Vitamin D status among postmenopausal osteoporotic women: a hospital based cross-sectional study from Northern Sri Lanka.

Navaneethakrishnan Suganthan (✉ drn.suganthan@yahoo.com)
Faculty of Medicine, University of jaffna   https://orcid.org/0000-0001-7905-6709

Thirunavukarasu Kumanan
University of Jaffna Faculty of Medicine

Vithegi Kesavan
Teaching Hospital, Jaffna

Mahalingam Aravinthan
Teaching Hospital, Jaffna

Nadarajah Rajeshkannan
Civic park medical centre, NSW 2145

Abstract

Background Vitamin D deficiency is common among post-menopausal women and it is important to treat vitamin D deficiency to prevent falls and fractures in patients with osteoporosis. Few studies examined the prevalence of vitamin D deficiency in general population of Sri Lanka but no studies to date done among post-menopausal women with osteoporosis. This is the first study of such kind conducted to evaluate the serum vitamin D levels and factors related to Vitamin D deficiency among postmenopausal women.

Methodology Hospital based Cross -sectional study was conducted at the Endocrine Unit, Teaching Hospital from January to December 2018.During the study period 105 postmenopausal women registered for DEXA scan with Endocrine Unit were recruited to the study. Data collection was done by investigators and blood sample was taken from each participant by registered nursing officers and sample was analysed by using immunohistochemistry assays. Serum Vitamin D levels were categorized and data analysis was done using SPSS 26.

Results Mean age of 105 postmenopausal women was 67.7 with minimum 33 and maximum 84 years. Mean Vitamin D levels were 27.5(range11.7-52.5ng/ml). Vitamin D levels were adequate in only 36.2% (95%CI: 27.4-45.7) of women, 44% had insufficient levels and deficiency was present in 19% (95%CI: 12.4-27.4) of participants. Among the 105 women 20% were vegetarian and 53% of them consuming milk on average 3 days per week, 76.2% consuming fish on average 2 days per week, 64.8% consuming egg on average 1 day per week. Furthermore seventy five participants (71.4%) reported adequate level of sun exposure (>30minutes).Commonly reported vitamin deficiency symptoms includes paraesthesia (57.1%),bone pain (55.2%), easy fatigability (54.3%), malaise (51.4%), muscle cramps (43.8%) and proximal myopathy (40.0%).Among 71(66.7%) completed bone density assessment,38% (27.3-49.7) of them showed osteoporosis range. Vertebral Z score showed a significant correlation with vitamin D level(r-0.252, P-0.034).

Conclusion Prevalence of vitamin D deficiency is relatively high among the post-menopausal women with a provisional diagnosis of osteoporosis. It is essential to correct vitamin D deficiency with supplementation when initiating treatment for osteoporosis. So vitamin D testing is desirable in decision making to treat or not to treat.

Background

In recent years the prevalence and the awareness of osteoporosis are increasing and it has been estimated that 200 million of individuals suffer from osteoporosis worldwide (1). Nevertheless, about 75% of these people represent undiagnosed cases and do not receive appropriate treatment (1, 2). Bone is remodelled constantly throughout life. Peak bone mass is around the age of 30 years after which rate of bone-resorption is greater than the rate of bone formation. Approximately 3% of cortical bone is replaced each year and 25% of trabecular bone is resorbed and replaced each year (3). Osteoporosis is defined as

bone mineral density less than 2.5 SD below the mean peak value in young adults of the same race and sex (t score of < -2.5) (4). Women of all ethnic groups show an additional accelerated phase of bone loss, which occurs for about 10 years after the cessation of ovarian function. Total bone loss in osteoporosis may exceed 30 to 40% (5). Vitamin D deficiency is a risk factor for fall and fracture among post-menopausal women with osteoporosis(4) and vitamin D deficiency is a pandemic (6) health problem which was attributed for several health problems and well documented in different parts of the globe including Sri Lanka. Moderate level of sun exposure is the major source for Vitamin D as only limited dietary sources are rich in Vitamin D (7). Anyhow, it is still debatable regarding the cut off level to be treated and most of the evidences for health-related implications of Vitamin D deficiencies are through observational studies and with limited evidences from randomized control trials (8). Heath problems vary with life cycle and it was well known to link with rickets in paediatric population and osteopenia, osteoporosis and fractures in adults (6, 9).

Justification:

A study of Vitamin D inadequacy among 200 postmenopausal women presenting to Orthopaedics and Gynaecology out-patient departments of Khyber Teaching Hospital in Pakistan, showed high prevalence (59%) of vitamin D deficiency owing to their lack of knowledge, deficient diet, sedentary lifestyle and inadequate sun exposure (10). In Sri Lanka, as far as to our knowledge, prevalence of Vitamin D status not estimated among postmenopausal women, even though a general prevalence study indicated high prevalence of vitamin D deficiency (57.2%) (11). Hence, this study was conducted to evaluate serum total 25 hydroxy vitamin D (25(OH)-Vit D) levels, symptoms related to vitamin D inadequacy and factors related to Vitamin D deficiency in postmenopausal women.

