JNS
JOURNAL OF NUTRITIONAL SCIENCE

RESEARCH ARTICLE

Rate, risk factors and estimated time to develop attrition after under-five children started moderate acute malnutrition treatment in Gubalafto, North East Ethiopia

Yimer Mekonen[1] and Fassikaw Kebede[2]*

[1]*Dire Roka Health center, Gubalafto woreda Health office, North Wollo Zone, North East Ethiopia*
[2]*Department of Epidemiology and Biostatistics, college of health science, Woldia University, North East Ethiopia*

(Received 14 June 2022 – Final revision received 3 January 2023 – Accepted 10 January 2023)

Journal of Nutritional Science (2023), vol. 12, e15, page 1 of 6 doi:10.1017/jns.2023.4

Abstract

Lost from follow-up, after starting moderate acute malnutrition (MAM) is an ongoing challenge of public health until the admitted children reached the standard weight of a reference child. Thus, the present study aimed to assess the rate and estimated time to attrition after under-five children started treatment for MAM in the Gubalafto district. A facility-based retrospective cohort study was employed among 487 participant children who had been managed targeted therapeutic feeding from 1 June 2018 to 1 May 2021. The overall mean (±SD) age of the participants' children was 22·1 (±12·6) months. At the end of the study period, 55 (11·46 %) under-five children developed attrition from the treatment after starting ready use of therapeutic feeding. After checking all assumptions, a multivariable Cox regression model was used to claim independent predictors for time to attritions. The median time of attrition after starting treatment of MAM was 13 (IQR ±9) weeks, with the overall incidence of attrition rate reported at 6·75 children Per Week (95 % CI 5·56, 9·6). In the final model of multivariable Cox regression, the hazard of attrition was significantly higher for children from rural residence (AHR 1·61; 95 % CI 1·18, 2·18; $P = 0·001$), and caregivers with their dyads did not get nutritional counselling at baseline (AHR 2·78; 95 % CI 1·34, 5·78; $P = 0·001$). The findings of the present study showed that nearly one in every eleven under-five children was attrition (lost to follow-up) in a median time of 13 (IQR ±9) weeks. We strongly recommended for caregivers provisions of diversification of daily nutrition supplementation of their dyads.

Key words: **Attrition rate: Ethiopia: Moderate acute malnutrition: Under-five children**

Introduction

Community-Based Management of Acute Malnutrition (CMAM) is a decentralised community-based approach to treating acute malnutrition and is defined as WHZ/WLZ ≥−2 and <−3 or MUAC ≥11·5 cm and <12·5 cm[1]. Acute malnutrition is directly or indirectly responsible for 60 % of the 10·9 million deaths ofunder-five children, and two-thirds of this death occurred in the first year of their life[2–4]. When a child has developed moderate acute malnutrition (MAM), it has often suffered from lifelong repercussions through ought its perpetuation[5,6]. Accordingly, a pooled analysis of ten longitudinal studies from Asia, Africa and South America found that children with MAM had threefold increased mortality rates as compared with no MAM[1].

Globally, in 2018, one in twelve of the estimated 52 million children under five had acute malnutrition, and 2·9 million of

* **Corresponding author:** Fassikaw Kebede, email fassikaw123@gmail.com, fassikaw.k@wldu.edu.et

Abbreviations: AHR, adjusted hazard ratio; CHR, crude hazard ratio; CI, confidence interval; FMOH, Ethiopian Federal Ministry of Health; MAM, moderate acute malnutrition; MUAC, mid-upper arm circumference; OTP, oral therapeutic programme; RUTF, ready-to-use therapeutic feeding; SD, standard deviation; WFH, weight for height.

these children were admitted for ready-to-use therapeutic feeding (RUTF)[7]. This might be due to loss to follow-up or attrition of caregivers from the centre after starting the treatment[8]. Whereas attrition is the interruption or defaulting before reaching the target weight for at least two consecutive weeks and it is a composite term of defaulted and self-discharged cases[3,9,10].

According to international Sphere standards, there are four main existing criteria for MAM treatment, i.e. cured, attrition, transfer out and death[5,11]. However, about 20–36 % reported self-discharged from the treatment centre after starting target supplementary feeding (TSF)[7,12] caused 1·4–10·9 % transition relapse of complicated SAM[13–15]. Despite the government of Ethiopia has been working on increasing the recovery rate of under-five children from MAM, the mortality rate has still been in the unacceptable range after starting RUTF[12] and as high as 14 %[13,16]. Moreover, a remarkable variation is observed in attrition rates ranging as high as 1·67 %[17] to 25·2 %[18]. This might be associated with the increased intention of self-discharging at thetime of caregiver from the treatment centre before reaching the reference weight of the child with or without treatment progression[8,19].

