Journal of Biosciences and Medicines, 2024, 12, 161-169
https://www.scirp.org/journal/jbm
ISSN Online: 2327-509X
ISSN Print: 2327-5081

Investigation of 25-Hydroxy Vitamin D Status and Related Factors in Hospitalised Patients with Type 2 Diabetes Mellitus

Jie Luo[1,2], Weirong Pu[3*]

[1]Medical Institute, Qinghai University, Xining, China
[2]Qinghai Provincial Key Laboratory of Traditional Chinese Medicine Research for Glucolipid Metabolic Diseases, Xining, China
[3]Endocrinology Unit, Qinghai Hospital of T.C.M, Xining, China
Email: *1442298449@qq.com

How to cite this paper: Luo, J. and Pu, W.R. (2024) Investigation of 25-Hydroxy Vitamin D Status and Related Factors in Hospitalised Patients with Type 2 Diabetes Mellitus. *Journal of Biosciences and Medicines*, **12**, 161-169.
https://doi.org/10.4236/jbm.2024.124014

Received: March 18, 2024
Accepted: April 16, 2024
Published: April 19, 2024

Abstract

Objective: To investigate the distribution of 25-hydroxy Vitamin D level status in type 2 diabetes mellitus inpatients, as well as the differences in general conditions and clinical indicators in patients with different Vitamin D status. **Methods**: Retrospective analysis of 250 admitted type 2 diabetes inpatients admitted to the endocrinology department of qinghai provincial hospital of traditional chinese medicine from september 2022 to december 2023, collated and analysed the general data and laboratory indicators of the patient cases, and applied spss26.0 to process and analyse the data and explore the differences in the general conditions and commonly used clinical nutritional indicators of type 2 diabetes in patients with different 25-hydroxyVitamin D levels. The differences between the different 25-hydroxy Vitamin D levels in type 2 diabetes mellitus patients. **Results**: 1) A total of 250 inpatients with type 2 diabetes mellitus were included in this study, of which 56 cases (22.4%) were patients with 25 hydroxyvitamin D deficiency [25(OH)D < 20 ng/L]; 107 cases (44.8%) were patients with 25 hydroxyvitamin D insufficiency [20 ng/L ≤ 25(OH)D < 30 ng/L]; 87 cases (34.8%) were patients with 25 hydroxyvitamin D sufficiency [30 ≤ 25(OH) D < 100 ng/mL] 87 cases (34.8%). 2) There were differences in the distribution of gender, duration of disease, and place of residence of type 2 diabetes mellitus patients in different 25(OH)D level groups, with the number of female patients accounting for a significantly higher proportion of patients in the deficiency group than in the remaining two groups ($P < 0.05$), the mean age significantly higher than that of the good group ($P < 0.05$), and the proportion of patients in urban areas significantly higher than that of the remaining two groups ($P < 0.05$). There was no significant difference in the distribution of age and body mass index among the three groups of patients ($P > 0.05$). 3) The distribution of some laboratory indexes among the three groups of patients was differentiated, with the average level of glycated haemoglobin in the lack group being significantly higher than that of the remaining two groups, the average level of albumin being significantly lower than that of the remaining two groups, and the average level of haemoglobin being significantly lower than that of the good group ($P < 0.05$), and the differences in the levels of creatinine and lipids between the groups were not statistically significance ($P > 0.05$). **Conclusion**: The 25(OH)D level of type 2 diabetes mellitus inpatients is not optimistic. In clinical diagnosis and treatment, we should pay attention to the changes in 25 hydroxyvitamin D levels and other nutritional indexes of patients with type 2 diabetes mellitus, and focus on the control of blood glucose levels and timely supplementation of vitamins, proteins, and lipids, in order to improve the patients' physical status, reduce the incidence of complications, and improve the clinical efficacy and the patients' quality of life.

Keywords

Type 2 Diabetes, Hospitalised Patients, 25-HydroxyVitamin D, Nutritional Status

1. Introduction

Vitamin D (VD), also known as the "Anti-rickets vitamin", is a fat-soluble open-cyclic steroid hormone [1]. It consists of two forms: Vitamin D2 (ergocalciferol) and Vitamin D3 (cholecalciferol). Vitamin D2 is obtained from plant foods and Vitamin D3 is obtained primarily from UV light exposure. About 20 percent of the Vitamin D in our body comes from food and 80 percent is obtained from the skin by uv radiation. Vitamins D2 and D3 bind to Vitamin D-binding proteins in the blood and are transported to the liver, where they are metabolised by the 25-hydroxylase enzymes (cyp27a1 and cyp2r1) to 25-hydroxyVitamin D [25-hydroxyvitamind, 25(OH)D], known as calcitriol, which is the predominant form of circulating Vitamin D in the serum, and responds to the body's Vitamin D nutritional status [2].

