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Double burden of malnutrition: Prevalence of anemia among children with severe acute malnutrition in Tharparkar, Pakistan

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Abstract

Background Severe acute malnutrition (SAM) is one of the most critical forms of childhood malnutrition and remains a major contributor to morbidity and mortality in low-resource settings. Anemia frequently coexists with SAM and further compromises child health by increasing susceptibility to infection and delaying recovery. Evidence on the burden of anemia among children with SAM in drought-prone regions of Pakistan remains limited.

Methods A hospital-based cross-sectional study was conducted from March to June 2024 at the outpatient therapeutic program (OTP) of the district headquarters hospital in Tharparkar, Sindh, Pakistan. Children aged 6–59 months diagnosed with SAM were consecutively enrolled. Hemoglobin concentration was measured to assess anemia, while anthropometric indicators were used to confirm SAM. Descriptive statistics were used to estimate the prevalence and severity of anemia.

Results A total of 129 children with SAM were included. The prevalence of anemia among children with SAM was 90.7% (n = 117; 95% CI: 85.6–95.7). The mean (± SD) hemoglobin level was 9.0 ± 1.4 g/dL. Most anemic children had moderate anemia, indicating a substantial compounded health burden.

Conclusion Anemia is highly prevalent among children with severe acute malnutrition in Tharparkar, highlighting the convergence of multiple nutritional deficiencies in this vulnerable population. These findings underscore the need for integrated nutrition and anemia control strategies within SAM management programs, particularly in disaster-prone and underserved regions.

Keywords Severe acute malnutrition, Anemia, Hemoglobin, Children, Tharparkar

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Introduction

Malnutrition remains a major global public health challenge, particularly among children under five years of age [1]. It results from nutritional deficiencies, either because of insufficient intake of nutrients or because of repeated infections, or a combination of both, and may be classified as chronic or acute based on the duration and severity of nutritional deprivation. Acute malnutrition is further classified into two categories: moderate acute malnutrition (MAM) and severe acute malnutrition (SAM), depending on the degree of severity and the presence of edema.

According to the World Health Organization, SAM is a complex and extreme form of malnutrition that is harmful to the health and well-being of children [2].SAM is characterized by severe wasting, nutritional edema, or very low weight-for-height and is associated with a markedly increased risk of morbidity and mortality in children. Children affected by SAM often experience compromised physiological function, rendering them highly vulnerable to infectious diseases and poor treatment outcomes [3].

Anemia is characterized by decreased levels of hemoglobin (Hb) [4, 5], which impair the ability of red blood cells to transport oxygen efficiently [6], frequently coexists with SAM and further exacerbates child vulnerability. The concurrence of SAM and anemia is associated with impaired immune function, increased susceptibility to infections, delayed recovery, and a higher risk of adverse clinical outcomes [7]. Although the individual consequences of SAM are well documented, the burden and implications of anemia among children with SAM remain insufficiently characterized in many low-resource settings [8].

Globally, acute malnutrition affects millions of children, with the highest burden concentrated in South Asia and sub-Saharan Africa regions characterized by poverty, food insecurity, environmental adversity, and fragile health systems [9]. More than 55 million children under the age of five are affected, with 26 million of these cases being severe and acute, in those two regions [7]. These contextual factors contribute to the persistence of acute malnutrition and its associated complications, including anemia.

In Pakistan, malnutrition constitutes a critical public health concern [10, 11]. National-level evidence from the National Nutrition Survey 2018 and the Pakistan Demographic and Health Survey 2018 highlights persistently high levels of stunting, wasting, and underweight among children, particularly in rural areas of Sindh province [11]. Studies conducted in different regions of Pakistan, including the Punjab [12] and Sindh, identified key contributing factors such as poverty, illiteracy, large family sizes, and inadequate breastfeeding practices [13].

