

# Can self-perceived easy fatigability be a predictor of vitamin D deficiency in young Indian women?

Sanjay Kumar Rai<sup>1</sup>, Tej Pratap Gupta<sup>1</sup>, Manoj Kashid<sup>2</sup>, Omna Shaki<sup>3</sup>,  
Barun Kumar Chakrabarty<sup>4</sup>, Vimal Upreti<sup>5</sup>

<sup>1</sup>Department of Orthopaedics, 151 Base Hospital, Guwahati, Assam, <sup>2</sup>Department of Orthopaedics, SMBT Medical Colleges, Igatpuri, Nasik, Maharashtra, Departments of <sup>3</sup>Trauma and Emergency, <sup>4</sup>Pathology and <sup>5</sup>Medicine, 151 Base Hospital, Guwahati, Assam, India

## ABSTRACT

**Background:** Easy fatigability is a common presenting complaint in Indian women who visited primary care hospitals. Many medical conditions like cancer, chronic bronchial asthma, prolonged use of glucocorticosteroid, renal disorder, and hypothyroidism have been associated with low levels of vitamin D. Correction of vitamin D level improves the symptom of fatigue. Whether low vitamin D causes fatigue in otherwise healthy women is the subject of research. **Aim:** This prospective nonrandomized and therapeutic study observed the prevalence of hypovitaminosis D in women with fatigue and the effect of correction of vitamin D level in fatigue-like symptoms. **Material and Methods:** One thousand two hundred adult women, who presented in our primary care hospital with complaints of easy fatigue, otherwise no associated medical illness were included. They completed the fatigue assessment questionnaire (FAQ). Patients with hypovitaminosis D received cholecalciferol (60000 IU) therapy for 5 weeks. Scores of pre- and post-treatment FAQs were noted and compared. **Results:** The prevalence of low vitamin D was noted in 84.8% women who presented with main complaints of fatigue. After the correction of vitamin D level, fatigue symptom scores improved significantly ( $P < 0.001$ ) in 82.6% of the women in all five-subscale categories of the FAQ. **Conclusion:** We observed a high prevalence of low serum vitamin D level in women who presents with fatigue with no medical illness. A significant improvement was noted in the severity of their fatigue symptoms after the correction of vitamin D levels with cholecalciferol therapy.

**Keywords:** Cholecalciferol therapy, easy fatigability, hypovitaminosis D, Indian women, low vitamin D

## Introduction

Easy fatigue is the most common complaint in Indian women who otherwise healthy attended hospital. It is 33% prevalent in otherwise healthy patients who come to the hospital in the USA.<sup>[1]</sup> Chronic fatigue syndrome also called myalgic encephalomyelitis, is a debilitating and chronic disease characterized by prolonged fatigue. In other words, it is a state of inability to maintain erect posture or sustain a force, and it is interchangeably used by the

patients to describe a state of tiredness, don't feel like working, wants to take rest or "low energy."<sup>[2]</sup> Such women always want to take rest and feel low energy as it has a significant negative impact on family life, social life, and work performance.<sup>[3]</sup> Patients with easy fatigue complaints range of symptoms like nonspecific headache, nonspecific low backache, difficulty in sleep, poor cognitive function, and postexertional malaise. If we exclude the major organ dysfunction, advanced systemic illness (DM, HT, CKD and malignancy), osteomalacia, autoimmune diseases like RA, SLE and other endocrine diseases, including hypothyroidism; most patients with fatigue have no obvious cause. Lane TJ, in his study, showed even with detailed diagnostic workup of fatigue only in 5% the specific reason can be found.<sup>[4]</sup>

**Address for correspondence:** Dr. Manoj Kashid, Associate Professor, Department of Orthopaedics, SMBT Medical Collages Igatpuri Nasik, Maharashtra, India.

