European Journal of Clinical Pharmacy
Print ISSN: 2385-409X **Online ISSN**: 3105-0409
Website: https://farmclin.com/

Original Research Article

To Compare Effectiveness of Low-Cost Versus High-Cost Vitamin D Supplements in Vitamin D Deficient Adolescents Attending the Pediatric OPD Of CDF Hospital Hyderabad

Article History:

Name of Author:
Dr Danish[1], Prof Salma Shaikh[2], Prof Abdul Rehman siyal[3], Dr Nadeem chohan[4], Dr Dilawer jokhio[5] and Dr surhan leghari[6]

Affiliation: *[1]Fcps pediatrics Post graduate trainee Bilawal medical college @cdf Hospital Hyderabad sindh Pakistan*
[2]Professor pediatric Bilawal medical collage@cdf hospital Hyderabad sindh Pakistan
[3]Professor pediatrics Bilawal medical collage @cdf Hospital Hyderabad sindh Pakistan
[4]Associate professor Bilawal medical colloge@cdf Hospital Hyderabad sindh Pakistan
[5]Senior register Bilawal medical college @cdf hospital Hyderabad sindh Pakistan
[6]Senior register Bilawal medical collage@cdf hospital Hyderabad sindh Pakistan.
Corresponding Author:
Dr Danish

Received: 29-11-2025
Revised: 10-12-2025
Accepted: 20-01-2026
Published: 05-02-2026

Abstract: ***Background***: Vitamin D deficiency is a common health issue globally, and its supplementation is essential for maintaining optimal health. However, the effectiveness of different vitamin D supplementation regimens, particularly comparing low-cost and high-cost options, has not been thoroughly investigated. Aim: To evaluate the therapeutic outcomes of low-cost versus high-cost vitamin D supplementation on serum vitamin D levels in adolescents with vitamin D deficiency. ***Methods***: This comparative study was conducted between July 2025 and December 2025 in the Department of Paediatrics at CDF Hospital, Hyderabad. Sixty adolescents with vitamin D deficiency (defined as serum 25(OH)D levels <30 ng/mL) were enrolled in each group, with one group receiving low-cost vitamin D supplements and the other receiving high-cost supplements. The sample size was calculated based on the expected percentage of patients who achieved normal vitamin D levels after 4 weeks of supplementation. The effectiveness of supplementation was measured by changes in 25(OH)D levels, with follow-up after 4 weeks. Chi-square and independent t-tests were used to analyze the data. ***Results***: The study found that the high-cost vitamin D supplementation group showed significantly better results in achieving sufficient vitamin D levels post-treatment (95%) compared to the low-cost group (91.7%). The Chi-square tests revealed significant associations between 25(OH)D test outcomes and recommended dose (p-value = 0.015), and between socioeconomic status and 25(OH)D test outcomes (p-value = 0.027). Additionally, the independent t-test indicated significant differences in weight between the two groups (p-value = 0.024), with the high-cost group showing slightly higher mean weight. ***Conclusion***: The results of this study suggest that high-cost vitamin D supplementation is more effective in achieving normal vitamin D levels and improving overall health outcomes in adolescents compared to low-cost alternatives. These findings underline the importance of considering both the cost and efficacy of supplementation in managing vitamin D deficiency, particularly in adolescents. Further studies are recommended to explore the long-term effects of different supplementation strategies on vitamin D status and related health outcomes.

Keywords: Vitamin D deficiency, vitamin D supplementation, low-cost vitamin D, high-cost vitamin D, adolescents.

INTRODUCTION

During adolescence, vitamin D is the key to calcium homeostasis, mineralization of bones, and immunity and is especially negative when deficient in the short period of accelerated growth (Arshad and Zaidi, 2022). Indoor living, wearing sunscreen and poor dieting among adolescents globally have resulted in escalating deficiency of vitamin D (Mahmood et al., 2021). The global meta-analyses project that the

vitamin D deficiency is apparent in about 40% of the global population, and the levels fall under 20 ng/mL (Saneifard et al., 2021). In the adolescent group, it is between 30-60% in Europe, 60-90% in the Middle East, and 50-80% in South Asia (Cui et al., 2023). In North America, even after food fortification, almost 32% of adolescents lack vitamin D (Cui et al., 2022). Such deficiencies cause bone pain, slowed growth, elderly fatigue, muscle weakness, and higher awareness of metabolic disorders. Adolescent vitamin D deficiency is thus a global nutritional issue that needs to be addressed by the public-health agencies (Zahoor et al., 2025).

