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NUTRITIONAL DEFICIENCIES AND ANEMIA AMONG CHILDREN UNDER FIVE YEARS: EVIDENCE FROM DISTRICT KARAK, KHYBER PAKHTUNKHWA

Aamir Asif[1], Yasin Mahmood[*2], Muhammad Imshad[3], Muhammad Sajjad Ahmad[4]

[1,*2,3,4]*Rehman College of Allied Health Sciences, Rehman Medical Institute, Peshawar, Pakistan*

[*2]yaseenmahmood96@gmail.com

Corresponding Author: *
Yasin Mahmood

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ABSTRACT

BACKGROUND: *Nutritional deficiencies and anemia constitute major public health challenges adversely affecting children under five years of age, contributing to increased morbidity, developmental delays, and diminished cognitive outcomes. District Karak, situated in Khyber Pakhtunkhwa (KPK), Pakistan, shares many of the socioeconomic vulnerabilities that perpetuate undernutrition across the province, yet targeted epidemiological data from this region remain limited.*

OBJECTIVES: *To determine the prevalence of nutritional deficiencies and anemia and to examine their association with gender in children under five years of age in District Karak, KPK.*

METHOD: *A cross-sectional study was conducted from January 2022 to June 2022 at the Department of Paediatrics, District Headquarters Teaching Hospital, Karak, KPK. Following ethical approval, 310 children under five years of age of both genders were enrolled using purposive sampling. Children already diagnosed with malnutrition or anemia and undergoing treatment were excluded. Sociodemographic data were collected, and mid-upper arm circumference (MUAC) was measured using Shakir's tape. Three millilitres of venous blood were drawn to assess hematological parameters. Prevalence was expressed as frequencies and percentages. The chi-square test assessed the association of nutritional deficiencies and anemia with gender, and the independent sample t-test compared hematological parameters between nutritionally deficient and well-nourished children.*

RESULTS: *Of 310 participants, 207 (66.8%) were identified as nutritionally deficient based on MUAC measurements. Children aged 12–23 months constituted the most severely affected age group. Anemia was present in 84.5% of children. Nutritionally deficient children had significantly lower hemoglobin levels compared to their well-nourished counterparts (p-value = 0.002). No statistically significant gender-based differences in the prevalence of nutritional deficiency or anemia were observed.*

CONCLUSION: *The prevalence of nutritional deficiencies and anemia is alarmingly elevated among children under five years in District Karak, KPK. These findings underscore the urgent need for targeted nutritional interventions, community-based health education, and improved healthcare access within the district.*

Keywords: *Anemia, Children, Gender, Khyber Pakhtunkhwa, Mid-Upper Arm Circumference, Nutritional Deficiency, Prevalence*

INTRODUCTION

Nutrition refers to the indispensable role that macronutrients and micronutrients play in the maintenance, growth, and reproduction of the human organism. Access to adequate nutrition is widely recognized as a fundamental human right, encompassing the ability to obtain and prepare nutritionally sufficient food at an affordable cost. Malnutrition whether caused by a deficiency, excess, or imbalance of nutrients — produces serious adverse effects on body composition, physiological function, and clinical outcomes. It remains disproportionately prevalent in developing nations, where poverty, social marginalization, and limited healthcare access compound nutritional vulnerability [1,2].

Children in low- and middle-income countries bear a particularly heavy burden of malnutrition, which is among the most significant contributors to morbidity and developmental delays globally. In these settings, undernutrition is estimated to be responsible for approximately 3.5 million deaths annually and accounts for 35 percent of all illnesses occurring in children younger than five years [3]. Acute malnutrition, which may be primary or secondary in origin, results from an inadequate intake of calories or protein, and is strongly influenced by environmental, political, and socioeconomic factors that disrupt food supply [4].

Malnutrition encompasses two broad categories: undernutrition and overnutrition. Undernutrition remains one of the leading preventable causes of death worldwide [5]. Pakistan carries a disproportionately high burden of child malnutrition relative to comparable developing economies, with girls historically at greater risk of severe malnutrition than boys [6]. During the critical first five years of life, adequate nutrient intake is essential for immune function, physical growth, and cognitive development. Poverty, limited educational opportunities, and vulnerability to environmental adversities such as floods further intensify this burden in Khyber Pakhtunkhwa (KPK) and its constituent districts, including Karak [7].

The mid-upper arm circumference (MUAC) has been widely adopted as a simple, rapid, and accurate anthropometric tool for identifying nutritional deficiency in children under five, particularly in resource-constrained settings where more complex anthropometric assessments may not be feasible [8].

