

Outcomes of Severe Acute Malnutrition Management in Therapeutic Feeding Centres. A Retrospective Cross-Sectional Study in Aden, Yemen (2025)

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Abstract

Severe acute malnutrition (SAM) remains a major public health concern in countries affected by crises, particularly in conflict-affected settings. Therapeutic Feeding Centres (TFCs) play a crucial role in the management of complicated SAM cases. This study aimed to assess treatment outcomes and key performance indicators – including recovery, mortality, and default rates – in TFCs, in order to inform health policies and strengthen international health cooperation in these contexts. Yemen was selected as a relevant case study because, according to the most recent UNICEF data, it reports some of the poorest outcomes in South Asia regarding SAM management within TFCs. The study covered ten governorates in southern Yemen, with a specific focus on the Aden governorate, which was selected due to its particularly low performance indicators. The analysis further investigated the functioning of the two local TFCs operating in the area. The findings revealed that TFCs integrated within Primary Healthcare Centres (PHCs), rather than hospitals, achieved better performance outcomes by standardizing patient admissions throughout the year and reducing seasonal peaks during the summer months. Furthermore, effective interventions aimed at reducing mortality and default rates – especially among children aged 5–59 months – required continuity of care, which PHCs were better able to ensure in crisis settings such as Yemen. These results suggest that health policies addressing SAM in conflict-affected areas should prioritize international health cooperation initiatives that invest in the establishment and strengthening of PHC services rather than hospital-based care alone.

Introduction

Severe acute malnutrition (SAM) is a life-threatening condition affecting millions of children globally and is associated with a markedly increased risk of mortality, particularly among children under five years of age (1). SAM includes stunting, wasting and overweight. Globally, an estimated 45 million children are affected by wasting, with SAM representing the most severe form and contributing significantly to child deaths if left untreated (2). UNICEF data show that, in 2024, West and Central Africa, East and Southern Africa, and South Asia had the highest prevalence of stunting, affecting approximately one third of children under five. Among these regions, South Asia achieved more rapid progress in reducing stunting, whereas sub-Saharan Africa remained the only region where the number of stunted children continued to rise. Overall, the highest numbers of stunted children were recorded in sub-Saharan Africa (62 million) and South Asia (56 million). Regarding wasting, 6.6% of children under five worldwide were affected in 2024, including 1.9% suffering from severe wasting, corresponding respectively to 42.8 million and 12.2 million children. South Asia continued to report the highest prevalence, highlighting the urgent need for earlier and more effective interventions. Child overweight, conversely, represents a growing concern across almost all world regions. In 2024, prevalence remained below 5% only in South Asia, East and Southern Africa, and West and Central Africa. However, marked increases were observed in East Asia and the Pacific, South Asia, Latin America and the Caribbean, and North America. Between 2012 and 2024, the number of overweight children rose significantly in South Asia, East and Southern Africa, West and Central Africa, and Latin America and the Caribbean (3).

The burden of SAM is disproportionately higher in fragile and conflict-affected settings, where food insecurity, displacement, poor sanitation, and limited access to healthcare services exacerbate the risk of malnutrition (4). In these regions, the persistence of protracted conflicts has generated profound economic instability and severely disrupted access to essential services, including healthcare, sanitation, and food supply systems (5, 6). These interconnected crises have substantially exacerbated household food insecurity and have been consistently associated with a sharp increase in child malnutrition, particularly wasting and stunting, across affected populations (7, 8). Recent evidence from conflict-affected settings further highlights how displacement, the collapse of health infrastructures, and restricted humanitarian access contribute to the deterioration of children's nutritional status and overall health outcomes (9, 10).

In these areas, these ongoing prolonged conflicts have as consequences economic instability, and disruption of essential services (11). These factors have resulted in widespread food insecurity and a substantial increase in child malnutrition rates across the country (12, 13).

Therapeutic Feeding Centres (TFCs), also known as stabilization centres, are specialized inpatient facilities designed to manage complicated cases of SAM, particularly among children presenting with medical complications such as infections, severe dehydration, or anorexia (2, 14). These centres provide comprehensive medical and nutritional care following standardized protocols recommended by the World Health Organization (WHO), including phased feeding with therapeutic diets such as F-75 and F-100, alongside appropriate clinical management (15, 16). Monitoring treatment outcomes—such as recovery, mortality, and default rates—is essential for evaluating the effectiveness and quality of SAM management programs (17, 18). The Sphere Project provides internationally recognized benchmarks for these indicators, recommending recovery rates greater than 75%, mortality rates below 10%, and default rates below 15% (19). These indicators are widely used to assess program performance and guide improvements in humanitarian nutrition interventions.

There are numerous studies examining the efficacy of TFCs in Africa; however, comparable evidence from Asia remains extremely limited or entirely lacking (7, 20–22). Despite the critical importance of these evaluations, there is still limited published evidence on the performance of Therapeutic Feeding Centres (TFCs) in South Asia. This gap is particularly concerning in Yemen, which reports some of the poorest nutritional and health indicators in the region and where evidence on the outcomes of Severe Acute Malnutrition (SAM) management in TFCs remains scarce. Generating context-specific evidence is therefore essential to guide program planning, optimize resource allocation, and ultimately improve child survival outcomes. In this regard, the present study also seeks to contribute to evidence-based health policies and to strengthen international health cooperation in humanitarian and resource-constrained settings.