Methodology

Study Design: Hospital based cross -sectional study

Place and duration of Study: This study was conducted at the Endocrine Unit, Teaching Hospital Jaffna from January 2018 to December 2018.

Methods:

During the study period (January 2018 to December 2018), 105 postmenopausal women who were registered for Dual-Energy X-ray Absorptiometry (DEXA) scan with Endocrine Unit, Teaching Hospital Jaffna were recruited to the study. Women on medications, such as glucocorticoids and anticonvulsants popularly attributed to cause bone loss, individuals on hormone replacement therapy, those with conditions that affect bone metabolism and contributing to osteoporosis, such as multiple myeloma, diseases of the kidney or liver, mal absorption diseases, Paget's disease, primary hyperparathyroidism, uncontrolled hypo or hyper thyroidism and who has been on vitamin D supplements were excluded from the study.

Data collection was done by investigators using interviewer administered questionnaire and venepuncture was done in aseptic condition. Venous blood sample (10mL) was taken from each participant by registered nursing officers and sample was analysed by Chemical pathology laboratory at Teaching hospital Jaffna. To maintain uniformity, sample analysis was done by registered medical laboratory technicians at Teaching hospital Jaffna and measured by a competitive immunoassay with enhanced chemiluminiscence detection technique by using Vitros 3600 Immuno Diagnostic system with dedicated reagents from Orthoclinical Diagnostics (Limit of quantitation (LOQ) - 8.00ng/mL, limit of detection (LOD) - 7.43 ng/mL and reportable range is 8.00-150 ng/mL). Total 25 hydroxy vitamin D was measured and categorized as sufficient (more than 30 ng/mL), insufficient (20–30 ng/mL) and deficient (less than 20 ng/mL) (13). Same reference range was used previously in Sri Lankan prevalence study (11). Albumin corrected total plasma calcium level measured among 77 participants and normal reference range for corrected plasma calcium is defined as 2.10 to 2.55 mmol/L.

Study variables were collected by using interviewer administered questionnaire. Data analysis was done using SPSS 26 (Statistical Package for Social Sciences). Descriptive statistics such as mean with SD (Standard Deviation) were calculated and in addition Chi-square test was used to find the significance between groups. P value less than 0.05 was considered as significant. Frequency presented as percentage with 95% CI (Confidence Interval). CI was calculated by using WIN PEPI epidemiological software version 11.65(12). Bone Mineral Density Assessment was categorized based on the hip bone mineral density using World Health Organisation (WHO) and International Osteoporosis Foundation Dual-energy X-ray absorptiometry (DEXA) assessment diagnostic criteria. T-score is the number of standard deviations below the mean value of the young healthy population (14, 15).

Results

Background characteristics: This study included 105 postmenopausal women. Mean age was 67.7 with minimum 33 and maximum 84 years. Twenty-one participants were vegetarian (20%), 24 women (22.9%) reported walking as their main mode of transport, whereas 3.8% used cycling. Furthermore, seventy-five participants (71.4%) reported adequate level of sun exposure (>30 minutes/day) and only 2 women reported using sun screen (1.9%). Mean 25(OH)-Vit D level was 27.5 ng /mL with a range of 11.7-52.5 ng/mL (Table 1). The data showed fairly symmetrical distribution (skewness-0.472) (Figure 1). Albumin corrected plasma Calcium level was measured only among 77 participants and mean calcium level was 2.24 mmol/L with the range of 1.16mmol/L to 2.54 mmol/L.

Prevalence: 25(OH)-Vit D levels were adequate only in 36.2% (95%CI: 27.4-45.7) of women. Forty four percent had insufficient levels. Vitamin D deficiency was present in 19% (95%CI: 12.4-27.4) of postmenopausal women. Cumulative prevalence of insufficient and deficient level of 25(OH)-Vit D was 63.8% (95%CI: 54.3-72.6) (Table 2). A positive correlation was observed between age and 25(OH)-Vit D level (Pearson co efficient: r-0.225, P-0.021) among study participants.

Food habits related to vitamin D: Among the 105 participants only 20% were vegetarian and 53% of them consumed milk on average 3 days per week, 76.2% consumed fish on average 2 days per week, 64.8% consumed egg on average 1 day per week **(Table 3).** Mean 25(OH)-Vit D level among vegetarian group was 28.54 ng/mL, but among non-vegetarian group, level was 27.55 ng/mL(P-0.615).