E-mail: manojkashid@yahoo.com

Received: 10-06-2019

Revised: 10-01-2020

Accepted: 13-01-2020

Published: 28-02-2020

### Access this article online

#### Quick Response Code:



Website:  
www.jfmpc.com

DOI:  
10.4103/jfmpc.jfmpc\_862\_19

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

**How to cite this article:** Rai SK, Gupta TP, Kashid M, Shaki O, Chakrabarty BK, Upreti V. Can self-perceived easy fatigability be a predictor of vitamin D deficiency in young Indian women? J Family Med Prim Care 2020;9:997-1002.

Many studies have shown an association of hypovitaminosis D level and fatigue symptom in many medical conditions like cancer, autoimmune disease like myasthenia gravis, and improvement in fatigue symptom scores observed after normalization of vitamin D levels.<sup>[5-7]</sup> There are many published data that reported a high prevalence of low vitamin D in the general population. Vitamin D deficiency is a silent, and it is a pandemic. This vitamin deficiency is the most neglected vitamin deficiency among all. It is frequently under-diagnosed and under-treated nutritional deficiency in today world because it does not produces any acute symptoms.<sup>[6,8,9]</sup> Among developing countries, as far as India is concern, vitamin D deficiency is rampant in Indian individuals irrespective of their age, gender, race and geography however it is more in women.<sup>[10-12]</sup> It is a well known fact that vitamin D is produced in the skin on exposure to sunlight (UVB rays). Sun exposure alone is not enough for optimum level of vitamin D. Therefore, despite plenty of sunshine in India vitamin D deficiency is widely prevalent.

Hypovitaminosis D leads to skeletal system abnormalities like osteopenia, osteomalacia, osteoporosis and worsens muscle strength.<sup>[13]</sup> It has been noticed in many studies that the low vitamin D leads to fatigue, reduction of skeletal muscles function and strength through vitamin D receptors on muscle in otherwise healthy individuals.<sup>[14,15]</sup> Whether normalization of serum low vitamin D improves symptoms of fatigue in such individuals is not known, as no study has been published so far. Our aim is to observe the effect of correction of hypovitaminosis D in Indian women with vague symptoms of fatigue in otherwise no medical or surgical comorbidity.

## Material and Methods

### Study selection

The present study was a prospective non-randomized as well as a therapeutic study that observed the effect of normalization of low serum vitamin D in fatigue symptoms and scores of the women who presented with fatigue, with no associated medical comorbidity. Patient enrolment started on Sep 2017 and the follow-up completed in March 2019. The study was reviewed and approved by the Institutional ethical committee of the hospital, on 08 Aug 2017.

Young adult women of reproductive age group between 18 and 50 year who presented in our general outpatient department and Orthopaedics department with vague symptoms of generalized fatigue as their main complaint and volunteered to enroll in the study as they were ready to come in follow up as and when asked.

### Inclusion criteria

The inclusion criteria were women has symptoms of fatigue for more than 4 weeks with no known medical comorbidity.

### Exclusion criteria

- (a) Younger than 18 and older than 50 year
- (b) any known medical comorbidity like IHD, CKD, DM, liver disease Rheumatoid, SLE or any other autoimmune disorders

- (c) women already taking calcium and Vit D supplements for any other reason or otherwise
- (d) women taking medicines which can alter Vit D and calcium metabolism.

### Collection of data

Once informed consent taken for the study, the authors asked patients to complete a fatigue scale assessment questionnaire (fatigue severity scale questioners; FSS).<sup>[16]</sup> Patients' serum vitamin D (25-hydroxy cholecalciferol) levels were tested. All patients with low serum vitamin D levels (less than 30 ng/ml) received oral vitamin D (cholecalciferol 60000 IU) three times per week for 5 weeks, if not contraindicated. This therapeutic regimen has been extensively reported as a safe and effective treatment.<sup>[17-21]</sup> There were no adverse events due to cholecalciferol therapy were documented in our study. After completion of cholecalciferol therapy, all women were asked to complete the FSS and their serum vitamin D assessment was done to ensure normalization.