Methods

Study design and setting

A retrospective cross-sectional study was conducted in Yemen in accordance with the methodologies already applied in literature (16, 20–22). Yemen was identified as significant country case study because

it has the worst data in the South Asia considering UNICEF data (5). Yemen has experienced as one of the most severe humanitarian crises worldwide, driven by prolonged civil war since 2014 (23, 24).

The country is effectively divided into two main zones of influence. The northern region, including the capital Sana'a and surrounding areas, is controlled by the Houthi rebels. The southern region remains formally under the control of the internationally recognized government of Yemen. Data on SAM with complications and its treatment in TFCs were collected from the following governorates, as belonging to the part of the country under the official government: Abyan, Aden, Al-Dale, Al-Maharah, Hadhramaut, Lahij, Ma'rib, Taiz, Shabwah, and Socotra (Annex 1).

Study population and data source

Particular attention was given to the governorate reporting the lowest rates, with a more detailed analysis conducted on data from its local health facilities recognized as TFCs. The study included integrated secondary data on all children aged 0–14 years admitted to TFCs in the selected governorates with SAM during the study period, from January to December 2025. Investigated variables were total admissions, recovered children, deaths, and defaulters.

Specifically, the governorate of Aden was selected for an in-depth investigation due to its negative recovery, mortality, and default rates. It was therefore decided to investigate the numbers for each individual TFC that insists here to understand how to improve data. The two considered TFCs were, namely:

- the Alsadaqa teaching hospital (ATH) in the district of Ash Shaikh Outhman (ATH), a tertiary referral hospital serving as a stabilization centre for complicated SAM;
- the Alburaiqa Complex Primary Healthcare Centre (ACPHC) in the district of Al Buraiqeh, a district-level facility providing outpatient therapeutic feeding services and basic inpatient care.

Instead, about detailed data from TFCs located within the governorate of Aden, the investigated variables were also collected monthly and for age-ranges (< 6 months, 6–59 months, > 6 years).

Sources

The present study did not require the approval of an ethics committee as it is based solely on the analysis of aggregated, anonymized and publicly available secondary data, which do not allow in any way the identification of participants. However, approval for data use was obtained from the Aden Health Office of the Ministry of Public Health and Population.

Data analysis

Data were cleaned and analysed using descriptive statistical method. Statistical analyses were conducted using Stata 19 (StataCorp, College Station, TX, USA). As key performance indicators and performance indicators were fixed the standards established by the Sphere project (19):

- Recovery rate = number of recovered / total admissions > 75%
- Mortality rate = number of deaths / total admissions < 3%
- Default rate = number of defaulters / total admissions < 15%

Monthly and age ranges were assessed using graphical time-series methods.

Results

Overall outcomes in Yemen

A total of 8,125 with severe acute malnutrition were admitted to TFCs in the ten governorates of recognized government of Yemen during 2025. Of these, 7,666 were discharged and transferred to outpatient care (recovery rate = 94.3%), 53 died (mortality rate = 0.6%), and 176 dropped-off treatments (default rate = 2.2%). All three considered rates remained well below the recommended thresholds of Sphere standard. These findings indicate strong program performance across TFCs in the considered area. However, these data were pulled down by data related to Aden governorate (Table 1).

Table 1

– TFCs' volume of activity in governorates under the control of Data on Recognized Government of Yemen

Governorates	Total admissions	Recovered	Recovery rate	Deaths	Mortality rate	Defaulters	Default rate
Abyan	1188	1159	97.6%	2	0.2%	12	1.0%
Aden	1020	883	86.6%	12	1.2%	62	6.1%
Al-Dale	446	418	93.7%	11	2.5%	1	0.2%
Al-Maharah	31	30	96.8%	0	0.0%	1	3.2%
Hadhramaut	885	867	98.0%	4	0.5%	4	0.5%
Lahij	801	752	93.9%	7	0.9%	30	3,7%
Ma'rib	1093	1029	94.1%	10	0.9%	24	2.2%
Taiz	1946	1809	93.0%	7	0.4%	42	2,2%
Shabwah	679	682	100.4%	0	0.0%	0	0.0%
Socotra	36	37	102.8%	0	0.0%	0	0.0%
Total	8125	7666	94.3%	53	0.6%	176	2.2%
Average			95.7%		0.6%		1.9%
Dev. Stand.			4.5%		0.8%		2.0%
CI			3.2%		0.5%		1.4%

Considering the 95% confidence intervals (recovery rate 95.7% +/- 3.2%; mortality rate 0.6% +/- 0.5%, and default rate = 1.9% +/- 1.4%), data of Aden governorate were all out. It was therefore decided to investigate the numbers for each individual TFC that insists here to understand how to improve data.