Anemia, characterized by a hemoglobin concentration below the normal threshold for age, affects approximately two billion individuals globally, making it a public health emergency of the first order. By impairing the oxygen-carrying capacity of blood, anemia exerts far-reaching consequences on maternal and child health during pregnancy and childbirth, on children's learning and development, and on adult productivity and economic output [9]. Among children aged 6 to 59 months, anemia defined as a hemoglobin level below 110 g/L affects an estimated 43 percent of the global population in this age group. It ranks as the thirteenth leading cause of death and the third leading cause of disability globally, measured in disability-adjusted life years. In Pakistan, between 40 and 70 percent of children under five years are estimated to suffer from anemia, with consequences including growth retardation, impaired cognitive development, reduced physical capacity, and elevated infant mortality. The widespread prevalence of micronutrient deficiencies, compounded by social determinants and limited healthcare access, is considered the primary driver of anemia in the Pakistani context [10].

Epidemiological evidence on nutritional deficiencies and anemia in children under five from Khyber Pakhtunkhwa's smaller districts including Karak remains sparse. District Karak, located in the southeastern part of KPK, shares the socioeconomic challenges that characterize much of the province, yet has received limited targeted research attention. The present study aims to determine the prevalence of nutritional deficiencies and anemia among children under five years of age in District Karak, KPK, and to examine their association with demographic variables including gender and age.

METHODOLOGY

This cross-sectional study was conducted at the Department of Paediatrics, District Headquarters Teaching Hospital, Karak, Khyber Pakhtunkhwa,

from January 2022 to June 2022 over a period of six months.

A sample size of 310 participants was estimated using the WHO sample size calculator (www.openepi.com, version 3), applying 90% statistical power and an alpha of 0.05, based on a previously reported 56% frequency of anemia among stunted children [12]. After obtaining written informed consent from parents or legal guardians, a total of 310 children under five years of age of both genders were consecutively enrolled using purposive sampling. Children with a pre-existing diagnosis of nutritional deficiency or anemia who were already receiving treatment were excluded from the study.

Sociodemographic data were collected using a structured proforma. A pre-tested and validated questionnaire adapted from a previously utilized survey instrument (originally developed for a study in Kenya) was employed to collect information on demographic characteristics, nutritional status, health indicators, anemia-related parameters, household environment, and additional socioeconomic variables [22]. Mid-upper arm circumference was measured using Shakir's measuring tape to the nearest millimetre; a MUAC of less than 12.5 cm was considered indicative of nutritional deficiency. Classification into moderate acute malnutrition (MAM) and severe acute malnutrition (SAM) sub-categories was not performed, in order to maintain focus on overall nutritional deficiency prevalence and characteristics within the study population.

Three millilitres of venous blood were collected under standard aseptic conditions to assess hematological parameters, including hemoglobin, red blood cell count, haematocrit, MCV, MCH, MCHC, white blood cell count, and differential leucocyte count. Data were entered and analysed using SPSS version 21. Prevalence of nutritional deficiency and anemia was reported as frequencies and percentages. The chi-square test was used to assess the association of these conditions with gender, and the independent sample t-test was used to compare hematological parameters between nutritionally deficient and well-nourished children. A p-value of ≤0.05 was considered statistically significant.

RESULTS

The study enrolled 310 children under five years of age from the paediatric outpatient and inpatient settings of District Headquarters Teaching Hospital, Karak. Of the total participants, 182 (58.7%) were male and 128 (41.3%) were female. The mean age of the study participants was 29.6 ± 8.0 months. The mean MUAC for the entire cohort was 12.26 ± 1.06 cm; the mean MUAC for male participants was 12.14 ± 1.07 cm and for female participants was 12.34 ± 1.03 cm. No statistically significant difference in MUAC between male and female participants was observed (p-value = 0.097). Table 1 summarises the baseline demographic and clinical characteristics of the study participants by gender.

Table 1: Baseline Characteristics of Study Participants by Gender (N = 310)

Characteristic	Total (n = 310)	Males (n = 182, 58.7%)	Females (n = 128, 41.3%)	p-value
Mean Age (months)	29.6 ± 8.0	—	—	—
Mean MUAC (cm)	12.26 ± 1.06	12.14 ± 1.07	12.34 ± 1.03	0.097
Anemia [n (%)]	262 (84.5%)	151 (82.96%)	111 (86.7%)	0.369
No Anemia [n (%)]	48 (15.5%)	31 (17.04%)	17 (13.3%)	—
Nutritionally Deficient [n (%)]	207 (66.8%)	117 (64.29%)	90 (70.31%)	0.267
Well-Nourished [n (%)]	103 (33.2%)	65 (35.71%)	38 (29.69%)	—

Overall, 207 (66.8%) of the 310 participants were classified as nutritionally deficient on the basis of MUAC measurements. Anemia was identified in 262 (84.5%) of all participants. Among male participants, 82.96% were anaemic, while 86.7% of female participants were affected. No statistically significant gender difference in anemia prevalence was detected (p-value = 0.369). These findings are further summarised in Table 2.

