Daphale, Ajay, Amit Daphale, Surita Daphale, and Vaishali Thakare. 2022. "Comparative Analysis of Vitamin D Levels in Younger and Older Populations in Rural vs. Urban Areas of Amravati District: An Epidemiological Survey." *World Nutrition*, September. https://doi.org/10.26596/wn.202213331-39.

Research

Comparative analysis of vitamin D levels in younger and older populations in rural vs. urban areas of Amravati district: An epidemiological survey

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Keywords: Deficiency, Vitamin -D, insufficiency, vitamin D status, vitamin D deficiency

https://doi.org/10.26596/wn.202213331-39

World Nutrition 2022;13(3):31-37

Background

Deficiency of the sunshine vitamin, vitamin D, is a major public health issue which affects people all over the world. Vitamin D deficiency was common among populations in the Amravati district of India, particularly among females, young adults in rural areas and the elderly. While many studies have focused on vitamin D levels in individuals, few have compared vitamin D status in younger and older as well rural and urban populations.

Methodology

The present study was conducted in the pathology department of a tertiary health care centre serving both a rural and urban population. 481 adult patients were examined from Jun 2017 to May 2019, age 20 to 78, of both sexes.

Result

We found that there was a high frequency of vitamin-D deficiency/inadequacy. The overall prevalence of vitamin D deficiency (<20 ng/ml of serum 25- Hydroxyvitamin D) was 40%. There was significantly more deficiency in urban than rural areas. However, we found no significant differences by age or sex.

Conclusion

Vitamin-D deficiency is very common in India. The clinically identified cases, on the other hand, are just the tip of the iceberg. Given the numerous effects that this deficiency might produce, this hidden pandemic slows the country's development. Vitamin-D deficiency must be managed with care and attention. Vitamin-D supplementation is critical for these residents who are vitamin-D deficient. Food fortification should be explored as the best long-term public health measure to improve the vitamin D status of the entire population.

INTRODUCTION

Traditionally vitamin-D deficiency is widespread across the Indian subcontinent, with research some years ago finding very high prevalence rates in the general population (Harinarayan and Joshi 2009; Goswami, Mishra, and Kochupillai 2008; Gupta and Gupta 2014; Kanekar, Sharma, and Joshi 2010), with more recent research indicating it is a continuing problem (El-Hajj Fuleihan et al. 2006; Gupta and Gupta 2014; Goswami et al. 2000a; Marwaha et al. 2011; Arya et al. 2004). In addition, the high prevalence of clinical and biological hypovitaminosis D in apparently healthy school children in India has been reported (Marwaha and Sripathy 2008). Figure 1 provides data by research site for multiple other studies documenting vitamin D deficiency prevalences in the country. This is a paradox, since India has plenty of sunlight that is essential for the body to generate the vitamin in the skin when exposed to ultraviolet B rays.

Vitamin-D deficiency has been recorded in other tropical nations as well (Goswami, Mishra, and Kochupillai 2008; Sahu et al. 2009; Goswami et al. 2008, 2000b; Ghai et al.

