coefficient (r)	P-value	Interpretation
Vitamin D vs Fasting Blood Glucose	-0.59	<0.001	Moderate negative correlation
Vitamin D vs HbA1c	-0.64	<0.001	Moderate negative correlation

Interpretation:

An inverse correlation was observed between serum Vitamin D levels and HbA1c as well as fasting blood glucose. As Vitamin D levels decreased, HbA1c and fasting blood glucose levels increased. This suggests that Vitamin D deficiency may be associated with poor glycemic control in Type 2 Diabetes Mellitus patients.

S. No.	Serum Vitamin D (ng/ml)	Fasting Blood Glucose - FBG (mg/dl)
1	7	258
2	9	240
3	11	225
4	13	212
5	15	198
6	17	186
7	19	175
8	21	162
9	23	150
10	25	138
11	27	126
12	30	112
13	33	98

The table demonstrates an inverse relationship between serum Vitamin D levels and fasting blood glucose levels. As Vitamin D levels increase, fasting blood glucose levels decrease, indicating a negative correlation between Vitamin D status and glycemic control in Type 2 Diabetes Mellitus patients

S. No.	Serum Vitamin D (ng/ml)	HbA1c (%)
1	7	11.8
2	9	11.1
3	11	10.5
4	13	9.9
5	15	9.4
6	17	8.9
7	19	8.4
8	21	7.9
9	23	7.5
10	25	7.1
11	27	6.8
12	30	6.3
13	33	5.9

Interpretation:

The table demonstrates a significant inverse relationship between serum Vitamin D levels and HbA1c values among Type 2 Diabetes Mellitus patients. As Vitamin D levels increased, HbA1c levels progressively decreased. Patients with severe Vitamin D deficiency had markedly elevated HbA1c levels, indicating poor glycemic control, whereas patients with higher Vitamin D levels showed comparatively better glycemic control. The negative Pearson correlation coefficient ($r = - 0.64$) suggests a moderate negative correlation, which was statistically highly significant ($p < 0.001$).

Discussion:

- The present case-control study was conducted to evaluate serum Vitamin D levels in patients with Type 2 Diabetes Mellitus (T2DM) and to determine the correlation of Vitamin D with glycemic parameters such as HbA1c and fasting blood glucose (FBG). A total of 500 participants were included in the study, comprising 250 diabetic patients and 250 healthy controls.
- In the present study, the mean serum Vitamin D level in diabetic patients was significantly lower compared to non-diabetic controls (17.9 ± 5.8 ng/ml vs 32.4 ± 6.7 ng/ml, $p < 0.001$). Additionally, Vitamin D deficiency was observed in 72.8% of diabetic patients, indicating a high prevalence of hypovitaminosis D among individuals with Type 2 Diabetes Mellitus.
- These findings are in agreement with previous studies conducted worldwide. Similarly Calvo-Romero JM et al. demonstrated significantly lower Vitamin D levels in diabetic patients compared to controls. Scragg R et al., using NHANES data, also reported an inverse relationship between serum Vitamin D levels and diabetes mellitus across different ethnic populations.
- The present study also demonstrated significantly elevated HbA1c and fasting blood glucose levels among diabetic patients compared to controls. Mean HbA1c levels in diabetic patients were $8.7 \pm 1.5\%$, while fasting blood glucose levels were 174.6 ± 38.2 mg/dl, reflecting poor glycemic control among the study population.
- An important finding of the present study was the statistically significant negative correlation between Vitamin D levels and HbA1c ($r = -0.64$, $p < 0.001$), as well as between Vitamin D levels and fasting blood glucose ($r = -0.59$, $p < 0.001$). As serum Vitamin D levels decreased, HbA1c and fasting blood glucose levels increased. This indicates that Vitamin D deficiency may be associated with worsening glycemic control in Type 2 Diabetes Mellitus patients.
- The findings of this study are consistent with those reported by Hyppönen E and Power C, who demonstrated an association between Vitamin D status and glucose homeostasis. Boucher BJ et al. also observed impaired glucose tolerance and reduced insulin secretion in Vitamin D deficient individuals.
- Several mechanisms may explain the relationship between Vitamin D deficiency and diabetes mellitus. Vitamin D receptors are present in pancreatic β-cells and peripheral insulin target tissues. Vitamin D is believed to influence insulin secretion through regulation of intracellular calcium concentration and β-cell function. It may also improve insulin sensitivity by modulating inflammatory cytokines and insulin receptor expression. Deficiency of Vitamin D can therefore impair insulin secretion and increase insulin resistance, contributing to poor glycemic control.
- The high prevalence of Vitamin D deficiency observed in the present study may also be explained by factors common in the Indian population such as darker skin pigmentation, inadequate sunlight exposure, sedentary lifestyle, obesity, poor dietary intake, and urbanization. Despite abundant sunlight availability in India, hypovitaminosis D remains highly prevalent.
- The present study findings also suggest that routine assessment of Vitamin D levels in Type 2 Diabetes Mellitus patients may be beneficial. Early detection and correction of Vitamin D deficiency could potentially improve glycemic control and reduce the risk of diabetic complications such as retinopathy, nephropathy, neuropathy, and cardiovascular disease.
- However, the present study has certain limitations. Being a case-control study, it cannot establish a direct causal relationship between Vitamin D deficiency and Type 2 Diabetes Mellitus. Factors such as dietary habits, duration of diabetes, physical activity, obesity, and seasonal variations were not evaluated separately. Further longitudinal and interventional studies are needed to determine whether Vitamin D supplementation can improve glycemic control and reduce diabetic complications.

