

## Prevalence of Suboptimal Vitamin D Level and Mean Serum Level of 25-Hydroxy Vitamin D in Different Patient Groups at Chulabhorn Hospital: Retrospective Study

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**Objective:** To study the prevalence of suboptimal vitamin D level (vitamin D insufficiency and vitamin D deficiency) and mean blood level of 25-hydroxy vitamin D in different patient groups at Chulabhorn Hospital.

**Materials and Methods:** The present study was a retrospective descriptive study. Data of all patients who visited Chulabhorn Hospital and were tested for serum 25-hydroxy vitamin D level between August 1<sup>st</sup>, 2016 and September 31<sup>st</sup>, 2018 were collected from the computer database. The primary outcome was the prevalence of suboptimal vitamin D level at Chulabhorn Hospital. The secondary outcome was the prevalence of suboptimal vitamin D level and mean serum level of 25-hydroxy vitamin D in different patient groups.

**Results:** Data from 1,211 patients were obtained from the database. The prevalence of suboptimal vitamin D level was 71.4%. The mean serum 25-hydroxy vitamin D (25(OH)D) level was 25.6 ng/ml. The mean serum 25(OH)D level was higher in the outpatient department group than the intensive care unit and inpatient department group with statistical significance and practical significance ( $p < 0.001$ , effect size 0.58).

**Conclusion:** Suboptimal level of vitamin D was common at Chulabhorn Hospital.

**Keywords:** Vitamin D deficiency, Vitamin D insufficiency, Suboptimal vitamin D level, Chulabhorn Hospital, Thailand

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Osteoporosis is a major public health problem all over the world. The disease leads to non-traumatic fractures, which impact the quality of life and increase the mortality of the affected patients<sup>(1)</sup>. In Thailand, the prevalence of osteoporosis is 33% among women aged 50 to 70 years old<sup>(2)</sup>.

For the prevention of osteoporosis, calcium with vitamin D supplementation is recommended and results in a small but significant improvement in hip bone density<sup>(3)</sup>. Sufficient serum vitamin D level is important for good bone strength because vitamin D helps calcium absorption in the

intestine and accelerates reabsorption of calcium from kidneys. A molecular study found that vitamin D helps balance levels of receptor activator of nuclear factor kappa-B ligand (RANKL), which is important in the bone remodeling process. Many studies showed that a suboptimal serum level of vitamin D may be related to an increased probability of fracture. For example, Tahririan et al found that blood vitamin D level was significantly lower in fracture groups compared with a control group ( $p = 0.035$ )<sup>(4)</sup>.

The incidence of suboptimal vitamin D level (vitamin D insufficiency and deficiency) in the general population has significantly increased and may be due to lifestyle changes. Suboptimal vitamin D has been reported even in Asian countries<sup>(5)</sup>, including Thailand<sup>(6)</sup>, in which individuals have more opportunity for sunlight exposure, the main source of vitamin D, compared with other countries.

The present study was conducted to study the prevalence of suboptimal vitamin D level and mean serum level of 25-hydroxy vitamin D (25(OH)D) in different patient groups at Chulabhorn Hospital in Thailand using definition from the newest clinical practice guideline from the Endocrine Society: Evaluation, Treatment, and Prevention of Vitamin D Deficiency<sup>(7)</sup>.

### Materials and Methods

The present study was approved by the ethical

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committee of Chulabhorn Hospital (EC No. 041/2560). The study was a retrospective descriptive study. All patients who visited Chulabhorn Hospital from 1<sup>st</sup> August 2016 to 31<sup>st</sup> September 2018 and who had been tested for serum 25(OH)D were included in the present study.

According to Endocrine Society Guideline 2011, vitamin D level was measured by measuring serum circulating 25(OH)D<sup>(7)</sup>. The gold standard method for measuring serum circulating 25(OH)D is mass spectrometry. However, because of the complexity, time requirement and limited availability, mass spectrometry is not suitable in the real clinical setting. We used an electrochemiluminescence immunoassay (Elecys kit; Roche Diagnostics, Thailand). The inter-assay and intra-assay coefficients of variations of 25(OH)D were 3.53% and 1.64%, respectively. Vitamin D deficiency is circulating serum 25(OH)D level <20 ng/ml. Vitamin D insufficiency is circulating serum 25(OH)D level 20 to <30 ng/ml. Suboptimal vitamin D level means circulating serum 25(OH)D level <30 ng/ml (both vitamin D insufficiency and deficiency were included).

A total of 1,211 patients with serum 25(OH)D results were obtained from the computer database. Patient demographic information such as sex, age, body mass index (BMI), address and the departments that the patients visited was collected.

