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ARTICLE

Prevalence of severe acute malnutrition and its effect on under-five mortality at a regional hospital in South Africa

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Introduction: Severe acute malnutrition (SAM) is an important global and national public health concern. It contributes to under-five mortality but is also largely a preventable disease.
Objective: This study aimed to assess the prevalence of and mortality associated with SAM.
Design: A retrospective review of hospital files was conducted.
Setting: Dora Nginza Hospital, Eastern Cape, South Africa was the site of the study.
Subjects: The study included children from 6 to 59 months of age admitted to the paediatric ward between January 1, 2018 and December 31, 2018. Children with chronic disease were excluded. Ethics approval was granted by Walter Sisulu University (053/2019).
Outcome measures: Anthropometric, co-morbid and outcomes data were retrieved and analysed.
Results: A total of 1 296 children were included in the study, 93 with SAM. The prevalence of SAM was 7.2%. Children with SAM had a median age of 16 months (IQR 11–25). Gender distribution was 52 (56%) females and 41 (44%) males. The inpatient mortality rate for children with SAM was 6.5%. Children with SAM were at significantly increased risk of mortality (RR 5.97, 95% CI 3.1–11.6, p-value < 0.0005). Three factors were significantly associated with mortality: nutritional oedema, sepsis, and hypokalaemia.
Conclusion: The prevalence of SAM at Dora Nginza Hospital is high, and children with SAM are at significantly increased risk of mortality. Specific risk factors for mortality include sepsis, urinary tract infection, nutritional oedema and hypokalaemia. Modifiable factors associated with SAM and SAM-related mortality need to be targeted urgently to improve outcomes.

Keywords: severe acute malnutrition, prevalence, South Africa

Introduction

Severe acute malnutrition (SAM) specifically is defined as weight-for-height below −3 Z score, mid-upper arm circumference (MUAC) less than 115 mm and/or bilateral nutritional oedema.[1] SAM is an important public health concern, because it is a preventable disease that contributes significantly to under-five morbidity and mortality. The prevalence of SAM globally is approximately 7.3% but rates vary vastly between different areas.[2] Low- to middle-income countries carry the highest burden with rates of 14.6% reported in southern Asia and 5% in South Africa.[2,3]

Studies from different countries report mortality associated with SAM to range from 1.2% to as high as 9.3%.[4–6] The proportion of under-five mortality caused by neonatal disorders was 30%, pneumonia and gastroenteritis 10.0% respectively, unnatural causes 8%, congenital abnormalities 6% and malnutrition 4.0%.[7] Neonatal disorders, pneumonia and gastroenteritis are the major contributing causes to under-five mortality, with an additional significant contribution from malnutrition.

The South African under-five mortality is currently estimated at 34 deaths per 1 000 live births.[8] Sustainable development goal 3.2 aims to end preventable deaths of children under five years of age and reduce under-five mortality to at least 25 per 1 000 live births by 2030.[9] SAM is a preventable contributor to under-five mortality and as such should be a target for active intervention to improve outcomes in children aged under five years.

There is a paucity of studies that have assessed the prevalence, risk factors and outcomes of SAM in the Eastern Cape. The aim of this study therefore was to assess the prevalence of SAM at Dora Nginza Hospital, assess outcomes of children with SAM at the institution, determine factors associated with SAM and determine the role of SAM-associated co-morbidities in outcome.

Methods

Study design

A retrospective, descriptive cross-sectional study was conducted. Data were retrieved from participants' files at Dora Nginza Hospital, Port Elizabeth, in the Eastern Cape.

Study sample

The study population included children between 6 and 59 months of age admitted to Dora Nginza Hospital from January 1, 2018 to December 31, 2018. The lower age limit of six months was used as there is no consensus on diagnostic criteria for SAM in younger patients.[10–12] However, prevalence data were retrieved, but not included in detailed statistical analysis, in children between 29 days and 5 months of

chronological age admitted during the study period in order to describe the condition in this age group. Those < 2 500 g at birth were excluded as they were considered to be in a recovery period following low birthweight and still experiencing catch-up growth. Children with known chronic medical or surgical conditions and neonates (less than 29 days) were excluded. Children with chronic disease were omitted in order to exclude the possible confounding effect of chronic disease on childhood growth and nutritional status. Children with tuberculosis and human immunodeficiency virus (HIV) were not excluded as these conditions are treatable and children are expected to thrive. Neonates were excluded as variation and monitoring of growth is different in the neonatal period compared with older infants and children.[13] The children who met the inclusion criteria, i.e. aged 6–59 months, satisfied the WHO diagnostic criteria of SAM and had no chronic disease were designated as having SAM. Children with SAM were treated using the WHO Ten Steps guideline for management of SAM.[14,15]