Overall outcomes in Aden governorate

Considering admissions, the distribution of users in the Aden governorate was 52.8% (n = 530) at the Alsadaqa teaching hospital (ATH) in the district of Ash Shaikh Outhman and 47.4% (n = 478) at the Alburaiqa Complex Primary Healthcare Centre (ACPHC) in the district of Al Buraiqeh.

The percentages were reversed if the data relating to the taking charge by the TFCs on the total of the governorate were examined: 47.3% (n = 417) at the AHC and 52.7% (n = 465) at the ACPHC. This was because only 78.7% (n = 417) of children admitted to the AHC were redirected to the TFCs compared to 97.3% (n = 465) of those admitted to the ACPHC.

Assessing the rates, data were dragged down by data from the ATH, which were borderline or even negative compared to the threshold values imposed by the Sphere project. 91.6% of deaths (n = 11) and 88.7% of defaulters (n = 55) recorded in the Aden governorate occurred at ATH in 2025.

At the ATH, the recovery rate was 78.7%, accompanied by a mortality rate of 2.1% and a default rate of 10.4%, indicating suboptimal treatment outcomes and a higher proportion of patients discontinuing care before completion. In contrast, the ACPHC achieved substantially better performance indicators, with a recovery rate of 97.3%, a markedly lower mortality rate of 0.2%, and a default rate of only 1.5%, reflecting greater treatment effectiveness, improved continuity of care, and stronger patient retention (Table 2).

Table 2
Data on Aden governorate TFCs

	Alsadaqa teaching hospital (Ash Shaikh Outhman)		Alburaika Complex Primary Healthcare Centre (Al Buraigeh)		Total	Average	Dev.Stand.	CI
	No.	%	No.	%				
Total admissions	530	52,8%	478	47.4%	1008			
Recovered children in TFCs	417	47.3%	465	52.7%	882			
Recovery rate	78,7%		97,3%		87,5%	88%	13,2%	1,2%
Deaths	11	91.6%	1	8.3%	12			
Mortality rate	2,1%		0,2%		1,2%	11%	1,3%	0,1%
Defaulters	55	88.7%	7	11.3%	62			
Default rate	10,4%		1,5%		6,2%	5.9%	6.3%	0.6%

Seasonal and age-groups trends

To identify which areas should be prioritized to improve performance and better align ATH outcomes with those achieved by ACPHC, ATH data were stratified by age group (Table 3) and seasonality and compared with those from ACPHC (Graphics 1–4).

In both centres, the majority of admissions - more than three-quarters- involved children aged 6–59 months, representing 77.1% (n = 408) at ATH and 79.5% (n = 380) at ACPHC. Children younger than 6 months accounted for 19.0% (n = 80) at ATH and 17.8% (n = 83) at ACPHC, while children older than 5 years represented only a small proportion of admissions, corresponding to 1.7% (n = 7) at ATH and 3.2% (n = 15) at ACPHC. More or less, recovery rates across age groups followed a distribution similar to that observed for admissions.

Regarding mortality, 93% of all deaths recorded in the Aden governorate occurred at ATH in 2025. Among these deaths, 62% (n = 8) involved children younger than 6 months, while 38% (n = 5) occurred among children aged 6–59 months. In particular, ATH recorded 5 deaths (38.5%) among children aged 6–59 months, whereas no deaths were reported in the same age group at ACPHC. Among children younger than 6 months, ATH reported 12 deaths (21.8%), compared with 2 deaths (28.6%) at ACPHC. Deaths among children older than 5 years were limited, with only 1 case (1.8%) at ATH and none at ACPHC.

The majority of defaulters in both facilities were children aged 6–59 months, accounting for 42 cases (76.4%) at ATH and 5 cases (71.4%) at ACPHC. Among infants younger than 6 months, ATH reported 12 defaulters (21.8%), compared with 2 cases (28.6%) at ACPHC. Children older than 5 years accounted for only 1 defaulter (1.8%) at ATH, while no cases were reported at ACPHC.

Table 3
Data on Aden governorate TFCs for age groups

		Alsadaga teaching hospital (Ash Shaikh Outhman)		Alburaika Complex Primary Healthcare Centre (Al Buraiqeh)	
		No.	%	No.	%
Total admissions	Less the 6 Months	107	20.2%	83	17.4%
	From 6–59 Months	408	77.1%	380	79.5%
	More then 5 Years	14	2.6%	15	3.1%
Recoverd children in TFCs	Less the 6 Months	80	19.0%	83	17.8%
	From 6–59 Months	334	79.3%	367	78.9%
	More then 5 Years	7	1.7%	15	3.2%
Deaths	Less the 6 Months	8	61.5%	1	100%
	From 6–59 Months	5	38.5%	0	0%
	More then 5 Years	0	0%	0	0%
Defaulters	Less the 6 Months	12	21.8%	2	28.6%
	From 6–59 Months	42	76.4%	5	71.4%
	More then 5 Years	1	1.8%	0	0%

