

# Evaluation of the Association between Serum Levels of Vitamin D and Benign Paroxysmal Positional Vertigo (BPPV): A Case-Control Study

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## Abstract

**Background:** Benign paroxysmal positional vertigo (BPV) is the most common cause of the high prevalence of vertigo. Today, BPV is caused by the separation of autochthonous particles from the macular atrial. As a result, these particles float in a semicircular canal and change position by gravity. The majority of vertigo causes arise from the inner ear.

**Aim:** This study aims to measure the vitamin D level in patients with BPPV who visited Loghman Hakim Hospital clinics and compare the results with controls.

**Methods:** This comparative study evaluated the effect of vitamin D on reducing BPV. Demographic information of patients was collected through interviews. The physical examinations were recorded through a questionnaire. For the group with BPPV, we did the Epley maneuver and measured the vitamin D level. We compared the vitamin D levels of these patients with the matched control group.

**Results:** In this study, 148 patients were evaluated. Sixty-three patients were male, and 85 patients were female. All case and control patients were tested for vitamin D levels. Of 93 patients with benign vertigo, 39 (41.9%) patients had normal vitamin D levels, and 54(58.1%) patients had below normal. In the control group, 43 (78.2%) patients had normal vitamin D, and 12 (21.8%) patients had less than normal. There was a statistically significant difference between the two groups.

**Conclusion:** The present study indicated that BPV was more prevalent in people with vitamin D deficiency, and vitamin D treatment could effectively control and reduce the prevalence of this disease.

**Conflicts of Interest:** The Authors declare no conflicts of interest.

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## Introduction

Benign paroxysmal positional vertigo (BPPV) is characterized by a sense of spiral movement that accompanies with typical nystagmus. These symptoms are provoked by head positional change. The clinical manifestation may range from a mild dizziness to a

debilitating vertigo with nausea and vomiting which may interfere with daily life of the patient (1). In posterior BPPV, changing the head position relative to gravity induces a torsional nystagmus with short latency. When the lateral semicircular canal is affected, by

rolling the patients head from side to side in the supine position, the geotropic or apogeotropic positional nystagmus is manifested (2,3). No neurological symptoms except vertigo should be presented (2). The anterior BPPV is rare, presenting with the vertical nystagmus caused by straight head hanging (4). BPPV is the most common cause of vertigo among patients. An epidemiologic study estimated that 2.4% of the population (3.2% of female, 1.6% of male) suffered from BPPV in their life (5). The dissociation, degeneration and ectopic calcification of otoconia in utricular macula resulted in floating otolith debris in one or more semicircular canals (usually posterior one). The otolith debris caused BPPV. BPPV is manifested by severe, recurrent vestibular vertigo/dizziness and it is not related to another disorder. Usually, an attack of BPPV last less than 1 minute and provoked by changing the head position. An attack followed by typical positional nystagmus (5–7). Risk factors of BPPV were female gender, osteoporosis, migraine, head trauma, high TC level, and vitamin D deficiency (8). Several factors such as winter, postmenopose and physical inactivity were likely attributed to BPPV. The higher incidence of BPPV has also been observed at the end of winter, when serum vitamin D level is lowest (9). BPPV was more common in postmenopausal women. One of the reasons was that vitamin D deficiency can be influenced by Estrogen deficiency (8). Lack of physical activity in elderly women increased 2.6 times higher risk for BPPV (10). Vitamin D mainly regulated the absorption of calcium and phosphorus in the small intestine (11). As a result, vitamin D deficiency can change the dynamic turnover of otoconia, which is composed of calcium carbonate. Any change in otoconia's composition may lead to easier dislodgment and eventually the formation of the otolith, which could cause BPPV (12, 13). This study aims to measure the vitamin D level in patients

with BPPV who visited Loghman Hakim Hospital clinics and compare the results with controls.