Data collection

Participants were identified from Dora Nginza Hospital paediatric ward's admission book. Anthropometric data retrieved from the ward admission book were used to identify participants as being SAM or non-SAM using the WHO diagnostic criteria of SAM. The hospital files of participants with SAM were retrieved and detailed information on demographics, anthropometry, clinical data, laboratory data and outcome was collected from the hospital files of children with SAM aged between 6 and 59 months with no chronic disease. Children without SAM and those who did not meet the inclusion criteria were used to calculate the prevalence of SAM and to compare mortality outcomes of children with and without SAM.

Data collected included:

(i) Presence or absence of SAM: Anthropometry, including weight, height and MUAC and presence or absence of oedema, was retrieved as measured and assessed by the attending health professional. MUAC was measured using a 1 mm graded non-elastic measuring tape. SAM was defined using the WHO growth charts as a weight-for-length of less than −3 Z score, and/or MUAC of less than 115 mm, in children aged 6–59 months and/or with nutritional oedema. A MUAC of less than 110 mm was used to define SAM in children aged 29 days–5 months.

(ii) Associated factors for SAM including parents' employment status, whether receiving child support grant and feeding practices.

(iii) Co-morbidities in children with SAM including diarrhoea, lower respiratory tract infection, sepsis, meningitis, urinary tract infection, tuberculosis, anaemia, hypothermia, hypoglycaemia, dehydration, shock, weeping dermatosis and hypokalaemia.

(iv) Outcome of children with SAM including death, discharge or transfer to another institution. The outcome of discharge or transfer was the day the health professional decided that the child was ready for transfer or discharge, not the day of transfer or discharge if the days differed.

Ethics

Ethical clearance was obtained from Walter Sisulu University human research ethics committee (053/2019), Eastern Cape health research committee (EC_201908_008) and approval obtained from Dora Nginza Hospital. Patient identifiers were not captured, to ensure confidentiality.

Statistics

Continuous data that were not normally distributed were described using the median and interquartile range. The chi-square test was used to assess association between categorical variables and $p < 0.05$ was considered significant. Relative risk with 95% confidence limits was used to assess the difference in mortality in children with SAM compared with children without SAM, and multivariate analysis utilising the Cochran's and Mantel–Haenszel tests was used to determine factors associated with outcomes (hospital stay > 1 week and mortality).

Results

In all, 2 092 children were admitted during the study period and 768 of them were younger than 6 months. The overall prevalence of SAM in children younger than 6 months was 4.1%.

During this period, 1 324 children between 6 and 59 months were admitted, of whom 19 were excluded due to missing anthropometric data. A total of 133 of the remaining 1 305 children were diagnosed with SAM (based on anthropometry), thus the overall prevalence of SAM including children with and without chronic disease was 10.2%. Scrutiny of hospital files of children with SAM revealed that 31 had a chronic underlying disease, and in 9 cases the hospital files were missing. Therefore, information on anthropometry and chronic disease was available for 1 296 children (Figure 1). Of the children with SAM and underlying chronic disease, 17 had a cardiac disease (of whom 3 had trisomy 21 and 1 trisomy 18), 7 had cerebral palsy, 4 had foetal alcohol syndrome, 2 had neurological disease and 1 had chronic liver disease.

Severe acute malnutrition was diagnosed in 93/1 296 (7.2%) children aged between 6 and 59 months. The median age of children with SAM was 16 months (IQR 11–25), 52 (56%) were female and 41 (44%) were male. There were 45 (49%) HIV-exposed children and 22 (24%) who tested positive for HIV. A total of 12 of the 22 children who tested HIV-positive were newly diagnosed with HIV infection, the HIV viral load was not done on 10 of the children, and on 2 the HIV viral load was done and both children were not virologically suppressed. The remaining 10 children were known HIV reactive at the time of admission; 6 were virologically not suppressed and in

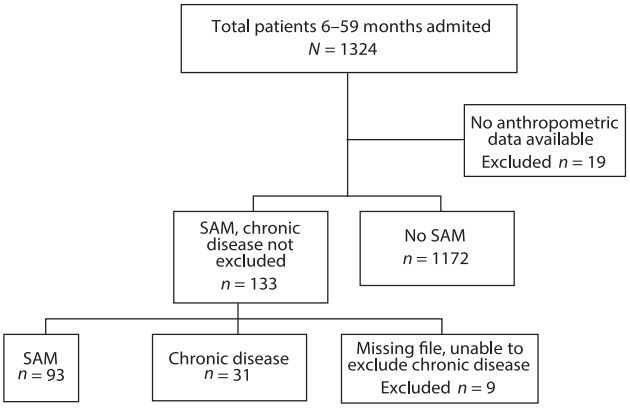

Figure 1: Summary of the study population.