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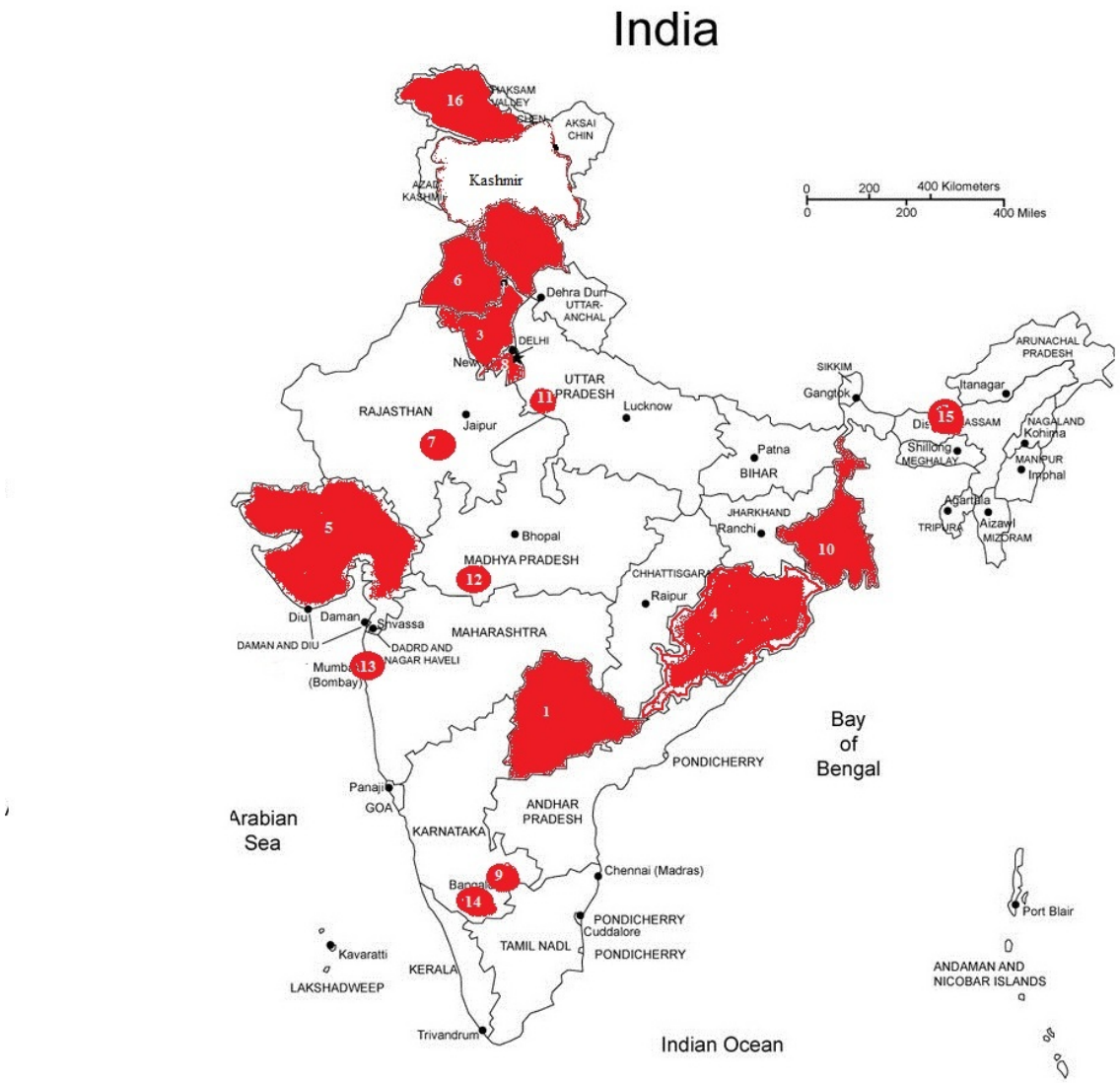

Site of the study (Ref.)	Vitamin D deficiency (%)	Site of the study (Ref.)	Vitamin D deficiency (%)
1) Hydrabad (13)	56%	9) Bengaluru (37)	70.7 %
2) Shimla (14)	93%	10) Kolkata (38)	52.9 %
3) Ballabgarh (17)	93.3 %	11) Agra (33)	61.2 %
4) Cuttack, Odisa (18)	84.9 %	12) Mohad MP (32)	65.4 %
5) Ahmadabad (19)	93.3 %	13) Mumbai (45)	87.5 %
6) Panjab (20)	90 %	14) Mysore (46)	66.5 %
7) Gurgaon (35)	93 %	15) Guwahati (47)	42 %
8) New Delhi (36)	93.5	16) Jammu (21)	53.4 %

Figure 1. State wise distribution of prevalence of vitamin D deficiency in India

2015; Harinarayan et al. 2007). Regardless, it is the most underdiagnosed dietary deficiency on the planet (Marwaha et al. 2011; van Schoor and Lips 2011).