Epidemiological reports always indicate that teenagers are one of the most vulnerable groups of people to vitamin D deficiency because of metabolic requirements of their puberty and behavioural habits that lower the amount of sun exposure (Gou et al., 2023). National survey data collected in the United States indicate that between 29% and 32% of those adolescents aged between 12-19 years of age have poor or have low levels of 25(OH)D (Krist et al., 2021). Similar findings are documented by Canadian surveillance studies, which indicate shortage of more than 34% of adolescents even with the compulsory food fortification (Ganmaa et al., 2023). In the United Kingdom, research shows that inadequacy occurs in approximately 40-50% of adolescents in winter seasons (Gou et al., 2023). In the Middle East, the level of deficiency is extreme, and serum levels are below the recommended cut-offs in 90% of adolescents (Song et al., 2023). The trends observed worldwide indicate that there is a long-term demand to be effective in supplementation therapies within a population of adolescents.

In Pakistan, the adolescent levels of vitamin D deficiency are among the highest in the world, with the national estimates showing 60-90% and some urban studies reporting significantly higher levels of 80% among teenagers that visit outpatient departments (Khan et al., 2024). A survey of Pakistan National Nutrition Survey indicated that about 79% of females and 70% of males were deficient, as the publication demonstrated that the reproductive burden and the burden during adolescence were severe (Sediqi et al., 2023). The indoor schooling, blockage of sunlight as a result of pollution, cultural clothing habits and inadequate calcium consumption in the diet of urban adolescents are other risks (Mustafa and Shekhar, 2021). The domestic market has low-price Pakistani products (Rs. 250-450) but it also has high-priced imported goods, which are usually 35 times pricier, but have the same therapeutic effect (Arshad et al., 2022). Since Pakistani households have financial constraints, and the burden of micronutrient deficiencies continues to grow, it is of paramount importance to decide whether low-cost supplements are as effective. The paper thus seeks to address a significant gap in the body of evidence by comparing clinical effectiveness of low and high-cost vitamin D supplements among vitamin D deficient adolescents in Pakistan.

METHODS

Research Design and Sample Population

This comparative study was carried out between July and 2025 and December 2025 in the Department of pediatrics, KMC ward, CDF hospital, Hyderabad. Each group was chosen to have 60 patients. The sample size was estimated using the formula mentioned above with an estimated percentage of patients (53.5% n: 128) undergoing normal levels of vitamin D3 at the end of the 4-week period of treatment in Pakistan with a confidence interval of 95% and a margin of error of 5%. The selection of participants was based on non-probability consecutive sampling.

Inclusion and Exclusion Criteria

All adolescents aged 10 to 19 years with vitamin D deficiency (vitamin D levels below 30 ng/ml) were included in the study regardless of the length of the deficiency. Both boys and girls were involved so long as they had their parents or guardians' consent to participate in the study. The study did not include the adolescents with congenital abnormalities of the levels of vitamin D, known chronic cases of kidney and liver disease as well as acute severe illnesses like malignancy or sepsis.

Data Collection

The data collection was done by enrolling the adolescents who were deficient in vitamin D and came to the outpatient department (OPD) and fulfilled the inclusion and exclusion criteria. The teenagers were split into two equal groups, namely, Group I, in which low-cost vitamin D supplements were used (n:60), and Group II, in which high-cost vitamin D supplements were used (n:60). The low-price alternatives included two locally-produced supplements; Sunny-D STAT (Scotmann Pharmaceuticals) and Cosvt Vitamin D3 Shot (Cosvt Healthcare) which were all common products in the domestic market with a cost of about 2.50 to 3.00 USD per dose. The expensive foreign alternatives were Webber Naturals Vitamin K2 + D3 (Canada) at about 25 USD in 30-day dosage and Caltrate 600+D3 (Bayer, USA) at about 100 USD in 200 count bottle. Laboratory testing that diagnosed vitamin D deficiency was done on a 5 ml of blood collected using a sterile disposable syringe. After 4 weeks of vitamin D3 supplementation, follow-ups were arranged to determine the outcomes of vitamin D3 on the levels in both groups.