Vitamin D is one of the essential micronutrients, which is closely related to human bone metabolism. Vitamin D can regulate calcium and phosphorus metabolism in the body to maintain the balance of calcium and phosphorus in the blood, and can also maintain normal bone growth and prevent osteoporotic fracture in the elderly. In addition, the nutritional status of Vitamin D in the human body is also related to cardiovascular disease, immune system, respiratory system and other human functions. Vitamin D deficiency and insufficiency can seriously affect the operation of many normal physiological functions in the human body. In recent years, a large number of studies have shown that Vitamin D deficiency is closely related to the occurrence and development of diabetes mellitus, and that the two key factors in the development of T2DM are insulin resistance and insufficient insulin secretion, which are present throughout the entire process of the occurrence and development of T2DM, and that Vitamin D plays a role in both of the above mechanisms of the development of T2DM. [3] 25(oh)d] is the main circulating and storage form of Vitamin D in the human body, and it is the best indicator of Vitamin D nutritional status because of its long half-life, the fact that synthesis is not directly regulated by hormones, and its high concentration in the blood [4]. The normal value of 25(OH)D in adults is 30 - 100 ng/mL, 25(OH)D < 20 ng/L is vitamin D deficiency, and 20 ng/L ≤ 25(OH)D < 30 ng/L is vitamin D insufficiency. In the course of this paper, the correlation between 25-hydroxyvitamin D and patients' general condition and biochemical indexes in type 2 diabetic inpatients will be studied and analysed as follows.

2. Information and Methodology

2.1. General Information

Retrospective analysis of 250 inpatients with type 2 diabetes admitted to the Department of Endocrinology of Qinghai Provincial Hospital of Traditional Chinese Medicine from September 2022 to December 2023. Inclusion criteria: 1) Type 2 diabetes mellitus with a duration of more than 1 year. The diagnosis is in accordance with the World Health Organization (WHO) diagnostic criteria for the disease, and with reference to the Chinese Guidelines for the Prevention and Control of Diabetes Mellitus formulated by the Department of Disease Control of the Ministry of Health and the Diabetes Branch of the Chinese Medical Association in 2020, the diagnostic criteria are as follows: Diabetes mellitus is diagnosed by typical diabetes mellitus symptoms coupled with any one of the following conditions: a) Glucose level ≥ 11.1 mmol/L (200 mg/dl) at any time. b) Fasting plasma glucose (FPG) level ≥ 7.0 mmol/l (126 mg/dl). c) Two-hour blood glucose level ≥ 11.1 mmol/l (200 mg/dl) in the OGTT test. d) Glycosylated haemoglobin (HbA1c) ≥ 6.5%. 2) Patients with tumours; 3) Patients with systemic infectious diseases; 4) Patients with severe liver and kidney impairment; 5) Patients with other types of diabetes mellitus; 6) Patients with severe complications of diabetes mellitus; 7) Patients with mental disorders and other illnesses who are unable to complete the scale; 8) Patients with incomplete clinical data; patients who meet one of the above criteria can be excluded. A total of 250 cases were included in this study. A total of 250 cases were included, of which 144 cases were male, accounting for 57.6%; 106 cases were female, accounting for 42.4%; the maximum age was 70 years old, and the minimum age was 28 years old, with an average age of 55.87 ± 9.57 years; the shortest duration of the disease was 1, and the longest was 34 years, with an average duration of 8.64 ± 6.50 years.

2.2. Methodology

Indicator test: 5 ml of fasting venous blood was drawn from the patients after admission to the hospital, and then centrifuged at 6000 r/min for 15 min after 1 h, with a centrifugation radius of 12.5 cm. After centrifugation, the supernatant was collected into clean freezing tubes and stored at −80˚C, and then tested when all the samples were collected completely and uniformly. Glycated haemoglobin (hemoglobin a1c, hba1c), albumin (albumin, alb), serum creatinine (scr), triglycerides (trigalcerides, tg), total cholesterol (tc), low-density lipids (ldl) and low-density lipids (ldl) were detected by automatic biochemical analyser. Low-density lipoprotein cholesterol (ldl-c), high-density lipoprotein cholesterol (hdl-c). Hemoglobin (hb) was detected using an automatic haematology analyser. 25 hydroxy Vitamin D (25(oh)d) was measured by automatic immunoassay. Record the relevant testing data for statistical analysis, apply spss26.0 to process and analyse the data, and explore the correlation between 25-hydroxy Vitamin D levels in patients with type 2 diabetes mellitus and patients' general conditions, common clinical nutritional indexes, and Chinese medicine evidence type.