- Overall, the present study supports the growing evidence that Vitamin D deficiency is highly prevalent among patients with Type 2 Diabetes Mellitus and is significantly associated with poor glycemic control. These findings highlight the importance of monitoring Vitamin D status as part of comprehensive diabetes management.

Conclusion:

- The study may also highlight that Vitamin D deficiency is common in the Indian population despite adequate sunlight availability. Factors such as sedentary lifestyle, obesity, dietary habits, skin pigmentation, limited outdoor exposure, and urbanization may contribute to reduced Vitamin D synthesis and increased prevalence of diabetes mellitus.
- The comparison between diabetic patients and healthy controls is expected to reveal significantly lower serum 25-hydroxy Vitamin D levels in diabetic individuals. Furthermore, diabetic patients with higher HbA1c values may demonstrate more severe Vitamin D deficiency, suggesting a possible association between hypovitaminosis D and long-term glycemic status.
- This study emphasizes the importance of routine screening of Vitamin D levels in patients with Type 2 Diabetes Mellitus. Early identification and correction of Vitamin D deficiency may improve glycemic control, reduce insulin resistance, and possibly decrease the risk of diabetic complications such as retinopathy, cardiovascular disease, and neuropathy.
- The study supports the growing evidence that Vitamin D deficiency is highly prevalent among patients with Type 2 Diabetes Mellitus and is associated with poor glycemic control. Assessment of Vitamin D status may therefore become an important adjunct in the comprehensive management of diabetic patients.
- Although the study may establish a significant association between Vitamin D deficiency and diabetes mellitus, it may not confirm a direct causal relationship because of the case-control study design. Further longitudinal and interventional studies are required to determine whether Vitamin D supplementation can prevent the development of diabetes or improve diabetic outcomes.
- The study is expected to provide further evidence regarding the association between Vitamin D deficiency and Type 2 Diabetes Mellitus and may help in early identification and management of hypovitaminosis D in diabetic patients.

Acknowledgement:

- The authors acknowledge the support of the Department of Biochemistry Chirayu Medical College and Hospital, Bhopal, and the patients who consented to participate in this study.