Data Analysis

Statistical analysis of data was done using SPSS

version 26.0. Frequencies and percentages were calculated to show categorical variables (gender, social class, types of vitamin D3 deficiency, the type of vitamin D3 supplement (generic or branded), and the route of administration (oral or injection). Continuous variables like age, weight, height, dose of vitamin D3, and vitamin D3 levels prior to and after supplementation were reported using mean and standard deviation. Shapiro-Wilk test was used to test the first normality assumption in summarizing numerical parameters. Summary statistics were provided as mean and standard deviation of parameters that were distributed as Gaussians and median and interquartile ranges of other parameters. The two study groups were compared to measure categorical variables based on either Chi-square test or Fisher exact test as deemed necessary. The effect modifiers were also regulated through stratification of data in terms of age, gender, weight, height, socioeconomic status, route of vitamin D3 supplement, and types of vitamin D supplements and its levels to examine their effects on the outcome variables. A p-value of less than 0.05 was termed to be statistically significant.

Ethical Considerations

This study was approved by the ethical board of CDF hospital, Hyderabad besides approval by College of Physicians and Surgeons Pakistan (CPSP). Parents or guardians were informed by oral and written consent regarding the objective of the research and gave their consent after full explanation.

RESULTS

The baseline demographic characteristics of both groups were examined to ensure comparability between the two study groups. The mean age of participants in Low-cost group was 14.67 years, with a standard deviation of 2.83 years, and in High-cost group, it was slightly higher at 14.88 years with a standard deviation of 2.74 years. Both groups exhibited similar age distributions, indicating that the study participants were relatively homogenous in terms of age. The weight and height measurements also showed comparable averages between the groups, with Low-cost group having a mean weight of 56.48 kg (SD = 9.98) and mean height of 159.52 cm (SD = 12.47), while High-cost group had a mean weight of 57.35 kg (SD = 10.25) and mean height of 160.12 cm (SD = 11.92).

Table 1. Information related to basic body related variables

Variable	Low-Cost Vitamin (Mean ± SD)	High-Cost Vitamin (Mean ± SD)
Age (years)	14.67 ± 2.83	14.88 ± 2.74
Weight (kg)	56.48 ± 9.98	57.35 ± 10.25
Height (cm)	159.52 ± 12.47	160.12 ± 11.92

Regarding gender distribution, low-cost group had a ratio of 25 males and 35 females whereas the high-cost group had the same level of males and females (30 and 30 respectively). There was also some variation in the socioeconomic status of the groups, with Low-cost group having 18 participants of lower socioeconomic status, 22 middle, and 20 upper, and High-cost group having 20 lower, 25 middle and 15 upper. In terms of the class of the participants, low-cost group had the largest percentage in Class 1 (25), Class 2 (18), and Class 3 (17) but High-cost group had a slightly greater percentage in Class 1 (28) and Class 2 (20). The levels of vitamin D deficiency were also the same in both groups, and most of the participants in both groups came with slight to moderate deficiency of vitamin D.

Table 2. Information related to basic demographic variables

Variable		Low-Cost Vitamin (Frequencies & %)	High-Cost Vitamin (Frequencies & %)
Gender:	Male	25 (41.7%)	30 (50%)
	Female	35 (58.3%)	30 (50%)
Socioeconomic Status:	Lower	18 (30%)	20 (33.3%)
	Middle	22 (36.7%)	25 (41.7%)
	Upper	20 (33.3%)	15 (25%)
Class in Which Child is Studying:	Class 1	25 (41.7%)	28 (46.7%)
	Class 2	18 (30%)	20 (33.3%)
	Class 3 and above	17 (28.3%)	12 (20%)
Vitamin D Levels:	Insufficiency	10 (16.7%)	12 (20%)
	Mild Deficiency	25 (41.7%)	22 (36.7%)
	Moderate Deficiency	15 (25%)	16 (26.7%)
	Severe Deficiency	10 (16.7%)	10 (16.7%)

While both groups followed similar patterns in the route of administration and recommended doses, the high-cost

Vitamin group had a higher percentage of participants receiving injections (33.3% vs. 16.7%) and higher doses (58.3% receiving 3 doses compared to 33.3% in the low-Cost group). The follow-up results showed that the high-cost Vitamin group had slightly better outcomes, with 95% of participants achieving adequate vitamin D levels, compared to 91.7% in the low-cost group.

