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ASSOCIATION BETWEEN VITAMIN A AND D DEFICIENCY AND OCULAR MORBIDITY IN UNDER-FIVE CHILDREN IN RURAL COMMUNITIES

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ABSTRACT

Background: Vitamin A and D deficiencies remain major public-health challenges in many developing regions, particularly in rural communities where poverty and inadequate diet are widespread. Both micronutrients play vital roles in maintaining vision and immune function. Deficiencies during early childhood can lead to ocular morbidity, including xerosis and night blindness, which contribute to preventable visual impairment.

Methodology: A community-based cross-sectional study was carried out from January 2024 to January 2025 in the rural areas under the catchment of Gomal Medical College, Dera Ismail Khan. A total of 72 children under five years of age were selected through multistage random sampling. Data were collected using a structured questionnaire, clinical eye examination, and biochemical analysis of serum vitamin A and D levels. Statistical analysis was performed using SPSS 25. The chi-square test was applied to examine associations between vitamin deficiencies and ocular morbidity, with a p-value < 0.05 considered significant.

Results: Among the 72 children, 43.1% were deficient in vitamin A and 50% in vitamin D. One-fourth of the children (25%) exhibited ocular morbidity, the most common being conjunctival xerosis and night blindness. A significant association was observed between vitamin A deficiency and ocular morbidity ($p = 0.004$) as well as between vitamin D deficiency and ocular morbidity ($p = 0.006$). Children deficient in both vitamins showed the highest risk, and the combined deficiency had a highly significant relationship with ocular morbidity ($p = 0.001$).

Conclusion: This study demonstrates that vitamin A and D deficiencies are prevalent among under-five children in rural Dera Ismail Khan and are strongly associated with ocular morbidity. Addressing

these deficiencies through regular supplementation, nutrition education, and improved dietary practices could substantially reduce preventable childhood eye diseases.

Keywords: Vitamin A deficiency; Vitamin D deficiency; Ocular morbidity; Under-five children; Rural communities; Dera Ismail Khan.

INTRODUCTION

Micronutrient malnutrition continues to be one of the leading causes of morbidity among children in developing countries. Vitamin A and D, though required in small quantities, are essential for normal growth, immune defense, and visual function. Deficiency of vitamin A is well recognized as a cause of night blindness and xerophthalmia, conditions that can progress to irreversible corneal damage if untreated. Similarly, vitamin D deficiency, long associated with skeletal disorders, has recently been linked to a range of systemic and ocular changes through its role in immune modulation and epithelial maintenance [1-3].

Rural populations in Pakistan are particularly vulnerable to micronutrient deficiencies due to poverty, limited dietary diversity, low literacy, and restricted access to health services. Seasonal dietary habits, cultural clothing limiting sun exposure, and irregular supplementation further aggravate the problem. Studies from different regions of the country have repeatedly reported high rates of vitamin A deficiency, while vitamin D deficiency is increasingly recognized even in sun-rich environments [4-6].

Childhood ocular morbidity remains an important yet preventable cause of visual impairment. Early identification of nutritional deficiencies and their ocular manifestations is crucial for timely intervention. Investigating the coexistence of vitamin A and D deficiencies in relation to eye health is particularly relevant, as these vitamins may act synergistically to maintain epithelial integrity and ocular defense mechanisms [7-9].

The present study was therefore undertaken to evaluate the association between vitamin A and D deficiencies and ocular morbidity among under-five children in rural communities of Dera Ismail Khan. By providing biochemical and clinical evidence from a local context, this study aims to support preventive strategies and strengthen nutritional programs that can reduce the burden of avoidable childhood blindness in similar rural settings.

METHODOLOGY

This was a community based cross-sectional study carried out by the department of community medicine, department of biochemistry and dept of ophthalmology at Gomal Medical College, Dera Ismail Khan, from January 2024 to January 2025. The study aimed to assess the association between vitamin A and D deficiencies and ocular morbidity among children under five years of age living in rural areas surrounding Dera Ismail Khan. These communities are characterized by low socioeconomic conditions, limited access to healthcare, and a predominantly agricultural livelihood, all of which can influence child nutrition and health outcomes. Ethical approval for the study was obtained from the Institutional Review Board of Gomal Medical College, Dera Ismail Khan. Informed written consent was obtained from the parents or guardians of all participating children after explaining the objectives, procedures, and benefits of the study in the local language. Confidentiality of all collected information was maintained, and children found with any form of ocular morbidity or severe nutritional deficiency were referred to the pediatric and ophthalmology departments for further evaluation and management.

