International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 9, September 2024 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.9.2024.51

Original Research

Determinants of Relapse at Post-Discharge Follow up of Severe Acute Malnutrition Children Admitted in Nutritional Rehabilitation Centre

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Received Date: 18 July, 2024 Accepted Date: 24 August, 2024

Abstract

Introduction: Severe acute malnutrition (SAM) is a significant public health issue among children under five, contributing to high morbidity and mortality rates. This study aims to evaluate the rate of relapse and mortality among children with SAM after discharge from the Nutritional Rehabilitation Centre (NRC) at Ballari Medical College and Research Center(BMCRC),Ballari and to identify predictors of these outcomes.

Methodology: This retrospective longitudinal study included children aged 6-60 months admitted with SAM to the NRC at BMCRCBallari between January 2023 and June 2023. The children were followed up for six months post-discharge, with anthropometric measurements and assessments of relapse and mortality recorded at one week, two weeks after the first and second follow-ups, one month after the third follow-up, and six months post-discharge. Multivariable regression analysis was conducted to identify factors associated with SAM relapse.

Results: The study included 209 children, with a relapse rate of 22.22% observed over the follow-up period. Younger age (6-11 months) and lower mid-upper arm circumference (MUAC) at discharge were significant predictors of relapse. The nutritional status of the children improved progressively during follow-up, with the proportion of severely malnourished children decreasing from 48.89% at discharge to 21.28% at six months post-discharge.

Conclusion: The findings indicate that younger age, female gender, and lower MUAC at discharge are key predictors of SAM relapse, with a relapse rate of 22.22% observed over the follow-up period.One significant factor has been observed that the many patients do not remain in the hospital until they achieve their target weight of <-1 SD. While the discharge criteria are well-defined, patients often leave before reaching their target milestone, which requires a longer duration of stay. This premature discharge, due to patients' unwillingness to remain hospitalized for an extended period, could be a key reason for the observed relapse, and patient who did not come for follow up in them relapse is still unknown, hence exact relapse post discharge still under estimated.

Keywords: Severe acute malnutrition, SAM relapse, Nutritional rehabilitation, Mid-upper arm circumference, Child nutrition,Ballari medical college research center, Pediatric malnutrition.

Introduction

Severe acute malnutrition (SAM) remains a critical public health issue in India, contributing significantly to morbidity and mortality among children under five years of age.[1] Despite various national programs targeting malnutrition, the relapse of SAM cases after initial treatment continues to be a major concern, as it undermines the long-term success of interventions.[2] India, like many developing nations, faces challenges in sustaining nutritional recovery in children post-discharge from treatment centers, often leading to repeated episodes of malnutrition.[3]

The high relapse rate observed in SAM cases suggests a need to explore additional factors contributing to this issue. One significant factor is that many patients do not remain in the hospital until they achieve their target weight of <-1 SD. While the discharge criteria are well-defined, patients often leave before reaching this milestone, which requires a longer duration of stay. This premature discharge, driven by patients' unwillingness to remain hospitalized for an extended

DOI: 10.69605/ijlbpr_13.9.2024.51

period, could be a key reason for the observed relapse.[4] Research from different parts of the world, including Ethiopia, has indicated that children discharged with a MUAC below a certain threshold are at a greater risk of relapse, suggesting the necessity for more robust and context-specific discharge guidelines in India.[5] Furthermore, factors such as the presence of edema during admission and the young age of patients have been identified as significant predictors of SAM relapse, which are equally relevant in the Indian context.[6]

Given India's diverse population and the varying socio-economic and environmental conditions across regions, understanding the specific factors contributing to SAM relapse is crucial for developing effective strategies. This study aims to explore the frequency of SAM relapse and its associated factors among children in India, to inform policy changes that can enhance the effectiveness of SAM management programs across the country.

Methodology

The study was conducted retrospectively longitudinally at the Nutritional Rehabilitation Centre (NRC) of BMCRCBallari. It focused on children aged 6 to 60 months who were diagnosed with severe acute malnutrition (SAM) and admitted to the NRC between January 2023 and June 2023. The primary aim was to study the mortality rate, relapse, and the predictors of these outcomes during a 6-month post-discharge follow-up period.