Factors like transportation fees and the continual cost of accessory drugs shared the major responsibility self-discharged after treatment was initiated[20]. Previous study findings also suggested that factors including the number of families and distance of the treatment centre were the primary causes for interruptions of the treatment[18,21]. It may also be associated with healthcare providers' negative attitudes towards long waiting times and lack of social support[3,9,22]. In Ethiopia, there is limited information regarding the predictors of attrition rate from the treatment centre. The present work aimed to assess the rate, risk factors and estimated time to develop attrition after under-five children started MAM treatment in Gubalafto, North East Ethiopia.

Methods

Study areas and settings

The study was conducted in Gubalafto Woreda (Administrative set) from 1 June 2018 to 1 May 2021 in the North Wollo Zone, Amhara Region, North East Ethiopia. This woreda is located 521 km away from Addis Ababa, the capital city of Ethiopia, and has an estimated population of 176 492 distributed within thirty-four villages. Furthermore, this Gubalafto Woreda in the North Wollo Zone has thirty-four health posts for the treatment of MAM[16].

Study design

The facility-based retrospective cohort study was employed from 1 June 2018 to 1 May 2021.

Source and study population

All under-five children started treatment for MAM in the health post of Gubalafto district in the North Wollo Zone were the source population for this study.

Study population

Randomly selected files of under-five children (aged 6–59 months) within eight health posts that started MAM treatment from 1 June 2018 to 1 May 2021.

Sample size determination

The sample size was calculated based on the formula for double population proportions using open EPI-Info version 2.3.1. The formula considers the following parameters, levels of significant 5 %, power of the study of 80 % and risk ratio of 1·4, and the outcome of the unexposed group taking 27·1 % from[6]. The total sample size to detect the factors lost to follow-up (attrition rate) after starting MAM care in the stabilising centre was 424 (including 15 % adjustment for incomplete recorded). The final sample size was determined to be 482. The total under-five files found within randomly selected eight health posts (eight out of total thirteen health posts in Gubalafto) was found to be 487. Since the file (*N* 487) is small and manageable in resources, we included the samples without sampling procedures.

Dependent variables

The outcome variable for this research was attrition or loss from follow-up after MAM treatment started and coded as (Yes/No).

Independent variables

- Socio-demographic (age and sex);
- Type of malnutrition (Marasmus, Kwashiorkor and Marasmic Kwashiorkor);
- Medical comorbidities (TB, HIV, pneumonia, fever, diarrhoea, immunisation, Measles vaccine, vitamin A, routine medications);
- Admission category (new and re-admission).

Operational words

Attrition (lost from follow-up/defaulting). Where a child who was not seen for at least two consecutive weeks after being started RUTF with or without treatment progression and confirmed by a home visit for the outpatient component of the programme called defaulter/lost from follow-up/attrition[16].

Cured. A patient that has reached WHZ > 85 % or a targeted discharge weight[16].

Non-responder. Patients that did not reach the discharge criteria after 2 months in the oral therapeutic programme (OTP)[10].

Medical transfer. A patient that was referred to a health facility/hospital for medical reasons and this health facility will not continue the nutritional treatment[10].

Transfer out. A discharge with an outcome and the patient that has started the nutritional treatment in OTP and is referred to another site to continue the treatment[16].

Data collection instruments and quality control

Standard and pretested data extraction tools were used to extract the required information from individual charts. The data collectors and supervisors were trained for 2 d on the techniques of data collection for the important purposes of the study before the start of data collection. An assigned supervisor strictly followed and oversaw the completeness of the collected data and feedback was given daily. To assure the quality of the data, the investigators closely supervised the data collection procedure daily. The pretest was conducted in the Gonder Ber Health Center (which is not a study area) using 5 % of the total sample size which is not included in the actual sampling.

Data processing and analysis

Before data were analysed, the WHO Anthro-Plus-Version 1.04 and ENA for Nutrition Smart Software were used to generate the *Z*-score (WAZ, HAZ and WHZ/BAZ) to define the nutritional status of HIV-positive children. The incidence rate is calculated using the total number of people per year (PPY) individual contribution to follow-up as a denominator. The Kaplan-Meier plot estimates the median MAM-free survival time. Descriptive non-parametric statistical tests such as the Kaplan-Meier plot were used to estimate the median SAM-free survival time.