2.3. Statistical Methods

The height and weight of all subjects were measured in accordance with conventional methods, BMI was calculated, TCM diagnosis and typing was performed, and nutritional status was assessed. According to the basic principles of statistics, the research data were processed and analysed by spss26.0. Measurement data were expressed as mean ± standard deviation ($\overline{x} \pm s$), and one-way analysis of variance (ANOVA) was used for those who conformed to normal distribution and had a uniform variance; the Wilcoxon rank sum test was used for those who did not conform to normal distribution or had an irregular variance; the counting data were expressed as the number of cases, and the statistics were expressed as χ^2 test, in which $P < 0.05$ was used as the criterion to judge whether the difference was statistically significant or not. $P < 0.05$ was considered statistically significant.

3. Findings

3.1. Distribution of 25(OH)D Levels in Hospitalised Patients with Type 2 Diabetes Mellitus

The mean level of 25(OH)D in 250 type 2 diabetes inpatients was 18.37 ± 8.48 ng/l, of which 56 patients with Vitamin D deficiency [25(OH)D < 20 ng/l], accounting for 22.4%; 107 patients with Vitamin D insufficiency [20 ng/l ≤ 25(OH)D < 30 ng/l], accounting for 44.8%; and those with adequate Vitamin D 87 cases, accounting for 34.8%. The patients were divided into deficiency, insufficiency, and sufficiency groups according to their Vitamin D levels.

3.2. Differences in the General Conditions of Patients Hospitalised with Type 2 Diabetes Mellitus with Different 25(OH)D Levels

Results: As shown in Table 1, the gender of the three groups of patients was compared by the x^2 test, and the difference between the groups was statistically significant ($P < 0.05$), indicating that there was a difference in the gender distribution of 25(OH)D at different levels. This was followed by a two-by-two comparison between the groups, with a statistically significant difference between the gender distribution of the deficiency group compared to the other two groups ($P < 0.01$). Numerically, the deficiency group had a higher percentage of females.

Results: The age and disease duration data in the above data did not satisfy the normal distribution, so the Wilcoxon rank sum test was used, as shown in Table 2, the disease duration and age of the three groups of patients were compared, and the differences in age and disease duration between the groups of different certificates were statistically significant ($P < 0.05$), and after that a two-by-two comparison was carried out between the groups, and the average age and disease duration of the patients in the lack group were greater than those of the patients in the good group. The difference between the distribution groups was statistically significant ($P < 0.05$). There was no significant difference between the age and disease duration distribution of the deficiency group and the remaining two groups ($P > 0.05$).

Results: As shown in Table 3, the BMI of the three groups of patients was compared by the 2-test, and the difference between the groups was not statistically significant ($P > 0.05$), indicating that there was no significant difference in the distribution of BMI among patients in the groups with different 25(OH)D levels.

Table 1. Comparison of the gender of patients in each 25(OH)D level group.

25(OH)Dsubgroup on situations	Male		Females		χ^2	P
	Number of cases (n)	Component ratio	Number of cases (n)	Component ratio		
Deficiency group (n = 56)	22	39.3%	34	60.7%		
Inadequate group (n = 107)	64	59.8%	43	40.2%	1.834	<0.01
Good group (n = 87)	58	58.8%	29	41.2%		

Table 2. Age and duration of disease in each 25(OH)D level group.

Nutritional status cluster	Age (years, $\bar{x} \pm s$)	Duration of disease (years, $\bar{x} \pm s$)
Deficiency group (n = 56)	59.21 ± 10.03#	10.55 ± 6.84
Inadequate group (n = 107)	55.88 ± 8.87	8.76 ± 6.86
Good group (n = 87)	53.71 ± 9.59	7.28 ± 5.47
H	10.269	11.009
P	<0.01	<0.01

Note: #$P < 0.05$ compared to good group.

Table 3. BMI For Each 25(Oh)D level Group.

Chinese medicine evidence grouping	BMI (kg/m^2, $\bar{x} \pm s$)	H	P
Deficiency group (n = 56)	24.38 ± 4.00		
Inadequate group (n = 107)	25.13 ± 3.18	4.320	0.115
Good group (n = 87)	24.98 ± 3.11		

Results: As shown in Table 4, the difference between groups was statistically significant ($P < 0.05$) when comparing the places of residence of the three groups of patients by the x^2 test, indicating that there was a difference in the distribution of the places of residence of the different levels of 25(OH)D. This was followed by a two-by-two comparison between the groups, with a statistically significant difference between the gender distribution of the deficiency group compared to the other two groups ($P < 0.01$). Numerically, the lack group has a higher percentage of urban residents.