Symptoms: Commonly reported vitamin D deficiency symptoms are summarised in table 4. Fifty-eight postmenopausal women reported bone pain paraesthesia (57.1%) followed by bone pain (55.2%), easy fatigability (54.3%), malaise (51.4%), muscle cramps (43.8%) and proximal myopathy (40.0%). Further, comparison of musculoskeletal symptoms between group with sufficient levels of 25(OH)-Vit D and group with insufficient and deficient levels of 25(OH)-Vit D showed statistically not significant results (P>0.05) **(Table 5).**

Co-Morbid conditions: Comorbid conditions such as hypertension (44.8%), osteoarthritis (41.9%), psychiatric conditions (30.5%), Ischaemic heart disease (IHD) (11.4%), rheumatoid arthritis (3.8%) and malignancy (2.9%) were observed among participants **(Figure 2).** None had Type 1 Diabetes Mellitus nor tuberculosis and further analysis showed no association with vitamin D and psychiatric conditions (P-0.081) nor with any other comorbid conditions studied (P>0.05**) (Table7).**

Bone Density assessment: Among 105 participants 71 completed DEXA scan for bone density assessment (66.7%) **(Table 6).** Anyhow, postmenopausal women with hip bone T score within osteoporosis range was 38 %(CI: 27.3-49.7) and in the osteopenia range was also 38%. It is also worth to note that 7 participants (6.7%) had a prosthesis in situ. Further bivariate analysis showed no significant association between vitamin D deficiency and different categories of bone mineral density (P>0.05). Postmenopausal women with Vertebrae T score in osteoporosis range was high 46 (64.8%) and vertebral Z score showed a significant correlation with 25(OH)-Vit D level (r-0.252, P-0.034). Mean level of Vitamin D among women with osteoporosis was 29.8 ng/mL, whereas mean level among non-osteoporosis was 27.92 ng/mL(P-0.370) **(Table7).**

Discussion

Current study examined 25(OH)-Vit D levels to determine the prevalence of vitamin D deficiency or insufficiency and also looked into selected associated factors among post-menopausal women with suspected osteoporosis. Bone density assessment was carried out among 77 participants. To the best of our knowledge, this is the first study in the region where Vitamin D status was measured among post-menopausal women even though several studies examined vitamin D level in general population. Gunawardane et.al found that Vitamin D deficiency in Sri Lanka was 57.2% (<20 ng/mL), vitamin D insufficiency 31% (20-30 ng/mL) and the cumulative prevalence of deficiency & insufficiency was 88.2 % (11) and high prevalence was found among young adults (age 18-40) (11). In the present study, the mean 25(OH)-Vit D concentration was 27.5 ng /mL ±8.09ng/mL and 19% (95%CI: 12.4-27.4) had vitamin D deficiency (25(OH)- Vit D concentration <20ng/mL). Overall, we have found that cumulative deficiency and in- sufficiency of vitamin D was common, 63.8% (95%CI: 54.3-72.6). However, a study among 123

postmenopausal women evaluated in Romania reported 91.9% of them had 25(OH)-Vit D levels below 30 ng/mL (16). Likewise, a study done in Pakistan among 200 postmenopausal women presented to Orthopaedics and Gynaecology outpatient departments of Khyber Teaching Hospital showed that prevalence of vitamin D deficiency was 59 % and 22% had insufficient levels (10). Almost similar findings revealed in a study from North India which showed vitamin D deficiency among 62% of subjects (17). Even though, direct comparison among these studies is difficult, relatively low prevalence among our sample could be due to a good exposure to sunlight, a natural source of vitamin D throughout the year as Northern Sri Lanka is located in the tropical region. Historically, most of the requirement of vitamin D is from sun light–induced manufacture of cholecalciferol by skin (7). Seventy-five of participants (71.4%) reported adequate level of sun exposure (30minutes/day). Authors of the study conducted in Pakistan reported that the use of sun protection, wearing purdah and in general women do not go out of their home were possible explanations for low vitamin D levels in their population (10). However, in Sri Lankan culture, there is no cultural restriction for women to go out from their homes or force to fully cover themselves which support our findings.

Many studies have showed an increasing level of vitamin D deficiency with age [18, 19]. The main reason would be that the elders would have decreased concentrations of precursor of vitamin D3 (7-dehydrocholesterol) that leads to decreased ability to make vitamin D by skin [7]. However, in the present study, 25(OH)-Vit D level showed positive correlation with advancing age (r-0.225, P-0.021). Again the amount of sun exposure is a possible factor contributed to this finding. Young women tend to spend more time indoors with their occupation while a traditional house-wife in Jaffna and the elderly spend more time outdoors. This finding was in par with some previous studies (20, 21) and further a study in Thailand showed young people could have used more sunscreen because of cosmetic reasons (20), however this practice was not observed in this study as only two participants (1.9%) reported to use sunscreen. In terms of dietary sources, common non-fortified food sources include breast milk, cod liver oil, egg yolk, fish such Mackerel (canned), Salmon (canned), Salmon (fresh, farmed), Salmon (fresh, wild), Sardines (canned) Tuna (canned), cat fish, yogurt, margarine, cereals and mushroom (1,22). Among 105 participants 53% of them consumed milk on average 3 days per week, 76.2% consumed fish on average 2 days per week, 64.8% consumed egg on average 1 day per week. Nevertheless, no significant difference in 25(OH)- Vit D level was observed between those who consumed vitamin D rich food and those who did not(Table 7). This indicates dietary source not plays a pivotal role.