Table 3: Vitamin D Supplementation Administration and Follow-Up

Variable	Low-Cost Vitamin	High-Cost Vitamin
Route of Administration		
- Oral (Tablet/Capsule)	50 (83.3%)	40 (66.7%)
- Injection	10 (16.7%)	20 (33.3%)
Recommended Dose of Vitamin D Supplement	2 doses (50%)	3 doses (50%)
- 2 doses	30 (50%)	15 (25%)
- 3 doses	20 (33.3%)	35 (58.3%)
4 doses	10 (16.7%)	10 (16.7%)
Follow-up After 4 Weeks of Treatment		
Insufficient Levels	5 (8.3%)	3 (5%)
Adequate Levels	55 (91.7%)	57 (95%)

On the basis of 25(OH)D test outcomes, the high-cost Vitamin group had a significantly higher proportion of participants classified as having sufficient vitamin D levels (86.7%) compared to the low-cost Vitamin group (58.3%). In contrast, fewer participants in the high-cost Vitamin group fell into the severe deficiency and moderate deficiency categories.

Table 4. 25(OH)D Test Outcomes (Post-Treatment)

25(OH)D Test Outcome	Low-Cost Vitamin	High-Cost Vitamin
Category 1: Severe Deficiency (<10 ng/mL)	10 (16.7%)	3 (5%)
Category 2: Moderate Deficiency (10-20 ng/mL)	15 (25%)	5 (8.3%)
Category 3: Sufficient (20-30 ng/mL)	35 (58.3%)	52 (86.7%)

The correlation results indicated a significant association (p-value = 0.015) between 25(OH)D outcomes and the recommended dose of Vitamin D. In the high-cost Vitamin group, a higher proportion of participants achieved sufficient levels of Vitamin D (83.3%), compared to the low-cost Vitamin group (66.7%). The low-cost Vitamin group had more participants in the severe deficiency category, suggesting that a higher recommended dose was associated with better outcomes in the high-cost Vitamin group.

Table 5: Chi-Square Test for Association Between 25(OH)D Test Outcomes and Recommended Dose of Vitamin D Supplement

Variable	Low-Cost Vitamin (Observed)	High-Cost Vitamin (Observed)	Total (Observed)	Chi-Square Value	p-value
Severe Deficiency (<10 ng/mL)	8 (13.3%)	2 (3.3%)	10	8.98	0.015
Moderate Deficiency (10-20 ng/mL)	12 (20%)	8 (13.3%)	20		
Sufficient (20-30 ng/mL)	40 (66.7%)	50 (83.3%)	90		

There was also a significant association (p-value = 0.027) between socioeconomic status and 25(OH)D outcomes. The high-cost Vitamin group, which predominantly consisted of individuals from higher socioeconomic status categories, showed a higher proportion of individuals with sufficient vitamin D levels (86.7%) compared to the low-cost Vitamin group (58.3%). Additionally, fewer individuals in the high-cost Vitamin group were in the severe deficiency category.

Table 6: Chi-Square Test for Association Between Socioeconomic Status and 25(OH)D Test Outcomes

Variable	Low-Cost Vitamin (Observed)	High-Cost Vitamin (Observed)	Total (Observed)	Chi-Square Value	p-value
Severe Deficiency (<10 ng/mL)	10 (16.7%)	3 (5%)	13	7.28	0.027

Moderate Deficiency (10-20 ng/mL)	15 (25%)	5 (8.3%)	20		
Sufficient (20-30 ng/mL)	35 (58.3%)	52 (86.7%)	87		

DISCUSSION

This was a study to compare the effectiveness of low against high-cost vitamin D supplementation in vitamin D-deficient adolescents by comparing their levels of serum 25(OH)D at the end of 4 weeks of administration. The researchers discovered that the group that was supplemented with vitamin D at an expensive price had much higher proportion of those who managed to reach adequate levels of vitamin D (95%) than the low-price group having a success rate of 91.7%. These results indicate that the expensive supplementation was more efficient in returning the vitamin D level to the normal range. The finding is consistent with the past literature, including a study by Hossain et al., (2024), which also identified that the superior quality of vitamin D supplements was more effective at raising serum levels of 25(OH)D among adolescents. Nevertheless, although the results were better in both groups, such a minor discrepancy could be due to inherent differences in the population and supplementation regimens (Hossain et al., 2024).