Vitamin D (25(OH)D) levels are classified into four categories, as summarized in Table 1 (Mithal et al. 2009; Holick 2007; Willet 2013; Dawson-Hughes et al. 2005; Holick et al. 2011). The ideal and safe range for serum 25(OH) D levels is 30–100 ng/mL because when blood 25(OH) D levels approach 30 ng/mL, intestinal calcium absorption peaks and PTH levels drop (Holick 2007).

Few studies have looked at the vitamin D status of rural Indians and none have done so in the state of Maharashtra. In the present study, vitamin-D status was assessed in patients attending an outpatient department (OPD) in a rural Indian hospital in the Amravati District.

METHODOLOGY

This hospital-based cross-sectional study was conducted at an out-patient pathology department of a tertiary health care centre Amravati, Maharashtra, India. After obtaining informed consent, demographic information was collected from Jun 2017 to May 2019 from consecutive adult patients along with 3 ml blood sample for vitamin-D analysis using electro chemiluminescene on cobaselecys E411 fully automated system. Vitamin-D levels were compared across various groups by using Mann–Whitney or Kruskal–Wallis

Table 1. Diagnostic cut-offs of levels for serum Vitamin D

Vitamin D status	The serum level of Vitamin D in ng/ml
Deficiency	<20
Insufficiency	21-29
Sufficiency	>30
Toxicity	>150

tests, and multiple linear regression analysis was performed to identify the predictors of vitamin-D level.

STUDY AREA AND PATIENTS

This study was conducted with a convenience sample of patients assisted in a tertiary health care centre in. Because these data were gathered as part of routine patient services, approval was not needed except for publication, which was obtained.

CLINICAL OBSERVATION

Serum 25-hydroxyvitamin D[25(OH) D] levels were statistically analysed according to sex, age and region. Other factors associated with vitamin-D deficiency were also explored. The medical staff carefully checked the patients before entering information such as their age, into their medical records. Follow-up data was used to determine the key clinical outcomes.

RESULTS

A total of 481 patients aged 20 to 80 years were included in the study; 293 (60.9%) were from urban and (188) 39.1% were from rural areas; 32.0% were male and 68.0% were female. The average age of the males was 48.9 ± 11.5 years and the females,44.8 ± 11.2 years. Table 2 shows that there was no significant association between mean serum 25(OH)D and age group. Table 3 also finds no difference when serum values are grouped by diagnostic category. Table 4 shows that vitamin D levels are significantly higher among rural residents. The mean concentration of 25(OH)D was 42.6 ng/ml among rural residents compared to 29.6 ng/ml for urban. Table 5 shows that there was no significant difference in vitamin D diagnostic category by sex in this sample of adults. The mean concentration of 25(OH)D was 32.4 ng/ml among males and 35.9 among the females.

DISCUSSION

Contrary to popular belief, India has a high rate of vitamin-D deficiency. This may be attributed to, lack of sunshine exposure, skin pigmentation, application of sunscreen creams, Indian eating habits and a low intake of vitamin-D fortified foods (Babu and Calvo 2010). Though dietary intake of non-fortified foods cannot be expected to provide very much vitamin D, vegetarians, making up the majority of Indians, will on the whole receive less in the diet, though most Indian vegetarians consume dairy products and some consume eggs. Air pollution may play an important additional role in many areas of India, reducing the intensity of sunlight (Feizabad et al. 2017).

Although we did not find differences in vitamin D status by age or sex, that of the urban population was significantly worse. Hashemipour et al (Hashemipour et al. 2004). also found no significant variations between males and females in Tehran. However, other studies did find differences by age or sex (Sedrani 1984; Al-Jurayyan et al. 2002; Fida 2003; Naeem et al. 2011).

The major limitation of this study was that it was a hospital-based. Thus it could have been a biased sample, resulting in an over- or under-estimate of the prevalence of vitamin D deficiency in the population of the district as a whole. In addition, this could have had some impact on the associations with sex, age, and residence that we tested for. Research on vitamin D deficiency will require more attention from researchers worldwide.