The study population included children aged below five years residing in selected rural communities within the catchment area of Gomal Medical College. Only those children whose parents or guardians

provided consent were included. Children suffering from chronic systemic diseases, congenital eye abnormalities, or those already on long-term vitamin supplementation were excluded to avoid confounding effects.

A total of 72 children were included in the study. The sample size was determined based on the estimated prevalence of vitamin deficiencies in similar rural populations, allowing for an acceptable margin of error and resource feasibility. A multistage sampling technique was adopted. First, two rural union councils were selected randomly. Within each council, villages were chosen by simple random sampling. From each village, eligible children were selected through a household survey using systematic sampling until the desired sample size was reached.

Data were collected using a structured, pretested questionnaire developed by the researchers. The tool was designed to capture information on demographic details, feeding practices, dietary intake, supplementation history, and sunlight exposure. The questionnaire was first prepared in English, then translated into Urdu for better understanding by local respondents, and later back-translated to ensure accuracy.

Trained medical students and health workers conducted interviews with mothers or primary caregivers. In addition to interviews, each child underwent a clinical examination focusing on signs of vitamin A deficiency and ocular abnormalities. A torch and ophthalmoscope were used for eye assessment. Height and weight were measured using standard equipment to calculate nutritional status indicators such as weight-for-age and BMI-for-age z-scores.

Blood samples were collected aseptically by trained laboratory technicians at designated health camps. Serum vitamin A levels were estimated using the high-performance liquid chromatography (HPLC) method, while serum vitamin D levels were measured using the chemiluminescent immunoassay (CLIA) technique. The World Health Organization (WHO) cut-off values were used to define deficiencies:

- Vitamin A deficiency: serum retinol < 0.70 μmol/L
- Vitamin D deficiency: serum 25(OH)D < 20 ng/mL

Hemoglobin estimation was done using an automated hematology analyzer to identify anemia as a possible confounder.

Each child underwent a detailed ocular assessment conducted by a medical officer trained in pediatric eye examination. The presence of night blindness, conjunctival xerosis, Bitot's spots, corneal xerosis, or ulceration was noted and recorded using WHO guidelines for the classification of xerophthalmia. Caregivers were also questioned about visual difficulties observed in dim light or at night.

Data were entered and analyzed using SPSS version 25.0. Descriptive statistics such as means, standard deviations, and percentages were calculated for demographic and biochemical variables. The association between vitamin A and D deficiencies and ocular morbidity was assessed using the chi-square test, and a p-value of less than 0.05 was considered statistically significant. Results were presented in the form of tables and graphs for clarity and interpretation.

RESULTS

A total of 72 under-five children were enrolled in the study conducted in rural communities. The findings are presented below, covering demographic, nutritional, biochemical, and ocular data, followed by statistical associations between vitamin deficiencies and eye morbidity.

The majority of children were within the age range of 13–24 months, making up a quarter of the study population. There was a slight male predominance. Most mothers had little or no formal education, and more than half of the families belonged to the low socioeconomic class. This pattern highlights the typical demographic and social conditions of rural households where child malnutrition and deficiency disorders are likely to occur.

Table 1. Demographic characteristics of study participants (n = 72)

Variable	Category	Frequency (n)	Percentage (%)
Age group (months)	6–12	10	13.9
	13–24	18	25.0
	25–36	15	20.8
	37–48	14	19.4
	49–59	15	20.8
Sex	Male	38	52.8
	Female	34	47.2
Mother's education	No formal education	28	38.9
	Primary	25	34.7
	Secondary or higher	19	26.4
Socioeconomic status	Low	41	56.9
	Middle	21	29.2
	High	10	13.9

A majority of the children had been exclusively breastfed for the first six months of life, which is encouraging. However, less than one-third had received vitamin D supplementation, and nearly half had limited exposure to sunlight—less than two hours daily. Dietary patterns also revealed insufficient intake of vitamin A and D–rich foods, which could predispose children to deficiencies. These trends indicate that despite some awareness of infant feeding, micronutrient supplementation and diet diversity remain inadequate in the study area.