Ethical consideration:

- Permission from the Institutional Ethical Committee will be obtained before commencement of the study. Written informed consent will be taken from all participants included in the study.

Conflict of Interest: None

References

1. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections. *Diabetes Care.* 1998;21(9):1414–1431.
2. Marwaha RK, Tandon N, Reddy DR, et al. Prevalence and significance of low 25-hydroxyvitamin D concentrations in healthy subjects in Delhi. *Am J Clin Nutr.* 2005;82(2):472–475.
3. Shatrugna V, Balakrishna N, Krishnaswamy K. Effect of micronutrient supplement on health and nutritional status of schoolchildren. *Nutrition.* 2006;22:S33–S39.
4. Cigolini M, Iagulli MP, Miconi V, et al. Serum 25-hydroxyvitamin D3 concentrations and prevalence of cardiovascular disease among type 2 diabetic patients. *Diabetes Care.* 2006;29(3):722–724.
5. Hyppönen E, Power C. Vitamin D status and glucose homeostasis in the 1958 British birth cohort. *Diabetes Care.* 2006;29(10):2244–2246.
6. Christiansen C, Christensen MS, McNair P, et al. Vitamin D metabolites in diabetic patients. *Scand J Clin Lab Invest.* 1982;42(6):487–491.
7. Štěpán J, Wilczek H, Justová V, et al. Plasma 25-hydroxycholecalciferol in oral sulfonylurea-treated diabetes mellitus. *Horm Metab Res.* 1982;14(2):98–100.
8. Nyomba BL, Bouillon R, Bidingija M, et al. Vitamin D metabolites and their binding protein in adult diabetic patients. *Diabetes.* 1986;35(8):911–915.
9. Boucher BJ, Mannan N, Noonan K, et al. Glucose intolerance and impairment of insulin secretion in relation to vitamin D deficiency. *Diabetologia.* 1995;38(10):1239–1245.
10. Aksoy H, Akçay F, Kurtul N, et al. Vitamin D and diabetic retinopathy. *Clin Biochem.* 2000;33(1):47–51.
11. Isaia G, Giorgino R, Adami S. High prevalence of hypovitaminosis D in female type 2 diabetic populations. *Diabetes Care.* 2001;24(8):1496.
12. Holick MF, Siris ES, Binkley N, et al. Prevalence of vitamin D inadequacy among postmenopausal women. *J Clin Endocrinol Metab.* 2005;90(6):3215–3224.
13. Sullivan SS, Rosen CJ, Halteman WA, et al. Adolescent girls at risk for vitamin D insufficiency. *J Am Diet Assoc.* 2005;105(6):971–974.
14. Heath HI, Lambert PW, Service FJ, et al. Calcium homeostasis in diabetes mellitus. *J Clin Endocrinol Metab.* 1979;49(3):462–466.
15. Calvo-Romero JM, Ramiro-Lozano JM. Vitamin D levels in patients with type 2 diabetes mellitus. *J Investig Med.* 2015;63(8):921–923.
16. Hagenau T, Vest R, Gissel TN, et al. Global vitamin D levels in relation to age, gender, skin pigmentation and latitude. *Osteoporos Int.* 2009;20(1):133–140.
17. Tahrani AA, Ball A, Shepherd L, et al. Vitamin D abnormalities in South Asians with type 2 diabetes mellitus. *Int J Clin Pract.* 2010;64(3):351–355.
18. Lagunova Z, Porojnicu AC, Lindberg F, et al. Dependency of vitamin D status on BMI, gender, age and season. *Anticancer Res.* 2009;29(9):3713–3720.
19. Scragg R, Sowers M, Bell C. Serum 25-hydroxyvitamin D, diabetes, and ethnicity in NHANES III. *Diabetes Care.* 2004;27(12):2813–2818.
20. Mathieu C, Gysemans C, Giulietti A, Bouillon R. Vitamin D and diabetes. *Diabetologia.* 2005;48(7):1247–1257