The primary outcome was the prevalence of suboptimal level of vitamin D at Chulabhorn Hospital. The secondary outcomes were the prevalence of suboptimal level of vitamin D and mean serum level of 25(OH)D in different patient groups at Chulabhorn Hospital.

### Statistical analysis

Data were analyzed with STATA version 12.1 for Windows (StataCorp, Lake Station, TX, USA). Baseline characteristics are explained using number (n) and percentage. Quantitative data are presented using mean±SD and median and compared using independent t-test and one-way ANOVA. The qualitative data for prevalence were explained using number(n) and percentage, and logistic regression was used to identify factors related to suboptimal vitamin D level. Statistical significance was considered at  $p<0.05$ .

### Results

The present study included data from 1,211 subjects obtained from the computer database, with 1,025 women and 186 men. The majority of patients were 50 years old or older. More than 80% of the subjects lived in Bangkok and the central region of Thailand. More than 90% of serum 25(OH)D level tests were performed at an outpatient department (OPD) (Table 1).

The mean and median serum 25(OH)D levels were 25.6 and 24.8 ng/ml, respectively (Table 2). The prevalence of vitamin D deficiency was 28.1% and prevalence of vitamin D insufficiency was 43.3%. The majority of patients (71.4%) had serum 25(OH)D from 20 to below 30 ng/ml, indicating that over 70% of patients had suboptimal serum vitamin D level

The mean serum 25(OH)D level was slightly higher in male compared with female patients (27.7 vs. 25.18 ng/ml, respectively) with statistical significance ( $p=0.012$ ). An effect size of 0.27 of group difference indicated that there is below practical significance (effect size <0.41) (Table 3). There was also a statistically significant difference of mean 25(OH)D level among age groups, without practical significance ( $p<0.001$ , effect size 0.06). In the comparison of groups according to the departments that performed the test, mean serum 25(OH)D level was higher in the OPD group than the intensive care unit (ICU) and inpatient department (IPD) groups, with statistical significance and practical significance ( $p<0.001$ , effect size 0.58) (Table 3).

As shown in Table 4, the percentage of male patients with suboptimal vitamin D level was 61.3% (vitamin D insufficiency 33.3%, vitamin D deficiency 28%) compared with 73.3% (vitamin D insufficiency 45.2%, vitamin D deficiency 28.1%) in female patients. This result indicates that the prevalence of suboptimal vitamin D level was higher in female patients than male patients, with statistical significance in both univariate and multivariate analysis ( $p=0.001$  and  $<0.001$ , respectively). The other individual factors that significantly affected the vitamin D status were age (subjects younger than 50 years old tended to have suboptimal vitamin D level compared with older subjects,  $p<0.001$ ), BMI (subjects with BMI below the optimal range had a significantly lower percentage of suboptimal vitamin D level compared with subjects with normal BMI,  $p=0.04$ ), present address (the subjects who lived in the outer region of Thailand that include Northern, Northeastern, Eastern, Western and Southern region of Thailand had significantly lower percentage of suboptimal vitamin D than Bangkok,  $p=0.005$ ) and department to which the subjects were sent to test vitamin D status (patients tested at the ICU and IPD tended to have more deficiency in vitamin D level than patients tested at the OPD,  $p<0.001$ ) (Table 4). Among patients tested at the OPD, the prevalence of suboptimal vitamin D level was 77.6% in patients from the Menopause clinic, Woman Health Center; 61.1% in patients from the Oncologic clinic; 56.2% in patients from the Nephrology clinic; and 58.7% in patients from Orthopedics clinic.

### Discussion

Osteoporosis is a major public health problem. Osteoporotic fractures lead to an increase in mortality and a decrease in the quality of life of affected patients<sup>(1)</sup>. One of the major risk factors of osteoporosis is a suboptimal level of serum vitamin D, which is important for maintaining good bone strength via many mechanisms.

Suboptimal serum vitamin D level has been a major problem in many countries, not only in American or European countries, in which the population can have decreased opportunity for sun exposure, but also in Asian countries with a higher opportunity of sunlight exposure. In Asia, there has been growing concern regarding the potential for vitamin D insufficiency and deficiency. Man et al<sup>(5)</sup> performed a population-based cross-sectional study and examined the