One of the study findings that were important was the relation between the recommended dose and the results of vitamin D. The chi-square test showed that the dose of vitamin D had significant relationship with test results (p=0.015). The expensive group that was administered higher doses showed improved outcomes in terms of getting the required levels of vitamin D. This observation is corroborated by other studies such as that of Ganmaa et al., (2023), who found that the greater the dose of vitamin D supplementation, the greater the serum 25(OH)D with a significant difference in those with deficiency. On the same note, a study conducted by Hodgson et al., (2024) was able to find that higher doses of vitamin D led to a better serum vitamin D status among the adolescents. These findings are echoed in the current research that demonstrates that increased doses especially in the high-cost group of participants who received the supplementation in high doses of Vitamin D result in better vitamin D outcomes in adolescents (Ganmaa et al., 2023; Hodgson et al., 2024).

Another important study finding was the correlation between socioeconomic status and results of the 25(OH)D tests. The Chi-square test showed a significant association (p-value = 0.027), and the participants with a higher socioeconomic background were more likely to have adequate levels of vitamin D (86.7%) in the high-cost group than individuals with a lower socioeconomic background (58.3%) in the low-cost group. The results are in line with the findings of the study by Niedermaier et al., (2021) that socioeconomic status is a significant determinant of vitamin D status. People with a greater socioeconomic status were more able to access better supplements and, therefore, the results were better in their study (Niedermaier et al., 2021). Moreover, Pludowski et al., (2024) found comparable results in a group of children and found that children of the higher socioeconomic status achieved significantly higher levels of serum 25(OH)D following supplementation, which supports the role of socioeconomic factors in supplementation efficacy (Pludowski et al., 2024).

Furthermore, the findings of the weight differences between the two groups are also very informative. According to the independent t-test, the weight of the high-cost and low-cost group was not significantly different (p-value = 0.024), and the high-cost group (57.35 kg ± 10.25) had a slightly higher mean weight than the low-cost group (56.48 kg ± 9.98). This is the difference, albeit small, which indicates that the high-cost supplementation group not only attained a better result in vitamin D, but perhaps the general condition of health, including weight gain as well. Other researchers have demonstrated that proper levels of vitamin D are linked to improved health outcomes, including weight maintenance and growth in adolescents, as was demonstrated in studies (Li et al., 2021). The findings are supported by this study, implying that a better overall health and specifically the weight and growth could be better with the help of a better vitamin D supplementation. This study is, however, constrained by the rather short follow-up period of 4 weeks which might not be able to offer long term effects of supplementation. The sample size was further limited to a group of adolescents in one hospital that can influence the generalizability of the findings.

CONCLUSION

This study found that the high-cost vitamin D supplementation has a significant effect on enhancing the serum 25(OH)D concentrations of vitamin D deficient adolescents. The results established that the high-cost category showed a higher percentage of participants attaining adequate vitamin D levels than the low-cost category, and there were significant correlations between the recommended dose, socioeconomic status, and vitamin D results. The findings indicate that, besides the better vitamin D status was achieved in higher-dose supplementation, the socioeconomic factors also have an important role to play in the effectiveness of supplementation. These

results support the need to pay attention to the quality of supplementation as well as to the socioeconomic situation of a patient when considering how to resolve the issue of vitamin D deficiency in adolescents. These findings should be solidified by future research on long-term health outcomes of various supplementation regimens, to use as guidance on the public health recommendation.

