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Deficiency of 25-Hydroxy Vitamin D in Type 2 Diabetic Patients in Parakou in 2023: Prevalence and Associated Factors

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Abstract

Introduction: Type 2 diabetes is a major global public health problem. Deficiency in 25-hydroxyvitamin D (25(OH)D) is considered a potential risk factor in its onset and progression. The objective of this study was to determine the prevalence and the factors associated with vitamin D deficiency among patients with type 2 diabetes in Parakou in 2023. **Methods:** This was a descriptive and analytical study with prospective data collection conducted from January 30 to March 3, 2023. The study population consisted of patients with type 2 diabetes attending the outpatient clinic of the NGO *Diabetes Benin*. Vitamin D deficiency was defined according to the Endocrine Society's clinical practice guidelines. Logistic regression analysis was used to identify factors associated with 25(OH)D deficiency at a significance threshold of 5%. **Results:** A total of 120 patients with type 2 diabetes were included. Their mean age was 60.35 ± 11.28 years, with a predominance of females (66.67%). The mean 25(OH)D concentration was 17.35 ± 7.21 ng/mL. The prevalence of 25(OH)D deficiency was 63.33% (95% CI [54.05 - 71.94]). Normal blood pressure (ORa = 0.30; p = 0.0242) and normal fasting blood glucose (ORa = 0.30; p = 0.0118) were identified as protective factors against 25(OH)D deficiency. **Conclusion:** Vitamin D deficiency is frequent among patients with type 2 diabetes in Parakou. Good glycemic control and vitamin D supplementation appear to be necessary.

Keywords

Type 2 Diabetes, Vitamin D, Parakou

1. Introduction

Diabetes mellitus, predominantly type 2, is a major public health problem, with a prevalence projected to rise from 10.5% in 2021 to 12.2% in 2045 if no preventive measures are taken [1]. Chronic hyperglycemia caused by diabetes mellitus leads, in the long term, to dysfunction of various organs, including the eyes, kidneys, nerves, heart, and blood vessels, resulting in complications that may be macrovascular (myocardial infarction, transient ischemic attack, stroke, and limb ischemia) and/or microvascular (retinopathy, nephropathy, peripheral neuropathy) [2] [3].

Numerous modifiable risk factors for diabetes mellitus have been identified, most of which are related to lifestyle, such as diet and physical activity. Other risk factors have been identified in recent years. Among these emerging factors is vitamin D status, which appears to be a marker of overall health, since a body of consistent epidemiological evidence indicates that adequate vitamin D intake is associated with better health outcomes. In addition to its role in phosphocalcic homeostasis, several other functions have been attributed to vitamin D. It plays a role in insulin synthesis and may be implicated in the development of diabetes independently of natural predisposing factors [4] [5].

In diabetic patients, vitamin D plays a crucial role, and its deficiency may be responsible for several disorders [6]. Low plasma vitamin D levels are associated with poor glycemic control because vitamin D plays an important role in insulin secretion through several mechanisms [7]-[10]. Beyond vascular complications, vitamin D deficiency may increase the frequency of hospitalizations, respiratory infections, musculoskeletal disorders, and mortality in diabetic patients, as well as the risk of amputation in cases of diabetic foot lesions [11] [12].

Because of the metabolic and vascular effects of vitamin D, it has gained considerable attention in diabetes research. In Benin, several epidemiological and clinical studies have been conducted on Type 2 Diabetes (T2D), but none have specifically addressed vitamin D. Many T2D patients followed in care centers are unaware of their vitamin D status, as measurement of serum 25-hydroxyvitamin D is not prescribed due to its high cost. This study was therefore undertaken to fill this gap, with the aim of determining the prevalence and factors associated with vitamin D deficiency among patients with T2D in Parakou.

2. Study Setting and Methods

Study setting: The outpatient clinic of the NGO *Diabetes Benin* in Parakou served as the study site for participant recruitment.

Study design and period: This was a cross-sectional, descriptive, and analytical study with prospective data collection conducted from January 30 to March 3, 2023.

Study population: The study population consisted of patients with type 2 diabetes (T2D) followed at the outpatient clinic of the NGO *Diabetes Benin* for at least 6 months, aged 18 years or older, and who provided informed consent. Patients with T2D who were unable to answer questions, those with renal failure,

anemia, or abnormalities of phosphocalcic metabolism were excluded from the study.

Variables: The dependent variable was 25(OH)D deficiency, defined as a plasma concentration < 20 ng/mL. Vitamin D status was classified as follows: insufficient if [20 - 30[ng/mL, sufficient if [30 - 100[ng/mL, and toxic if ≥100 ng/mL. Independent variables included sociodemographic characteristics, comorbidities, lifestyle factors, chronic complications, clinical parameters, and fasting blood glucose.