Table 4. Residency by 25(OH)D level group.

25(OH)Dsubgroup on situations	Urban population		Rural population		χ^2	P
	Number of cases (n)	Component ratio	Number of cases (n)	Component ratio		
Deficiency group (n = 56)	48	85.7%	8	14.3%		
Inadequate group (n = 107)	39	36.4%	68	63.6%	43.967	<0.01
Good group (n = 87)	30	34.5%	57	65.5%		

3.3. Differences in Laboratory Indices among Hospitalised Patients with Type 2 Diabetes Mellitus with Different 25(OH)D Levels

In the above data, glycated haemoglobin (hba_{1c}), creatinine (scr), albumin (alb), total cholesterol (tc), and low-density lipoprotein (ldl-c) levels did not satisfy the normal distribution, so the Wilcoxon rank sum test was used, and the triglyceride (tg), and high-density lipoprotein (hdl-c) levels of the disease satisfied the normal distribution, with a chi-squared variance, so one-way ANOVA was used. As shown in Table 5, the above clinical indicators of the five groups of patients were compared, in which the differences between the hba_{1c}, alb, hb groups were statistically significant ($P < 0.05$). Afterwards, a two-by-two comparison between groups was carried out, in which the distribution of hba_{1c}, alb levels of patients in the deficiency group differed from that of the remaining two groups ($P < 0.05$); and the hb levels of patients in the deficiency group differed from that of the good group ($P < 0.05$). And there was no statistically significant difference in scr, tg, tc, ldl-c, hdl-c levels between groups ($P > 0.05$).

Table 5. Laboratory indicators for each 25(OH)D level group.

Clinical information	Deficiency group (n = 56)	Inadequate group (n = 107)	Good group (n = 87)	F/h	P	Normal reference value
Hba_{1c} (%, $\bar{x} \pm s$)	9.81 ± 3.05*#	8.09 ± 2.14	7.73 ± 1.96	18.354	<0.01	3.60 - 6.0
Scr (μmol/l, $\bar{x} \pm s$)	55.76 ± 14.94*#	58.37 ± 14.22	59.05 ± 13.43	2.253	0.324	40.0 - 88.0
Alb (g/l, $\bar{x} \pm s$)	41.47 ± 4.58	43.98 ± 3.49*	44.11 ± 3.16*#	15.449	<0.01	40.0 - 55.0
Tg (mmol/l, $\bar{x} \pm s$)	2.31 ± 3.21	2.41 ± 2.01	1.79 ± 1.06	2.198	0.113	0.00 - 1.70
Tc (mmol/l, $\bar{x} \pm s$)	4.90 ± 1.18	4.83 ± 1.10	4.33 ± 1.11*	0.589	0.745	0.00 - 6.20
Ldl-c (mmol/l, $\bar{x} \pm s$)	2.66 ± 0.86	2.64 ± 0.82	2.60 ± 0.78	0.078	0.962	0.00 - 3.37
Hdl-c (mmol/l, $\bar{x} \pm s$)	1.21 ± 0.37	1.11 ± 0.30	1.17 ± 0.24	1.914	0.150	0.00 - 1.04
Hb (g/l, $\bar{x} \pm s$)	151.77 ± 17.49#	159.06 ± 16.90	159.80 ± 18.37*#	8.439	0.015	115 - 150

Note: *$P < 0.05$ compared to inadequate group; #$P < 0.05$ compared to good group.

4. Discussion

The high prevalence of Vitamin D deficiency and insufficiency has attracted significant global attention in recent years [5]. A survey conducted by the Chinese Academy of Nutrition and Health shows that the prevalence of Vitamin D deficiency and insufficiency in the Chinese population over 60 years of age is 74.1%. According to a survey conducted by the Chinese Academy of Nutrition and Health, the prevalence of Vitamin D deficiency and insufficiency in the Chinese population over 60 years of age is 74.1%. The prevalence of Vitamin D deficiency and insufficiency in the T2DM population may be as high as 83.1% in some areas, and Vitamin D deficiency in the T2DM population is strongly associated with the risk of cardiovascular disease, nephropathy, retinopathy, neuropathy, and fractures [6]. It is clear that the T2DM population not only has poorer Vitamin D nutritional status, but also has a higher risk of disabling and fatal complications when combined with Vitamin D deficiency.