An analysis of the seasonal distribution of admissions shows peaks during the spring period in both facilities. However, at the ACPHC there is a clear correspondence between admissions and case management by the TFCs, reflecting a timely and widespread response to healthcare needs. This pattern is not observed at the ATH, where the transfer and management of cases by the TFCs occur later, shifting the peak in admissions to the summer period. This delay in case management may explain the sharp increase

in admissions observed in September 2025 (Graphics 1 and 2). At ATH, however, there was no correspondence between Peak activity and deaths, which are distributed throughout the year. This suggested a system problem, attributable to the lack of specialized personnel and specific technologies, to corroborate what has already been hypothesized regarding the possible reasons for deaths, especially in the age group with less than 6 months (Graphic 3). With regard to defaulters, their trend appeared to be inversely related to seasonal admission peaks. This pattern may reflect the limited capacity of the facility to manage increased patient inflows during peak periods while simultaneously ensuring continuity of care for patients already enrolled in treatment, who consequently discontinue care. These shortcomings may be linked to the absence of robust protocols capable of guaranteeing adequate continuity of care and, ultimately, improving treatment outcomes, particularly through a reduction in default rates (Graphic 4).

Graphic 1 – Total admissions in Aden Governorates monthly segmented for age-ranges

Graphic 2 - Recovered children in Aden Governorates monthly segmented for age-ranges

Graphic 3 – Deaths in Aden Governorate monthly segmented for age-ranges

Graphic 4 - Defaulters in Aden Governorate monthly segmented for age-ranges

Discussion

This study aimed to assess treatment outcomes and key performance indicators – including recovery, mortality, and default rates – in TFCs operating in Yemen, in order to inform health policies and strengthen international health cooperation in conflict-affected settings.

Overall, findings demonstrate that TFCs operating in governorates under the control of the internationally recognized Government of Yemen achieved favourable treatment outcomes during 2025, despite the ongoing and severe humanitarian crisis. All indicators remained within the minimum standards recommended by the Sphere Handbook, confirming the effectiveness of the nutritional treatment programmes implemented (19).

These findings are particularly relevant when considered within the broader context global child malnutrition and humanitarian emergencies. Malnutrition remains one of the leading causes of morbidity and mortality among children under five years of age globally, especially in low- and middle-income countries affected by poverty, food insecurity, and armed conflict (1, 10). Yemen continues to face one of the world's most severe humanitarian crises, characterized by prolonged conflict, economic collapse, disruption of healthcare services, and widespread food insecurity (3, 4).

In such contexts, previous evidence has consistently shown that exposure to conflict significantly increases the risk of child malnutrition and poor health outcomes by limiting access to food, healthcare, water, sanitation, and social protection systems (6, 8).

Against this backdrop, the strong overall performance observed across most Yemeni TFCs demonstrates that, when adequately supported, therapeutic feeding programmes can remain effective even in highly

fragile environments. This finding reinforces the importance of sustained international humanitarian and technical support.

The present results also contribute to the growing evidence supporting the effectiveness of therapeutic feeding interventions for children with SAM. Previous studies conducted in emergency and low-resource settings have demonstrated that both inpatient and community-based nutritional programmes can achieve high recovery rates and reduced mortality when implemented according to standardized protocols and supported by adequate continuity of care (15, 17). In line with this evidence, the high recovery rates observed in several governorates suggest that many Yemeni TFCs have successfully adapted international SAM management guidelines to the local humanitarian context.

However, the analysis also identified important disparities in programme performance across governorates, particularly in Aden. Compared with the national average, Aden demonstrated lower recovery rates alongside higher mortality and default rates, indicating localized weaknesses within the healthcare system.

A more detailed facility-level analysis identified the Alsadaqa Teaching Hospital (ATH) as the main contributor to poorer outcomes. While the Alburaiqa Complex Primary Healthcare Centre (ACPHC) achieved excellent performance indicators -including a recovery rate of 97.3% and a default rate of 1.5%-ATH reported a substantially lower recovery rate (78.7%) and a higher default rate (10.4%), approaching the upper limits established by Sphere standards. This difference of 18.6 percentage points in recovery performance between the two facilities has important implications for health policy and humanitarian programming. It suggests that strengthening primary healthcare-based models such as ACPHC, rather than relying primarily on tertiary hospital-based models like ATH, may represent a more effective strategy for SAM management. Primary healthcare centres are typically better integrated within community health networks, enabling stronger links with the local population and ensuring continuity of care over time, which is essential for improving treatment adherence and clinical outcomes (15, 21).

The age-stratified analysis further highlighted that infants younger than six months represented the most vulnerable group, accounting for the majority of deaths recorded at ATH. This finding is consistent with existing literature highlighting the complexity of SAM management in this group, which often requires specialized neonatal care, breastfeeding support, maternal interventions, and advanced clinical management (14, 16, 18). The concentration of mortality among infants under six months may therefore reflect limited availability of specialized personnel and neonatal expertise within ATH. From a health systems perspective, these results underscore the need to strengthen paediatric and neonatal capacity within TFCs operating in fragile contexts.