Where

$$S_{\mathrm{KM}} = \pi_{t_{(i)} \le t} p_i$$

$$S_{\mathrm{KM}}(t) = 1 \quad \text{if } t < t(1)$$

The final analysis was computed using the Cox proportional hazard regression model after checking all the above assumptions and covariates having <0·2 *P*-values in the bivariable analysis were fitted to the Cox proportional multivariable model. Finally, statistical significance was declared at a *P*-value of <0·05. Our multivariable Cox proportional hazard regression was written during a consecutive follow upon an individual under observation experiencing the event in a period centred on that point in time. The equation of the Cox model has expressed as follows:

I. $H(t) = h_0(t) \times \exp(b_1X_1 + b_2X_2 + \ldots b_pX_p)$.
II. Where the hazard function $h(t)$ depends on several P covariates $(X_1, X_2, \ldots X_p)$.
III. Whose impact is measured by the size of the respective coefficients $(b_1, b_2, \ldots, b_p)$.

The term h_0 is called the baseline hazard (constant HR) and is the value of the hazard if all X_i are equal to zero (the number exp(0) equals 1). That is, $h(t)$ reminds us that the hazard may (and probably will) vary over time in the event of attrition.

Table 1. Baseline socio-demographic characteristics of children with MAM cases admitted to selected health posts in Gubalafto district from June 2018 to 2021

Variables	Categories	Frequency	Percentage (%)
Age of children	6–24 months	321	67
	25–48 months	137	28·5
	49–59 months	22	4·5
Sex of children	Female	238	49·5
	Male	242	50·5
Caregivers age	15–20	49	10·2
	21–39	373	77·7
	≥40	58	12·1
Marital status	Single	95	19·8
	Married	354	73·7
	Divorced/ widowed	31	6·4
Residency	Rural	311	64·5
	Urban	169	34·5
Number of family in the house	≤3	42	8·7
	4–6	287	59·8
	≥7	171	31·5
Distance from home to HP	<15 km	310	65·2
	≥15 km	170	34·8
Family income (Birr)	<2000	65	13·5
	≥2000	415	86·5

An appealing feature of the final Cox model is that the baseline hazard function is estimated as the normal distribution or non-parametric (constant over time), and so unlike most other statistical models, the survival times are not assumed to follow a particular statistical distribution. Finally, Cox – the proportional hazard assumption – was checked through three pillar principals, with the two graphical assumptions (log–log plot graph observations and observed versus expected graph symmetrical assumption) and statically assumptions (global goodness-of-fit test). Finally, Nelson alone and Cox Snell residual tests were used for checking the final model adequacy.

Result

Socio-demographic characteristics of children

After excluding seven (1·6 %) files of individual charts due to incompleteness, we reviewed 480(98·4 %) charts of under-five children from 1 June 2018 to 1 May 2021. More than half, 242 (50·5 %) of the children enrolled in the study were male in gender. The overall mean (±SD) of the age of the participants' cases was 22·1 (±12·6) months, with the majority 321(67 %) of them finding 6–24 months age group. Nearly three in a fourth of 311(65 %) caregivers in their dyads were from rural inhabitants, and the majority 310(64·5 %) of them ≤15 km far from the treatment centre. Moreover, the largest proportion of caregivers 354 (73·7) is married as shown in Table 1.

Baseline clinical and nutritional characteristics

The majority of 359(74·8 %) participant children did not have a comorbidity, however, 25 % of 121(25·2 %) of them had different comorbidities. Diarrhoea 10·8 % (*N* 52), pneumonia

8·7 % (*N* 42) and HIV 3·3 % (*N* 16) were some of the manifested comorbidities. The largest proportion of 415(86·5 %) under-five children was identified as newly admitted children. Of the total 400 participants, 377(78·5 %), 141(29·4 %) and 140(29·1 %) cases were fully vaccinated for measles, had vitamin A supplemented and 141(29·4 %) dewormed after starting the treatment, respectively. The median weight during admission found for marasmic, marasmic kwashi and oedematous cases was 6·5 kg (IQR ±3·3 kg), 8·9 kg (IQR ±5·7 kg) and 9·97 kg (IQR ±3·45 kg), respectively as shown in Table 2.