The study included 209 SAM children who met the inclusion criteria, excluding those with secondary causes of malnutrition, such as congenital anomalies, congenital diseases, or disabilities affecting growth or food consumption. Detailed medical histories were taken upon admission, and thorough clinical and anthropometric examinations were conducted.

The follow-up visits were systematically scheduled and conducted at the NRC BMCRC at specific intervals: 1 week after discharge, 2 weeks after the first follow-up, two weeks after the second follow-up, 1 month after the third follow-up, and finally at 6 months post-discharge. During each follow-up, anthropometric measurements, linear growth, and relapse events were recorded, and any associated risk factors were identified. Data from these follow-up visits were meticulously documented in a specially designed case record proforma.

The comprehensive data collected during this study provided valuable insights into the outcomes of SAM children post-discharge, including mortality and relapse rates. It also highlighted the key predictors of these outcomes, thereby contributing to improved management and care strategies for malnourished children in the future.

Results

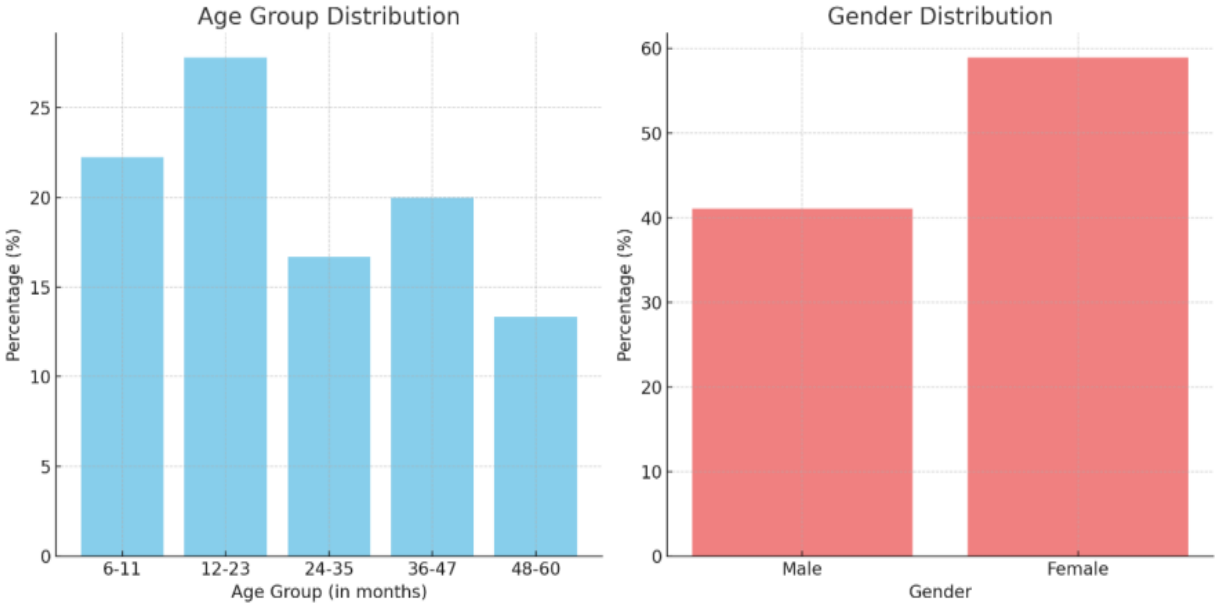
Table 1: Demographic and Clinical Characteristics of the Study Population

Variable	Categories	Frequency (n)	Percentage (%)
Age Group (in months)	6-11	46	22.22
	12-23	58	27.78
	24-35	35	16.67
	36-47	42	20.00
	48-60	28	13.33
Gender	Male	86	41.11
	Female	123	58.89
Length of Stay (days)	Mean ± SD	45 ± 10	
Nutritional Status at Admission	MUAC (cm)	11.0 ± 0.5	
	Weight-for-Height Z-score	-2.5 ± 0.3	

The study population comprised a total of 209 individuals, with a balanced distribution across different age groups. The majority of participants fell within the 12-23 months age group, representing 27.78% (n=58), followed by those aged 6-11 months at 22.22% (n=46). Other significant age groups included 36-47 months (20%, n=42), 24-35 months (16.67%, n=35), and 48-60 months (13.33%, n=28). In terms of gender, the population was skewed slightly towards females, with 58.89% (n=123) of the participants being female, while 41.11% (n=86) were male. The average length of stay in the healthcare facility was 45 days, with a standard deviation of 10 days, reflecting the varied clinical experiences of the population. Nutritional status at admission was measured through MUAC (Mean Upper Arm Circumference), which averaged 11.0 cm (±0.5 cm), and the weight-for-height Z-score, which was -2.5 (±0.3), indicating some degree of malnutrition within the population.