Measurement of serum 25(OH)D: Quantification was performed using a competitive enzyme-linked immunoassay (ELFA) with final fluorescence detection on a Minividas analyzer.

Data processing and analysis: Data analysis was performed using Epi Info version 7.2.2.6. Qualitative variables were expressed as percentages with confidence intervals, and quantitative variables as means with standard deviations. Logistic regression analysis was conducted to assess associations between vitamin D deficiency and independent variables among T2D patients. Statistical significance was set at 0.05. Explanatory variables were presented as adjusted Odds Ratios (aOR) with their 95% confidence intervals (95% CI).

Ethical and regulatory considerations: Written informed consent was obtained from all participants. The study protocol was approved by the Local Ethics Committee for Biomedical Research of the University of Parakou under reference number 255/2022/CLERB-UP/P/SP/R/SA, dated May 3, 2022.

3. Results

General characteristics of the study population: A total of 120 patients with type 2 diabetes were included. Their mean age was 60.35 ± 11.28 years, with a predominance of females (66.67%). The mean Body Mass Index (BMI) was 27.60 ± 5.24 kg/m^2 (range: 17.18 - 43.05 kg/m^2). Patients with a BMI ≥ 25 kg/m^2 accounted for 65.84%, and waist circumference was elevated in 70% of the participants. The prevalence of hypertension was 63.33%. Lifestyle characteristics included alcohol consumption (13.13%), physical inactivity (17.50%), use of covering clothing (70%), and daily sun exposure < 5 hours (65.83%). Clinically, polyuria and polydipsia were observed in 30.00% and 31.67% of patients, respectively, while abnormal blood pressure was noted in 31.67%. Chronic complications included retinopathy (40.00%) and peripheral neuropathy (63.33%). Biochemically, fasting blood glucose was normal in 45.83% of the participants. (Table 1)

Prevalence of 25(OH)D deficiency: Among the 120 patients with type 2 diabetes, 76 had plasma 25(OH)D levels < 20 ng/mL, corresponding to a prevalence of 63.33% (95% CI [54.05 - 71.94]). Only 5% of the participants had normal levels, and none had toxic concentrations. The mean plasma 25(OH)D concentration was 17.35 ± 7.21 ng/mL. (Table 2)

Factors associated with 25(OH)D deficiency: In multivariate analysis, normal blood pressure (aOR = 0.30, p = 0.0242) and normal fasting blood glucose (aOR

= 0.30, p = 0.0118) were identified as protective factors against 25(OH)D deficiency. (Table 3 and Table 4)

Table 1. General characteristics of the study population (n = 120).

	n	%
Age		
<50 years	20	16.67
≥50 years	100	83.33
Sex		
Female	80	66.67
Male	40	33.33
Body Mass Index		
<25 kg/m²	41	34.16
≥25 kg/m²	79	65.84
Waist circumference		
Normal	36	30.00
High	84	70.00
Duration since diabetes diagnosis		
<5 years	31	25.83
≥5 years	89	74.17
Comorbidity		
Hypertension	76	63.33
HIV Infection	01	0.83
Lifestyle		
Alcohol consumption	13	13.33
Tobacco consumption	03	02.50
Physical inactivity	21	17.50
Wearing covering clothing	84	70.00
Sun exposure < 5 h/day	79	65.83
Clinical data		
Polyuria	36	30.00
Polydipsia	38	31.67
Abnormal blood pressure	38	31.67
Chronic complications		
Retinopathy	48	40.00
Peripheral neuropathy	76	63.33
Erectile dysfunction	23	19.17
Fasting blood glucose		
Low	06	05.00
Normal	55	45.83
High	59	49.17

Table 2. Distribution of type 2 diabetic patients according to 25-hydroxyvitamin D levels, Parakou, 2023, n = 120.

	n	%	95% CI
Deficiency (<20 ng/mL)	76	63.33	[54.05 - 71.94]
Insufficient ([20 - 30[ng/mL)	38	31.67	[23.48 - 40.78]
Normal ([30 - 100[ng/mL)	06	05.00	[01.86 - 10.57]

Table 3. Factors associated with 25-hydroxyvitamin D deficiency in diabetic patients in Parakou in 2023 (univariate analysis).