Seasonal trends also provide important operational insights. Both investigated facilities experienced peaks in admissions during spring, likely driven by worsening food insecurity, increased infectious disease transmission, and seasonal socioeconomic stressors. However, while ACPHC demonstrated a rapid alignment between admissions and treatment capacity, ATH showed delays in transferring patients into TFC care, resulting in a shift of peak therapeutic activity toward the summer months (7, 9). This pattern suggests limited surge capacity and reduced responsiveness during periods of increased demand. In

humanitarian settings characterized by recurrent shocks and fluctuating patient inflows, strengthening preparedness and surge-response capacity is essential to maintaining continuity and quality of care.

Importantly, mortality at ATH remained relatively evenly distributed throughout the year, rather than mirroring seasonal admission peaks. This suggests that deaths were not solely attributable to temporary overcrowding, but more likely reflect persistent structural weaknesses, including shortages of trained personnel, insufficient specialized equipment, inconsistent implementation of WHO treatment guidelines, and limited capacity to manage complex paediatric cases. Similar systemic challenges have been documented in conflict-affected healthcare systems, where prolonged instability undermines institutional resilience and quality of care (11, 23, 24).

Finally, the elevated default rate observed at ATH warrants particular attention. Treatment interruption remains a critical challenge in SAM management programmes because it increases the risk of relapse, clinical deterioration, and mortality. Previous studies have shown that defaulting is often associated with barriers to access, caregiver burden, weak follow-up systems, and limited continuity of care (20, 22). The inverse relationship observed between seasonal admission peaks and default trends may indicate that periods of increased patient inflow reduced the facility's capacity to maintain adequate follow-up and patient retention mechanisms. Strengthening community outreach, caregiver counselling, and patient-tracking systems could therefore contribute to improving treatment adherence and programme effectiveness. These challenges are likely linked to limited technical and professional resources, as well as the absence of rigorous case management protocols capable of ensuring continuity of care and, ultimately, more favourable treatment outcomes, particularly through a reduction in default cases.

Limits and future developments Strengths and limitations

This study has several limitations that should be acknowledged. The retrospective design restricts the ability to establish causal relationships between variables and outcomes, as the analysis relies on previously recorded information rather than prospective follow-up. Furthermore, the use of routine program records may introduce data quality concerns, including incomplete documentation, inconsistencies, or missing information. Finally, the dataset lacked detailed demographic and clinical variables, such as age stratification and information on comorbidities, which limited the depth of the analysis and prevented a more comprehensive assessment of factors influencing treatment outcomes.

Future research should aim to address these limitations through prospective study designs that allow for a more robust evaluation of causal relationships and treatment effectiveness. Collecting more detailed socio-demographic and clinical information, including nutritional status indicators and the presence of comorbidities, would provide a deeper understanding of factors associated with patient outcomes. Further studies could assess the impact of contextual factors such as resource availability, staff capacity, and accessibility of services. Moreover, it would also be necessary to conduct an in-depth investigation into the situation in the governorate of Al-Dale, where the mortality rate appeared to be particularly elevated, reaching approximately 2.5%.

Conclusions

Overall, this study highlights the value of monitoring TFCs performance indicators in humanitarian settings for the effective treatment of SAM. While the Yemeni TFC network demonstrated strong overall effectiveness, the significant disparities identified between facilities emphasize the importance of targeted interventions aimed at strengthening weaker centres. From an international health cooperation perspective, these findings support the need for sustained investment in interventions to establish TFCs mainly to PHCs primary centres because of the demonstrated effectiveness of the adopted standardized clinical protocols, referral systems, nutritional supply chains, and integrated maternal-child health services here.

In conflict-affected countries such as Yemen, strengthening the resilience and quality of nutritional treatment programmes is essential not only to improve SAM outcomes but also to reduce preventable child mortality and support broader humanitarian health objectives.

Declarations

Ethics approval and consent to participate:

Ethical approval and informed consent were not required, as the study was based exclusively on secondary anonymized data.

Consent for publication:

Not applicable.

Competing interests:

The author declares that there are no competing interests.

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Author Contribution

Authors' contributions: MSB designed the study and collected the data and wrote the initial draft. LBD designed the study and revised the draft. MG analyzed and interpreted the data, preparation of the manuscript. All authors read and participated in the writing of the draft and approved the final manuscript. MSB: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources Data curation,

Writing - Original Draft, Writing - Review & Editing, Visualization, Supervision, Project administration, Funding acquisition. LBD: Validation, Formal analysis, Investigation, Resources, Data curation, Writing - Review & Editing, Visualization, Supervision, Project administration, Funding acquisition. MG: Methodology, Validation, Formal analysis, Resources, Data curation, Writing - Review & Editing, Visualization,