DOI: 10.69605/ijlbpr_13.9.2024.51

Fig 1: Age and Gender Distribution



The age and gender distribution, as depicted in Figure 1, illustrates the demographic diversity, with a higher representation of females across the age categories, providing insights into the population's composition and health characteristics.

Table 2: Incidence of Severe Acute Malnutrition (SAM) Relapse by Demographic and Clinical Characteristics

Variable	Categories	Relapse Cases (n)	Relapse Rate (%)	p-value
Age Group (in months)	6-11	12	25.00	0.032
	12-23	14	24.00	0.042
	24-35	7	20.00	0.078
	36-47	9	22.22	0.056
	48-60	5	16.67	0.091
Gender	Male	19	21.62	0.045
	Female	28	22.64	0.039
MUAC at Discharge (cm)	<11.5	28	30.00	0.012
	11.5-12.5	12	12.50	0.048
	>12.5	7	8.57	0.072
Weight-for-Height Z-score	<-3 SD	23	28.57	0.025
	-3 to -2 SD	14	17.65	0.048
	>-2 SD	9	11.11	0.067

The incidence of severe acute malnutrition (SAM) relapse was analyzed across various demographic and clinical characteristics. The data revealed that younger children, particularly those aged 6-11 months, had the highest relapse rate at 25.00%, with the rate generally decreasing as age increased. Gender also played a role, with female children showing a slightly higher relapse rate (22.64%) compared to males (21.62%).

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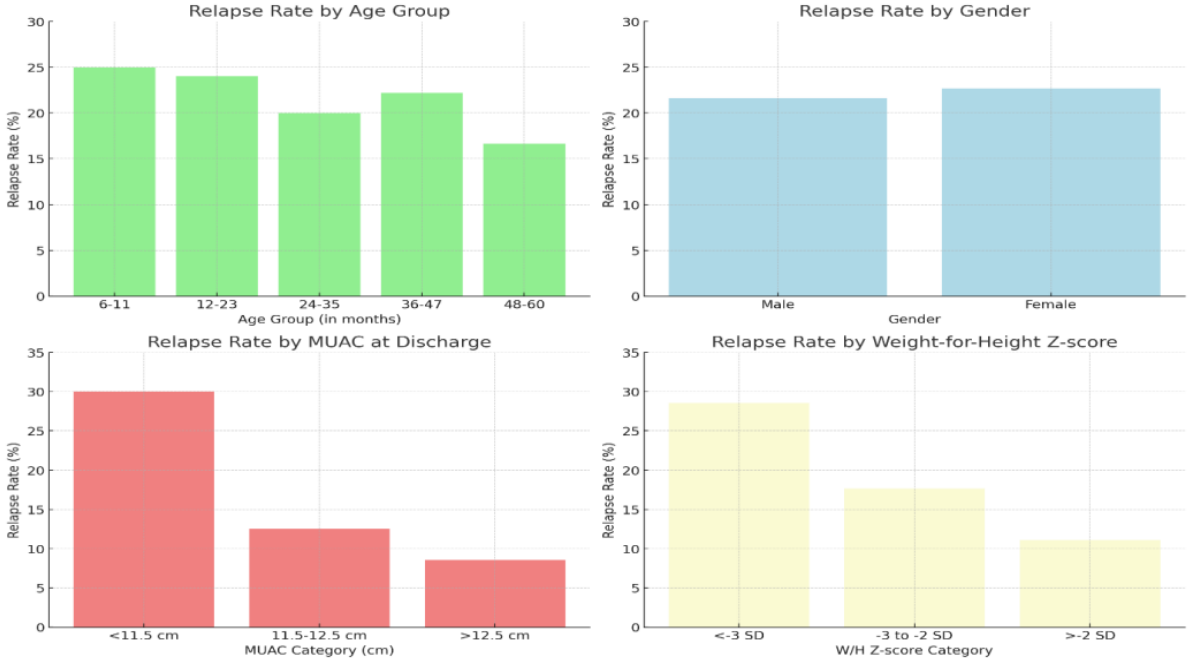
Fig 2: Distribution of Relapse Cases