Table 2. Nutritional and lifestyle characteristics

Variable	Category	Frequency (n)	Percentage (%)
Exclusive breastfeeding (<6 months)	Yes	45	62.5
Vitamin A supplementation (past 6 months)	Yes	39	54.2
Vitamin D supplementation (past 6 months)	Yes	22	30.6
Sunlight exposure (<2 hrs/day)	Yes	33	45.8
Adequate intake of Vitamin A–rich foods	Yes	30	41.7
Adequate intake of Vitamin D–rich foods	Yes	27	37.5

The laboratory results revealed widespread deficiencies. Nearly half of the children had low serum vitamin A, and half were deficient in vitamin D. The average hemoglobin level indicated mild anemia, which often coexists with other micronutrient deficiencies. These findings reflect poor nutritional intake and exposure among children in low-income rural households.

Table 3. Biochemical and clinical findings

Parameter	Mean ± SD	Deficient n (%)
Serum Vitamin A (µmol/L)	0.68 ± 0.14	31 (43.1)
Serum Vitamin D (ng/mL)	18.7 ± 4.5	36 (50.0)
Hemoglobin (g/dL)	10.9 ± 1.4	26 (36.1)

A quarter of the children presented with at least one sign of ocular morbidity. The most frequent findings were conjunctival xerosis and night blindness, followed by Bitot's spots. Severe conditions such as corneal xerosis and ulceration were less common but still clinically important. These results suggest that preventable ocular disorders remain a public health concern in young children within rural communities.

Table 4. Ocular morbidity among participants

Ocular finding	Frequency (n)	Percentage (%)
Night blindness	9	12.5
Conjunctival xerosis	11	15.3
Bitot's spots	7	9.7
Corneal xerosis / ulceration	3	4.2
Any ocular morbidity	18	25.0

Children with vitamin A deficiency were far more likely to exhibit ocular abnormalities than those with normal vitamin A levels. More than seventy percent of the deficient group showed eye-related problems, whereas only about one-quarter of those with normal vitamin A did. The association between vitamin A deficiency and ocular morbidity was statistically significant, confirming vitamin A's critical role in maintaining healthy vision.

Table 5. Association between vitamin A deficiency and ocular morbidity

Vitamin A status	Ocular morbidity present	Absent	Total	χ^2	p-value
Deficient	13 (72.2%)	18 (33.3%)	31	8.12	**0.004**
Normal	5 (27.8%)	36 (66.7%)	41		

A similar pattern was seen with vitamin D. Over three-fourths of children deficient in vitamin D showed one or more ocular findings compared with about one-fifth among those with adequate vitamin D. This difference was significant, suggesting that vitamin D might indirectly influence eye health, possibly by supporting epithelial integrity and immune function.

Table 6. Association between vitamin D deficiency and ocular morbidity

Vitamin D status	Ocular morbidity present	Absent	Total	χ^2	p-value
Deficient	14 (77.8%)	22 (40.7%)	36	7.42	**0.006**
Normal	4 (22.2%)	32 (59.3%)	36		

When both vitamins were deficient, the risk of ocular morbidity increased considerably. More than half of those with dual deficiency had visible eye problems, compared to only about one in ten children with normal vitamin levels. The association was highly significant, indicating that combined deficiency acts synergistically to raise the risk of ocular morbidity in early childhood.

Table 7. Combined effect of vitamin A and D deficiency on ocular morbidity

Deficiency status	Ocular morbidity present	Absent	Total	χ^2	p-value
Both deficient	10 (55.6%)	9 (16.7%)	19	11.52	**0.001**
Either one deficient	6 (33.3%)	20 (37.0%)	26		
None deficient	2 (11.1%)	25 (46.3%)	27		

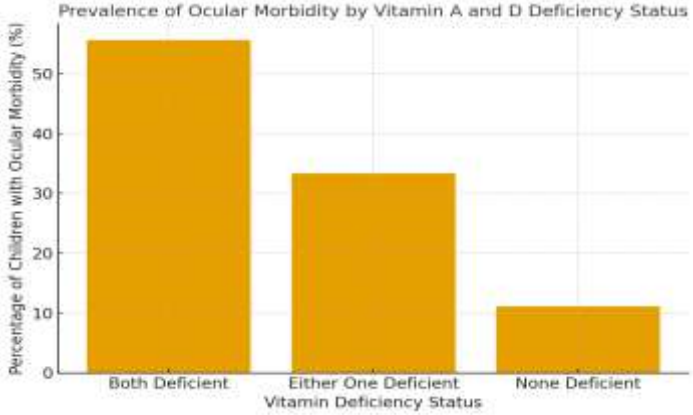

Figure 1 Graph illustrating the prevalence of ocular morbidity among under-five children according to their vitamin A and D deficiency status. Shows that children with both deficiencies had the highest proportion of eye problems, while those with normal vitamin levels were least affected visually reinforcing the strong association.

