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A Retrospective Study of Serum 25 Hydroxyvitamin D Levels in Adults in the Baoding Area Regarding Gender, Age, and Seasonal Influences

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Abstract: *Objective*: To analyse the overall nutritional status of 25 hydroxyvitamins in the population of the Baoding area, and to explore the factors influencing it. *Methods*: 2,022 patients who attended the Affiliated Hospital of Hebei University from July 2022 to July 2023 were selected as study subjects. Serum 25(OH)D levels were measured, and the differences in the distribution of serum 25(OH)D levels among different genders, ages, and seasons in Baoding were analyzed. *Results*: The mean serum 25(OH)D level of adults in the Baoding area was 16.19 ± 6.63 ng/ml, with a deficiency rate of 78.4% (1585/2022) and an insufficiency rate of 18.0% (364/2022). The serum 25(OH)D deficiency rate in adult males was 67.7% (113/167), and the difference was not statistically significant ($P > 0.05$) when comparing the deficiency rates of all age groups. The serum 25(OH)D deficiency rate in adult females was 79.4% (1472/1855), and the difference was statistically significant when comparing the deficiency rates in all age groups ($P < 0.05$). The adults in summer had the highest 25(OH)D levels, with a sufficiency rate of 1.8% (36/2022), and the difference was statistically significant when comparing the 25(OH)D levels of adults in different seasons ($P < 0.01$). *Conclusion*: The rate of vitamin D deficiency and insufficiency in the population of the Baoding area is high, so it is necessary to strengthen the publicity and education for the residents of the Baoding area, to improve the residents' knowledge of vitamin D, and to take effective measures to improve the vitamin D level of the residents, and special attention should be paid to vitamin D supplementation of the adult females between the ages of 18–44 years old.

Keywords: Serum 25 hydroxyvitamin D; Vitamin D deficiency

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1. Introduction

Vitamin D is a fat-soluble vitamin that is very important for human health. It not only plays a key role in the metabolism of calcium and phosphorus but also participates in the regulation of various physiological processes such as immune function, cell proliferation, and differentiation. In recent years, the study of vitamin D has received much attention, as it is closely related to the occurrence and development of a variety of diseases, such

as metabolic syndrome, osteoporosis, cardiovascular and cerebrovascular diseases, cancer, diabetes mellitus, and so on. 25-hydroxyvitamin D (25(OH)D) is considered to be the most accurate test for detecting the level of vitamin D in the human body. In this study, 25(OH)D levels were statistically analyzed based on clinical data in the population of Baoding area, to investigate the differences in 25(OH)D levels in the population of Baoding area in different genders, ages, and seasons, and to analyze the factors related to vitamin D deficiency.

2. Objects and methods

2.1. Research target

A total of 2022 outpatients and inpatients were selected from July 2022 to July 2023 who attended the laboratory test department of the Affiliated Hospital of Hebei University. Exclusion criteria: Bone metabolism diseases, severe liver and kidney diseases, tumor diseases, inborn genetic metabolic diseases, endocrine system diseases, and vitamin D-dependent rickets. All of them were ≥18 years old, of which, 167 cases were adult males and 1855 cases were adult females.

2.2. Instruments, reagents, equipment

Beckman DXI800 fully automated chemiluminescence immunoassay analyzer is used, the test reagents are provided by Beckman Coulter Ltd. and in-house QC is carried out daily (provided by Bó Lè Laboratory Co. Ltd.), which is qualified to ensure the accuracy of the test results.

2.3. Research methodology

Blood was taken from the median elbow vein in the fasting state in 3 mL, and centrifuged in a PP Centrifuge-type BeckmanCoulter.Inc centrifuge at 3,000 r/min for 10 min, and the 25-(OH)D level was promptly measured on the machine.

2.4. Grouping and diagnostic criteria

Serum 25(OH)D levels were observed in different genders, different age groups, and different seasons in the Baoding area.

Population age groups: males 18–44 years, 45-60 years, >60 years; females 18–44 years, 45–60 years, >60 years.

The four seasons are grouped according to a meteorological classification: spring from March to May, summer from June to August, autumn from September to November, and winter from December to January on the Gregorian calendar.

Diagnostic criteria were grouped according to the Consensus on the Clinical Use of Vitamin D and its Analogues as shown in **Table 1** [1].

Table 1. Diagnostic criteria based on 25(OH)D levels

Deficient	Insufficient	Adequate
<20 ng/ml (<50 nmol/L)	20–30 ng/ml (50–70 nmol/L)	>30 ng/ml (>75 nmol/L)

2.5. Statistical methods

SPSS 22.0 statistical software was used for relevant statistical analyses. Measurement information was expressed as mean ± standard deviation (mean ± SD), count data were expressed as percentage and number of cases, *t*-test was used for comparison between two groups, and one-way analysis of variance (ANOVA) was

used for comparison between multiple groups; count data were expressed as cases (percentage), and χ^2 test was used for comparison between groups. $P < 0.05$ was used to indicate that the difference was statistically significant.