Vitamin D deficiency symptoms are rather nonspecific which include back pain (non-radiating), arthralgia, proximal muscle weakness, headache, fatigue, altered mood, insomnia and hair loss (23, 24). In our study 57.1% postmenopausal women reported paraesthesia followed by bone pain (55.2%), easy fatigability (54.3%), malaise (51.4%), muscle cramps (43.8%) and proximal myopathy (40.0%). However, there was no statistical significance observed at 5% level when comparing symptoms among groups with 25(OH)-Vit D deficiency and with adequate levels of 25(OH)-Vit D. This could be due to the fact that the symptoms are non-specific and are common in post-menopausal women even without vitamin D efficiency or might also be associated with other age related co morbid conditions such as osteoarthritis. For example, among 105 participants 41.9% had osteoarthritis and 3.8% had rheumatoid arthritis. The

study also investigated the relationship between vitamin D deficiency and menopausal symptoms and concluded that the data is not supportive of vitamin D status association with menopause related symptoms (25).

Vitamin D deficiency reported to be high in prevalence among inpatients with mental illness in previous studies (26, 27). Thirty percent of samples had psychiatric conditions and mean 25(OH)-Vit D level (25.63ng/mL) was less among the participants with psychiatric conditions compared to those not having psychiatric conditions (28.68ng/ml). But this results did not show statistically significant difference (P-0.076).

It is well known fact that prevalence of osteoporosis is common among postmenopausal women and several risk factors implicated for this high prevalence includes vitamin D deficiency. Falls and risk of fractures were well associated with vitamin D deficiency among post-menopausal osteoporosis (4). Out of 105 post-menopausal women suspected with osteoporosis 71 (66.7%) completed bone density assessment and results revealed osteoporosis was present in 38% (27.3-49.7) and another 38% showed osteopenia. However, Vertebral T score within osteoporosis range was higher (64.8%) and (33.8%) showed osteopenia. Present study failed to show association with different categories of T scores with vitamin D deficiency except Vertebral Z score which showed a significant correlation with 25(OH)-Vit D level (r-0.252, P-0.034). This results could be due to a small size sample and this study was not designed to show this association (not a comparative study). Nevertheless, it is a well-known fact that vitamin D deficiency is more prevalent among post-menopausal women and supplement of vitamin D might prevent of falls and fractures, particularly with people with osteoporosis (4, 28, 29).

The appropriate cut-off level to treat vitamin D deficiency or insufficiency is a dilemma (8). To maintain minimum required 25(OH)-Vit D level (30 to 32 ng /mL) requires 2,200 to 3,000 IU/day from all available resources including sun exposure, food and supplements (30, 31, 32). Further, age specific recommendations suggest 200 IU of vitamin D daily from birth to age 50, 400 IU/day for age 51 to 70 years, and 600 IU/day for those aged 70 years and above (33,34) This recommendation presume that usual sources of vitamin D such as sun exposure and food are not adequate (31,32). It is an observation that vitamin D supplements for all post-menopausal women may lead to hypervitaminosis D. Still, supplementation with vitamin D for post-menopausal women with vitamin deficiency is beneficial in preventing osteoporosis especially to prevent complications of fall and fracture (11, 16). Since high prevalence of vitamin D deficiency among post-menopausal women with suspected osteoporosis has been shown by this study, it emphasizes the fact that early screening for suboptimal 25(OH)-Vit D level among the above group is crucial to prevent osteoporotic fractures and falls.

Limitations:

The strengths of this study are that this was the first study in Sri Lanka specifically examined the prevalence of vitamin D deficiency among post-menopausal women with suspected osteoporosis and explored some protective factors like sun exposure. 25(OH)-Vit D level measured by competitive immunoassay with enhanced chemiluminiscence technique method which is one of the standard clinical

laboratory methods. However, some limitations of the study includes that we did not obtain information about some anthropological measurements such as **BMI**(Body Mass Index); physical activity; socioeconomic status and the influence of seasonal effects and climatic changes on vitamin D deficiency. Calcium level measurement completed only among 77 participants due financial and social reasons. Furthermore, sample size estimated only with the aim of estimating prevalence but validity of the study would have been improved if we had an estimated sample size for sub analysis. Some participants (33.3%) did not complete bone density assessments which could be the reason for some factors not showing statistically significant association, even though some relationship observed in psychiatric condition, sun exposure, z/t scores of vertebral DEXA and 25(OH)-Vit D level.

