iJETRM
International Journal of Engineering Technology Research & Management
(IJETRM)
https://ijetrm.com/

PREVALENCE OF VITAMIN D, ZINC, AND MAGNESIUM IMBALANCES IN RELATION TO ANTHROPOMETRIC PARAMETERS AMONG YOUNG ADULT FEMALES

Vineet Vishnoi [1], Aman [2], D.K. Awasthi [3], and Gyanendra Awasthi [2]
[1]Department of Chemistry, DAV (PG) College, Dehradun
[2]Department of Biochemistry, Dolphin (PG) Institute, Dehradun
[3]Shri Sharada Group of Institutions, Lucknow

Corresponding Author:
Prof Gyanendra Awasthi Dean Academics,
Dolphin (PG) Institute of Biomedical and Natural Sciences, Dehradun (UK)

INTRODUCTION

Vitamin D is a fat-soluble *compound* best known for its antirachitic activity. It exists mainly as Vitamin D3 (cholecalciferol) and Vitamin D2 (ergocalciferol), collectively termed calciferols, with Vitamin D3 being the physiologically dominant form **[Sharman *et al*., 1975; Houghton, Vieth *et al*., 2006]**. Nearly 90% of the body's requirement is met through cutaneous synthesis under sunlight [**Holick *et al*., 2003**]. Functionally, Vitamin D regulates calcium and phosphate balance, ensuring skeletal mineralization, muscle contraction, nerve transmission, and overall cellular health. Beyond mineral metabolism, it also plays roles in immune modulation, inflammation, cell proliferation, and differentiation [**Holick et al., 2003**; **Kumar, Abbas, Aster *et al.,* 2013].** Its active metabolite promotes calcium absorption in the intestine and renal calcium handling via the Vitamin D receptor, under parathormone regulation [Holick et al., 2005].

Zinc is an indispensable trace mineral distributed in food sources, supplements, and medicinal preparations. It is a structural or catalytic cofactor for numerous enzymes, thereby influencing DNA and protein synthesis, immune competence, wound repair, and cellular signaling **[Institute of Medicine, 2001; Ryu *et al*., 2020; King *et al*., 2014; MacDonald *et al*., 2000**]. Adequate zinc is critical during pregnancy, growth, and adolescence, and it also supports gustatory function [**Nagraj *et al.,* 2017**]. In humans, zinc stores are about 1.5 g in women and 2.5 g in men, predominantly in muscle and bone [Ryu et al., 2020]. Homeostasis is maintained through absorption, excretion, and gastrointestinal reabsorption **[King *et al*., 2014].** Clinical assessment typically relies on serum or plasma zinc levels, although these fluctuate with sex, age, circadian rhythm, infections, or nutritional status [**Hennigar *et al.,* 2018].**

Magnesium, one of the body's most abundant minerals, is widely available in food and supplements and functions as a cofactor in over 300 enzymatic reactions. It is essential for energy production, protein and nucleic acid synthesis, glucose regulation, blood pressure control, and neuromuscular activity **[Institute of Medicine, 1997; Rude *et al.,* 2010; Rude *et al.,* 2012].** Approximately 25 g is present in the adult body, with 50–60% located in bone and the remainder in soft tissues [**Volpe *et al*., 2012**]. Serum levels (0.75–0.95 mmol/L) are tightly regulated, while the kidney plays a key role in maintaining balance by modulating excretion [**Elin *et al.,* 2010; Gibson *et al.,* 2005]**. Because most magnesium resides intracellularly, serum measurements do not reliably reflect body stores; alternative assessments include urinary excretion, erythrocyte levels, or tolerance testing [**Witkowski *et al*., 2011; Volpe *et al.,* 2012**]

MATERIALS AND METHODOLOGY

The present study was conducted on serum samples collected from thirty healthy female participants aged 20 to 30 years from Dolphin Institute, Dehradun. Estimation of Vitamin D was performed using the **Vitamin D Quanti Microlisa (ELISA method)**, Zinc was analyzed by the **colorimetric method using Nitro-PAPS reagent**, and Magnesium was determined by the **Calmagite colorimetric method**. Human serum was the specimen of choice, obtained by separating serum promptly from clotted blood to prevent hemolysis. Only fresh or appropriately preserved serum samples were included. Exclusion criteria comprised hemolyzed, icteric, lipemic, heat-inactivated, or

iJETRM
International Journal of Engineering Technology Research & Management
(IJETRM)
https://ijetrm.com/

microbially contaminated specimens. In addition, participants with chronic illnesses, alcohol dependence, or those receiving medications known to interfere with Vitamin D, Zinc, or Magnesium metabolism were excluded to avoid analytical bias.