In present study data like age, race, vital parameters, FSS Score before treatment, serum vitamin D level (ng/ml) before treatment, FSS Score after treatment, serum vitamin D level (ng/ml) after treatment was collected and analyzed.

### Data collection and statistical analysis

We used the patient data in Microsoft Excel 2007 spreadsheet and analyzed using Statistical Package for the Social Sciences (SPSS) (version 17.0). A total of 1200 women were planned for sequential sampling who presented with complaints of easy fatigue and low serum vitamin D levels to obtain an adequate sample that would provide 80% power to the study hypotheses.

In our study, we used Wilcoxon paired test to calculate the difference in median between pre and post vitamin D level after treatment assuming the distribution of difference of scores is not normal. A sample size of 1200 women achieved 86% power to detect a 50% relative increase in serum vitamin D levels over an average baseline of 10 ng/ml (+5 ng/ml) with a standard deviation of 10 ng/ml using a two-sided Wilcoxon test with  $P \leq 0.05$ .

After data collection, we noticed normal distribution for data analysis, the paired *t* test was used to compare the mean of vitamin D levels and fatigue scores pre and post- vitamin D replacement therapy except for the comparison between pre and post-therapy physical score and total score.

We also used Paired *t* test to compare the mean pre- and post-therapy vitamin D levels, and fatigue scores (FSS). We also used Univariate analysis on the collected data. Independent T Test was used to compare continuous variables between the normal and low vitamin D group. Fisher Exact tests as well as Pearson Chi Square test were used to compare categorical variables between the low vitamin D group with normal. Finally, Wilcoxon Ranked Sum Test was used to compare the median

of pre- and post- vitamin D replacement therapy physical scale, FSS scores and total scores.

In present study Pearson Correlation Coefficient was used to assess the correlation between initial (pre-therapy) vitamin D levels with the initial (pre-therapy) fatigue scores, and the correlation between post-therapy vitamin D levels with the post-therapy fatigue scores. Multivariable logistic regression was applied to assess the relationship between a normalized post-therapy serum vitamin D level and changes on total FSS scores by adjusting the association between race and state of depression were significant at the  $P \leq 0.2$  level.

## Results

A total of 1260 women with fatigue were recruited and completed the FSS fatigue assessment questionnaire (FAQ). 12 women (0.9%) patients were excluded due to normal levels of serum Vit D, 21 women (1.6%) were excluded because they were detected raised blood sugar in the routine hemogram test and the rest 1200 (95.2%) women received vitamin D therapy were actually included in the study [Figure 1]. The prevalence of low vitamin D was noted in 1047 women (87.3%) among 1200 patients. The demographical details and baseline characteristics have been shown in [Table 1].

In our study, FSS was used which consist of sets of 09 questionnaire to assess the severity of fatigue in different situations during the past week. Scoring or Grading of each item vary from 1 to 7, where 1 indicates strong disagreement and 7, a strong agreement, and the final score represents the mean value of the 9 items [Figure 2].

### Assessment of Fatigue and its scoring

In the present study, we used MFCSI-SF (Multidimensional Fatigue Symptom Inventory) which consists of 30-item which