4 the HIV viral load was not done. The HIV status of one of the 93 children was unknown.

The demographic characteristics of the study sample are summarised in Table 1.

Weight-for-length (WFL) was less than −3 SD in 61 (66%) children and nutritional oedema was present in 33 (35%). The MUAC was not documented in 17 (18%) children, and it was noted to be less than 115 mm in 28 of 76 (37%) measured children.

The majority of the participants had a poor socioeconomic status, with 75 (85%) children receiving the child support grant and in 50 (57%) cases both parents were unemployed. Thirteen children were not receiving the child support grant. In five of the patients not receiving the child support grant both parents were employed, in one case the mother was employed, two had no birth certificate, in two cases the mothers had no identification documents, one was not a South African citizen, in one case the family was a victim of domestic violence, and in one case the information could not be retrieved.

The history of feeding practices was poorly documented in the patient files. The age of initiation of complementary feeds was not documented in the files of 62 (67%) children.

Table 1: Sociodemographic characteristics of the study sample with SAM ($n = 93$)

Characteristic	Number	Percentage
Age:		
6–12 months	32/93	34
>12–24 months	37/93	40
> 24–59 months	24/93	26
HIV status:		
Exposed negative	24/93	26
Exposed positive	21/93	23
Unexposed negative	46/93	49
Unexposed positive*	1/93	1
Unknown	1/93	1
Immunisation status:		
Up to date	61/93	66
Not up to date	31/93	33
Unknown	1/93	1
Admission anthropometric measurements:		
WFL < −3SD	61/93	66
MUAC < 115 mm	28/76	37
Nutritional oedema	33/93	35
Socioeconomic status:		
Child support grant	75/88	85
Mother unemployed	73/93	78
Father unemployed	57/88	65
Both parents unemployed	50/88	57
Feeding practices:		
Exclusive breastfeeding for 6 months	14/53	26
Formula feeding in children ≤ 2 years	29/69	42

WFL = Weight-for-length; MUAC = Mid-upper-arm circumference
*Unexposed positive: One patient tested HIV positive, but mother tested HIV negative. The route of HIV transmission was not clear.

Table 2: Co-morbidities at admission in children with SAM ($n = 93$)

Co-morbidities and conditions at admission	*n* (%)
Anaemia (Hb < 11.0 g/dl)	73 (78)
Lower respiratory tract infection	72 (77)
Diarrhoea	47 (51)
Tuberculosis	30 (32)
Sepsis	29 (31)
Dehydration	29 (31)
Hypokalaemia (< 3 mmol/l)	22 (24)
Hypothermia (axillary temperature < 35.0 c)	17 (18)
Urinary tract infection	13 (14)
Weeping dermatoses	10 (11)
Shock	6 (6)
Hypoglycaemia (< 3 mmol/l)	4 (4)
Meningitis	3 (3)

The most commonly occurring co-morbidity in children with SAM was anaemia, 73 (78%), followed by lower respiratory tract infection and diarrhoea, 72 (77%) and in 47 (51%) respectively. Other co-morbidities that were observed are summarised in Table 2.

The median hospital stay before discharge/transfer was 9 days (IQR 6–16). HIV status, nutritional oedema and individual co-morbidities were compared with duration of hospital stay to assess which factor(s) was/were associated with duration of hospital stay (Table 3). HIV-positive status, nutritional oedema, sepsis and tuberculosis were independently associated with significantly longer duration of hospital stay (> 1 week) on multivariate analysis.

A total of 1 203 children without SAM were admitted and 13 died, resulting in an inpatient mortality for patients without SAM of 1.1%. Ninety-three children with SAM were admitted and 6 died, resulting in an inpatient mortality for patients with SAM of 6.5%. The mortality in patients with SAM was significantly higher than in those without SAM (Figure 2). Factors significantly associated with mortality included nutritional oedema, sepsis, urinary tract infection and hypokalaemia (Table. 4). Multivariate analysis revealed that the effect of UTI on mortality was not independent of sepsis and was no longer significant after adjusting for sepsis.