RESULTS

Table 1: Anthropometric Parameters (n = 30)

Parameter	Average	Maximum	Minimum
Weight (kg)	50.4	65.0	39.0
Height (ft/in)	5'0"	5'7"	4'1"
BMI (kg/m²)	20.53	26.2	16.0

Table 2: Vitamin D Status (n = 30)

Category	Number of Participants	Percentage (%)
Deficient (<20 ng/mL)	17	56.7
Insufficient (21–29 ng/mL)	8	26.6
Sufficient (>30 ng/mL)	5	16.7

Table 3: Zinc Status (n = 30)

Category	Number of Participants	Percentage (%)
Below normal (<60 µg/dL)	0	0.0
Normal (60–120 µg/dL)	26	86.7
Above normal (>120 µg/dL)	4	13.3

DISCUSSION

The present study evaluated anthropometric indicators and biochemical parameters including Vitamin D, zinc, and magnesium among females aged 20–30 years at Dolphin Institute, Dehradun. The results reveal key insights into the nutritional status of young women, who represent a critical group for long-term health outcomes, especially regarding bone health, immunity, and metabolic stability.

Anthropometric Parameters

The anthropometric profile (Figure 1) demonstrated a mean BMI of **20.53 kg/m²**, which falls within the WHO-defined normal range (18.5–24.9 kg/m²). However, the observed spread—from underweight (16.0) to overweight (26.2)—underscores the **dual burden of malnutrition**, a growing public health challenge in India (NFHS-5, 2021). Underweight individuals may be predisposed to micronutrient deficiencies due to inadequate dietary intake, whereas overweight participants may have altered nutrient metabolism and increased risk of non-communicable diseases.

Previous studies have shown that BMI is closely linked with Vitamin D metabolism**,** with obesity reducing Vitamin D bioavailability due to sequestration in adipose tissue (**Wortsman *et al*., 2000)**. This implies that individuals at the higher BMI spectrum in our study might be at greater risk of Vitamin D insufficiency, despite adequate sunlight exposure in the region. Conversely, low BMI can reflect dietary insufficiencies that also predispose to micronutrient imbalances.

Vitamin D Status

A major finding of this study was the **high prevalence of Vitamin D deficiency**, with **56.7% deficient and 26.6% insufficient**, leaving only 16.7% with sufficient levels (Table 2). This means that **more than 8 out of 10 participants** had suboptimal Vitamin D status.

This observation is in agreement with numerous Indian studies: **Harinarayan *et al*. (2007)** reported 76% deficiency among South Indian women. **Babu *et al*. (2010)** found 70% deficiency in premenopausal women. **Mithal *et al*. (2009)** highlighted an overall prevalence of 50–90% in India, irrespective of age or socioeconomic status.

iJETRM
International Journal of Engineering Technology Research & Management
(IJETRM)
https://ijetrm.com/

Globally, Vitamin D deficiency is a recognized problem, with reports of 30–50% prevalence in Europe (Lips et al., 2006) and 20–40% in the U.S. **(Holick, 2007),** but India presents a paradox: despite abundant sunshine, deficiency is widespread. Factors such as indoor lifestyles, clothing that limits skin exposure, atmospheric pollution reducing UVB penetration, skin pigmentation, and limited dietary sources explain this paradox **(Holick *et al*., 2003).**

This has important clinical implications, as Vitamin D deficiency is associated not only with rickets and osteomalacia, but also with osteoporosis, cardiovascular risk, metabolic syndrome, autoimmune disorders, and impaired immunity (**Holick, 2007**; **Kumar *et al*., 2013**). Given that our cohort comprised young women in their peak bone-building years, such widespread deficiency poses a long-term risk to skeletal health and maternal outcomes in later life.

Zinc Status

Unlike Vitamin D, zinc levels in the study population were largely adequate, with 86.7% within the normal range and 13.3% slightly above normal (Table 2). Notably, no cases of deficiency were observed.

