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Correlation Between Micronutrients And Clinical Conditions Among Children Admitted At Government General Hospital, Nalgonda.

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ABSTRACT

We conducted to explore how micronutrient levels relate to the health conditions of children admitted and to examine the relationship between micronutrient with clinical conditions. Materials and Methods: A cross-sectional observational study was conducted at Department of Biochemistry and Paediatrics, GMC Nalgonda with 100 Children in the age group of 1 – 12 years admitted in paediatric wards. Venous samples were collected after taking consent and serum micronutrients (Vit – B_{12} & D_3, Iron, Calcium, Magnesium, Copper and Zinc) were estimated and data was analyzed using MS Excel. Results: Out of 100 children, 38% acute febrile illness (AFI), 33% acute gastroentertitis (Acute GE), 22% severe acute malnutrition (SAM) and 7% seizures and in this 80% were anemic. Children had significant low Fe and Zn levels and high Copper levels. The decreased levels of Fe, Zn and high levels of Cu are seen in AFI, Acute GE, SAM and Seizures. Correlation between hemoglobin and other micronutrients, though a weak inverse relationship with iron (r = -0.21) and calcium (r = -0.16) was observed. Vit B_{12} showed weak negative correlations with zinc and copper, while vitamin D_3 had no significant correlations with other parameters. These findings highlight the complex and sometimes non-linear interplay of micronutrients, influenced by absorption, storage, inflammation, and clinical disease. Conclusion: Anemic children should be estimated for and supplemented with Vit-B_{12}, Fe and Zn to correct anemia and prevent Cu toxicity.

1. INTRODUCTION:

In growing children, micronutrients support critical biological functions as cofactors and coenzymes, contributing to their physical and mental well-being [1]. The children's growth and development are delayed, immune systems weaken, and human potential is impacted globally by micronutrient deficiencies[2]. When these micronutrients are lacking or imbalanced, the consequences can be severe, leading to conditions such as anemia, seizures, osteoporosis, autoimmune diseases, neurodegenerative disorders, and other genetic and systemic health problems[3]. This constitutes a significant public health concern across both developing and developed nations. In the past 30

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years, the prevalence of anemia has been the sole basis for estimating the global prevalence of micronutrient deficiencies[2]. In developing country, malnutrition, anemia, and micronutrient deficiencies still affect children's health and nutritional status. In Telangana[5], roughly 10–15% of children have one or more micronutrient deficiencies, compared to 40–50% in India[4]. A study done in multiple centers in India found that a lot of urban school-aged kids (ages 6 to 16) were lacking in calcium (59.9%), iron (49.4%), vitamin D (39.7%), and vitamin B12 (33.4%) [5]. Iron deficiency was also linked to both underweight and overweight children, which means that malnutrition can affect kids of any weight and is also linked to a number of behavioral and awareness issues[6]. Adequate intakes are necessary to ensure normal growth and development in infants and children, a specific population group at risk of micronutrient deficiencies. In Nalgonda, a predominantly rural district in Telangana, limited studies have been conducted on the prevalence of micronutrient deficiencies and their clinical implications among hospitalized children. This study aims to bridge this gap by assessing the correlation between micronutrient deficiencies and clinical conditions in this population.

MATERIALS AND METHODS:

This cross- sectional observational study conducted at Department of Biochemistry and Paediatrics encompassed children aged 1-12 years who admitted to the pediatric ward of Government General Hospital, Nalgonda between 1st March to 22nd June 2024. Children admitted to Intensive Care Unit and hemolysed samples and stray values, prior supplementation with Vit-B_{12} & D_3, Iron, Calcium, Magnesium, Copper, Zinc, and who are not willing to participate in this study were excluded. Data on patient gender, height, and weight were collected and analyzed. The research ethics committee of Government Medical College, Nalgonda granted ethical approval for the study (approval no: GMC/NLG/2024/32) and after captivating of consent from parents/gradience of participants 3ml venous blood samples were collected were assessed immediately. Vit-B_{12} & D_3 by CLIA, Iron, Calcium, Magnesium, Zinc and Copper by specific dye methods using automated and semi- auto analyser. Using MS Excel, data was collected, put into tables, and analyzed. Categorical variables were presented as numbers and percentages (%), while continuous variables were expressed as means and standard deviations (SD). The $\chi 2$ test was employed to analyses categorical variables between different groups. The t-test were utilized to evaluate the mean differences between the groups. A p-value of <0.05 was considered significant.

RESULTS:

Our study encompassed a cohort of 100 participants, comprising 46% (n=46) females and 54 (n=54) males. The mean ± SD age of participants was 3.85±3.52years, Distributions of diagnosis of these participates were 38% acute febrile illness (AFI), 33% acute gastroentertitis (Acute GE), 22% severe acute malnutrition (SAM) and 7% seizures shown in fig.01. Out of 100, 80 (80%) were anemic.