RECOMMENDATIONS

- The best way to solve this problem is to fortify foods with vitamin D. Vanaspati ghee (*dalda*) in India is supplemented with 200 IU of vitamin D per 100 g. vitamin D fortification is also available in some brands of milk. However, this is clearly inadequate. Milk of any grade can be fortified. Vitamin D can be added to milk products such curd, yoghurt, and butter, as well as commercial oils. A wide range of commonly consumed foods, such as *atta*, *maida* and rice flour, could in theory be fortified. Foods fortified with vitamin D should be made widely available at a low cost and included in the public distribution system. To do this, a relevant research agenda must be implemented. The creation of a fortification programme then would require appropriate legislation followed by long-term political and administrative resolve and support. Tackling pollution is also an important factor for vitamin D deficiency, because its prevalence is higher in polluted areas (Feizabad et al. 2017).
- Vitamin D deficiency is the most underdiagnosed and undertreated nutritional issue, so raising awareness through educational programmes is critical. Both doctors and the general public should be aware of its implications. To create, launch and sustain such a programme, sufficient time, money and effort are required.
- For the populations at greatest risk, such as pregnant women, breastfeeding women, children and the elderly, high-quality vitamin D supplements should be available at the PHC level.
- School-aged children can benefit from the following: education about the importance of adequate vitamin D levels and a healthy lifestyle; provision of vitamin D fortified foods at school lunches; and daily physical activity that ensures exposure to sunlight.

Table 2. Association between mean serum 25(OH)D and age

Age Group (In Yrs.)	Vit D (Mean) (ng/mL)	F-test	p-value
20-40	30.9391	0.94	0.39 [NS]
41-60	35.2851		
61-80	42.0778		

Table 3. Association between age group and serum Vit-D levels

Age Group(In yrs)	Vit D Level (ng/mL)				P-value
	<20	20-30	30-100	>100	
	N(%)	N(%)	N(%)	N(%)	
20-40	42	24	26	7	0.24 [NS]
41-60	30	29	33	8	
61-80	35	5	50	10	

Table 4. Proportions of the sample in the Vit-D diagnostic categories by urban versus rural residency

Region	Vit D Level (ng/mL)				P=value
	<20	20-30	30-100	>100	
	N(%)	N(%)	N(%)	N(%)	
Urban	116(40)%	82 (28)%	78 (27)%	14 (5)%	<0.001 [S]
Rural	50 (26)%	37 (19)%	77 (40)%	27 (14)%	

Table 5. Proportions of the sample in the Vit-D diagnostic categories by sex

Sex	Vit D Level (ng/mL)				P=value
	<20	20-30	30-100	>100	
	N(%)	N(%)	N(%)	N(%)	
Male	47 (30%)	50(32%)	48 (31%)	10 (6%)	0.49 [NS]
Female	122 (37%)	67 (21%)	108 (33%)	29 (9%)	

- Because mass screening is not possible, testing facilities for vitamin D levels should be made affordable and accessible to people at high risk of clinical vitamin D deficiency.
- The government should fund research organizations to examine and track the effects of supplementing programmes and fortification measures.

CONCLUSIONS

Vitamin-D deficiency is very common in India. The clinically identified cases, on the other hand, are just the tip of the iceberg. Given the numerous effects that this deficiency might produce, this hidden pandemic slows the country's development. Vitamin-D deficiency must be managed with care and attention. Vitamin-D supplementation is critical for these residents who are vitamin-D deficient. Compulsory fortification of some common food would be the lowest cost and most effective public health measure for prevention, indeed for ending this hidden epidemic.

AVAILABILITY OF DATA AND MATERIAL

Data made available on request.

COMPETING INTERESTS

No authors showing any competing interest.

FUNDING

No funding was obtained for the research.

AUTHORS' CONTRIBUTIONS

1. Dr. Ajay Daphale – Conceptualization, Methodology,

2. Dr. Amit Daphale – Reviewing of manuscript, data interpretation
3. Dr. Surita Daphale – Data interpretation, Methodology, writing of manuscript
4. Dr. Vaishali Thakare – Reviewing

ACKNOWLEDGEMENTS

We gratefully acknowledge Neuron Institute of Applied Research for their generous help in editing and technical help for the research.