Conclusions

As this study demonstrated relatively high prevalence of vitamin D deficiency among post-menopausal women with suspected osteoporosis, treatment of vitamin D deficiency with supplementation is essential to prevent fractures in whom vitamin D through dietary sources and sunlight exposure are not sufficient. In addition, it is essential to consider vitamin D supplementation when initiating treatment for osteoporosis in particular the bisphosphonate therapy. The authors recommend routine testing of vitamin D in postmenopausal women of this population in order to make concrete decisions to initiate Vitamin D supplementation as a routine.

Abbreviations

25(OH)-Vit D- 25 hydroxy vitamin D

DEXA -Dual-Energy X-ray Absorptiometry

SPSS- Statistical Package for the Social Sciences

SD-Standard Deviation

CI-Confidence Interval

WHO-World Health Organisation

IHD-Ischaemic Heart Disease,

BMI-Body Mass Index

Declarations

Ethical clearance was obtained from the Ethical Review Committee of the Faculty of Medicine, University of Jaffna. Permission to carry out this study was obtained from the Director, TH, Jaffna and informed

written consent was obtained from the participants after explaining the purpose and the nature of the study

Consent to publish

Not applicable as there is no individual data in any form

Availability of data and material

Data can be provided on request from NR or NS

Competing interests

The authors declare that none of the authors has competing interests.

Authors' contributions

NS, VK, MA and TK conceived the study. NS, VK and KA involved in the data and sample collection. NR did analysis. NR, NS and TK wrote the manuscript. All authors read and approved the manuscript.

Authors' Information

1. Department of Medicine, Faculty of Medicine, University of Jaffna, Jaffna, Sri Lanka
2. Teaching hospital Jaffna, Sri Lanka
3. Civic Park Medical Centre, Sydney, NSW 2145, Australia

References

1. Vijayakumar R, Bu¨sselberg D. Osteoporosis: An under-recognized public health problem, journal of local and global health science 2016:2;10.5339/jlghs.2016.2

2. Adami S, Giannini S, et.al. Vitamin D status and response to treatment in post-menopausal osteoporosis. Osteoporos Int. 2009; 20(2):239-44. doi: 10.1007/s00198-008-0650-y.

3. Sahota O, Masud T, San P. Vitamin D insufficiency increases bone turnover at the hip in patients with established vertebral osteoporosis. Clin Endocrinol (Oxf). 1999; 51:217-21

4. Inderjeeth CS, Harrod W, Andrisha JI. Osteoporosis in older people, managing the risks. Medicine Today. 2019; 20(8): 10-18

5. Sachdeva A, Seth S, Khosla AH, Sachdeva S. Study of some common biochemical bone turnover markers in postmenopausal women. Indian J Clin Biochem 2005; 20(1):131-4. doi: 10.1007/BF02893058

6. Holick MF, Chen TC. Vitamin D deficiency: a worldwide problem with health consequences, Am J Clin Nutr. 2008; 87 (suppl):1080S−6S.

7. Holick M F, Matsuoka LY, Wortsman J. Age, vitamin D, and solar ultraviolet. Lancet (London, England). 1989; 2(8671):1104−5.

8. Lucas R, Neale R. What is the optimal level of vitamin D? Separating the evidence from the rhetoric, Australian Family Physician. (2014) 43:3: 120-122

9. Lips P, Duong T, Oleksik A, Black DM, Cummings S, Cox D, et al. The Multiple Outcomes of Raloxifene Evaluation Study Group. A global study of vitamin D status and parathyroid function in postmenopausal women with osteoporosis: baseline data from the multiple outcomes of raloxifene evaluation clinical trial. J Clin Endocrionol Metab. 2001; 86:1212-18.

10.Akhtar, S & Jan,R. Prevalence of Vitamin D Inadequacy among Postmenopausal Women, Medical forum monthly a journal for all specialists;2019.24,11:58-59 available at:

https://www.medforum.pk/index.php/article-database/9-articles/71-prevalence-of-vitamin-d-inadequacy-among-postmenopausal-women

11. Gunawardane K, et.al. Prevalence of vitamin D deficiency and its association with diabetes in a South-Asian population, Endocrine Abstracts (2015); 38: 273; doi:10.1530/endoabs.38.P273

12. Abramson JH. WINPEPI updated: computer programs for epidemiologists, and their teaching potential, Abramson Epidemiologic Perspectives & Innovations 2011, 8:1. doi:10.1186/1742-5573-8-1.