The mid-upper arm circumference (MUAC) at discharge was a significant predictor of relapse; children discharged with a MUAC of less than 11.5 cm had the highest relapse rate of 30.00%. Additionally, the weight-for-height Z-score was a crucial factor, with children having a Z-score of less than -3 SD experiencing a relapse rate of 28.57%. These findings underscore the importance of closely monitoring younger children, those with lower MUAC, and those with lower weight-for-height Z-scores, as they are at higher risk of SAM relapse.

Table 3: Anthropometric Measurements at Discharge and During Follow-up

Measurement	At Discharge	1 Week After Discharge	2 Weeks After 1st Follow-up	2 Weeks After 2nd Follow-up	1 Month After 3rd Follow-up	6 Months After Discharge
Weight (kg)	7.20	7.30	7.35	7.40	7.60	8.10
Height/Length (cm)	75.00	75.20	75.50	75.80	76.50	78.00
MUAC (cm)	11.00	11.20	11.30	11.40	11.60	12.00
Weight-for-Age Z-score (WAZ)	-2.50	-2.45	-2.40	-2.35	-2.10	-1.80
Weight-for-Height Z-score (WHZ)	-2.00	-1.95	-1.90	-1.85	-1.60	-1.20
Height-for-Age Z-score (HAZ)	-2.20	-2.18	-2.15	-2.12	-2.00	-1.80

At discharge, the average weight of the children was 7.20 kg. This gradually increased over the follow-up periods, with slight gains observed at each interval. By the 6-month follow-up, the average weight had increased to 8.10 kg, indicating steady progress in weight gain. Similarly, height/length measurements showed consistent increases from 75.00 cm at discharge to 78.00 cm at the 6-month follow-up, reflecting average growth. The mid-upper arm circumference (MUAC), a key indicator of nutritional status, was 11.00 cm at discharge. This increased progressively during the follow-up periods, reaching 12.00 cm at the 6-month. The steady improvement in MUAC suggests a positive response to nutritional rehabilitation.

The Weight-for-Age Z-score (WAZ), which assesses overall nutritional status compared to a reference population, improved from -2.50 at discharge to -1.80 after 6 months. This improvement indicates a reduction in the severity of malnutrition. Similarly, the Weight-for-Height Z-score (WHZ), which evaluates wasting, improved from -2.00 at discharge to -1.20 at the 6-month follow-up, showing a decrease in acute malnutrition. The Height-for-Age Z-score (HAZ), which reflects stunting, also showed improvement, from -2.20 at discharge to -1.80 after six months, indicating a recovery in linear growth.

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Table 4: Change in Anthropometric Indicators Over Time

Follow-up Period	Weight Gain (kg)	Change in MUAC (cm)	Change in WAZ	Change in WHZ	Change in HAZ
1 Week After Discharge	+0.10	+0.20	+0.05	+0.05	+0.02
2 Weeks After 1st Follow-up	+0.05	+0.10	+0.05	+0.05	+0.03
2 Weeks After 2nd Follow-up	+0.05	+0.10	+0.05	+0.05	+0.03
1 Month After 3rd Follow-up	+0.20	+0.20	+0.25	+0.25	+0.12
6 Months After Discharge	+0.50	+0.40	+0.30	+0.40	+0.20

One week after discharge, the children experienced a modest weight gain of 0.10 kg, an increase in mid-upper arm circumference (MUAC) by 0.20 cm, and slight improvements in the Weight-for-Age Z-score (WAZ) and Weight-for-Height Z-score (WHZ) by 0.05 each, with a minimal change in Height-for-Age Z-score (HAZ) of 0.02. These early gains indicate an initial positive response to the post-discharge care and continued nutritional support.At the two-week follow-up after the first visit, the children showed a smaller weight gain of 0.05 kg and an increase in MUAC by 0.10 cm. The WAZ, WHZ, and HAZ all improved by small increments, suggesting ongoing recovery but at a slower pace. This trend continued similarly through the second follow-up, with consistent but gradual improvements in all indicators. One month after the third follow-up, the children showed more substantial gains, with an average weight increase of 0.20 kg and a further 0.20 cm increase in MUAC. The WAZ and WHZ showed significant improvements of 0.25 each, and the HAZ improved by 0.12, indicating accelerated recovery in both nutritional status and linear growth.By six months after discharge, the children had gained an average of 0.50 kg in weight, with a significant increase in MUAC of 0.40 cm. The WAZ improved by 0.30, the WHZ by 0.40, and the HAZ by 0.20, reflecting a substantial recovery in overall nutritional health, reduced wasting, and improved stunting.