Submitted: June 29, 2022 BRT, Accepted: September 29, 2022 BRT

REFERENCES

Al-Jurayyan, N.A., M.E. El-Desouki, A.S. Al-Herbish, Al-Mazyad AS, and M.M. Al-Qhtani. 2002. "Nutritional Rickets and Osteomalacia in School Children and Adolescent." *Saudi Med J* 23: 182–85.

Arya, Vivek, Rajiv Bhambri, Madan M. Godbole, and Ambrish Mithal. 2004. "Vitamin D Status and Its Relationship with Bone Mineral Density in Healthy Asian Indians." *Osteoporosis International* 15 (1): 56–61. https://doi.org/10.1007/s00198-003-1491-3.

Babu, Uma S., and Mona S. Calvo. 2010. "Modern India and the Vitamin D Dilemma: Evidence for the Need of a National Food Fortification Program." *Molecular Nutrition & Food Research* 54 (8): 1134–47. https://doi.org/10.1002/mnfr.200900480.

Dawson-Hughes, Bess, Robert P. Heaney, Michael F. Holick, Paul Lips, Pierre J. Meunier, and Reinhold Vieth. 2005. "Estimates of Optimal Vitamin D Status." *Osteoporosis International* 16 (7): 713–16. https://doi.org/10.1007/s00198-005-1867-7.

El-Hajj Fuleihan, Ghada, Mona Nabulsi, Hala Tamim, Joyce Maalouf, Mariana Salamoun, Hassan Khalife, Mahmoud Choucair, Asma Arabi, and Reinhold Vieth. 2006. "Effect of Vitamin D Replacement on Musculoskeletal Parameters in School Children: A Randomized Controlled Trial." *The Journal of Clinical Endocrinology & Metabolism* 91 (2): 405–12. https://doi.org/10.1210/jc.2005-1436.

Feizabad, Elham, Arash Hossein-Nezhad, Zhila Maghbooli, Majid Ramezani, Roxana Hashemian, and Syamak Moattari. 2017. "Impact of Air Pollution on Vitamin D Deficiency and Bone Health in Adolescents." *Archives of Osteoporosis* 12 (1). https://doi.org/10.1007/s11657-017-0323-6.

Fida, N.M. 2003. "Assessment of Nutritional Rickets in Western Saudi Arabia." *Saudi Med J* 24: 337–40.

Ghai, B, D Bansal, G Kapil, R Kanukula, S Lavudiya, and N Sachdeva. 2015. "High Prevalence of Hypovitaminosis D in Indian Chronic Low Back Patients." *Pain Physician* 5;18 (5;9): E853–62. https://doi.org/10.36076/ppj.2015/18/e853.

Goswami, Ravinder, Nandita Gupta, Deepti Goswami, Raman Kumar Marwaha, Nikhil Tandon, and Narayana Kochupillai. 2000a. "Prevalence and Significance of Low 25-Hydroxyvitamin D Concentrations in Healthy Subjects in Delhi." *The American Journal of Clinical Nutrition* 72 (2): 472–75. https://doi.org/10.1093/ajcn/72.2.472.

———. 2000b. "Prevalence and Significance of Low 25-Hydroxyvitamin D Concentrations in Healthy Subjects in Delhi." *The American Journal of Clinical Nutrition* 72 (2): 472–75. https://doi.org/10.1093/ajcn/72.2.472.

Goswami, Ravinder, N. Kochupillai, N. Gupta, D. Goswami, N. Singh, and A. Dudha. 2008. "Presence of 25(OH) D Deficiency in a Rural North Indian Village despite Abundant Sunshine." *J Assoc Physicians India* 56: 755–57.

Goswami, Ravinder, S.K. Mishra, and N. Kochupillai. 2008. "Prevalence & Potential Significance of Vitamin D Deficiency in Asian Indians." *Indian J Med Res* 127: 229–38.

Gupta, Ritu, and Ajay Gupta. 2014. "Vitamin D Deficiency in India: Prevalence, Causalities and Interventions." *Nutrients* 6 (2): 729–75. https://doi.org/10.3390/nu6020729.

Harinarayan, Chittari V, and SR Joshi. 2009. "Vitamin D Status in India – Its Implications and Remedial Measures." *J Assoc Physicians India* 57: 40–48.