Tharparkar, one of the most drought-prone and socioeconomically disadvantaged districts of Sindh, is characterized by chronic food insecurity due to recurrent droughts, dependence on rain-fed agriculture, and widespread poverty. These conditions disproportionately affect children and women, resulting in persistently high levels of acute malnutrition. Despite the known vulnerability of this population, local evidence regarding anemia among children with SAM in Tharparkar remains scarce.

This lack of region-specific data limits informed clinical management and targeted nutrition interventions. Therefore, this study aimed to determine the prevalence of anemia among children with severe acute malnutrition residing in Tharparkar, Sindh, Pakistan.

Study objective

The primary objective of this study was to assess the prevalence of anemia among children with severe acute malnutrition (SAM).

Materials & methods

Study design, setting, data collection, and time frame

A hospital-based cross-sectional study was conducted at Civil Hospital Mithi, the district headquarters hospital of Tharparkar, Sindh, Pakistan. Data collection was carried out from 3 March 2024 to 15 June 2024. Civil Hospital Mithi is a secondary-care public health facility with an 80-bed pediatric ward, a nutrition stabilization center, a pediatric outpatient department (OPD), and an outpatient therapeutic program (OTP) that provides treatment for children with severe acute malnutrition (SAM).

The hospital serves as the primary referral center for the district and manages a high caseload of children with SAM through the OTP, making it an appropriate setting for assessing anemia among this vulnerable population.

Population

The study population consisted of children aged 6–59 months attending the OTP during the study period. Eligible children were enrolled using consecutive non-probability sampling, whereby all children meeting the inclusion criteria were recruited as they presented to the OTP.

As this was a hospital-based study, the findings may not be fully generalizable to all children with SAM in the community, and selection bias cannot be excluded.

Eligibility criteria

Inclusion criteria

- Children aged 6–59 months.
- Diagnosed with severe acute malnutrition according to World Health Organization (WHO) criteria.
- Enrolled in the OTP at Civil Hospital Mithi.

Table 1 Operational definitions of the study variables

Variable	Definition
Under five children	Children aged less than 5 years.
Hemoglobin	Oxygen-carrying protein in blood, measured in g/dl.
Nonanemic	Hb > 11.0 g/dl.
Anemic Hb level < 11.0 g/dl	
Anemia mild	Hb 10–10.9 g/dl.
Anemia moderate	Hb 7.0 g/dl and 9.9 g/dl.
Anemia Severe	Hb < 7.0 g/dl.
Severe acute malnutrition (SAM)	MUAC less than 11.5 cm or bilateral pitting edema at the feet [14]
MUAC	A MUAC of less than 11.5 cm indicates SAM; above 13.5 cm, a MUAC is considered normal [15].

- Availability of hemoglobin measurement.

Exclusion criteria

- Children with missing hemoglobin data.
- Children with known chronic or congenital disorders.

Sample size

Sample size determination

The sample size was calculated using a single population proportion formula. A prevalence (p) of 57% for anemia among children under five years of age was assumed based on findings from the National Nutrition Survey 2018. A 95% confidence level and a 5% margin of error were applied. To account for an anticipated 20% non-response rate and an estimated 90% eligibility rate, the minimum required sample size was calculated to be 129 children. Accordingly, 129 children with SAM attending the OTP between March and June 2024 were included in the study.

Operational definitions

Operational definitions of the study variables are outlined in Table 1.

Data collection

Anthropometric assessment

Anthropometric measurements were performed by trained healthcare staff using standardized procedures. Body weight was measured using a calibrated RGZ-20 digital weighing scale, with children wearing minimal clothing. Mid-upper arm circumference (MUAC) was measured using a standard, non-stretchable MUAC tape. Each measurement was taken twice, and the average of the two readings was recorded to minimize measurement error.