Table 2: Prevalence of Anemia by Gender (N = 310)

Characteristic	Total (n = 310)	Males (n = 182, 58.7%)	Females (n = 128, 41.3%)	p-value
Mean Age (months)	29.6 ± 8.0	—	—	—
Mean MUAC (cm)	12.26 ± 1.06	12.14 ± 1.07	12.34 ± 1.03	0.097
Anemia [n (%)]	262 (84.5%)	151 (82.96%)	111 (86.7%)	0.369

Table 3 presents the distribution of nutritional deficiency across age groups. The prevalence of nutritional deficiency varied significantly with age, peaking in the 12–23 months age group (87.8%) and reaching its lowest point in the 48–59 months age group (25.0%). A statistically significant association between age group and nutritional deficiency was confirmed (chi-square = 84.29; $p < 0.001$).

Table 3: Association of Nutritional Deficiency with Age Group (N = 310)

Age Group (Months)	Not Deficient [n (%)]	Deficient [n (%)]	Chi-square	p-value
6–11	1 (100.0%)	0 (0.0%)		
12–23	16 (12.2%)	115 (87.8%)		
24–35	15 (25.0%)	45 (75.0%)	84.29	< 0.001
36–47	20 (40.0%)	30 (60.0%)		
48–59	51 (75.0%)	17 (25.0%)		
Total	**103 (33.2%)**	**207 (66.8%)**		

Table 4 compares hematological parameters between nutritionally deficient (n = 207) and well-nourished (n = 103) children. Nutritionally deficient children exhibited significantly lower mean hemoglobin levels (8.72 ± 1.98 g/dl) than well-nourished children (9.47 ± 1.93 g/dl; p = 0.002). Mean MCHC was also significantly lower in the nutritionally deficient group (30.76 ± 2.82%) compared to the well-nourished group (31.54 ± 2.59%; p = 0.02). No statistically significant differences were detected between the two groups for RBC count, haematocrit, MCV, MCH, WBC count, or differential leucocyte counts (neutrophils, lymphocytes, eosinophils, basophils, and monocytes).

Table 4: Comparison of Hematological Parameters Between Nutritionally Deficient and Well-Nourished Children

Hematological Parameter	Nutritionally Deficient (n = 207) Mean ± SD	Well-Nourished (n = 103) Mean ± SD	p-value
Haemoglobin (g/dl)	8.72 ± 1.98	9.47 ± 1.93	0.002*
RBCs (million/mm³)	4.31 ± 0.85	4.41 ± 0.85	0.313
Haematocrit (%)	29.8 ± 10.3	30.9 ± 8.7	0.355
MCV (µm³)	67.22 ± 8.78	69.01 ± 8.70	0.091
MCH (pg)	21.38 ± 7.08	22.91 ± 9.03	0.104
MCHC (%)	30.76 ± 2.82	31.54 ± 2.59	0.02*
WBCs (per mm³)	10.02 ± 0.67	9.91 ± 0.49	0.878
Neutrophils (%)	48.24 ± 17.60	49.54 ± 19.33	0.553
Lymphocytes (%)	42.96 ± 16.58	41.75 ± 17.40	0.553
Eosinophils (%)	5.96 ± 3.58	6.26 ± 4.41	0.521
Basophils (%)	1.49 ± 0.63	1.43 ± 0.59	0.382
Monocytes (%)	1.1 ± 0.63	1.1 ± 0.60	0.173

* *Statistically significant ($p \leq 0.05$)*

Table 5 presents the association of gender with anemia and nutritional deficiency. The prevalence of anemia was 48.7% in males and 35.8% in females, and the difference was not statistically significant (chi-square = 0.808; p = 0.369). Similarly, the prevalence of nutritional deficiency was 37.7% in males and 29.0% in females, a difference that also did not reach statistical significance (chi-square = 1.23; p = 0.267).

Table 5: Association of Gender with Anemia and Nutritional Deficiency (N = 310)

Parameter	Male [n (%)]	Female [n (%)]	Chi-square	p-value
Anaemic	151 (48.7%)	111 (35.8%)	0.808	0.369
Non-Anaemic	31 (10.0%)	17 (5.5%)		
Nutritionally Deficient	117 (37.7%)	90 (29.0%)	1.23	0.267
Well-Nourished	65 (21.0%)	38 (12.3%)		

DISCUSSION

The present study investigated the prevalence of nutritional deficiencies and anemia among children under five years of age in District Karak, Khyber Pakhtunkhwa a district that, to the best of our knowledge, has not previously been the subject of dedicated paediatric nutritional epidemiology. The findings reveal an alarmingly high burden of both conditions, with two-thirds of children classified as nutritionally deficient and over four-fifths found to be anaemic.