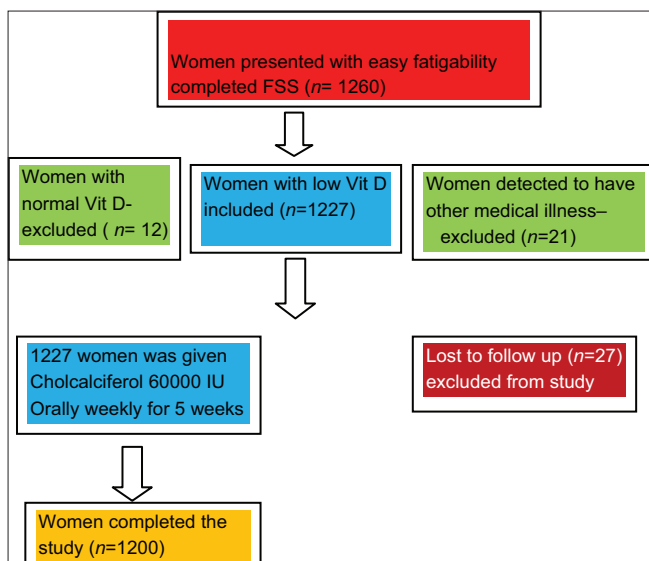


Figure 1: Flow diagram of study, the way it was conducted

empirically divided into 5 subgroup categories. The assessment of fatigue is based on scores on a 5-point scale. (0 = not at all, to 4 = extremely). The question includes general scale, emotional scale, physical scale, mental scale, and vigor scale. A high score indicates high fatigability in general, physical, emotional, and mental scales of MFCSI- SF however it was low in score in vigor scale. The total score is obtained by subtracting the score of vigor scale from the sum of the scores of all other scales. A high total score indicates a high level of fatigue.<sup>[22]</sup>

We noticed that there was no statistically significant difference in the mean MFCSI-SF scores in the general scale and physical MFCSI-SF scores between all 1227 women and 1200 women with low vitamin D levels at initial assessment [Table 2]. However, we find a statistically significant correlation in MFCSI-SF scores between mental scale, emotional scale, and vigor scale between pre and post vitamin D therapy in all 1239 and 1200 women. Pearson correlation was used to calculate all except for the vitamin D levels and Spearman Rho correlation was used for MFCSI-SF total scores.

### Primary endpoint

Over 4 weeks, the mean FAS decreased significantly after vitamin D therapy  $-3.3 \pm 5.8$ .

95% confidence interval [CI] for change ( $-16.1$  to  $4.7$ ) compared with pre therapy ( $-0.7 \pm 5.4$ ; 95% CI for change ( $-9.2$  to  $8.6$ ); ( $P = 0.01$ )[Table 3]. FAS improved significantly after vitamin D therapy ( $P < 0.001$ ). Improvement rather amelioration of fatigue was reported after vitamin D therapy.

### Secondary endpoints

We noticed improvement in fatigue score at the end of 4 weeks' follow-up, as assessed by the self-developed FSS, was reported by 991 (82.6%) of vitamin D treated women.

A significant increase in 25-OH vitamin D was observed after therapy ( $11.28 \pm 16.81$  vs  $74.38 \pm 69.95 \mu\text{g/L}$ ;  $P < 0.001$ ). A significant decrease in PTH levels in vitamin D-treated women as compared to pre therapy. Calcium and phosphate levels remained unchanged in pre and post therapy [Table 3]. We

Fatigue Severity Scale (FSS, English version)*							
	strongly disagree			strongly agree			
	1	2	3	4	5	6	7
1. My motivation is lower when I am fatigued.	0	0	0	0	0	0	0
2. Exercise brings on my fatigue.	0	0	0	0	0	0	0
3. I am easily fatigued.	0	0	0	0	0	0	0
4. Fatigue interferes with my physical functioning.	0	0	0	0	0	0	0
5. Fatigue causes frequent problems for me.	0	0	0	0	0	0	0
6. My fatigue prevents sustained physical functioning.	0	0	0	0	0	0	0
7. Fatigue interferes with carrying out certain duties and responsibilities.	0	0	0	0	0	0	0
8. Fatigue is among my three most disabling symptoms.	0	0	0	0	0	0	0
9. Fatigue interferes with my work, family, or social life.	0	0	0	0	0	0	0

\*Patients are instructed to choose a number from 1 to 7 that indicates their degree of agreement with each statement where 1 indicates strongly disagree and 7, strongly agree. [Krupp et al, Arch Neurol 1989]

Figure 2: Fatigue severity scale and questioners (FSS)

observed no adverse effect during study period and all women tolerated vitamin D therapy very well.