Table 2 Characteristics of children under five years of age attending the OTP at civil hospital

Characteristics	Mean (SD)	
Age	11.5 (6.4) months	
Weight	5.56 (1.0) kg	
Hb	9.0 (1.4) g/dl.	
	Frequency(N)	**Percentage %**
Gender		
Male	74	57.4
Female	55	42.6
Age		
6–12 months	91	70.5
12–36 months	36	27.9
36–59 months	02	1.6
MUAC		
<11.5	126	97.67%
>11.5	03	2.3%

Hemoglobin estimation

Venous blood samples (approximately 300 µL) were collected under aseptic conditions into EDTA tubes. Hemoglobin concentration was measured using an automated hematology analyzer (Nihon Kohden) by an experienced laboratory technician following standard operating procedures [16, 17]. Anemia was classified according to World Health Organization (WHO) cutoff values, as described in Table 1.

Statistical analysis

Data were analyzed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize participant characteristics. Continuous variables were reported as means with standard deviations (SD), while categorical variables were presented as frequencies and percentages. The prevalence of anemia among children with SAM was calculated using WHO criteria, along with 95% confidence intervals.

Associations between categorical variables were assessed using Pearson's chi-square test or Fisher's exact test, as appropriate. A p-value < 0.05 was considered statistically significant. Multivariable analysis was not performed because the primary objective of the study was to estimate prevalence rather than identify independent predictors.

Results

Characteristics of the study participants

Table 2 summarizes the characteristics of children with severe acute malnutrition (SAM) included in the study. The mean (± SD) age of the children was 11.5 ± 6.4 months, and the mean (± SD) body weight was 5.56 ± 1.0 kg. The mean (± SD) hemoglobin concentration among participants was 9.0 ± 1.4 g/dL.