3. Results

3.1. Comparison of serum 25(OH)D levels between different genders and age groups

Comparison of serum 25(OH)D levels in adult males of different age groups showed no statistically significant difference ($P = 0.188$). Comparison of adult serum 25(OH)D levels in females of different age groups showed no statistically significant difference ($P = 0.201$), as shown in **Table 2**.

Table 2. Comparison of serum 25(OH)D levels in adult males and adult females of different ages (± SD, ng/ml)

Age group	25(OH)D levels in adult males	25(OH)D levels in adult women
18–44 years	15.93 ± 6.39	20.17 ± 12.61
45–60 years	16.97 ± 6.52	27.41 ± 6.32
>60 years	16.53 ± 6.68	17.29 ± 7.21
F-value	1.674	1.620
P-value	0.188	0.201

3.2. Analysis of serum 25(OH)D levels in people of different sexes and ages

The serum 25(OH)D level in adults was 16.19 ± 6.63 ng/ml, with a deficiency rate of 78.4% (1585/2022) and an insufficiency rate of 18.0% (364/2022). The serum 25(OH)D deficiency rate in adult males was 67.7% (113/167), and the difference was not statistically significant ($P > 0.05$) when comparing the deficiency rates in all age groups. The serum 25(OH)D deficiency rate of adult females was 79.4% (1472/1855), and the difference was statistically significant when comparing the deficiency rates of all age groups ($P < 0.05$), as shown in **Table 3**.

Table 3. Nutritional status of serum 25(OH)D in people of different sexes and ages/case (percentage/%)

Sex	Age groups	Deficient	Insufficient	Adequate	χ^2 value	*P*-value
Adult males	18-44 (n = 37)	21 (56.8)	14 (37.8)	2 (5.4)	3.872	0.424
	45-60 (n = 59)	40 (67.8)	17 (28.8)	2 (3.4)		
	>60 (n = 71)	52 (73.2)	15 (21.1)	4 (5.6)		
Adult females	18-44 (n = 1618)	1302 (80.5)	261 (16.1)	55 (3.4)	11.754	<0.05
	45-60 (n = 99)	69 (69.7)	27 (27.3)	3 (3.0)		
	>60 (n = 138)	101 (73.2)	30 (17.1)	7 (3.5)		

3.3. Analysis of serum 25(OH)D nutritional status in different seasonal populations

Comparison of 25(OH)D nutritional status in adults in different seasons showed statistically significant differences ($P < 0.01$), as shown in **Table 4**.

Table 4. Nutritional status of serum 25(OH)D in adults in different seasons/case (percentage/%)

Pneumococcal case by season	Deficient	Insufficient	Adequate	χ^2 value	*P*-value
Spring (n = 772)	644 (83.4)	109 (14.1)	19 (2.5)	97.890	<0.01
Summer (n = 474)	319 (67.3)	119 (25.1)	36 (7.6)		
Autumn (n = 360)	255 (70.8)	97 (26.9)	8 (2.2)		
Winter (n = 416)	367 (88.2)	39 (9.4)	10 (2.4)		

3.4. Comparison of serum 25(OH)D levels in adults in different seasons

Adult 25(OH)D levels were highest in the summer, with a sufficiency rate of 1.8% (36/2022), and in the winter, with a deficiency rate of 88.2% (367/2022), with a statistically significant difference ($P < 0.01$) when comparing adult 25(OH)D levels in the different seasons, as shown in **Table 5**.

Table 5. Comparison of serum 25(OH)D levels in adults in different seasons (± SD, ng/ml)

Pneumococcal case by season	25-hydroxyvitamin D levels
Spring	15.03 ± 5.88
Summer	18.84 ± 8.07
Autumn	17.25 ± 6.00
Winter	14.42 ± 5.46
F-value	49.369
P-value	<0.01

4. Discussion

Vitamin D is a fat-soluble vitamin that is very important for human health. It not only plays a key role in the metabolism of calcium and phosphorus [1]. It is also involved in the regulation of various physiological processes such as immune function, cell proliferation, and differentiation. In recent years, the study of vitamin D has received more and more attention, and it has a close influence on the occurrence and development of many diseases, such as metabolic syndrome, osteoporosis, cardiovascular and cerebrovascular diseases, cancer, diabetes, and other diseases [2–3]. It has a close impact on the occurrence and development of many diseases, such as metabolic syndrome, osteoporosis, cardiovascular and cerebrovascular diseases, cancer, diabetes, and other diseases. Studies have shown that vitamin D deficiency is widespread in China [4]. Therefore, it is very important to study the vitamin D content in the population.