Child nutritional deficiency has emerged as an escalating public health concern across Pakistan. Inadequate dietary intake, suboptimal caregiving practices, recurrent infectious illnesses, and inequitable food distribution at the household

level all contribute to this burden. It is estimated that nearly 50% of children under five years across Pakistan suffer from some form of nutritional deficiency [11], a figure that the present study substantially exceeds likely reflecting the particularly disadvantaged socioeconomic environment of District Karak. Poverty, social insecurity, inflation, unemployment, and food insecurity collectively compound nutritional vulnerability across KPK's districts [12,13].

The prevalence of nutritional deficiency in the current study (66.8%), measured by MUAC, is higher than several previously published findings from Pakistan and the wider South Asian region. Asif et al. reported a prevalence of 18.3% among children under five in Multan [14], while Biswas et al. documented a prevalence of 32.22% in West Bengal, India [15]. Haq et al. reported 46% in children in Peshawar, KPK, in flood-affected settings [16]. A closely comparable figure of 66.1% was reported by Menghwar et al. in District Tharparkar, Sindh [17] a district with socioeconomic characteristics broadly similar to those of District Karak. Additionally, Hadi et al., working in Peshawar, KPK, documented that 70% of children under five were nutritionally deficient as assessed by MUAC [18]. The present findings are therefore consistent with evidence from districts sharing similar levels of socioeconomic deprivation within Pakistan.

The high prevalence of anemia (84.5%) documented in this study substantially exceeds previously reported figures from other Pakistani urban and peri-urban settings. Khan et al. reported a prevalence of 63.7% among hospitalised children under five in Karachi [19]. The observed discrepancy may reflect the hospital-based nature of the current sample children presenting to paediatric services are inherently more likely to suffer from nutritional and hematological pathology than community-based populations as well as the specific socioeconomic and dietary constraints characteristic of District Karak. It is also consistent with the recognized pattern of higher anemia burden in rural KPK compared to major urban centres.

Regarding the 12–23 months age group, the disproportionate burden of nutritional deficiency observed (87.8%) is consistent with established patterns in the regional and global literature. This age window coincides with the transition from exclusive breastfeeding and complementary feeding to household diets, a period during which micronutrient and caloric adequacy are particularly vulnerable to disruption. Targeted interventions during this critical developmental window including promotion of appropriate complementary feeding, micronutrient supplementation, and growth monitoring are therefore especially warranted.

In contrast to findings by Laghari et al., which identified a higher prevalence of severe nutritional deficiency among females [6], the present study found no statistically significant association between gender and either nutritional deficiency or anemia. This finding may be partly attributable to the comparatively higher female literacy rate in District Karak (estimated at 56.6%), which may mitigate gender-based disparities in child feeding practices and healthcare-seeking behaviour. Female education is widely recognized as one of the most powerful determinants of child nutritional outcomes, acting as a vehicle for empowerment, improved adaptive capacity, and reduced vulnerability to poverty and food insecurity [20,21].

Importantly, nutritionally deficient children in the current study had significantly lower hemoglobin levels ($p = 0.002$) and MCHC values ($p = 0.02$) compared to their well-nourished counterparts, corroborating the well-established bidirectional relationship between nutritional deficiency and iron-deficiency anemia. Inadequate dietary intake leads to iron depletion, which in turn compromises erythropoiesis and hemoglobin synthesis — a vicious cycle that can only be interrupted through simultaneous nutritional and hematological interventions.

The study has several limitations. The hospital-based sample may not be representative of the broader under-five population of District Karak, as children presenting to tertiary paediatric services are more likely to be unwell and nutritionally compromised than community-dwelling children. The sample size, while statistically powered for prevalence estimation, limits the capacity for granular sub-group analysis. Classification into MAM and SAM sub-categories was not performed.

Future research should include community-based sampling frames, larger cohorts, and the incorporation of dietary assessment and micronutrient-specific biochemical testing.

CONCLUSION

This study documents an alarmingly high prevalence of nutritional deficiencies and anemia among children under five years of age in District Karak, Khyber Pakhtunkhwa. With 66.8% of study participants found to be nutritionally deficient and 84.5% anaemic, these findings represent a significant public health emergency within the district. Children aged 12–23 months bore the highest burden of nutritional deficiency, underscoring the critical importance of this developmental window for targeted intervention. While no statistically significant gender based differences were observed, the overall magnitude of these conditions demands urgent, coordinated action. Nutritional deficiency was significantly associated with lower hemoglobin and MCHC levels, reinforcing the close pathophysiological link between nutritional adequacy and hematological health in young children.

Policymakers, district health authorities, and healthcare providers in KPK must prioritize multi-sectoral interventions including community nutrition programmes, micronutrient supplementation, growth monitoring, and maternal education specifically targeting children under two years of age and their caregivers in socioeconomically disadvantaged districts such as Karak, to address this preventable and devastating burden.

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