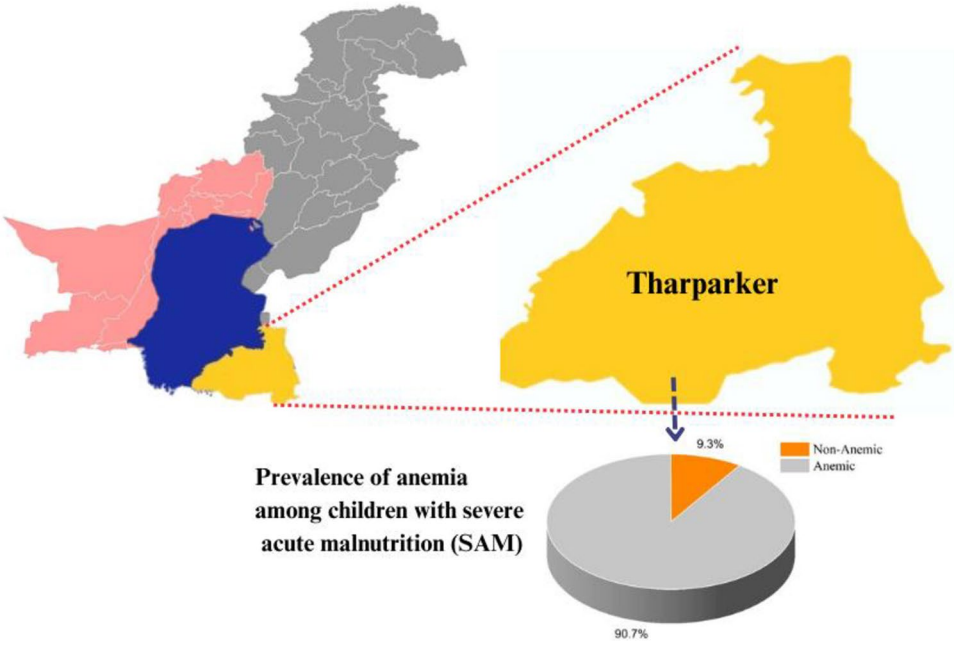

Fig. 1 Prevalence of anemia among children with SAM

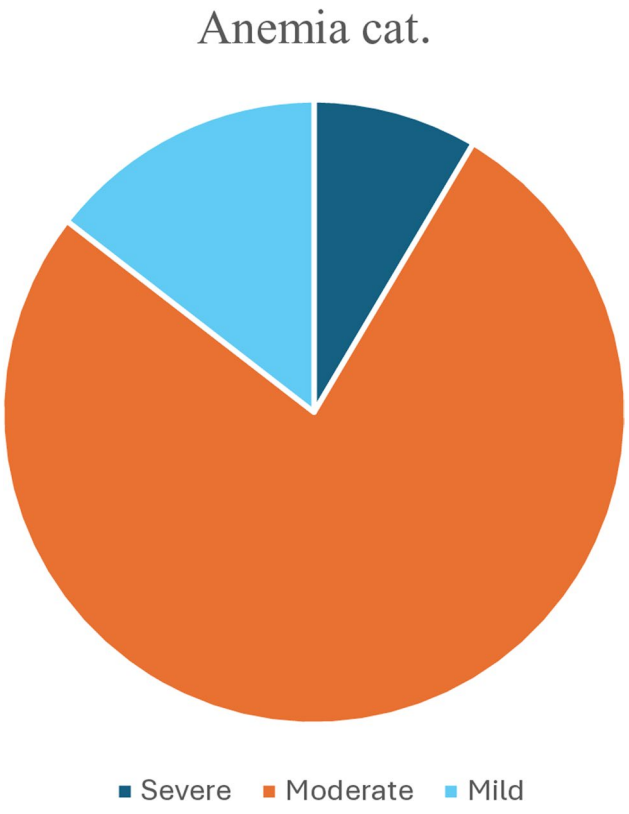

Fig. 2 Distribution of anemia severity among children under the five attending OPT ($n = 117$)

Of the 129 children included, 74 (57.4%) were male and 55 (42.6%) were female. The majority of children, 91 (70.5%), were aged 6–12 months, followed by 36 (27.9%) aged 12–36 months, and 2 (1.6%) aged 36–59 months.

Regarding nutritional status, 126 children (97.6%) had a mid-upper arm circumference (MUAC) of < 11.5 cm, while 3 children (2.3%) had a MUAC ≥ 11.5 cm but were classified as having SAM due to the presence of bilateral pitting edema.

Figure 1 shows the prevalence of anemia among children with SAM. Overall, 117 children (90.7%) were anemic, while 12 children (9.3%) had normal hemoglobin levels.

Severity of anemia

Figure 2 presents the distribution of anemia severity among anemic children. Of the 117 anemic children, 17 (13.2%) had mild anemia, 90 (69.8%) had moderate anemia, and 10 (7.8%) had severe anemia.

Anemia by age group

Figure 3 illustrates anemia prevalence across different age categories. Among children aged 6–12 months, 82 of 91 (90.1%) were anemic. In the 12–36-month age group, 33 of 36 children (94.2%) were anemic. All children aged 36–59 months ($n = 2$) were anemic.

Table 3 shows the severity of anemia across age groups. Moderate anemia was the most frequent category in both the 6–12-month and 12–36-month age groups. Among children aged 36–59 months, anemia severity was evenly distributed between the mild and moderate categories.