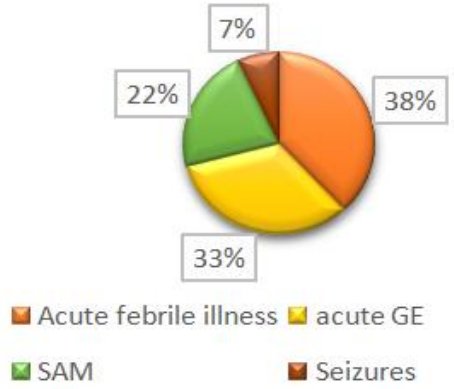

Fig. 01: Showing the Diagnosis of participants.

Table no.01: Showing the Mean and SD of Hemoglobin, Vit-B12, Vit-D3, Iron, Calcium, Magnesium, Zinc and Copper in all participants.

Parameter (Normal values)	Mean	SD
Hemoglobin (12 - 15g/dL)	10.62	1.66
Vit-B12 (120-914pg/ml)	307.33	103.20
Vit-D3 (Def.<10, Insuf.10-29, Suf. 30-100 and toxic>100)	34.45	9.49
Iron (Male:70-180 mcg/dl and Female: 60-180mcg/dl)	31.80	8.50
Calcium (9 - 11mg/dl)	9.79	0.54
Magnesium (1.6 - 2.6 mg/dl)	1.84	0.19
Zinc (65 - 118 mcg/dl)	54.83	16.43
Copper (30 - 170 mcg/dl)	265.96	150.40

Table no.02: Showing the Mean and SD of Hemoglobin, Vit-B12, Vit-D3, Iron, Calcium, Magnesium, Zinc and Copper of Acute Febrile Illness (AFI), Acute Gastroentertitis (Acute GE), Severe Acute Malnutrition (SAM) and Seizures.

		Acute Febrile Illness (AFI) (n-40)	Acute Gastroentertitis (Acute GE) (n-33)	Severe Acute Malnutrition (SAM) (n-20)	Seizures (n-7)
Hemoglobin	**Mean**	11.04	10.26	10.57	10.11
	SD	1.39	1.80	1.81	1.26
Vit-B12	**Mean**	312.55	315.94	300.32	260.43
	SD	104.47	119.34	78.18	60.83
Vit-D3	**Mean**	34.21	36.64	31.18	35.71

Journal of Molecular Science
Journal of Molecular Science
Volume 35 Issue 2, Year of Publication 2025, Page 92-95
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	SD	8.73	8.18	11.49	9.22
Iron	**Mean**	31.16	32.55	31.36	33.14
	SD	9.01	8.46	8.49	4.49
Calcium	**Mean**	9.83	9.79	9.66	10.03
	SD	0.57	0.53	0.50	0.52
Magnesium	**Mean**	1.84	1.88	1.78	1.84
	SD	0.18	0.16	0.22	0.21
Zinc	**Mean**	58.50	50.67	55.82	51.43
	SD	18.09	14.33	16.33	10.24
Copper	**Mean**	298.18	226.55	252.64	318.71
	SD	151.54	121.25	167.98	155.51

Table no.03: Showing the comparison (p-values) of Hemoglobin, Vit-B12, Vit-D3, Iron, Calcium, Magnesium, Zinc and Copper between groups (Acute Febrile Illness (AFI), Acute Gastroentertitis (Acute GE), Severe Acute Malnutrition (SAM) and Seizures).

	Hemoglobin	Vit-B12	Vit-D3	Iron	Calcium	Magnesium	ZINC	COPPER
AFI Vs Acute GE	0.047	0.900	0.240	0.514	0.808	0.417	0.053	0.035
AFI Vs SAM	0.275	0.641	0.263	0.932	0.262	0.269	0.575	0.294
AFI Vs Seizures	0.115	0.217	0.687	0.580	0.396	0.962	0.331	0.750
Acute GE Vs SAM	0.544	0.597	0.049	0.621	0.354	0.078	0.231	0.515
Acute GE Vs Seizures	0.840	0.250	0.798	0.861	0.302	0.601	0.897	0.100
SAM Vs Seizures	0.553	0.243	0.367	0.612	0.113	0.572	0.523	0.381

Table no.04: Showing the correlation of Hemoglobin, Vit-B12, Vit-D3, Iron, Calcium, Magnesium, Zinc and Copper in all percipients.

	Hb	**Vit- B12**	**Vit-D3**	**Iron**	**Calcium**	**Magnesium**	**Zinc**	**Copper**
Hb	1	0.09	-0.01	-0.21	-0.16	-0.14	0.07	0.05
Vitamin-B12	0.09	1	-0.05	0.11	0.00	-0.12	-0.15	-0.12
Vitamin-D3	-0.01	-0.05	1	0.00	0.08	0.01	0.03	0.01
Iron	-0.21	0.11	0.00	1	-0.10	-0.08	-0.03	-0.18
Calcium	-0.16	0.00	0.08	-0.10	1	0.09	0.01	0.06
7dMagnesium	-0.14	-0.12	0.01	-0.08	0.09	1	-0.05	-0.02
Zinc	0.07	-0.15	0.03	-0.03	0.01	-0.05	1	-0.16
Copper	0.05	-0.12	0.01	-0.18	0.06	-0.02	-0.16	1

DISCUSSION:

This study evaluated the serum micronutrient profiles and their correlation with clinical conditions in a pediatric cohort (mean age 3.85 ± 3.52 years), focusing on Hemoglobin, Vitamin B_{12}, Vitamin D_3, Iron, Calcium, Magnesium, Zinc, and Copper levels among children with Acute Febrile Illness (AFI), Acute Gastroenteritis (GE), Severe Acute Malnutrition (SAM), and Seizures. The results reveal significant nutritional and biochemical disparities that may underlie the participants' clinical presentations.