The development of diabetes is associated with pancreatic beta cell dysfunction, defects in insulin signalling pathways and systemic inflammation [7], a growing body of research [8] [9] evidence suggests that Vitamin D deficiency plays a non-negligible role in the development of diabetes mellitus, and that Vitamin D has emerged as a potential diabetes risk modifier, and that Vitamin D metabolism as a therapeutic entry point may serve as a potential therapeutic target for diabetes mellitus. Vitamin D deficiency is not only involved in the onset and development of diabetes, but also closely associated with diabetes-related complications [10]. The regulatory effects of Vitamin D on insulin synthesis, secretion, and insulin sensitivity are the basis for its use in the prevention and treatment of diabetes and its complications. Patients at high risk of diabetes and those with diabetes should have their Vitamin D levels checked regularly, and those with Vitamin D deficiency should be supplemented and intervened in a timely manner.

Vitamin D deficiency affects many physiological functions in the body, including bone metabolism and glucose metabolism. Vitamin D deficiency is aggravated in T2DM hospitalised patients because of their longer duration of illness, poorer glycaemic control, insufficient exercise and shorter sun exposure. This study showed that the average level of 25(OH)D in 250 type 2 diabetes mellitus inpatients was 18.37 ± 8.48 ng/L, of which 56 patients with 25-hydroxyvitamin D deficiency [25(OH)D < 20 ng/L] accounted for 22.4%; 107 patients with 25-hydroxyvitamin D insufficiency [20 ng/L ≤ 25(OH)D < 30 ng/L] accounted for 44.8%; and 87 patients with adequate 25 hydroxyvitamin D, accounting for 34.8%. The prevalence of vitamin D deficiency may be related to fewer outdoor activities in hospitalised patients and the negative metabolic effects of T2DM. This is in line with the study by Huimin [3] *et al.* which confirmed that serum 25(OH)D levels were significantly deficient in patients with type 2 diabetes mellitus. Gender, disease duration of patients with type 2 diabetes mellitus in different 25(OH)D level groups. There were differences in the distribution of place of residence ($P < 0.05$), the number of female patients in the patients in the deficiency group accounted for a significantly higher proportion than the remaining two groups ($P < 0.05$), the mean age was significantly higher than that of the good group ($P < 0.05$), and the proportion of urban patients was significantly higher than that of the remaining two groups ($P < 0.05$). The gender diffuse may be related to the influence of fluctuating hormone levels brought about by menopause in female patients; the age difference may be related to a greater lack of outdoor exercise and a decrease in dietary absorption capacity in the elderly; the difference in the distribution of places of residence may be related to the fact that there were fewer physical workers than mental workers in urban patients, and outdoor exercise was insufficient. There was no significant difference in the distribution of age and body mass index among the three groups ($P > 0.05$), but the average age of the patients in the deficiency group was older, so the decrease in vitamin D level may be related to the increase in age. The distribution of some laboratory indexes of patients in the three groups was different, in which the average level of glycated haemoglobin in the deficiency group was significantly higher than that of the remaining two groups, the average level of albumin was significantly lower than that of the remaining two groups, and the average level of haemoglobin was significantly lower than that of the good group ($P < 0.05$). The results suggest that patients in the deficiency group may also face the risk of poor glycaemic control, hypoproteinaemia, anaemia and other problems in clinical practice, which deserves the attention of clinical workers. The regulatory effect of vitamin D on insulin synthesis, secretion and insulin sensitivity is the basis of its prevention and treatment of diabetes and its complications, and more and more evidence suggests that vitamin D deficiency is associated with abnormalities in glucose and insulin metabolism, Song *et al.* [11] study of the relationship between serum 25(OH) and T2DM showed an inverse trend between serum 25(OH)D and T2DM incidence. This also suggests that the nutritional level of vitamin D in patients is closely related to the development of diabetes mellitus, and that combined therapy based on vitamin D supplements may be an effective method of diabetes mellitus treatment, and that patients at high risk of diabetes mellitus, as well as patients with diabetes mellitus, should be tested regularly for vitamin D levels and supplemented in a timely manner in patients with deficiencies.

In conclusion, in the process of clinical diagnosis and treatment, we should pay attention to the changes of 25 hydroxyvitamin D level and other nutritional indexes of patients with type 2 diabetes mellitus, and pay attention to the control of blood glucose level while timely supplementation of vitamins, proteins, and lipids, in order to improve the patients' physical status, reduce the incidence of complications, and improve the clinical efficacy and the patients' quality of life.

Conflicts of Interest

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

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