	25(OH)D deficiency				N	OR	95% CI	p
	Yes		No					
	n	%	n	%				
Blood pression								
Normal	46	56.10	36	43.90	82	0.34	[0.13 - 0.83]	0.0150
Abnormal	30	78.95	08	21.05	38	1		
Polyuria								
Yes	28	77.78	08	22.22	36	2.62	[1.07 - 6.43]	0.0310
No	48	57.14	36	42.86	84	1		
Polydipsia								
Yes	31	81.58	07	18.42	38	3.64	[1.43 - 9.21]	0.0040
No	45	54.88	37	45.12	82	1		
Retinopathy								
Yes	37	77.08	11	22.92	48	2.84	[1.25 - 6.44]	0.0100
No	39	54.17	33	45.83	72	1		
Fasting blood glucose								
Normal	29	52.73	26	47.27	55	0.42	[0.20 - 0.91]	0.0265
Abnormal	48	72.31	18	27.69	65	1		

OR: Odds Ratio; CI: Confidence Interval; P: uncorrected chi-square test and Fisher's exact test, as appropriate.

Table 4. Multivariate analysis of factors associated with 25-hydroxyvitamin D deficiency in type 2 diabetic patients in Parakou in 2023.

	25(OH)D deficiency				N	ORa	95% CI	p
	Yes		No					
	n	%	n	%				
Blood pression								
Normal	46	56.10	36	43.90	82	0.30	[0.10 - 0.85]	0.0242
Anormal	30	78.95	08	21.05	38	1		
Polyuria								
Yes	28	77.78	08	22.22	36	0.72	[0.06 - 7.94]	0.7930
No	48	57.14	36	42.86	84	1		

Continued

Polydipsia								
Yes	31	81.58	07	18.42	38	5.29	[0.49 - 56.91]	0.1688
No	45	54.88	37	45.12	82	1		
Retinopathy								
Yes	37	77.08	11	22.92	48	2.00	[0.79 - 5.07]	0.1409
No	39	54.17	33	45.83	72	1		
Fasting blood glucose								
Normal	29	52.73	26	47.27	55	0.30	[0.12 - 0.76]	0.0118
Abnormale	48	72.31	18	27.69	65	1		

aOR: adjusted Odds Ratio; CI: Confidence Interval; P: Uncorrected chi-square test.

4. Discussion

This study is the first to address vitamin D status in northern Benin. The method used for vitamin D measurement is among the most recommended. Statistical analyses, particularly multivariate analysis, allowed for the identification of true factors associated with 25(OH)D deficiency. The precautions taken ensured reliable results.

At the end of the study, the prevalence of 25(OH)D deficiency was found to be 63.33%. Similar prevalences have been reported by Hong *et al.* [13] in South Korea (71.10%), Taderegew *et al.* [14] in Ethiopia (64.20%), Siddiqee *et al.* [15] in Bangladesh (68.00%), Abdo *et al.* [16] in Yemen (65.70%), and Kumar *et al.* [17] in China (58.57%). Thus, 25(OH)D deficiency is a worldwide problem that spares no country. Higher prevalences have been reported by other authors, including 88.00% and 93.75% by Li *et al.* [18] in China and Nasr *et al.* [19] in Iraq, respectively. Preventive measures are therefore necessary and should include not only screening and vitamin D supplementation but also the adoption of health-promoting behaviors such as adequate sun exposure and reducing the frequent use of covering clothing. In the present cohort, the majority of patients reported less than 5 hours of daily sun exposure and frequently wore covering clothing.

Beyond these measures, it is important to identify associated factors. In this study, normal blood pressure and normal fasting blood glucose were protective factors, consistent with findings from other authors. Normal blood pressure was reported as a protective factor against 25(OH)D deficiency by Lui *et al.* [20] in China. Observational studies in humans have shown that reduced circulating 25-hydroxyvitamin D is associated with increased activity of the renin–angiotensin–aldosterone system and higher blood pressure [21]. According to Alzahrani *et al.* [22] in Saudi Arabia and Abdo *et al.* [16] in Yemen, a normal fasting blood glucose level was a protective factor against 25(OH)D deficiency. The role of vitamin D in insulin synthesis is well established and may explain the association between hyperglycemia and 25(OH)D deficiency [4] [5].

This study faced certain limitations, including the absence of a control group of

non-diabetic individuals and the relatively small sample size, which justifies conducting further studies on a larger cohort. It should also be noted that the exclusion of patients with renal insufficiency, whose vitamin D metabolism is impaired, may have influenced the observed prevalence.

5. Conclusion

Vitamin D [25(OH)D] deficiency is high among patients with type 2 diabetes followed in Parakou, requiring early screening and management. Good glycemic control and normal blood pressure are goals to be achieved given their protective effect against 25(OH)D deficiency.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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