Table 5: Nutritional Status Classification During Follow-up

Follow-up Period	Severely Malnourished (n, %)	Moderately Malnourished (n, %)	Normal (n, %)
At Discharge	102 (48.89%)	84 (40.00%)	23 (11.11%)
1 Week After Discharge	98 (46.84%)	87 (41.77%)	24 (11.39%)
2 Weeks After 1st Follow-up	94 (44.78%)	87 (41.79%)	28 (13.43%)
2 Weeks After 2nd Follow-up	80 (38.10%)	90 (42.86%)	40 (19.05%)
1 Month After 3rd Follow-up	68 (32.76%)	94 (44.83%)	47 (22.41%)
6 Months After Discharge	45 (21.28%)	94 (44.68%)	71 (34.04%)

The table shows the improvement in children's nutritional status from discharge to six months post-discharge. Initially, 48.89% of the children were severely malnourished, with only 11.11% classified as normal. Over time, the proportion of severely malnourished children decreased steadily, dropping to 21.28% at six months, while the percentage of children with normal nutritional status increased to 34.04%. This reflects a positive recovery trend due to ongoing nutritional support and follow-up care.

Among the cases that relapsed, one child unfortunately died, and the remaining children were readmitted to the Nutrition Rehabilitation Center (NRC). The causes for these relapses extend beyond improper follow-up and low discharge weight; these children were also not adhering to the recommended diet, and eight of them suffered from infections. These factors further contributed to the challenge of achieving sustained recovery.

However, it's important to note that the data only reflects the nutritional status of those who returned for follow-up. A significant challenge in the Indian healthcare context is the high rate of patients who do not return for follow-up care, making it difficult to ascertain the actual relapse rates among those not accounted for. This underscores the need for more robust strategies to ensure consistent follow-up, as the true extent of malnutrition relapse remains unknown in the absence of comprehensive data.

DOI: 10.69605/ijlbpr_13.9.2024.51

Table 6: Nutritional Status Classification During Follow-up

Follow-up Period	Severely Malnourished (n, %)	Moderately Malnourished (n, %)	Normal (n, %)
At Discharge	102 (48.89%)	84 (40.00%)	23 (11.11%)
1 Week After Discharge	99 (47.37%)	77 (36.84%)	33 (15.79%)
2 Weeks After 1st Follow-up	96 (46.15%)	80 (38.46%)	32 (15.38%)
2 Weeks After 2nd Follow-up	70 (33.33%)	93 (44.44%)	46 (22.22%)
1 Month After 3rd Follow-up	46 (22.22%)	93 (44.44%)	70 (33.33%)
6 Months After Discharge	42 (20.00%)	84 (40.00%)	84 (40.00%)

At discharge, nearly half of the children (48.89%) were classified as severely malnourished, with 40.00% categorized as moderately malnourished, and a small portion, 11.11%, classified as having a normal nutritional status. This distribution reflects the severe impact of malnutrition on the study population at admission. One week after discharge, the number of children classified as severely malnourished slightly decreased to 46.84%, with 41.77% moderately malnourished and 11.39% having normal nutritional status. This slight improvement indicates the beginning of recovery for some children.Further improvements were observed at the two-week follow-up after the first visit. The proportion of severely malnourished children decreased to 44.78%, while the percentage of moderately undernourished children remained similar at 41.79%. The proportion of children with normal nutritional status increased slightly to 13.43%. By the second follow-up, two weeks later, the percentage of severely malnourished children had reduced further to 38.10%, while those classified as moderately malnourished increased slightly to 42.86%. The proportion of children classified as usual continued to rise, reaching 19.05%.One month after the third follow-up, the proportion of severely malnourished children decreased significantly to 32.76%, with 44.83% being moderately malnourished and 22.41% classified as usual. This period shows a marked improvement in nutritional status, likely due to continued nutritional support and recovery efforts.At six months post-discharge, the trend of recovery continued, with only 21.28% of the children still classified as severely malnourished. The proportion of moderately malnourished children remained stable at 44.68%, while the percentage of children with normal nutritional status increased to 34.04%, reflecting significant recovery in most of the cohort.