**Table 1.** Baseline characteristics (n=1,211)

Baseline characteristics	n	Percent
Sex		
Male	186	15.4
Female	1,025	84.6
Age (years)		
Means±SD, median, min-max	61.14±13.23, 61.42, 12.48 to 104.85	
<30 years	14	1.2
30 to 39 years	58	4.8
40 to 49 years	164	13.5
50 to 59 years	318	26.3
≥60 years	657	54.2
Body mass index (kg/m <sup>2</sup> )		
Means±SD, median, min-max	23.92±4.48, 23.56, 12.45 to 53.13	
<18.5 kg/m <sup>2</sup>	99	8.2
18.5 to 22.9 kg/m <sup>2</sup>	445	36.7
23.0 to 24.9 kg/m <sup>2</sup>	248	20.5
25.0 to 29.9 kg/m <sup>2</sup>	318	26.3
≥30 kg/m <sup>2</sup>	101	8.3
Present address		
Bangkok	474	39.1
Northern region	17	1.4
Northeastern region	72	6.0
Western region	38	3.1
Central region (except Bangkok)	503	41.5
Eastern region	57	4.7
Southern region	50	4.1
Departments		
ICU and IPD	120	9.9
Outpatient department	1,091	90.1
Woman health center	595	49.1
Oncologic clinic	18	1.5
Nephrological clinic	89	7.3
Orthopedics clinic	104	8.6
Others	285	23.5

n = number; CRA = Chulabhorn Royal Academy; ICU = Intensive care unit; IPD = Inpatient department

prevalence of suboptimal vitamin D levels in a multi-ethnic sample of Asian adults including Chinese, Malay and Indian individuals. Of the 1,139 participants, 25(OH)D concentration was suboptimal in 76.1% of subjects. Nimitphong et al summarized the prevalence of vitamin D deficiency from national population-based studies in Southeast Asia and found that the total prevalence rates of 25(OH)D below 50 nmol/L and below 75 nmol/L were 69% and 94%, respectively. For South Korea, the prevalence of 25(OH)D below 50 nmol/L was 47% in males and 65%

in females, and the prevalence of 25(OH)D below 75 nmol/L was 87% in males and 94% in females. From the present study, although the cut-off value was slightly different from the cut-off from the Endocrine Society guideline 2011, the authors can conclude that vitamin D deficiency is common in Southeast Asia<sup>(8)</sup>.

In present study performed in Thailand, which is located in the tropics and a sunshine-abundant area, Chailurkit et al randomly selected 2,641 adults from the Thai 4<sup>th</sup> National Health Examination Survey (2008 to 2009)

**Table 2.** Serum circulating 25-hydroxy vitamin D level in total sample

	n	Percent
Vitamin D (25(OH)D level, ng/ml)		
Mean±SD, median, min-max	25.56±9.95, 24.76, 2.00 to 93.66	
Deficiency (<20.00, ng/ml)	340	28.1
Insufficiency (20.00 to 29.99, ng/ml)	525	43.3
Normal (30.00 to 49.99, ng/ml)	323	26.7
(≥50, ng/ml)	23	1.9
n = number		

**Table 3.** Serum circulating 25-hydroxy vitamin D level separated by individual factors

Individual factors	25(OH)D level (ng/ml)			p-value
	Mean±SD	95% CI	Effect size	
Sex			0.27	0.012*
Male	27.70±12.97	25.82 to 29.57		
Female	25.18±9.25	24.61 to 25.74		
Age			0.06	<0.001*
<30 years	20.29±6.54	16.51 to 24.06		
30 to 39 years	20.19±7.60	18.19 to 22.19		
40 to 49 years	22.17±7.82	20.96 to 23.38		
50 to 59 years	24.56±8.34	23.64 to 25.48		
≥60 years	27.48±10.85	26.65 to 28.31		
Body mass index			0.01	0.126
<18.5 kg/m <sup>2</sup>	26.99±13.63	24.27 to 29.70		
18.5 to 22.9 kg/m <sup>2</sup>	25.54±10.04	24.61 to 26.48		
23.0 to 24.9 kg/m <sup>2</sup>	25.56±9.07	24.43 to 26.70		
25.0 to 29.9 kg/m <sup>2</sup>	25.85±9.41	24.81 to 26.88		
≥30 kg/m <sup>2</sup>	23.37±8.76	21.64 to 25.10		
Present address			0.01	0.053
Bangkok	24.75±9.70	23.88 to 25.63		
Northern region	26.94±10.15	21.72 to 32.15		
Northeastern region	27.53±9.95	25.19 to 29.87		
Western region	29.41±9.84	26.18 to 32.65		
Central region	25.60±10.17	24.70 to 26.49		
Eastern region	25.76±10.20	23.05 to 28.47		
Southern region	26.44±8.99	23.89 to 28.99		
Departments			0.58	<0.001*
Outpatient department	26.25±9.46	25.69 to 26.82		
ICU and IPD	19.27±11.93	17.11 to 21.43		
SD = Standard deviation; ICU = Intensive care unit; IPD = Inpatient department				
* p<0.05				

cohort. The prevalence of vitamin D insufficiency (defined as 25(OH)D <75 nmol/L) was 64.6%, 46.7% and 33.5% in Bangkok, municipal areas except Bangkok and outside municipal areas, respectively<sup>(9)</sup>. Even though the cut-off of