### Discussion

Easy fatigue in a routine household work or even during office hours specially in Indian are very common complaints and it has been associated with many adverse health problems. Women who suffer from easy fatigability have higher morbidity and mortality especially after menopause age.<sup>[23,24]</sup> Vitamin D plays an essential role in calcium metabolism and it facilitates the reabsorption of

calcium from the kidneys and absorption of calcium from the small intestine as well as it also play important role in releasing calcium from the bone.<sup>[25,26]</sup> Hypovitaminosis D reduces serum total and ionized serum calcium which results into increase in parathormone (PTH) level, increase in bone turnover (osteoclastic/osteoblastic activity) decrease in bone mineralization/density. The renal effects are increase in urinary phosphate excretion, decrease in urinary calcium excretion, and decrease in serum phosphate level, subsequently leads to bone demineralization and muscle weakness which intern manifested as fatigue.<sup>[25]</sup>

**Table 1: Demographical details and baseline characteristics**

Variables	Women with low vit D (n=1127)	Women with normal vit D (n=12)	Total (n=1239)
Age group			
18-25	90	07	97
26-35	129	02	131
36-45	312	01	313
45-50	596	01	597
Pulse rate (mean SD)	74.89 (12.38)	75.34 (11.57)	72.92 (31.27)
Systolic BP (mean SD)	122.45 (15.47)	124.67 (18.61)	120.47 (21.39)
Diastolic BP (mean SD)	76.19 (12.81)	73.56 (19.38)	70.13 (29.51)
BMI			
Less than 18.5	19	6	25
18.5 to <25	981	02	983
25.0 to <30	113	01	114
30 to <35	14	03	17
PTH ( ng/dl)	45±17	45±16	45±13
Serum Calcium (mmol/L)	2.23±0.06	2.23±0.06	2.22±0.07
Alkaline phosphates (U/L)	53	52	52
Hb (g/L)	127	119	128
Urea (mg/L)	27	21	25
Creatinine (umol/L)	72	71	69
TSH (mU/L)	1.65	1.68	1.54

**Table 2: Fatigue scores: Details of Multidimensional fatigue symptom inventory-short form**

MSF-SF Variables	Women with low Vit D before therapy (n=1127)	Women with low Vit D after therapy (n=1127)	Total (n=1239)	P
General scale (mean SD)	17.22 (5.7)	8.94 (6.25)	17.22 (5.7)	<0.001
Emotional scale (mean SD)	13.21 (6.34)	5.67 (5.41)	8.82 (6.7)	<0.0056
Vigor scale (mean SD)	9.61 (4.71)	14.82 (6.81)	8.26 (5.1)	<0.0056
Mental scale (mean SD)	13.91 (4.91)	7.34 (2.56)	8.31 (6.23)	<0.00571
Physical scale (median IQR)	8 (4-15.8)	3 (1-8)	8 (4-13.8)	<0.001
Total score (median IQR)	41.76 (14-54.62)	10.5 (2-19)	33 (15-51)	<0.00532
Serum Vit D level (ng/ml) mean SD	11.28 (16.81)	74.38 (69.95)		<0.001

**Table 3: Changes in fatigue assessment scale (FSS) and blood parameters after 4 weeks of vitamin D treatment**

Characteristics	Women with low Vit D before therapy (n=1127)	Women with low Vit D after therapy (n=1127)	P
Change in fatigue			
FAS (Fatigue)	-0.7±5.4	-3.3±5.8	<0.001
Improvement in fatigue (n %)	-	82.6%	
FSS – fatigue assessment scale			
Base line	13.21 (6.34)	5.67 (5.41)	<0.0056
At 04 weeks after therapy	21.8±6.8	12.4±9.4	<0.0052
Blood parameters			
PTH	27.2±9.3	15.6±7.4	<0.0051
Serum Vit D level (ng/ml)	4.8±14	-2.8±16	<0.0056
Calcium (mmol/L) (mean SD)	11.28 (16.81)	74.38 (69.95)	<0.0051
	0.01 {-0.4-0.8}	0.01 {-0.6-0.7}	<0.001