Table 3: Factors associated with hospital stay > 1 week in children with SAM

Co-morbid condition	*p*-value	Relative risk (RR)	95% confidence interval (CI)
HIV positive	**0.005**	**1.6**	**1.2–2.2**
Nutritional oedema	**0.02**	**1.5**	**1.1–2.0**
Anaemia (Hb < 11.0 g/dl)	0.3	1.3	0.8–2.0
Lower respiratory tract infection	3.4	1.5	0.9–2.6
Diarrhoea	0.2	0.8	0.6–1.1
Tuberculosis	**0.002**	**1.7**	**1.3–2.3**
Sepsis	**0.01**	**1.5**	**1.1–2.1**
Urinary tract infection	0.5	1.2	0.8–1.8
Meningitis	0.8	1.1	0.5–2.5

Bold: Statistically significant factors ($p < 0.05$)

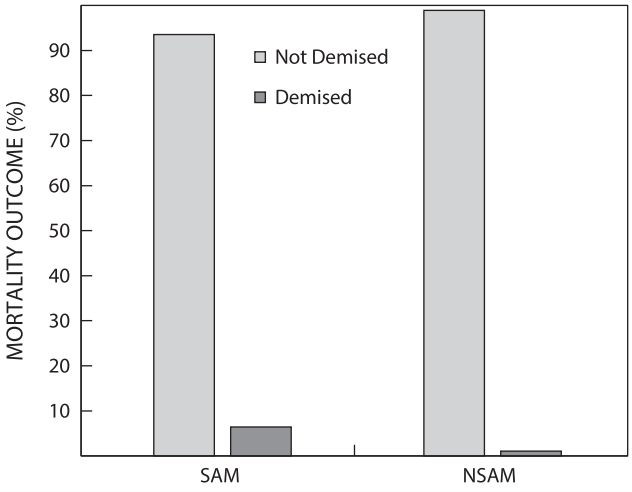

Figure 2: Mortality outcomes in patients with and without SAM. SAM: severe acute malnutrition; NSAM: non-SAM; *p*-value < 0.0005 (RR 5.97, 95% CI 3.1–11.6).

Discussion

The study found a high in-hospital prevalence of SAM (7.2%), and high associated inpatient mortality (6.5%). Increased mortality was associated with sepsis, nutritional oedema and hypokalaemia. Prolonged hospital stay was associated with sepsis, nutritional oedema, HIV-positive status and tuberculosis. The prevalence of SAM in the current study may be an overestimate as the study was conducted in a hospital setting and excluded children managed at community level, and therefore may not be comparable with the reported SAM prevalence for Southern Africa.[2] Despite this, the data indicate that the prevalence of SAM is high[16,17] and substantial public health and intersectoral effort is required to reduce it. The ultimate aim is for all children to be free of malnutrition in all its forms.[2]

Table 4: Characteristics and co-morbidities associated with mortality in children wit**h SAM**

Factor	*p*-value	Relative risk (RR) (95% CI)
Age	0.6	1.7 (0.2–14.2)
Gender	0.8	1.3 (0.3–6.0)
HIV status	0.6	0.6 (0.1–3.2)
WFL < −3 SD	0.3	2.6 (0.3–21.5)
MUAC < 115 mm	0.9	1.1 (0.2–6.4)
Nutritional oedema	**0.01**	**9.1 (1.1–74.6)**
Anaemia	0.2	Not applicable: zero cells
Diarrhoea	0.98	0.98 (0.2–4.6)
LRTI	0.7	1.5 (0.2–11.8)
Sepsis	**0.004**	**11.0 (1.3–90.3)**
Tuberculosis	0.4	0.4 (0.1–3.4)
Urinary tract infection*	**0.009**	**6.2 (1.4–27.3)**
Hypothermia	0.3	2.2 (0.5–11.2)
Hypoglycaemia	0.6	Not applicable: zero cells
Dehydration	0.9	1.1 (0.2–6.7)
Shock	0.3	2.9 (0.4–21.0)
Weeping dermatosis	0.4	Not applicable: zero cells
Hypokalaemia (< 3 mmol/l)	**0.01**	**6.5 (1.3–32.9)**

RR: relative risk; CI: confidence interval; *urinary tract infection. This result was no longer significant after adjusting for sepsis. Bold: Statistically significant factors ($p < 0.05$)

The majority of children admitted with SAM were under 2 years of age with a median age of 16 months. This is similar to findings from Zambia, where the median age of patients admitted with SAM was also 16 months.[18] Children under two years of age appear to be a particularly high-risk group and may benefit from closer routine follow-up and growth monitoring.