In recent years, there has been a growing interest in vitamin D-related research, and several studies have shown that the occurrence and development of many diseases are closely related to vitamin D deficiency. Vitamin D regulates insulin secretion and cellular insulin sensitivity and maintains the balance of blood glucose levels. Vitamin D deficiency may lead to insulin resistance and pancreatic β-cell hypofunction, thus leading to diabetes mellitus [5]. A foreign meta-analysis showed that higher plasma 25(OH)D concentrations were protective against the risk of diabetes [6]. Metabolic syndrome (MS) is a group of diseases manifested by various metabolic abnormalities such as obesity, abnormal glucose metabolism, lipid metabolism disorders hypertension, and so on. Several studies have shown that vitamin D deficiency is associated with diabetes mellitus [7–9]. Several studies have shown that vitamin D deficiency is closely related to the development of

metabolic syndrome and that low vitamin D levels increase the risk of developing MS. In recent years, it has been found that the vitamin D receptor (VDR) exists in cardiovascular and cerebrovascular vessels, and vitamin D is closely related to the occurrence and progression of cardiovascular and cerebrovascular diseases by binding to the VDR. Vitamin D deficiency may lead to cardiovascular diseases such as abnormal vascular function, atherosclerosis, and hypertension. Some studies have reported that patients with higher levels of vitamin D have a substantially lower risk of cardiovascular disease [10].

Vitamin D in the human body mainly comes from food and skin synthesis. Vitamin D in food mainly comes from animal foods such as fish, egg yolks, and dairy products, and processed foods such as milk, orange juice, and cereals are also rich in vitamin D. When sunlight hits the skin, ultraviolet radiation converts 7-dehydrocholesterol in the skin to vitamin D3, which in turn synthesizes vitamin D. This is the main source of vitamin D. In particular, for people with low vitamin D intake, sunlight exposure promotes vitamin D synthesis, which is an important way to maintain adequate vitamin D levels [1].

The effect of age on vitamin D levels in the human body is significant but different studies have yielded different results. The present study showed that the serum 25(OH)D level in adult males was 17.97 ± 8.47 ng/ml and in adult females it was 16.03 ± 6.41 ng/ml. The overall level of 25(OH)D in adults above 60 years of age was lower than the level in the age group 44–60 years and higher than the level in the age group 18–44 years. However, the 25(OH)D levels in adult males were the lowest, lower than the 18–44 and 45–60 age groups. Xu Junyue et al. showed that adult females had the highest levels of vitamin D in the 18–44 age group, but the present study showed that adult females had the lowest levels in the 44 age group, with intermediate levels in the >60 age group, and the highest levels in the 45–60 age group, which was considered to be possibly related to the fact that local females in the 18–44 age group spend a lot of time indoors and have less exposure to sunlight, and also to high levels of stress from school and work, and that women in this age group are in their childbearing years and have a higher demand for vitamin D [11]. The highest levels were found in the 45–60 age group. Minors and the elderly spend more time outdoors and are exposed to more sunlight, so their vitamin D levels are relatively high.

Vitamin D levels in the human body are affected by different seasons. Baoding is located in the west-central part of Hebei Province, in the eastern foothills of the northern Taihang Mountains, in the western part of the Jizhong Plain, between 38°10’-40°00’ north latitude and 113°40’-116°20’ east longitude. The city’s terrain slopes from northwest to southeast. The landscape is divided into two categories: mountains and plains. Sunshine is more abundant in the mountains than in the plains, with an average of 2,167 hours of sunshine per year according to the China Meteorological Data Network. As discussed above, one of the main ways for the human body to obtain vitamin D is through skin synthesis, and sunlight is the main factor that promotes synthesis. In winter, the intensity of sunlight is lower, people usually wear more clothes, and their skin has less direct contact with sunlight, so the opportunity to synthesize vitamin D is reduced; whereas in summer, the intensity of sunlight is higher, people usually wear fewer clothes, and their skin is exposed to a larger area of the skin, so the opportunity to synthesize vitamin D increases, and so the level of vitamin D is relatively normal. Wang Qing et al. found that the prevalence of vitamin D deficiency was significantly lower in the summer than in other seasons in Kunshan [12]. The present study showed that adults in Baoding had the highest levels of vitamin D in the summer and the lowest levels in the winter, which is consistent with the results of several previous studies [12–14]. This is the same as many previous studies.

There is a correlation between gender and vitamin D deficiency, with several studies showing that females are more likely to suffer from vitamin D deficiency [12–15]. The present study shows that adult women in the 18–44 and 44–60 age groups have a higher prevalence of vitamin D deficiency than men, which may be related

to women's lifestyle habits and sex hormone levels.

In conclusion, after the retrospective study of 2022 patients, this study found that the rate of vitamin D deficiency and insufficiency in the population of Baoding area is relatively high, which is closely related to age and season, and that vitamin D deficiency affects health, so it is necessary to strengthen publicity and education for the residents of Baoding area, to raise the awareness of vitamin D among the local residents, and to take effective measures to increase the vitamin D level of residents and to increase the contact time with sunlight and taking vitamin D supplements when necessary.

There are some limitations in this study, such as only one year of testing samples from Hebei University Hospital were selected for this study, and most of them were adult women, which may result in bias in the experimental results. The study population was adults, and vitamin D levels of the under-aged population were not analyzed. Moreover, it was not clear whether the testing population was taking vitamin D supplements and suffered from diseases affecting the vitamin D levels, so the study needs to be further improved.

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Disclosure statement

The authors declare no conflict of interest.

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