The present study shows that Vitamin D deficiency is prevalent among apparently healthy young women who attended OPD for easy fatigability. In India vitamin D deficiency is very common irrespective of regions, age, gender, rural, or urban areas despite exposure to sunlight, it is surprisingly as high as 70 to 100% as many studies reported.<sup>[27-29]</sup> Chronic fatigue syndrome is fairly common even in young Indian women. A study was done by Patel, *et al.* in 3000 randomly selected women showed that more than 12% of women report chronic fatigue, and the most prominent risk factors are older age, socioeconomic status, in young women because of marital disharmony, violence, and mental disorders.<sup>[30]</sup>

The Indian women are slightly different from the western country. The typical Indian women have many transitions in her life, first a daughter then wife and finally a mother. Women married early in life, she starts looking after the household of her husband that will now include the in-laws, the brother or sisters of her husband, her own child. If she belongs to a rural area, she must do cooking, washing, tending to cattle. She must be heavily involved in getting things done like making breakfast for all getting children ready for school and their lunch box, packed lunch, return to cleaning and brooming, fetching water for drinking and washing. There is very little space for the desire of gaining independence. She may eat something or may decide to wait for the children to return and have meals together. By this time, it is already late afternoon and it will be the time to start with the next round of cooking, cleaning, the same cycle of work and after the children and in-laws are asleep, she used to take dinner whatever left in the kitchen and be available for her husband. There is definitely a lack of balanced diet in her meal throughout the year and this led to easy fatigability and early osteoporosis.

In the urban areas, the women used to live in a congested colonies and flats, which devoid of proper sunlight exposure, walking or playing area. It is further added by a sedentary lifestyle, lack of physical exercise, eating junk food, air-conditioned room, watching cable TV and engaged in WhatsApp and other social media networking. The primary source of Vitamin D being sunlight, and India has adequate sunshine exposure all through the year, but urban population hardly exposed themselves to sun exposure, which resulted in reduced or diminish Vitamin D synthesis through skin. This habit was supported by many studies done in the Indian population.<sup>[31-33]</sup> The optimization of Vitamin D level improves symptoms of fatigue as is observed in the present study and also observed by Nowak *et al.*<sup>[34]</sup> and Roy *et al.*<sup>[35]</sup> who also noted that correction of this vitamin significantly improve fatigue.

It is also suggested to create awareness through media, seminar and medical camps among the population regarding the prevalence of Vitamin D deficiency and the measures to be taken to avoid it by increasing exposure to sunlight, intake of Vitamin D rich diet as well as Vitamin D supplementation if required. The government should consider regarding fortification of food

with Vitamin D through national healthcare programs. It is the duty of primary health caregiver or family physician to screen all such young women with easy fatigability. It is also stated that young women otherwise healthy feeling, easy fatigability should be screened for Vitamin D deficiency.

### Limitation of study

Since we did not enroll all patients at the same time of year to reduced bias like sunlight exposure, which likely to influence fatigue due to sun-induced vitamin D synthesis. Further limitation may be the effect of seasonal variation, amount of clothing and level of physical work at home or office.

### Conclusion

Women who complaints of easy fatigability without any medical comorbidity hypovitaminosis D should be ruled out and if found should be treated. It is the duty of primary health caregiver or family physician to screen all such young women with easy fatigability. Optimization of low vitamin D level with cholecalciferol 60000 IU therapy significantly improves the severity of fatigue symptoms in otherwise healthy women who were included in the study, presented with a vague symptom of fatigue. Easy fatigability being a major presenting complaint in these women, serum 25-OHD level should be tested and low serum 25-OHD levels should be corrected to improve their symptoms as in Indian women, hypovitaminosis D is rampant.