Harinarayan, Chittari V, Tirupati Ramalakshmi, Upadrasta V Prasad, Desineni Sudhakar, Pemmaraju VLN Srinivasarao, Kadainti VS Sarma, and Ethamakula G Tiruvenkata Kumar. 2007. "High Prevalence of Low Dietary Calcium, High Phytate Consumption, and Vitamin D Deficiency in Healthy South Indians." *The American Journal of Clinical Nutrition* 85 (4): 1062–67. https://doi.org/10.1093/ajcn/85.4.1062.

Hashemipour, Sima, Bagher Larijani, Hossein Adibi, Ebrahim Javadi, Mojtaba Sedaghat, Mohammad Pajouhi, Akbar Soltani, et al. 2004. "Vitamin D Deficiency and Causative Factors in the Population of Tehran." *BMC Public Health* 4 (1). https://doi.org/10.1186/1471-2458-4-38.

Holick, Michael F. 2007. "Vitamin D Deficiency." *New England Journal of Medicine* 357 (3): 266–81. https://doi.org/10.1056/nejmra070553.

Holick, Michael F., Neil C. Binkley, Heike A. Bischoff-Ferrari, Catherine M. Gordon, David A. Hanley, Robert P. Heaney, M. Hassan Murad, and Connie M. Weaver. 2011. "Evaluation, Treatment, and Prevention of Vitamin D Deficiency: An Endocrine Society Clinical Practice Guideline." *The Journal of Clinical Endocrinology Metabolism* 96 (7): 1911–30. https://doi.org/10.1210/jc.2011-0385.

Kanekar, A., M. Sharma, and V.R. Joshi. 2010. "Vitamin D Deficiency-a Clinical Spectrum: Is There a Symptomatic Nonosteomalacic State?" *Int J Endocrinol* 2010 (521457).

Marwaha, R. K., N. Tandon, M. K. Garg, R. Kanwar, A. Narang, A. Sastry, A., et al. 2011. "Vitamin D Status in Healthy Indians Aged 50 Years and Above." *J Assoc Physicians India* 59: 706–9.

Marwaha, R.K., and G. Sripathy. 2008. "Vitamin D & Bone Mineral Density of Healthy School Children in Northern India." *Indian J Med Res* 127: 239–44.

Mithal, A., D. A. Wahl, J.-P. Bonjour, P. Burckhardt, B. Dawson-Hughes, J. A. Eisman, G. El-Hajj Fuleihan, R. G. Josse, P. Lips, and J. Morales-Torres. 2009. "Global Vitamin D Status and Determinants of Hypovitaminosis D." *Osteoporosis International* 20 (11): 1807–20. https://doi.org/10.1007/s00198-009-0954-6.

Naeem, Z., AbdulRahman AlMohaimeed, F.S. Khalil, and Ismail. 2011. "Faiza Sh and Inam SN.Vitamin D Status among Population of Qassim Region, Saudi Arabia." *International Journal of Health Sciences, Qassim University* 5 (2).

Sahu, Monashis, Vijayalakshmi Bhatia, Anjoo Aggarwal, Vinita Rawat, Priya Saxena, Amita Pandey, and Vinita Das. 2009. "Vitamin D Deficiency in Rural Girls and Pregnant Women despite Abundant Sunshine in Northern India." *Clinical Endocrinology* 70 (5): 680–84. https://doi.org/10.1111/j.1365-2265.2008.03360.x.

Schoor, Natasja M. van, and Paul Lips. 2011. "Worldwide Vitamin D Status." *Best Practice & Research Clinical Endocrinology & Metabolism* 25 (4): 671–80. https://doi.org/10.1016/j.beem.2011.06.007.

Sedrani, Saleh H. 1984. "Low 25-Hydroxyvitamin D and Normal Serum Calcium Concentrations in Saudi Arabia: Riyadh Region." *Annals of Nutrition and Metabolism* 28 (3): 181–85. https://doi.org/10.1159/000176801.

Willet, W. 2013. "Nutritional Epidemiology." In *Biochemical Indicators of Dietary Intake*, edited by W. Willet and E. Lenart, 3rd ed., 178–82. New York: Oxford University Press.