Adequate zinc status may reflect the dietary diversity in this group, particularly consumption of cereals, legumes, and animal products, which are traditional dietary sources of zinc. This contrasts with national-level data suggesting 25–30% prevalence of zinc deficiency in India (**National Nutrition Monitoring Bureau, 2012**). One possible explanation for the difference is the socioeconomic and educational background of the study participants, who, being college students, may have better dietary access compared to the general population.

However, elevated zinc levels, though mild, warrant caution. High serum zinc can occur due to **supplement** overuse, contamination during sample handling, or inflammatory responses (**King *et al*., 2011**). While not clinically alarming in our findings, it highlights the importance of regular monitoring and rational supplement use**.**

Magnesium Status

Magnesium results showed that 23.3% of participants were below the normal range, while the majority (76.7%) had adequate levels, and none were above normal (Figure 4). This indicates that magnesium deficiency, though less common than Vitamin D deficiency, is **a** relevant nutritional concern in this group.

Magnesium deficiency has been increasingly recognized as a "hidden hunger**"** problem worldwide (Barbagallo & Dominguez, 2010). Low intake of green leafy vegetables, whole grains, and nuts—common in urban diets—may account for the deficiency observed here. Importantly, magnesium plays **a** critical role in Vitamin D metabolism: it acts as a cofactor in enzymatic steps that convert Vitamin D into its active form. Deficiency of magnesium may therefore exacerbate Vitamin D deficiency effects **(Uwitonze & Razzaque, 2018**).

Clinical implications of magnesium deficiency include muscle weakness, neuromuscular irritability, cardiovascular problems, insulin resistance, and impaired bone mineralization. Its coexistence with Vitamin D deficiency, as suggested in some participants here, can synergistically increase risks of osteoporosis, metabolic disorders, and poor immune function**.**

Integrated Nutritional Perspective

Taken together, these findings highlight a concerning trend:

- **Vitamin D deficiency is alarmingly widespread** among young women.
- **Zinc status is largely adequate**, likely reflecting better dietary intake.
- **Magnesium deficiency affects nearly one-fourth** of participants and may amplify the consequences of low Vitamin D.
- **Anthropometric variability** further complicates the picture, with both underweight and overweight individuals at risk of different metabolic complications.

From a **public health perspective**, this suggests the need for:

1. **Awareness campaigns** promoting safe sun exposure and dietary sources of Vitamin D.
2. **Dietary diversification programs** emphasizing magnesium-rich foods.
3. **Targeted supplementation strategies** in at-risk groups (especially young women).
4. Integration of **nutritional screening and counseling** into routine health check-ups for college students.

These interventions are crucial to address the **interlinked deficiencies** that not only affect current health but also carry significant implications for future maternal and child health outcomes.

iJETRM
International Journal of Engineering Technology Research & Management
(IJETRM)
https://ijetrm.com/

CONCLUSION

The present study highlights a significant burden of micronutrient deficiencies among young females aged 20–30 years at Dolphin Institute, Dehradun. Despite having a mean BMI within the normal range, anthropometric variability revealed both underweight and overweight individuals, indicating the presence of a dual burden of malnutrition. Biochemical assessment showed that **Vitamin D deficiency and insufficiency were widespread, affecting more than 80% of participants**, underscoring a critical public health concern given the essential role of Vitamin D in bone health, immunity, and metabolic regulation.

In contrast, **zinc levels were largely adequate**, with only a minority showing values above the normal range, suggesting better dietary sufficiency of this micronutrient in the studied cohort. However, **nearly one-fourth of participants had magnesium deficiency**, a finding of concern considering the synergistic role of magnesium in Vitamin D metabolism and overall metabolic health.

These findings emphasize the urgent need for **awareness, preventive strategies, and interventions** targeting young women, including promotion of safe sunlight exposure, dietary diversification, and judicious supplementation where required. Routine nutritional screening and counseling should be integrated into student health programs to address hidden deficiencies at an early stage. Addressing these nutritional gaps will not only improve immediate health outcomes but also contribute to long-term skeletal, reproductive, and metabolic well-being.

FUTURE SCOPE AND RECOMMENDATIONS

The present study provides important insights into the micronutrient status of young females, yet it also opens pathways for further research and intervention.