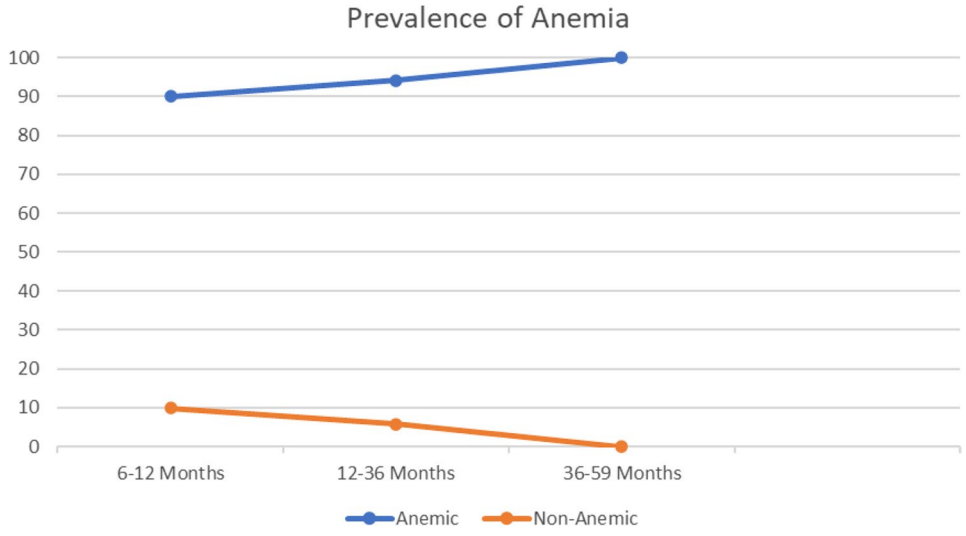

Fig. 3 Anemia frequency among various age groups

Table 3 Severity of anemia across different age categories

Age Category (Months)	Mild *n* (%)	Moderate *n* (%)	Severe *n* (%)
6–12	9(10.9)	67(81.7)	6(7.3)
12–36	7(21.2)	22(66.6)	4(12.1)
36–59	1(50)	01(50)	0(00)
Total	17	90	10

Association of anemia with sex and age

Table 4 presents the association of anemia with sex and age. Pearson's chi-square test showed no statistically significant association between sex and anemia status ($p = 0.4$). Fisher's exact test also indicated no significant association between age category and anemia status ($p = 1.0$).

Discussion

This study documents a very high burden of anemia among children with severe acute malnutrition (SAM) in Tharparkar, Sindh, highlighting a critical and compounded nutritional challenge in this drought-prone and resource-limited setting. The findings underscore the convergence of acute malnutrition and micronutrient deficiency among young children receiving care through outpatient therapeutic programs (OTPs).

The predominance of children in the first year of life reflects the heightened vulnerability of this age group, a period characterized by rapid growth, increased nutritional requirements, and dependence on adequate complementary feeding [14]. Although low body weight and reduced hemoglobin levels are expected among children with SAM, the observed anemia prevalence in this study is notably high. The overall anemia prevalence exceeds that reported in national surveys of under-five children in Pakistan and is comparable to, or higher than, estimates reported among SAM populations in other low-income settings [18, 19]. Hospital-based studies from South Asia and sub-Saharan Africa have similarly reported anemia prevalence exceeding 70–85% among children with SAM, supporting the consistency of these findings across comparable clinical contexts [15, 20].

Across age categories, anemia remained highly prevalent, with moderate anemia being the most common severity level. This pattern aligns with previous studies indicating that moderate anemia predominates among malnourished children presenting to health facilities, while severe anemia, though less frequent, remains clinically significant [16, 17, 21]. The absence of a statistically significant association between anemia and age or sex in this study is consistent with findings from other hospital-based SAM cohorts, suggesting that anemia affects

Table 4 Association of anemia with sex and age

Characteristics		Anemia			df	P value
		Yes	No	Total		
Gender	Male	66	08	74	1	0.4
	Female	51	04	55		
Age	6–12 months	82(64.1)	09(7.0)	91	2	1.0
	12–36 months	33(25.6)	3(2.3)	36		
	36–59months	2(1.6)	0(00)	2		

children with SAM broadly, irrespective of demographic subgroups [22]. In addition, children with SAM often experience impaired nutrient absorption and increased metabolic demands [23] both of which may contribute to reduced hemoglobin synthesis.

Chronic inflammation and repeated infections, common in malnourished populations, may further exacerbate anemia through inflammation-mediated suppression of erythropoiesis [24, 25]. Although the present study did not collect detailed dietary, clinical, or socioeconomic data to directly assess these mechanisms, the findings are consistent with established evidence linking nutritional deficiencies and infection burden to anemia in children with SAM [26].