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Data Availability

I used the research data in this study

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Figures

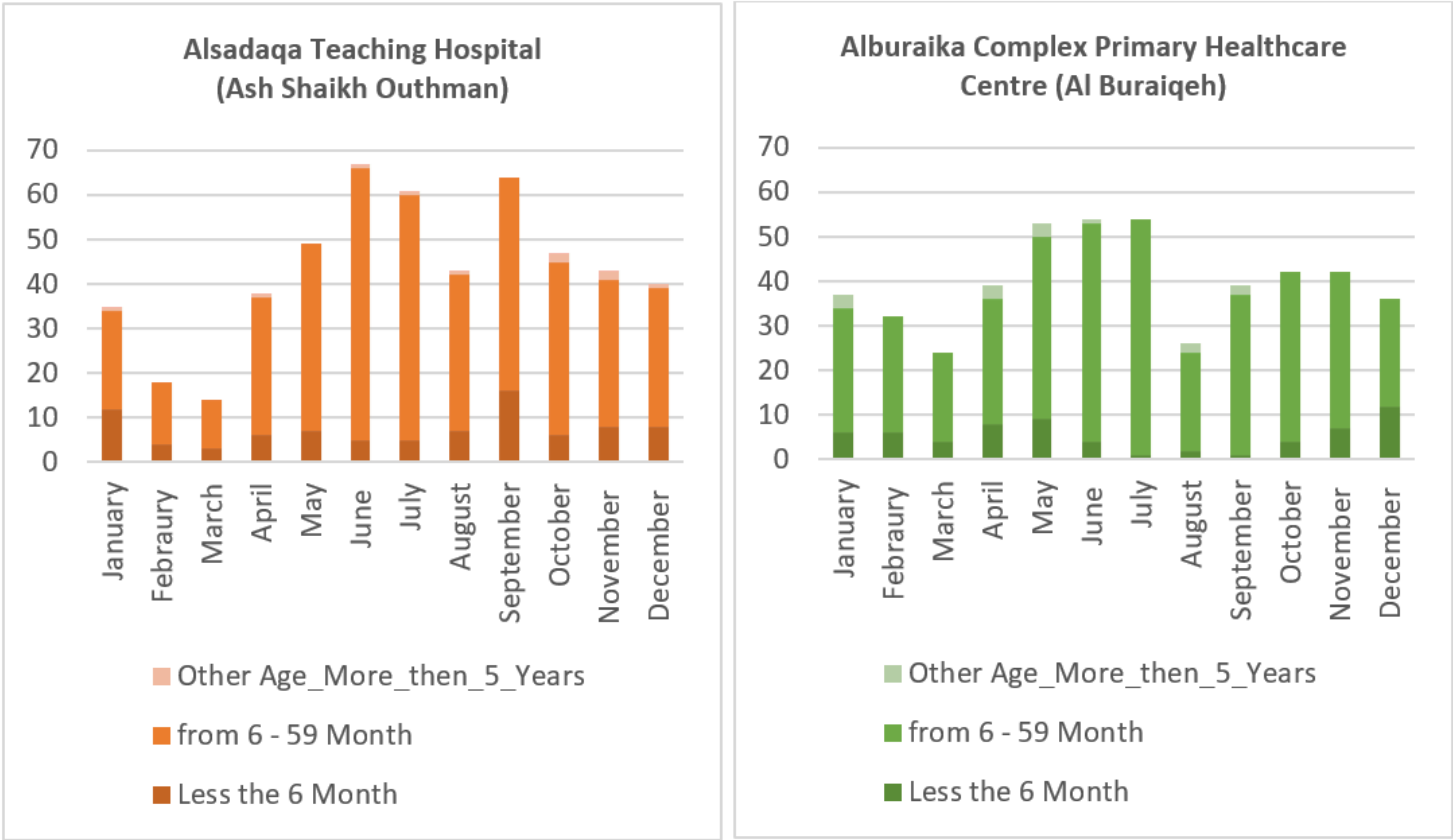


Figure 1

Graphic 1 – Total admissions in Aden Governorates monthly segmented for age-ranges