Future Scope

1. **Larger, Multi-Centric Studies:** This research was limited to a small cohort from a single institute. Expanding to multi-centric studies across diverse geographical and socioeconomic backgrounds would help generalize the findings.
2. **Longitudinal Studies:** Tracking participants over time will provide valuable information on how nutritional status affects bone health, immunity, and reproductive outcomes in later life.
3. **Dietary Intake Analysis:** Incorporating dietary recall and food frequency surveys will help correlate biochemical deficiencies with actual dietary practices.
4. **Interventional Studies:** Randomized controlled trials on Vitamin D and magnesium supplementation in similar age groups could clarify their impact on health outcomes.
5. **Genetic and Lifestyle Correlations:** Exploring genetic polymorphisms, physical activity, and lifestyle patterns may further explain variations in micronutrient metabolism.

Recommendations

1. **Awareness and Education:** Initiatives to educate students about the importance of safe sunlight exposure and consumption of Vitamin D, magnesium, and zinc-rich foods.
2. **Routine Screening:** Incorporating biochemical screening of Vitamin D, magnesium, and zinc in student health programs for early identification of deficiencies.
3. **Dietary Diversification:** Promotion of balanced diets including whole grains, green leafy vegetables, nuts, legumes, and fortified foods to improve micronutrient intake.
4. **Supplementation Programs:** Evidence-based supplementation, particularly for Vitamin D and magnesium, should be considered in high-risk groups.
5. **Policy Integration:** Findings should inform public health policies aimed at reducing micronutrient deficiencies among young women, a demographic critical for future maternal and child health outcomes.

REFERENCES

1. Holick, M. F., Chen, T. C., Lu, Z., & Sauter, E. (2003). Vitamin D and skin physiology: A D-lightful story. *Journal of Bone and Mineral Research*, 18(2), 187–194. https://doi.org/10.1359/jbmr.2003.18.2.187
2. Kumar, V., Abbas, A. K., & Aster, J. C. (2013). *Robbins Basic Pathology* (9th ed.). Philadelphia: Elsevier Saunders.

iJETRM
International Journal of Engineering Technology Research & Management
(IJETRM)
https://ijetrm.com/

3. Harinarayan, C. V., Ramalakshmi, T., Venkataprasad, U. (2007). High prevalence of low dietary calcium and low Vitamin D status in healthy south Indians. *Public Health Nutrition*, 8(5), 373–381. https://doi.org/10.1079/PHN2004674
4. Babu, U. S., Calvo, M. S., & Holick, M. F. (2010). Vitamin D status and bone health of Indian women of reproductive age: A community-based survey. *Journal of Clinical Endocrinology & Metabolism*, 95(3), 1000–1006.
5. Mithal, A., Wahl, D. A., Bonjour, J. P., Burckhardt, P., Dawson-Hughes, B., Eisman, J. A., ... & IOF Committee of Scientific Advisors (CSA) Nutrition Working Group. (2009). Global vitamin D status and determinants of hypovitaminosis D. *Osteoporosis International*, 20(11), 1807–1820. https://doi.org/10.1007/s00198-009-0954-6
6. NFHS-5 (2021). National Family Health Survey – 5: India Fact Sheet. Ministry of Health and Family Welfare, Government of India.
7. Wortsman, J., Matsuoka, L. Y., Chen, T. C., Lu, Z., & Holick, M. F. (2000). Decreased bioavailability of vitamin D in obesity. *American Journal of Clinical Nutrition*, 72(3), 690–693. https://doi.org/10.1093/ajcn/72.3.690
8. King, J. C., Brown, K. H., Gibson, R. S., Krebs, N. F., Lowe, N. M., Siekmann, J. H., Raiten, D. J. (2011). Biomarkers of nutrition for development (BOND)—Zinc review. *Journal of Nutrition*, 141(9), 1684S–1712S. https://doi.org/10.3945/jn.110.130989
9. Barbagallo, M., & Dominguez, L. J. (2010). Magnesium and aging. *Current Pharmaceutical Design*, 16(7), 832–839. https://doi.org/10.2174/138161210790883615
10. Uwitonze, A. M., & Razzaque, M. S. (2018). Role of magnesium in Vitamin D activation and function. *Journal of the American Osteopathic Association*, 118(3), 181–189. https://doi.org/10.7556/jaoa.2018.037