The exceptionally high prevalence observed in Tharparkar may also reflect broader contextual factors. Persistent poverty, recurrent droughts, food insecurity, and limited access to diversified diets characterize this region and have been repeatedly linked to poor child nutrition outcomes [27, 28]. Previous studies conducted in Tharparkar and other underserved districts of Sindh have reported similarly high rates of malnutrition and anemia, reinforcing the regional nature of this public health problem [11, 29]. Children presenting to OTPs may represent more severe cases, which could partly account for the elevated prevalence observed in this hospital-based sample.

From a programmatic perspective, these findings highlight the importance of integrating routine anemia screening and management within SAM treatment protocols. While OTPs primarily focus on anthropometric recovery, addressing coexisting anemia through timely diagnosis, appropriate micronutrient supplementation, and follow-up care may improve overall treatment outcomes. Strengthening nutrition-sensitive interventions and addressing broader social determinants of health are essential to reduce the dual burden of SAM and anemia in disaster-prone regions such as Tharparkar.

Conclusion

This study assessed the prevalence of anemia among children with severe acute malnutrition (SAM) in Tharparkar, Pakistan, and found that anemia is highly prevalent in this population, with the majority of affected children presenting with moderate anemia. These findings highlight a substantial and overlapping nutritional burden among malnourished children in this drought-prone and resource-limited region. The coexistence of SAM and anemia underscores the need to address micronutrient deficiencies alongside anthropometric recovery within child nutrition programs.

Recommendations

The findings indicate the need for integrated and context-specific interventions to address the dual burden of SAM and anemia. Strengthening outpatient therapeutic program (OTP) services by incorporating routine anemia screening, timely diagnosis, and appropriate micronutrient supplementation may improve treatment outcomes. In addition, efforts to improve food security, dietary diversity, and access to essential healthcare services are critical. At a broader level, nutrition-sensitive interventions addressing poverty, food insecurity, and maternal and child feeding practices are essential to reduce the long-term burden of malnutrition and anemia in vulnerable and disaster-prone regions such as Tharparkar.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, its hospital-based design may have introduced selection bias, as only children who accessed care through the OTP were included; therefore, the results may not be fully representative of all children with SAM in the community. Second, data on nutritional deficiencies other than anemia were not collected, limiting a comprehensive assessment of micronutrient status and underlying causes of malnutrition. Information on household socioeconomic status, living conditions, maternal education, and dietary practices was also not available, restricting analysis of broader social and environmental determinants.

Additionally, the small number of children aged 36–59 months limits the interpretation of findings within this age category, and percentage estimates for this group should be interpreted with caution. Finally, the cross-sectional study design precludes causal inference between SAM and anemia. Despite these limitations, the study provides valuable evidence on the high co-occurrence of anemia and severe acute malnutrition among children in a highly vulnerable region of Pakistan.

Abbreviations

SAM	Severe acute malnutrition
MUAC	Mid-upper arm circumference
Hb	Hemoglobin
NNS	National Nutrition Survey
PDHS	Pakistan Demographic and Health Survey
OTP	Outpatient therapeutic program
OPD	Outpatient department
EDTA	Ethylenediaminetetraacetic acid

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Authors' contributions

Study conception & Design: BM, SQ, DR. Approvals and permissions: SQ, DR. Literature Search: DR, TS, NS. Data collection: DR. Analysis: BM, RM, RS. Writeup: NS, BM, TS, RS. Figure preparation: NS, TS. Final proofreading: BM, DR, NS.

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Data availability
All relevant data are contained within the manuscript itself. The dataset includes summary tables and analyses presented in the results section.

Declarations

Ethics approval and consent to participate
The study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethical Review Committee of Mekran Medical College, Turbat (MMC/ERC/6/2/2024; dated 08 February 2024). Administrative permission was secured from the Civil Surgeon and the In-Charge of Civil Hospital Mithi. Written informed consent was obtained from parents or legal guardians prior to participant enrollment, and confidentiality of all participant data was maintained.

Consent for publication
Not applicable, as no patient-identifiable data or images are included in this manuscript.

Competing interests
The authors declare no competing interests.

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