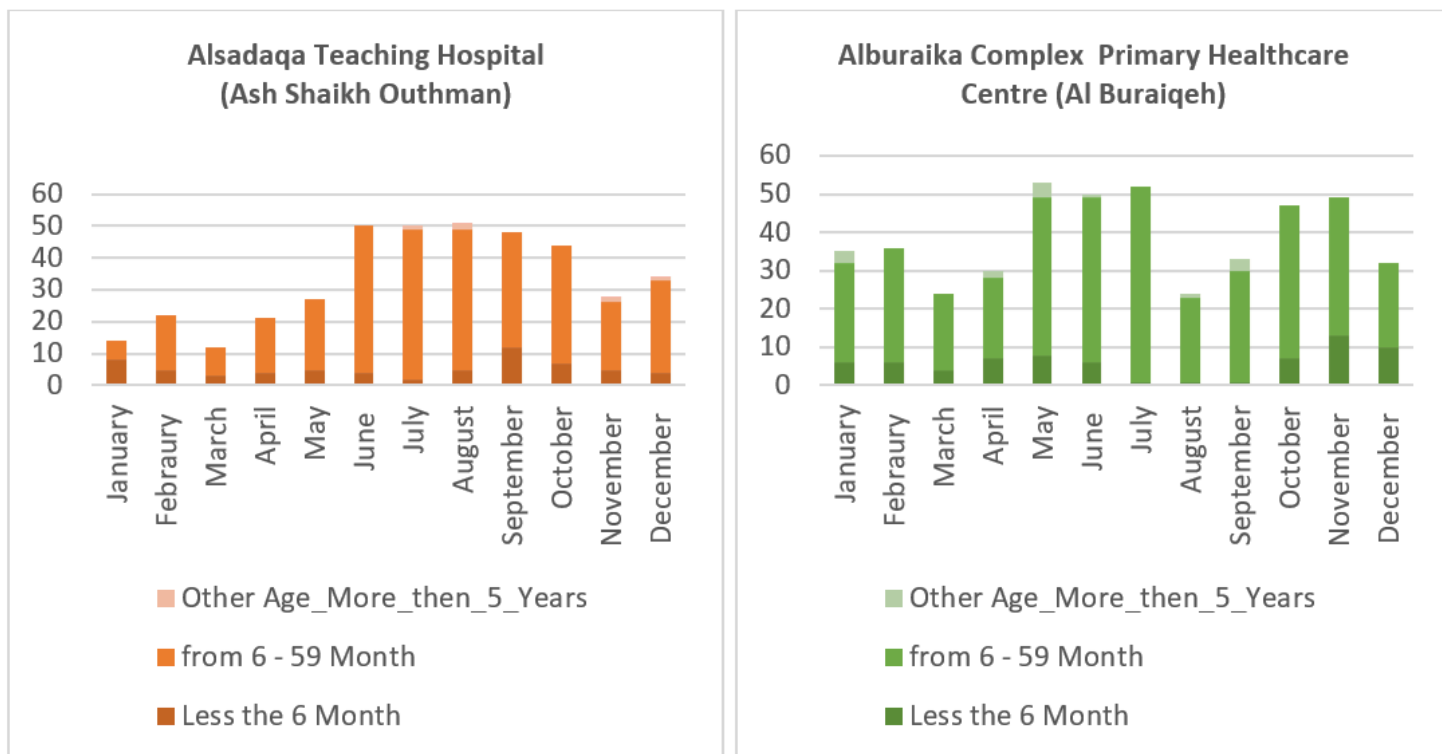


Figure 2

Graphic 2 - Recovered children in Aden Governorates monthly segmented for age-ranges