13. Holick,M.F. Vitamin D deficiency, BMJ Best Practice ,reviewed on December 2019 Available at: https://bestpractice.bmj.com/topics/en-us/641/pdf/641.pdf Accessed on 5th January 2020

14. IOF, International Osteoporosis Foundation. Diagnosing Osteoporosis. Available at : https://www.iofbonehealth.org/diagnosing-osteoporosis. Accessed on 6th September 2019.

15. Nguyen TV, Center JR, Eisman JA. Osteoporosis: underrated, under diagnosed and undertreated. Medical Journal of Australia2004; 180 (5 Suppl): S18-S22.

16. Capatina, C et.al. Vitamin D Deficiency in Postmenopausal Women – Biological Correlates. MAEDICA – a Journal of Clinical Medicine 2014; 9(4): 316-322

17. Narula R, Tauseef M, Ahmad IA, Agarwal K, et al. Vitamin D Deficiency Among postmenopausal women with osteoporosis. J Clin Diagn Res 2013; 7(2):336–338.

18. Daly RM, Gagnon C, Lu ZX, Magliano DJ, Dunstan DW, Sikaris KA, Zimmet PZ, Ebeling PR, Shaw JE. Prevalence of vitamin D deficiency and its determinants in Australian adults aged 25 years and older: a national, population-based study. Clin Endocrinol. 2012; 77(1):26–35. 26.

19. Rucker D, Allan JA, Fick GH, Hanley DA. Vitamin D insufficiency in a population of healthy western Canadians. Can Med Assoc J. 2002; 166(12):1517–24.

20. Chailurkit LO, Aekplakorn W, Ongphiphadhanakul B. Regional variation and determinants of vitamin D status in sunshine-abundant Thailand. BMC Public Health. 2011; 11:853.

21. Lee, M. et al. Vitamin D deficiency in northern Taiwan: a community-based cohort study. BMC Public Health (2019) 19:337. doi:10.1186/s12889-019-6657-9

22. Bordelon,P.et.al. Recognition and Management of Vitamin D Deficiency. American Family Physician (2009)80: 8; 843-846.

23. Glerup, H. Mikkelsen, K. Poulsen,L. et.al. Hypo-vitaminosis D myopathy without biochemical signs of osteomalacic bone involvement. Calcif Tissue Int .(2000) 66: 77.

24. Plotnikoff, G. A & Quigley, J.M. Prevalence of severe hypovitaminosis D in patients with persistent, nonspecific musculoskeletal pain. Mayo Clin Proc (2003)78:1463-1470

25. LeBlanc,E.S. et.al. Vitamin D levels and menopause-related symptoms .Menopause. 2014 November; 21(11): 1197–1203. doi:10.1097/GME.0000000000000238.

26. Cuomo, A.et.al. Prevalence and correlates of Vitamin D deficiency in sample of 290 Inpatients with Mental illness. Frontiers in Psychiatry (2019)10: 167; doi: 10.3389/fpsyt.2019.00167

27. Geddes JA, Inderjeeth CA. Evidence for the treatment of osteoporosis with vitamin D in residential care and in the community dwelling elderly. Biomed Res Int 2013; 2013: 463589.

28. Gaugris, S. et.al. Vitamin D inadequacy among post-menopausal women: a systematic review. Q J Med 2005; 98:667–676. doi:10.1093/qjmed/hci09

29. Avenell A, Mak Jenson CS, O'Connell D. Vitamin D and vitamin D analogues for preventing fractures in post-menopausal women and older men. Cochrane Database Syst Rev 2014; (4): CD000227.

30. Bischoff-Ferrari HA, Giovannucci E, Willett WC, et al: Estimation of optimal serumconcentrationsof25-hydroxyvitaminDfor multiple health outcomes. AmJ Clin Nutr 84:18-28, 2006

31. Holick MF: Vitamin D deficiency. N Engl J Med 357:266-281, 2007

32. Heaney RP: The vitamin D requirement in health and disease. J Steroid Biochem Mol Biol 97:13-19, 2005

33. Dawson-Hughes B, Heaney RP, Holick MF, et.al. Estimates of optimal vitamin D status. Osteoporosis Int 16:713-716, 2005

34. Khan,Q.J. & Fabian, C.J. How I Treat Vitamin D Deficiency. Journal of Oncology Practice (2010) 6:2:97-102.

Tables

Table 1: Basic Statistics of Vitamin D level among Participants

Variable	Statistics	Value
Vitamin D Level (ng/mL)	Mean+/_SD	27.8+/_8.1
	Median	27.5
	Skewness	0.472
	Minimum	11.7
	Maximum	52.5
Calcium Level(mmol/L)	Mean+/_SD	2.24+/_0.32
	Median	2.32
	Min	1.16
	Max	2.54
Age	Mean	61.8
	SD	12.2
	Minimum	33
	Maximum	84
Vegetarian	Number (%)	21(20%)
Walking	Number (%)	24(22.9%)
Cycling	Number (%)	4(3.8%)
Adequate level Sun exposure(>30minutes/day)	Number (%)	75(71.4%)
Using Sun screen	Number (%)	2(1.9%)