## Methods

A case-control study was conducted on patients with positional vertigo who visited Loghman Hakim Hospital otolaryngology clinics from 2012 to 2019. Patients older than 18 years with one of the following manifestations were diagnosed with BPPV and included in this study:

1. Positional dizziness and vertigo attacks that are caused by changing the head position
2. Typical BPPV positional nystagmus
3. Not attributed to any other disorders(14).

The diagnosis of BPPV was based on diagnostic criteria of benign paroxysmal positional vertigo defined by Barany institute (6).

The posterior BPPV was diagnosed Dix-Hallpike maneuver that induces the positional nystagmus, which is typical and recurrent. The resultant nystagmus should be less than one minute with a short latency. The intensity declines as the time passes.

The lateral BPPV diagnosis was confirmed by supine position test. The supine position test is positive when it induces a typical positional nystagmus with no latency, lasting more than a minute. By passing the time intensity of nystagmus stays the same (2).

Patients who were suspected cases of anterior semicircular BPPV were assessed by Dix-Hallpike, or straight head hanging. The positive results explicit with recurrent vertical down-beating vertigo with variable intensity and short or absent latency. The nystagmus lasts less than one minute. Head hanging always cause nystagmus but positional change is usually associated with typical symptoms (2, 4).

No further cochlear manifestations like ear fullness, hearing loss, and tinnitus were presented in included patients. An expert neurologist eliminated the other causes of

vertigo and nystagmus that are caused by defects of central nervous system.

Patients with inner ear diseases, history of head trauma, under treatment with vitamin D supplements, and treated with Epley maneuver, any neurological focal findings, inability to do the positional maneuver, history of other vestibular diseases, presence of otitis media, and incorporative patients were excluded.

The demographical data was gathered via interviews and taking history. 148 consecutive patients with positional vertigo met the inclusion criteria. Patients were divided into two groups by examination, with and without BPPV. 93 patients suffered from BPPV. The diagnosis of BPPV was based on the typical history of recurrent episodes of paroxysmal vertigo caused by head motion and positional vertigo. Before the definitive diagnosis of BPPV, other causes of nystagmus were ruled out.

Venous blood samples were collected. The level of 25-hydroxy vitamin D was determined by an enzyme-linked immunoassay (ELISA) test. The serum vitamin D level more than 20 ng/mL was considered normal\*.

We compared the level of 25-hydroxy vitamin D of patients with BPPV diagnosis with those who had positional vertigo. Shahid Beheshti University of Medical Sciences approved this survey. The study protocol followed the deceleration of Helsinki. Informed consents were obtained.

A one-way ANOVA test was conducted to evaluate the difference between means of vitamin D levels in patients with BPPV and positional vertigo. All statistical analysis was conducted using SPSS version 26. A P-value less than 0.05 was considered significant.

## Results

Among 148 included cases, 63 (43%) and 85(57%) were men and women, respectively. 93(63%) patients suffered from BPPV, included 41(44%) men and 52(56%) women,

respectively. The demographical data are summarized in Table 1.

**Table 1.** the demographical information of included cases

Positional vertigo	BPPV	Gender
22 (34.9%)	41(65.1%)	Male
33 (38.8%)	52(61.2%)	Female

The mean age of patients with BPPV and positional vertigo were  $48\pm 9.7$  (standard deviation) and  $51.96\pm 9.03$ (standard deviation) years, respectively. The difference between the mean ages in the two groups was insignificant. As illustrated in table 2, 39(41.9%) of patients with BPPV had a normal level of 25-hydroxy vitamin D, while 43 (78.2%) of cases with positional vertigo had vitamin D level more than 20 ng/ml. The difference of vitamin D level in the two groups was statistically significant (P-value=0.032).

54 (58.1%) of patients with BPPV had low vitamin D level, which showed approximately more than half of patients with BPPV suffering from vitamin D deficiency.