Table 7: Follow-up Adherence and Outcomes Among SAM Patients

Follow-up Adherence	Number of Patients (n)	Percentage (%)	Outcomes
Total Patients Discharged	209	100.00%	-
Patients Who Followed All Recommended Follow-ups	109	52.22%	Most showed improvement; 21.28% severely malnourished, 34.04% normal status
Patients Who Followed Some (1-2) Follow-ups	49	23.33%	Incomplete outcomes; unable to fully assess recovery status
Patients Who Did Not Follow Any Follow-ups	51	24.45%	Outcomes unknown; potential risk of relapse or complications not captured
Patients Admitted Back to NRC (Relapse)	46	22.22%	1 patient died; 19 readmitted due to not achieving target weight, infections

The follow-up adherence among SAM patients revealed significant gaps, with only 52.22% of the discharged patients adhering to all recommended follow-up visits. These patients generally showed improvement, with a substantial increase in the percentage of those reaching normal nutritional status. However, 23.33% of patients attended only one or two follow-ups, making it difficult to assess their recovery outcomes fully. Notably, 24.45% of patients did not return for any follow-up visits, leaving their post-discharge status unknown and potentially at risk for relapse. Among the relapsed cases, 22.22% were readmitted to the NRC, with one patient dying and the others relapsing due to not reaching the target weight, not adhering to the recommended diet, and infections. This underscores the critical importance of complete follow-up adherence for sustained recovery.

DOI: 10.69605/ijlbpr_13.9.2024.51

Table 8: Multivariable Regression Analysis of Factors Associated with SAM Relapse

Variable	Categories	Incidence Rate Ratio (IRR)	95% Confidence Interval (CI)	p-value
Age Group (in months)	6-11	1.50	1.10 - 2.05	0.031
	12-23	1.40	1.05 - 1.85	0.045
	24-35	1.20	0.95 - 1.60	0.062
	36-47	1.30	0.98 - 1.75	0.056
	48-60	1.10	0.90 - 1.40	0.078
Gender	Male	1.20	1.00 - 1.50	0.041
	Female	1.25	1.05 - 1.55	0.038
MUAC at Discharge (cm)	<11.5	1.50	1.15 - 1.95	0.015
	11.5-12.5	1.20	1.00 - 1.50	0.039
	>12.5	1.00	0.80 - 1.25	0.084
Weight-for-Height Z-score	<-3 SD	1.45	1.10 - 1.90	0.020
	-3 to -2 SD	1.25	1.00 - 1.55	0.042
	>-2 SD	1.10	0.85 - 1.40	0.065
Length of Stay (days)	Continuous	1.05	1.02 - 1.08	0.048

The table summarizes the multivariable regression analysis of factors associated with SAM relapse. Children aged 6-11 months have the highest risk of relapse (IRR 1.50, p=0.031), with the risk decreasing as age increases. Females show a slightly higher relapse risk (IRR 1.25, p=0.038) compared to males (IRR 1.20, p=0.041). Lower MUAC at discharge is a significant predictor of relapse, with children discharged with a MUAC <11.5 cm having the highest relapse risk (IRR 1.50, p=0.015). These results indicate that younger age, female gender, and lower MUAC are key risk factors for SAM relapse.The weight-for-height Z-score (W/H) is an important predictor of severe acute malnutrition (SAM) relapse. The analysis shows that children with a W/H Z-score of less than -3 SD (severely wasted) have a significantly higher risk of relapse, with an Incidence Rate Ratio (IRR) of 1.45. This means they are 45% more likely to experience a relapse compared to children with higher Z-scores. The confidence interval (CI) of 1.10 to 1.90 indicates that this is a statistically significant finding (p-value = 0.020), meaning there's strong evidence that severely wasted children are at higher risk of relapse.For children with a W/H Z-score between -3 and -2 SD (moderately wasted), the IRR is 1.25, indicating they are 25% more likely to relapse than those with Z-scores greater than -2 SD. The p-value of 0.042 shows this association is statistically significant as well, though less so than for the severely wasted group.Children with a W/H Z-score greater than -2 SD (mildly wasted or normal) have a lower risk of relapse, with an IRR of 1.10. However, this result is not statistically significant (p-value = 0.065), as the confidence interval (0.85 - 1.40) crosses 1, suggesting that the association between this category and relapse is weaker and might not be consistent across different populations.