Table2: Vitamin D Status (Prevalence) among postmenopausal women with suspected osteoporosis

Vitamin D level	Number	Percentage with (95% CI)	Mean	SD
Sufficient Level(N=38) (more than 30 ng/mL)	38	36.2(27.4-45.7)	36.26	5.43
Insufficient level (N=47) (20–30 ng /mL)	47	44.8(35.5-54.4)	25.41	2.62
Deficient Level (N=20) (less than20 ng/mL)	20	19(12.4-27.4)	17.09	2.36
Cumulative Prevalence of deficiency and insufficiency	67	63.8(54.3-72.6)	27.75	8.09

Table 3: Vitamin D rich dietary intake among participants

Vitamin D rich food	Number	Percentage with 95%CI	Number of days in week(mean)
Egg	68	64.8(55.5-73.4)	1.32
Fish	80	76.2(67.4-83.6)	2.39
Milk	53	50.5(41.0-60.0)	3.28
Dairy products	82	78.1(69.4-85.2)	--

Table 4: Common musculoskeletal symptoms among postmenopausal symptoms

Symptoms	Number	Percentage with 95% CI
Bone pain	58	55.2(45.6-64.5)
Easy Fatigability	57	54.3(44.7-63.6)
Malaise	54	51.4(41.9-60.9)
Muscle cramps	46	43.8(34.6-53.4)
Paraesthesia	60	57.1(47.5-66.4)
Proximal Myopathy	42	40.0(31.0-49.6)

Table 5: Comparison of musculoskeletal symptoms between group with sufficient level 25(-OH) Vit D and group of insufficient and deficient level of 25(-OH)Vit D level

Symptoms	Sufficient level 25(-OH) Vit D	Insufficient & deficient level 25(-OH) Vit D	P Value
	No (%)	No (%)	
Bone Pain	18(31%)	40(69.0%)	P=0.222
Easy Fatigability	22(38.6%)	35(61.4%)	P=0.576
Malaise	16(29.6%)	38(70.4%)	P=0.150
Muscle cramps	16(34.8%)	30(65.2%)	P=0.791
Paraesthesia	24(40.0%)	36(60.0%)	P=0.348
Proximal Myopathy	19(45.2%)	23(54.8%)	P=0.115

TABLE 6. BONE MINERAL DENSITY ASSESSMENT RESULTS

Category Hip bone mineral density	Number	Percentage with 95% CI
Normal T-score of –1 or higher	17	24%(15.1-34.9)
Low bone mass (osteopenia) T-score between –1 and –2.5	27	38%(27.3-49.7)
Osteoporosis T-score of –2.5 or lower	27	38%(27.3-49.7)

Table 7: Comparison of Vitamin D level with selected factors

Factors		Number	Mean Vitamin D Level with SD	Statistics
Adequate sun exposure	Yes	75	28.6+_8.4	T=1.61,P-0.110
	No	30	25.8+_7.3	
Walking	Yes	24	27.9+_9.4	T-0.135 P-0.893
	no	81	27.7_-7.7	
Vegetarian Status	Vegetarian	21	28.5+_9.4	T-0.5,P-0.615
	Non Vegetarian	84	27.6+_7.8	
Psychiatric Condition	Yes	32	25.6+_7.5	T-1.794,P-0.076
	No	73	28.7+_8.2	
Osteoporosis of Hip	Yes	27	29.8+_10.4	T-0.903,P-0.370
	No	44	27.9+_7.6	
Osteoarthritis	Yes	44	27.08+_8.7	T- -0.721,P-0.473
	No	61	28.2+_7.7	
Milk	Yes	53	26.9+_7.8	T- -1.059,P-0.292
	No	52	28.6+_8.4	
Egg	Yes	68	27.4+_7.4	T-0.678,P-0.49
	No	37	28.5+_9.4	
Fish	Yes	80	27.7+_7.7	T- -0/193,P-0.848
	No	25	28.0+_9.33	