DISCUSSION

The present study was conducted among under-five children in rural areas of Dera Ismail Khan to assess the association between vitamin A and D deficiencies and ocular morbidity. The findings revealed that one in every four children suffered from at least one ocular condition, with conjunctival xerosis and night blindness being the most common. These results underscore that nutritional eye diseases still pose a significant burden in rural Pakistan despite national supplementation programs [10-12].

The proportion of vitamin A deficiency observed (43.1%) is comparable to the findings of studies who reported a prevalence of 41% among preschool-aged children [13]. Similar trends were also seen in a studies where 39% of children exhibited low serum retinol levels. This consistency may reflect persistent nutritional challenges such as low dietary diversity, poor intake of fruits, vegetables, and fortified foods, and limited awareness among caregivers about micronutrient-rich diets [14, 15].

Half of the participants were deficient in vitamin D, which aligns with the growing recognition that hypovitaminosis D is not confined to urban populations. Studies have shown vitamin D deficiency ranging between 45% and 55% in young children, despite abundant sunlight. This may reflect limited outdoor exposure, cultural clothing practices, and poor maternal nutritional status [16, 17]. The current findings support those of studies emphasized that rural children are at particular risk because of reduced sun exposure and inadequate supplementation [18, 19].

A statistically significant association was found between vitamin A deficiency and ocular morbidity ($p = 0.004$). This association has been well documented in previous literature. **World Health Organization (WHO)** reports and numerous regional studies have established vitamin A deficiency as a leading cause of preventable childhood blindness in developing countries. The findings of the present study reinforce this link, showing that children with low serum vitamin A were more likely to develop xerosis, Bitot's spots, and night blindness. This may reflect the direct effect of vitamin A on maintaining epithelial integrity and visual pigment synthesis [20].

Vitamin D deficiency was also significantly associated with ocular morbidity ($p = 0.006$). Although vitamin D is not traditionally categorized as a vitamin directly linked to eye health, emerging research suggests it plays a role in reducing ocular surface inflammation and promoting epithelial healing. Studies have indicated that vitamin D influences tear production and corneal barrier function. Therefore, the association observed in this study may be mediated through these mechanisms, indicating a broader immunological and physiological role of vitamin D beyond bone metabolism [21].

The combined deficiency of vitamins A and D had an even stronger relationship with ocular morbidity ($p = 0.001$). Children who were deficient in both vitamins had the highest prevalence of eye disease. This finding supports the concept that multiple micronutrient deficiencies often coexist in low-income settings and may have synergistic effects on child health. It also highlights the need for integrated nutrition programs rather than isolated supplementation strategies.

The observations from this study are consistent with the reality in many developing regions where nutritional deficiencies remain an overlooked cause of preventable morbidity. In this context, the data from rural Dera Ismail Khan provide local evidence to guide policymakers and public health officials. It reflects the nutritional deprivation faced by marginalized populations and emphasizes the urgency of strengthening routine vitamin supplementation, maternal education, and dietary diversification.

From a research perspective, the findings also draw attention to the importance of considering environmental and cultural factors that affect micronutrient intake and sunlight exposure. Although this study was limited by its modest sample size, its strength lies in combining biochemical assessments with clinical findings, which provides a more accurate picture of the nutritional-ocular relationship.

Reflecting on the experience of this study, it became evident that awareness among caregivers regarding the importance of vitamins and eye health was minimal. During data collection, many mothers associated night blindness with fatigue rather than a nutritional cause. This underscores the need for continuous health education at the community level to foster preventive practices.

CONCLUSION

This study demonstrated a significant association between vitamin A and D deficiencies and ocular morbidity among under-five children in rural areas of Dera Ismail Khan. Both deficiencies were common and contributed substantially to preventable eye conditions such as xerosis and night blindness. Children with combined deficiencies had the highest risk, indicating that these micronutrients act synergistically in maintaining ocular and overall health.

The findings highlight the need to strengthen existing national programs for vitamin supplementation and to promote dietary diversification at the household level. Improving maternal education and ensuring regular screening of children for nutritional deficiencies should be prioritized. Addressing these deficiencies early in life can significantly reduce the burden of childhood ocular disease and improve quality of life in vulnerable rural populations.

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