HIV exposure, with or without infection, appears to be an important risk factor for the development of SAM. In our study, 24% of children with SAM tested HIV-positive and 49% were HIV-exposed. HIV exposure in the SAM population is higher than that of the general South African paediatric population of approximately 31%.[19] Saloojee *et al*. similarly report that HIV is a major contributor to the development of SAM.[20] However, the role of HIV exposure, regardless of transmission of infection, is less well described. Possible reasons for this association include maternal illness impairing childcare and health-seeking behaviours, absence of parents due to hospitalisation or death and inability of parents to work and generate an income.[21]

Markers of poor socioeconomic status were highly prevalent in children with SAM, with 85% of the children receiving the child support grant and in 57% of these cases both parents were unemployed. Other studies from developing countries report similar findings.[22] In 6 of the 13 children who were not receiving the child support grant, the parents were employed. This suggests that financial stability alone will not prevent SAM. Additional strategies, such as education, will also be required. Several social circumstances such as domestic violence, unregistered children and parental demise were also highlighted as barriers to receiving the child support grant. This highlights the inequalities inherent in our society that need to be addressed to improve child health.

Baseline weight, height and presence or absence of nutritional oedema was well documented in patient files. However, in 18% of children the MUAC was not documented, highlighting the underutilisation of this important tool. According to the WHO, both WFL score and MUAC are equally effective at diagnosing SAM, but cases diagnosed using WFL and MUAC were not the same.[1] Therefore, both criteria should continue to be used independently for the diagnosis of SAM in order not to miss the diagnosis, especially in younger infants.[1]

Anaemia, diarrhoea and lower respiratory tract infections were highly prevalent co-morbidities in the study participants. This is in keeping with several other studies that report these conditions as common co-morbidities in patients with SAM.[23,24] Our study found prolonged hospital stays associated with SAM, specifically in patients with HIV, nutritional oedema, sepsis and tuberculosis. Other studies report treatment at a hospital stabilisation centre, inpatient complications and persistence of oedema for more than four days to be predictors of longer recovery time.[5] Prolonged hospital stays contribute to morbidity (possibly due to exposure to hospital pathogens), place socioeconomic strain on the community as parents are away from their work and families, and increase the burden on the health system related to intensive multidisciplinary care and overcrowding in hospital wards.

A significantly increased mortality of 6.5% was found in patients with SAM compared with patients without SAM in this study population. However, this is lower than the inpatient mortality reported amongst patients with SAM nationally within South

Africa (8.0%), in sub-Saharan Africa (9.0–20.7%), and in India (16.6%).[23,25,–28] This mortality rate is also within acceptable limits compared with international humanitarian guidelines, which recommend a mortality of less than 10% in children requiring admission for SAM.[29]

Four significant factors were associated with increased mortality in the study population. These included nutritional oedema, sepsis, urinary tract infection and hypokalaemia. The association of UTI with mortality was not independent of sepsis in our study and UTI has not been consistently reported to be associated with mortality in children with SAM. However, a Kenyan study showed that a urine dipstick positive for UTI was associated with mortality.[30] Sepsis and infectious morbidity, oedema, diarrhoea, electrolyte derangements, lack of appetite and lower WFH have consistently been associated with increased mortality in patients with SAM.[4,23,31]

The study has several important limitations. It was a retrospective study and as such the quality of the data was dependent on what was available in patient records. Some data, such as nutritional history and MUAC, were incomplete, and some files were missing. Both factors may have affected the study results. In addition, the prevalence and mortality outcomes of SAM reported were specific to a regional hospital facility and may not be generalisable to the broader community setting. However, the clinical and public health relevance of the findings is an important strength of the study.

SAM is a preventable condition that contributes significantly to under-five mortality. Public health commitment and resource allocation, both locally and nationally, are required to support the prevention and management of SAM as part of the first 1 000 days of life programme.

Conclusion

The prevalence of SAM at Dora Nginza Hospital is high, and children with SAM are at significantly increased risk of mortality. Specific risk factors for mortality include sepsis, nutritional oedema and hypokalaemia. Modifiable factors associated with SAM and SAM-related mortality need to be targeted urgently to improve outcomes.

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