Figures

Mean = 27.75
Std. Dev. = 8.088
N = 105

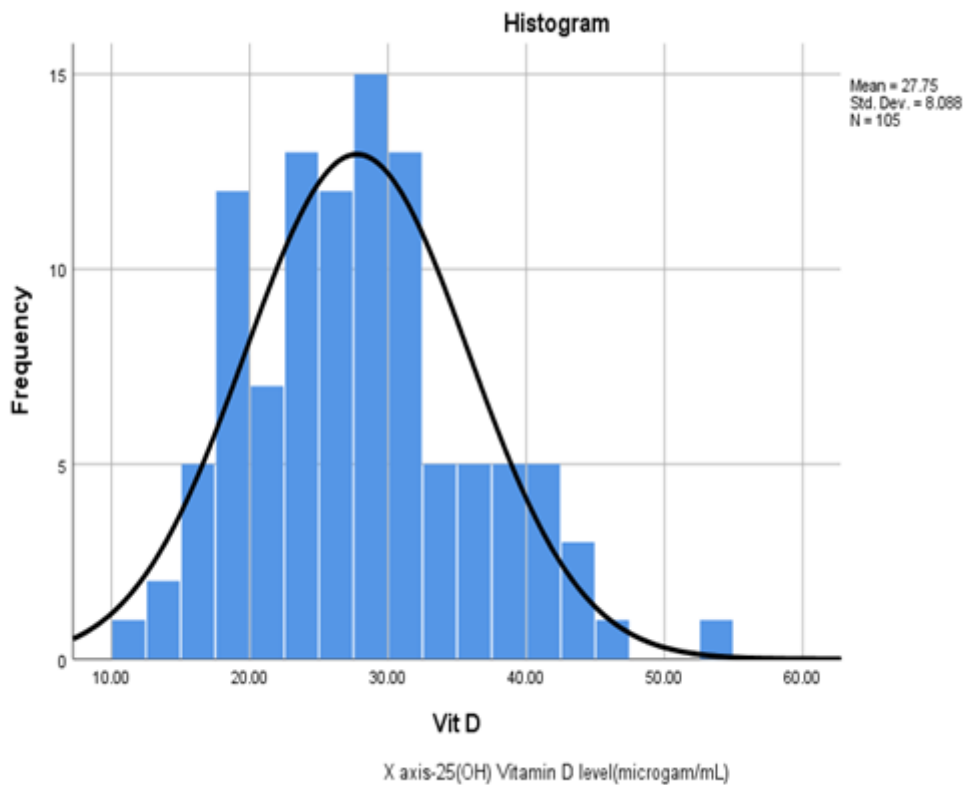X axis-25(OH) Vitamin D level(microgam/mL)
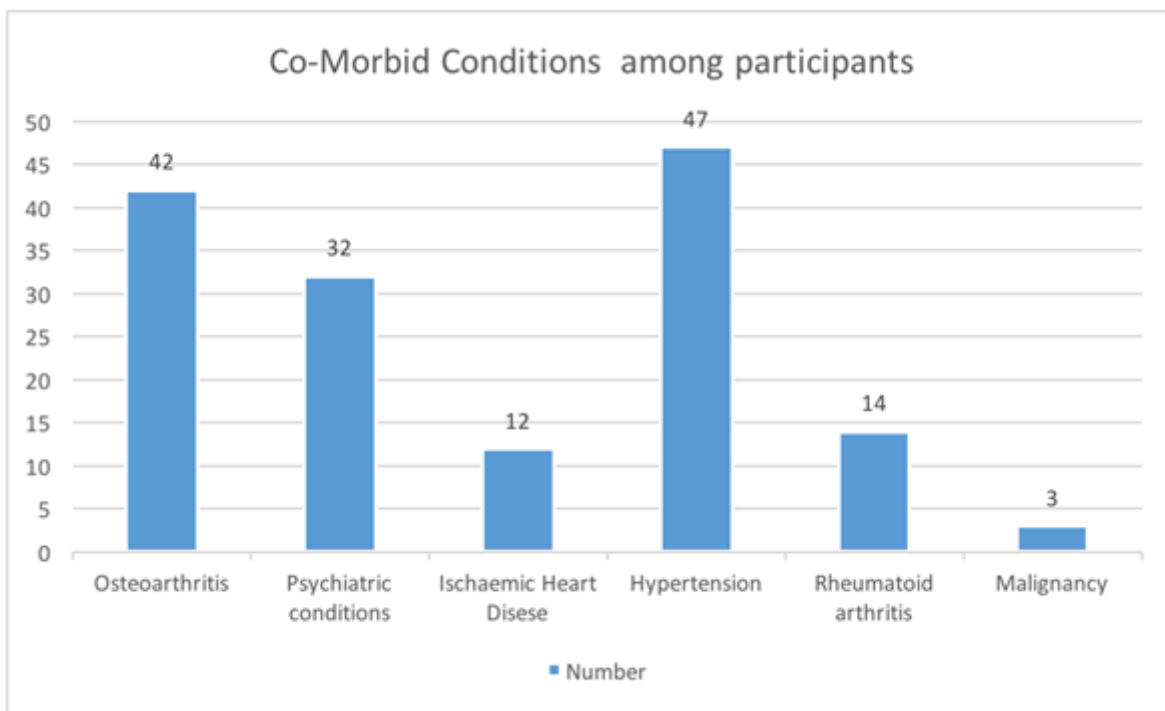
Figure 1

Histogram of the 25(OH)-Vit D levels

Figure 2

Co Morbid conditions among participants