**Table 4.** Prevalence of suboptimal vitamin D level separated by individual factors and factors related to suboptimal vitamin D level

Individual factors	Percentage of suboptimal vitamin D level	Univariate			Multivariate		
		OR	95% CI	p-value	OR	95% CI	p-value
Sex							
Male	61.3	1	-	-	1	-	-
Female	73.3	1.73	1.25 to 2.40	0.001*	2.13	1.47 to 3.08	<0.001*
Age							
<50 years	86.9	1	-	-	1	-	-
≥50 years	67.7	0.32	0.21 to 0.47	<0.001*	0.32	0.21 to 0.48	<0.001*
Body mass index							
<18.5 kg/m <sup>2</sup>	64.5	0.68	0.43 to 1.08	0.106	0.59	0.35 to 0.97	0.040*
18.5 to 22.9 kg/m <sup>2</sup>	72.8	1	-	-	1	-	-
23.0 to 24.9 kg/m <sup>2</sup>	71.4	0.93	0.66 to 1.31	0.685	1.03	0.72 to 1.46	0.887
25.0 to 29.9 kg/m <sup>2</sup>	70.4	0.89	0.65 to 1.22	0.473	0.96	0.69 to 1.33	0.799
≥30 kg/m <sup>2</sup>	75.2	1.13	0.69 to 1.87	0.617	1.12	0.67 to 1.86	0.673
Present address							
Outer region	64.5	1	-	-	1	-	-
Bangkok	74.5	1.60	1.14 to 2.24	0.006*	1.64	1.16 to 2.34	0.005*
Central region (except Bangkok)	71.8	1.40	1.01 to 1.94	0.047*	1.38	0.98 to 1.94	0.067
Departments							
Outpatient	70.2	1	-	-	1	-	-
ICU and IPD	82.5	2.00	1.23 to 3.26	0.005*	3.67	2.09 to 6.44	<0.001*

OR = Odds Ratio, Outer region = Northern+Northeastern+Eastern+Western+Southern region

\* p<0.05

vitamin D insufficiency was different from the new guideline from the Endocrine Society<sup>(7)</sup> used in the present study, the result showed the trend that suboptimal vitamin D level was common and varied across geographical regions.

In the present study, the overall prevalence of suboptimal vitamin D level was approximately 70%, which is similar to other studies conducted in Asia, Southeast Asia and Thailand<sup>(5,8,9)</sup>. This suggests that even in sunshine abundant countries in Asia, a suboptimal level of vitamin D, which is a risk factor for osteoporosis, should be a major public health concern.

When we focused on the group at risk of osteoporosis, such as postmenopausal women (from the Menopause Clinic, Woman Health Center), the prevalence of suboptimal level of vitamin D was slightly higher, 77.6%, than the overall sample (28.4% for vitamin D deficiency and 49.2% for insufficiency). The prevalence in this group at Chulabhorn Hospital was higher compared with previous studies conducted in this population in Eastern Asia<sup>(10)</sup> and Thailand<sup>(11,12)</sup> in which the prevalence ranged from 38% to 71%.

This study had several limitations. First, because

of the retrospective nature of the study, there were many important data that could not be collected from the database, such as sun exposure and sunscreen usage. Second, these data were from only one hospital, Chulabhorn Hospital; therefore, while the results are useful in describing the situation at the hospital and the nearby area, it may not apply to general Bangkok or the general Thai population.

The strengths of the present study are that the number of samples was high (n=1,211) and that the cut-off used for diagnosis of vitamin D deficiency and insufficiency was based on the newest clinical practice guideline from the Endocrine Society: Evaluation, Treatment, and Prevention of Vitamin D Deficiency<sup>(7)</sup>.

## Conclusion

Suboptimal level of vitamin D is common in patients at Chulabhorn Hospital. The prevalence is similar to that of a previous population-based study in Thailand as well as studies from other countries in Asia. Suboptimal level of vitamin D, which is the major risk factor of osteoporosis, should be a subject of concern because it represents an important adjustable factor that can reduce morbidity and

mortality from osteoporotic fracture.

### What is already known on this topic?

Previous studies showed that suboptimal serum vitamin D level is common in Asian countries, including Thailand. The prevalence ranged from 50% to 90% depending on the studies and the cut-off value. In Thailand, the prevalence also varied across geographical region with the highest prevalence in Bangkok (64.6%).

### What this study adds?

The present study was the first study in Thailand that used the definition of vitamin D deficiency, insufficiency and cut off of 25(OH)D level from the newest clinical practice guideline from Endocrine Society that was launched in 2011. The present study showed that suboptimal level of vitamin D was also common at Chulabhorn Hospital and the prevalence was similar to previous studies from Thailand and other countries in Asia.

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### Potential conflicts of interest

The authors declare no conflict of interest.

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