Anemia was prevalent in 80% of the study population, highlighting a significant public health concern. The mean hemoglobin level (10.62±1.66 g/dL) was below the standard reference range. This aligns with global data indicating that 40% of women of reproductive age and 42% of young children under the age of five are anemic, largely due to iron deficiency, chronic infections, and poor dietary intake [(6)]. The mean serum iron level (31.8±8.5 mcg/dL) was notably lower than normal, supporting iron deficiency as a likely cause of anemia. Additionally, the iron levels did not significantly differ among disease categories ($p>0.05$), suggesting widespread deficiency irrespective of clinical diagnosis. Hemoglobin inversely correlated with iron ($r = -0.21$), which could be due to the inflammatory blockade of iron utilization despite low serum levels anemia of chronic disease component.

Vitamin B_{12} levels (307.33±103.2 pg/mL) were within the reference range but skewed toward the lower side, particularly in seizure cases (260.43±60.83 pg/mL), suggesting a potential association between B_{12} and neurological function. Although not statistically significant, this trend supports previous findings linking B12 deficiency with seizure susceptibility and cognitive delays in children, and mild B_{12} deficiency, common in children with poor dietary intake, has been linked to neurodevelopmental delays and hematologic abnormalities[7].

Vitamin D_3 levels (mean 34.45±9.49 ng/mL) were generally sufficient; however, children with SAM had marginally lower levels (31.18±11.49 ng/mL). This supports reports of Vitamin D_3 deficiency in malnourished children due to poor dietary intake and impaired absorption. The only significant intergroup difference for Vitamin D_3 was observed between Acute GE and SAM ($p=0.049$), highlighting the need to monitor Vitamin D_3 in gastrointestinal illnesses that can impair absorption. No significant correlation was found between Vitamin D3 and any other parameter, Subclinical

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Volume 35 Issue 2, Year of Publication 2025, Page 92-95
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vitamin D deficiency is increasingly reported even in sun-rich countries, particularly in children with malnutrition or poor calcium absorption[8].

Calcium and magnesium were within normal limits across all subgroups, with no significant intergroup differences. However, children with SAM showed slightly lower calcium (9.66±0.5 mg/dL) and magnesium (1.78±0.22 mg/dL) levels. This supports literature that malnutrition affects bone mineral metabolism and electrolyte balance, although overt deficiencies may be masked due to redistribution during catabolic states, electrolyte disturbances are common in SAM, hence, serum electrolytes of every malnourished child admitted should be assessed and corrected to avoid fatal outcomes[9].

Zinc levels were below normal in the overall cohort (54.83±16.43 mcg/dL), especially in children with Acute GE (50.67±14.33 mcg/dL). Although the p-value for AFI vs. GE was borderline (p=0.053), the trend suggests clinical significance and warrants zinc supplementation in diarrheal illnesses. Negative correlations between zinc and copper (r = –0.16) align with the competitive absorption dynamics between these two trace elements. Zinc deficiency is well known to impair immune responses and increase the duration and severity of diarrheal and respiratory infections[10].

Unexpectedly, copper levels were elevated (265.96±150.40 mcg/dL), particularly in seizure (318.71±155.51 mcg/dL) and AFI groups (298.18±151.54 mcg/dL). High copper may indicate an acute-phase response, as ceruloplasmin (a copper-carrying protein) increases during systemic inflammation [(11)]. The significant difference in copper between AFI and GE (p=0.035) further supports its role as a biomarker of systemic inflammation or infection. Elevated copper without a corresponding zinc rise may reflect an inflammatory state and/or oxidative stress imbalance, which has been implicated in seizure pathophysiology[11].

Correlation analysis did not reveal strong relationships between hemoglobin and other micronutrients, though a weak inverse relationship with iron (r = -0.21) and calcium (r = -0.16) was observed. This paradoxical trend may arise from functional iron deficiency in inflammation (anemia of chronic disease), where iron sequestration occurs despite adequate stores. Vitamin B12 showed weak negative correlations with zinc and copper, while vitamin D3 had no significant correlations with other parameters. These findings highlight the complex and sometimes non-linear interplay of micronutrients, influenced by absorption, storage, inflammation, and clinical disease.

CONCLUSION:

The study reveals a high prevalence of micronutrient deficiencies among pediatric patients, particularly iron and zinc. Significant intergroup differences in Vitamin D and Copper highlight disease-specific nutritional vulnerabilities. These findings emphasize the importance of routine micronutrient screening and targeted supplementation in children with infections, malnutrition, or neurological symptoms.

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