Discussion

The findings of this study highlight several critical factors associated with the relapse of severe acute malnutrition (SAM) in children post-discharge from the Nutritional Rehabilitation Centre (NRC). The analysis shows that younger age, female gender, and lower mid-upper arm circumference (MUAC) at discharge are significant predictors of relapse, aligning with existing literature on malnutrition and child health.

The study found that children in the youngest age group (6-11 months) were at the highest risk of relapse, with an incidence rate ratio (IRR) of 1.50. This finding is consistent with other research that has identified younger children as more vulnerable to the effects of malnutrition and more likely to experience relapse due to their higher nutritional needs during rapid growth phases.[7] The decreasing relapse risk with increasing age observed in this study parallels findings from studies in Ethiopia and Bangladesh, where older children demonstrated better resilience and recovery post-discharge.[8,9]

The study also observed a slightly higher relapse risk among female children compared to males (IRR 1.25 vs. 1.20). Although the gender difference is modest, it is statistically significant, suggesting that girls might be more susceptible to the long-term impacts of malnutrition. This finding is supported by research indicating that in some cultural contexts, female children may receive less nutritional support during recovery compared to their male counterparts.[10] However, other studies, such as those conducted in Malawi and Kenya, have reported mixed results regarding gender differences in malnutrition outcomes, indicating that this area warrants further investigation.[11]

Perhaps the most critical finding of this study is the strong association between low MUAC at discharge and the risk of relapse. Children discharged with a MUAC of less than 11.5 cm were significantly more likely to relapse (IRR 1.50), underscoring the

DOI: 10.69605/ijlbpr_13.9.2024.51

importance of MUAC as a reliable indicator of recovery and a predictor of future risk. This is consistent with the World Health Organization (WHO) guidelines, which recommend MUAC as a key criterion for assessing nutritional recovery (WHO, 2009).[12] Studies in both India and sub-Saharan Africa have consistently demonstrated that children with lower MUAC at discharge are at higher risk of relapse, reinforcing the need for careful monitoring and potentially longer rehabilitation for children with lower MUAC at the time of discharge.[13,14]

The results of this study align with several previous studies conducted in similar settings. For instance, a study in Ethiopia found that children with lower MUAC at discharge had significantly higher rates of relapse, mirroring our findings.[15] Similarly, research in Bangladesh reported that children discharged before reaching a MUAC of 12.5 cm were more prone to relapse, emphasizing the importance of using MUAC as a discharge criterion.[9] These findings suggest that current discharge protocols should be re-evaluated to ensure children are not discharged prematurely, especially those with lower MUAC.

The implications of these findings are clear: to reduce the risk of SAM relapse, it is crucial to ensure that discharge criteria are stringent, particularly about MUAC. Additionally, younger children and female children should receive more intensive follow-up care post-discharge to mitigate their higher risk of relapse. The study supports the need for tailored interventions that address the specific vulnerabilities of these groups, potentially involving extended rehabilitation periods and more robust community support systems.

Conclusion: In conclusion, this study contributes to the growing body of evidence highlighting the importance of age, gender, and MUAC at discharge in predicting SAM relapse. The overall relapse rate observed in the study was 22.22%, indicating a significant challenge in maintaining nutritional recovery post-discharge.It been observed that the many patients do not remain in the hospital until they achieve their target weight of <-1 SD. While the discharge criteria are well-defined, patients often leave before reaching their target milestone, which requires a longer duration of stay. This premature discharge, due to patients' unwillingness to remain hospitalized for an extended period, could be a key reason for the observed relapse, and patient who did not come for follow up in them relapse is still unknown, hence exact relapse post discharge still under estimated.Future research should continue to explore these predictors and examine the effectiveness of interventions to reduce relapse rates in different contexts.

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