### Acknowledgements

The authors thank all patients who participated in the study and the hospital staff for their contributions to this study.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

### References

1. Kroenke K, Arrington ME, Mangelsdorff AD. The prevalence of symptoms in medical outpatients and the adequacy of therapy. *Arch Intern Med* 1990;150:1685-9.
2. Amato AA, Brown RH., Jr. Muscular dystrophies and other muscle diseases. In: Longo DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J, editors. *Principles of Internal Medicine*. 18<sup>th</sup> ed. Vol. 2. New York: McGraw Hill Medical; 2012. p. 3488.
3. Rosenthal TC, Majeroni BA, Pretorius R, Malik K. Fatigue: An overview. *Am Fam Physician* 2008;78:1173-9.
4. Lane TJ, Matthews DA, Manu P. The low yield of physical examinations and laboratory investigations of patients with chronic fatigue. *Am J Med Sci* 1990;299:313-8.
5. Askmark H, Haggård L, Nygren I, Punga AR. Vitamin D deficiency in patients with myasthenia gravis and improvement of fatigue after supplementation of vitamin D3: A pilot study. *Eur J Neurol* 2012;19:1554-60.

6. Dev R, DeFabbro E, Schwartz GG, Hui D, Palla SL, Gutierrez N, *et al.* Preliminary Report: Vitamin D deficiency in advanced cancer patients with symptoms of fatigue or anorexia. *Oncologist* 2011;16:1637-41.
7. Khan OJ, Reddy PS, Kimler BF, Sharma P, Baxa SE, O'Dea AP, *et al.* Effect of vitamin D supplementation on serum 25-hydroxyvitamin D levels, joint pain, and fatigue in woman starting adjuvant letrozole treatment for breast cancer. *Breast Cancer Res Treat* 2010;119:111-8.
8. Van der Meer IM, Middelkoop BJ, Boeke AJ, Lips P. Prevalence of vitamin D deficiency among Turkish, Moroccan, Indian and sub-Sahara African populations in Europe and their countries of origin: An overview. *Osteoporos Int* 2011;22:1009-21.
9. Mithal A, Wahl DA, Bonjour JP, Burckhardt P, Dawson-Hughes B, Eisman JA, *et al.* Global vitamin D status and determinants of hypovitaminosis D. *Osteoporos Int* 2009;20:1807-20.
10. Misra P, Srivastava R, Misra A, Kant S, Kardam P, Vikram NK, *et al.* Vitamin D status of adult females residing in Ballabgarh health and demographic surveillance system: A community-based study. *Indian J Public Health* 2017;61:194-8.
11. Rattan R, Sahoo D, Mahapatra S. Prevalence of Vitamin D deficiency in adults in the coastal regions of Odisha, India. *IOSR J Pharm Biol Sci* 2016;11:49-52.
12. Srimani S, Saha I, Chaudhuri D. Prevalence and association of metabolic syndrome and Vitamin D deficiency among postmenopausal women in a rural block of West Bengal, India. *PLoS One* 2017;12:e0188331.
13. Shinchuk LM, Holick MF. Vitamin d and rehabilitation: Improving functional outcomes. *Nutr Clin Pract* 2007;22:297-304.
14. Holick MF. Resurrection of vitamin D deficiency in rickets. *J Clin Invest* 2006;116:2062-72.
15. Avlund K, Pederson AN, Schroll M. Functional decline from age 80 to 85: Influence of preceding changes in tiredness in daily activities. *Psychosom Med* 2003;65:771-7.
16. Krupp LB, LaRocca NG, Muir-Nash J, Steinberg AD. The fatigue severity scale. Application to patients with multiple sclerosis and systemic lupus erythematosus. *Arch Neurol* 1989;46:1121-3.