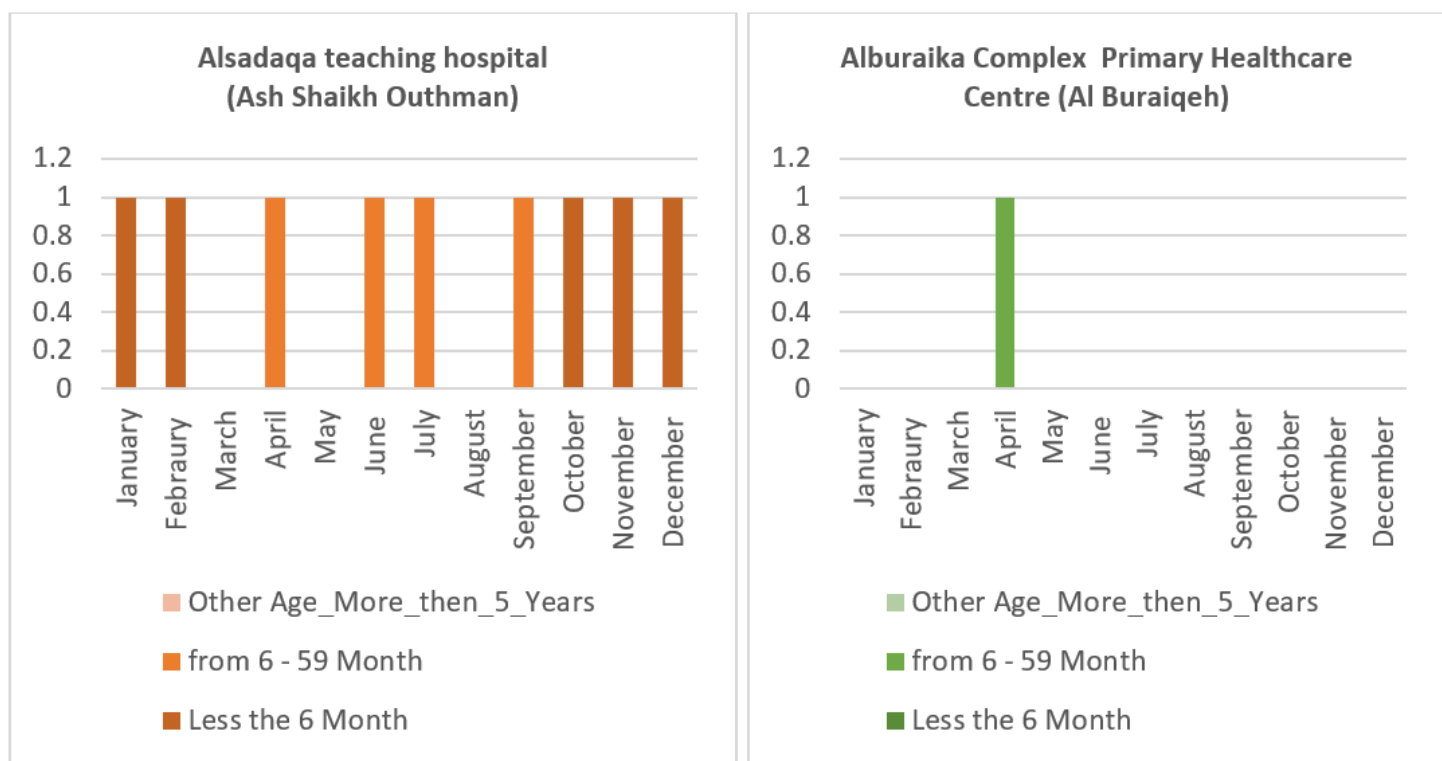


Figure 3

Graphic 3 – Deaths in Aden Governorate monthly segmented for age-ranges

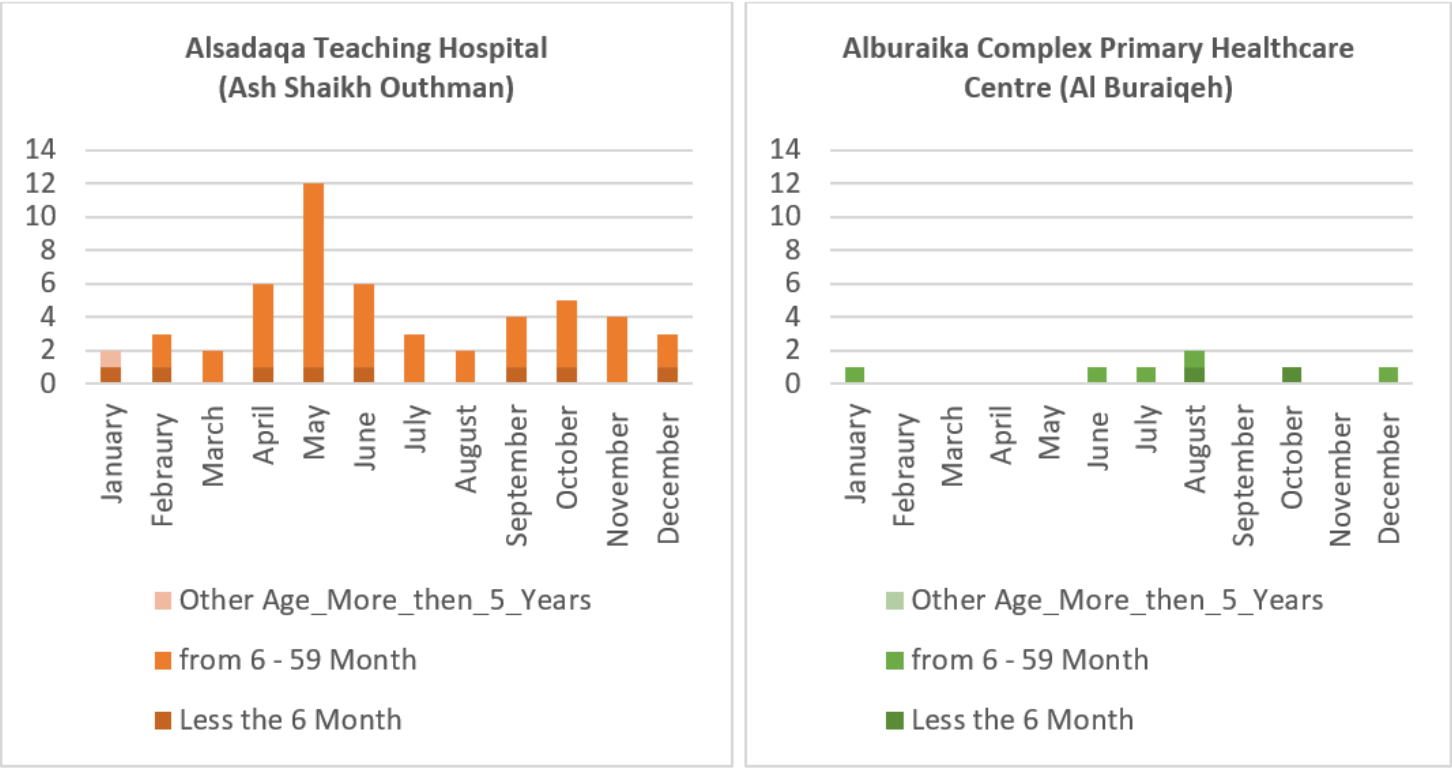


Figure 4

Graphic 4 - Defaulters in Aden Governorate monthly segmented for age-ranges

Supplementary Files

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- [Annexes.docx](#)