**Table 2.** Frequencies and percentages of vitamin D deficient patients in two mentioned groups

Vitamin D	BPPV	Positional vertigo	Total
Normal	39 (41.9%)	43 (78.2%)	82 (55.4%)
Deficient	54 (58.1%)	12 (21.8%)	66 (44.6%)
Total	93	55	148

## Discussion

BPPV is the most common form of vertigo especially in old population that provokes with change in the head position(5). Imbalance and dizziness are considered as symptoms of this disease. Other indirect consequences are depression, occupational problems, lifestyle changes, sleep disorders(15). The beneficial effect of vitamin D treatment on the severity of BPPV can be a direct impact of vitamin D on

the vestibular system or an indirect impact of vitamin D on muscle strength and musculoskeletal system.

The higher serum concentration of 25-hydroxy vitamin D is consistently associated with improved muscle strength and balance. This promotion of muscle strength may explain the mechanical basis of preventing falls with higher doses of vitamin D (16, 17).

In mice, vitamin D receptor mutant is associated with decreased performance. Therefore, vitamin D deficiency may predispose humans to impaired balance or posture control(18). Vitamin D is essential for calcium and bone homeostasis, so there is an association between bone marrow biomarkers and BPPV(13,19,20). Vitamin D supplemented also is more effective than calcium in reducing falling of elderly people through decreasing the recurrences of BPPV (21).

Sheikhzadeh et al. evaluated patients' serum level of 25-hydroxy vitamin D and severity of BPPV. Included cases were divided into two groups. One group was treated with vitamin D and Epley's treatment, and the other received only Epley's treatment.

All patients were followed up for six months. After two months of treatment, the severity of BPPV in two groups significantly decreased (P-value=0.001). However, in the long term follow up, Vitamin D supplemented caused persistent improvement and Epley's therapy was effective for a short time (22).

Tallat et al. also surveyed 2016 on 93 patients with unilateral posterior BPPV. They all were followed for 18 months. The study group was further divided into two subgroups based on the vitamin D level improvement. 65 patients with less than 10 ng/mL and 28 patients with more than 10 ng/mL increase in serum vitamin D level. They concluded that promoting vitamin D levels is associated with fewer BPPV attacks (23).

A hundred patients with BPPV were assessed to evaluate the impact of curative doses of vitamin D on BPPV symptoms. The cases were divided into two equal groups; both received standard treatments, one received 0.25 micrograms of vitamin D. Gu et al. concluded that this treatment helped to decrease symptoms of BPPV and osteoporosis (24).

In addition to increasing severity, the number of attacks, and symptoms, vitamin D deficiency can play a role as a risk factor for BPPV. Based on a case-control study consisting of 100 patients and 192 controls, low vitamin D levels were detected to be a risk factor for BPPV(13).

Twenty nine patients with BPPV were included to assess the hypothesis that BPPV is an indicator of a decline in bone density. Of included cases, 13 patients were osteoporotic. The correlation between the decrease in bone density and idiopathic BPPV was significant and Vitamin D levels caused decreasing bone turnover (25). While the prior study found a strong association between a decrease in bone density and BPPV, a systematic review in 2014 illustrated that although most studies support the relation of osteoporosis and BPPV, the evidence is not strong (26).

Despite previous studies, no important association between these indices and BPPV was found by analyzing T-score and vitamin D levels in a case-control study (12).

In this study, 148 patients were evaluated. All case and control patients were tested for vitamin D serum concentrations. Out of 93 patients with vertigo, 39 (41.9%) patients had normal vitamin D levels, and 54(58.1%) patients with positional vertigo had below normal. 43 (78.2%) patients had normal vitamin D concentrations in the control group. There was a statistically significant difference between the two groups.

Limitations: This study was conducted as a single-center survey. A multi-center study with more patients is required to have more precise results.

### Conclusion

The present study showed that BPPV was more prevalent in people with vitamin D deficiency and low levels of vitamin D may play a role as a risk factor for BPPV. For patients with recurrent attacks of BPPV, vitamin D supplementation would be a valuable option.

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### Conflicts of Interest

The authors declare no conflicts of interest.

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### Ethics

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