17. Pepper KJ, Judd SE, Nanes MS, Tangpricha V. Evaluation of vitamin D repletion regimens to correct vitamin D status in adults. *Endocr Pract* 2009;15:95-103.
18. Glerup H, Mikkelsen K, Poulsen L, Hass E, Overbeck S, Thomsen J, *et al.* Commonly recommended daily intake of vitamin D is not sufficient if sunlight exposure is limited. *Journal of internal medicine* 2000;247:260-8.
19. Ginde AA, Liu MC, Camargo CA Jr. Demographic differences and trends of vitamin D insufficiency in the US population, 1988-2004. *Arch Intern Med* 2009;169:626-32
20. Chapuy MC, Arlot ME, Duboeuf F, Brun J, Crouzet B, Arnaud S, *et al.* Vitamin D3 and calcium to prevent hip fractures in the elderly women. *N Engl J Med* 1992;327:1637-42.
21. Bischoff HA, Stähelin HB, Dick W, Akos R, Knecht M, Salis C, *et al.* Effects of vitamin D and calcium supplementation on falls: A randomized controlled trial. *J Bone Miner Res* 2003;18:343-51.
22. Asvat Y, Malcarne VL, Sadler GR, Jacobsen PB. Validity of the multidimensional fatigue symptom inventory-short form in an African-American community-based sample. *Ethn Health* 2014;19:631-44.
23. Indira SN, Murthy VN. Nature of psychiatric disturbances in menopausal women. *Indian J Clin Psychol* 1980;7:7.
24. Meng H, Hale L, Friedberg F. Prevalence and predictors of fatigue in middle-aged and older adults: Evidence from the health and retirement study. *J Am Geriatr Soc* 2010;58:2033-4.
25. Norman AW. Vitamin D metabolism and calcium absorption. *Am J Med* 1979;67:989-98.
26. DeLuca HF. The metabolism and functions of vitamin D. In *Steroid Hormone Resistance*. Boston, MA: Springer; 1986. p. 361-75.
27. Aparna P, Muthathal S, Nongkynrih B, Gupta SK. Vitamin D deficiency in India. *Journal of family medicine and primary care* 2018;7:324.
28. 29 G R Gupta A. Vitamin D deficiency in India: Prevalence, causalities and interventions. *Nutrients* 2014;6:729-75.
29. Harinarayan CV, Joshi SR. Vitamin D status in India - Its implications and remedial measures. *J Assoc Physicians India* 2009;57:40-8.
30. Patel V, Kirkwood BR, Weiss H, Pednekar S, Fernandes J, Pereira B, *et al.* Chronic fatigue in developing countries: Population based survey of women in India. *BMJ* 2005;330:1190.
31. Goswami R, Kochupillai N, Gupta N, Goswami D, Singh N, Dudha A. Presence of 25(OH) D deficiency in a rural North Indian village despite abundant sunshine. *J. Assoc. Physicians India* 2008;56:755-7.
32. Sahu M, Bhatia V, Aggarwal A, Rawat V, Saxena P, Pandey A, *et al.* Vitamin D deficiency in rural girls and pregnant women despite abundant sunshine in northern India. *Clin Endocrinol* 2009;70:680-4.
33. Ramakrishnan S, Bhansali A, Bhadada SK, Sharma R, Walia R, Ravikiran M, *et al.* Vitamin D status and its seasonal variability in healthy young adults in an Asian Indian urban population. *Endocr Pract* 2011;17:185-91.
34. Nowak A, Boesch L, Andres E, Battagay E, Hornemann T, Schmid C, *et al.* Effect of vitamin D3 on self-perceived fatigue: A double-blind randomized placebo-controlled trial. *Medicine* 2016;95:e5353.
35. Roy S, Sherman A, Monari-Sparks MJ, Schweiker O, Hunter K. Correction of low vitamin D improves fatigue: Effect of correction of low vitamin D in fatigue study (EVIDiF study). *N Am J Med Sci* 2014;6:396-402.