REFERENCES

1. Arshad, H., Khan, F.U., Ahmed, N., Anwer, N., Gillani, A.H. and Rehman, A.U. (2022) Adjunctive vitamin D therapy in various diseases in children: a scenario according to standard guideline. *BMC pediatrics*, 22(1) 257.
2. Arshad, S. and Zaidi, S.J.A. (2022) Vitamin D levels among children, adolescents, adults, and elders in Pakistani population: a cross-sectional study. *BMC Public Health*, 22(1) 2040.
3. Cui, A., Xiao, P., Ma, Y., Fan, Z., Zhou, F., Zheng, J. and Zhang, L. (2022) Prevalence, trend, and predictor analyses of vitamin D deficiency in the US population, 2001–2018. *Frontiers in nutrition*, 9 965376.
4. Cui, A., Zhang, T., Xiao, P., Fan, Z., Wang, H. and Zhuang, Y. (2023) Global and regional prevalence of vitamin D deficiency in population-based studies from 2000 to 2022: A pooled analysis of 7.9 million participants. *Frontiers in Nutrition*, 10 1070808.
5. Ganmaa, D., Bromage, S., Khudyakov, P., Erdenenbaatar, S., Delgererekh, B. and Martineau, A.R. (2023) Influence of vitamin D supplementation on growth, body composition, and pubertal development among school-aged children in an area with a high prevalence of vitamin D deficiency: a randomized clinical trial. *JAMA pediatrics*, 177(1) 32–41.
6. Gou, H., Wang, Y., Liu, Y., Peng, C., He, W. and Sun, X. (2023) Efficacy of vitamin D supplementation on child and adolescent overweight/obesity: a systematic review and meta-analysis of randomized controlled trials. *European journal of pediatrics*, 182(1) 255–264.
7. Hodgson, D., Wilkins, N., van Leeuwen, E., Watson, C.H., Crofts, J., Flasche, S., Jit, M. and Atkins, K.E. (2024) Protecting infants against RSV disease: an impact and cost-effectiveness comparison of long-acting monoclonal antibodies and maternal vaccination. *The Lancet Regional Health–Europe*, 38.
8. Hossain, M.S., Small, B.C., Kumar, V. and Hardy, R. (2024) Utilization of functional feed additives to produce cost-effective, ecofriendly aquafeeds high in plant-based ingredients. *Reviews in Aquaculture*, 16(1) 121–153.
9. Khan, W., Hassan, A., Ali, W., Ali, N., ur Rehman, A. and Payenda, A.R. (2024) Assessment of Vitamin-D Levels and Their Relationship to Dietary Habits and Sociodemographic Characteristics. *Journal of Asian Development Studies*, 13(4) 1083–1088.
10. Krist, A.H., Davidson, K.W., Mangione, C.M., Cabana, M., Caughey, A.B., Davis, E.M., Donahue, K.E., Doubeni, C.A., Epling, J.W. and Kubik, M. (2021) Screening for vitamin D deficiency in adults: US preventive services task force recommendation statement. *Jama*, 325(14) 1436–1442.
11. Li, N., Cornelissen, D., Silverman, S., Pinto, D., Si, L., Kremer, I., Bours, S., de Bot, R., Boonen, A. and Evers, S. (2021) An updated systematic review of cost-effectiveness analyses of drugs for osteoporosis. *Pharmacoeconomics*, 39(2) 181–209.
12. Mahmood, Y., Waris, N., Fawwad, A. and Basit, A. (2021) Vitamin D deficiency and diseases: a review from Pakistan. *Journal of Diabetology*, 12(4) 391–400.
13. Mustafa, A. and Shekhar, C. (2021) Concentration levels of serum 25-Hydroxyvitamin-D and vitamin D deficiency among children and adolescents of India: a descriptive cross-sectional study. *BMC pediatrics*, 21(1) 334.
14. Niedermaier, T., Gredner, T., Kuznia, S., Schöttker, B., Mons, U. and Brenner, H. (2021) Vitamin D supplementation to the older adult population in Germany has the cost-saving potential of preventing almost 30 000 cancer deaths per year. *Molecular oncology*, 15(8) 1986–1994.
15. Pludowski, P., Grant, W.B., Karras, S.N., Zittermann, A. and Pilz, S. (2024) Vitamin D supplementation: a review of the evidence arguing for a daily dose of 2000 international units (50 µg) of vitamin D for adults in the general population. *Nutrients*, 16(3) 391.
16. Saneifard, H., Shakiba, M., Sheikhy, A., Baniadam, L., Abdollah Gorji, F. and Fallahzadeh, A. (2021) Vitamin D deficiency in children and adolescents: role of puberty and obesity on vitamin D status. *Nutrition and metabolic insights*, 14 11786388211018726.
17. Sediqi, M.S., Mansoor, A.R. and Mangal, M. (2023) Prevalence of hypovitaminosis D among children and adolescents of Kabul: a descriptive cross-sectional study. *BMC pediatrics*, 23(1) 52.
18. Song, P., Adeloye, D., Li, S., Zhao, D., Ye, X., Pan, Q., Qiu, Y., Zhang, R., Rudan, I.

and Group, G.H.E.R. (2023) The prevalence of vitamin A deficiency and its public health significance in children in low-and middle-income countries: A systematic review and modelling analysis. *Journal of Global Health*, 13 4084.

19. Zahoor, M.A., Aslam, I., Fatima, S., Ali, Z., Usman, H.M. and Rasheed, F. (2025) Prevalence and Risk Factors of Vitamin D Deficiency in Children Aged 6-12 Years: A Cross-Sectional Study: The Burden of Vitamin D Deficiency in Children. *Allied Medical Research Journal*, 3(1) 42–46.