Treatment outcome and time to attrition

The 3-year retrospective cohort study of 480 cases yielded 5961 persons per day of risk observation. At the end of the study period, 391(81·46) children were cured, while the remaining 55(11·46 %) attrited from treatment, 18(3·75 %) died, 9(1·88 %) non-responded to treatment and 7(1·46 %) medically transferred to other health institutions. Of the total 55(11·46 %) defaulted (attrition) cases, the majority 45 (66·8 %) were lost to follow-up after 6 weeks. The median time to develop attrition was found to be 13 (IQR ±9) weeks. The overall incidence density rate of attrition was found to be 6·75 people per week (95 % CI 5·56, 9·6) with the survival rate of participant children at the end of follow-up found to be 81·4 % (95 % CI 76·5, 85·4).

Kaplan-Meier hazard curve and survival difference

There was a significant survival difference in the time of recovery from MAM for cases from rural residency with caregivers having feeding counselling during follow-up at baseline when tested by the log-rank test at $P < 0{\cdot}05$ as shown in the figures. Accordingly, there was a significant survival difference in the attrition rate of RUTF starting cases in rural and urban dwellers. Where about being rural, cases were early defaulted (attrition) from the treatment centre as compared with urban cases, evidenced by the log-rank test (χ^2; df(1) = 9·7, P = 0·03) (Fig. 1).

Table 2. Baseline clinical and nutritional characteristics of children with MAM cases admitted to TSFP at selected health posts in Gubalafto district from June 2018 to 2021

Variables	Categories	Frequency	Percentage (%)
Baseline MUAC	11·5–11·9 cm	206	42·9
	12—12·4 cm	274	57·1
Baseline weight	5–8·9 kg	180	37·5
	9–12·9 kg	293	61·0
	≥13 kg	7	1·5
Feeding counselling at baseline	No	136	28·3
	Yes	344	71·7
Cooking demonstration by healthcare provider for rations	No	170	35·4
	Yes	310	64·6
Baseline comorbidity	No	359	74·8
	Yes	121	25·2
Comorbidity types	Diarrhoea	52	43·0
	HIV/AIDS	16	13·0
	Pneumonia	42	8·7
	Others	11	2·24

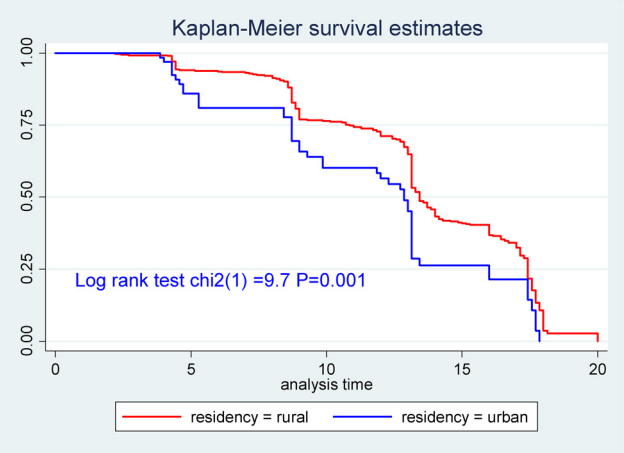

Fig. 1. Kaplan-Meier survival difference by the residency of children after starting MAM treatment of children aged 6–59 months in Gubalafto district, North East Ethiopia.

Moreover, there was a significant survival difference for caregivers on the attrition rate of RUTF starting cases in rural and urban dwellers. Moreover, there was a significant survival difference of attrition among caregivers who did not get child feeding counselling at base, linearly attrite as evidenced by the log-rank test (χ^2; df(2) = 31·4, P = 0·001) (Fig. 2).

Bivariable and multivariable Cox regression analysis for predictors

During bivariable Cox regression analysis, variables were checked whether they were associated with the incidence of attrition rate at *P*-value <0·25 for a candidate selection of multivariable Cox regression. There were fourteen categorical variables transferred for multivariable Cox regression.

After adjusting certain confounding, nine variables were fitted to build the final model. Only two variables were found independent predictors for the attrition rate of children from the OTP centre. These are when caregivers did not get feeding counselling for children at baseline (AHR 2·78; CI 1·34, 5·78; P = 0·001) and were caregivers in rural residences (AHR 1·61; CI 1·18, 2·18; P = 0·001) were significant predictors for attrition rate.

Overall, the model adequacy test

For the overall final multivariable Cox regression model, the adequacy test of Cox Snell residual test indicates the line is on the straight origin as shown in Fig. 3.

Discussion

The final report of the present study revealed that the overall crude incidence of attrition rate was found to be 6·75 % (95 % CI 5·56, 9·6). This is almost similar to the previously reported

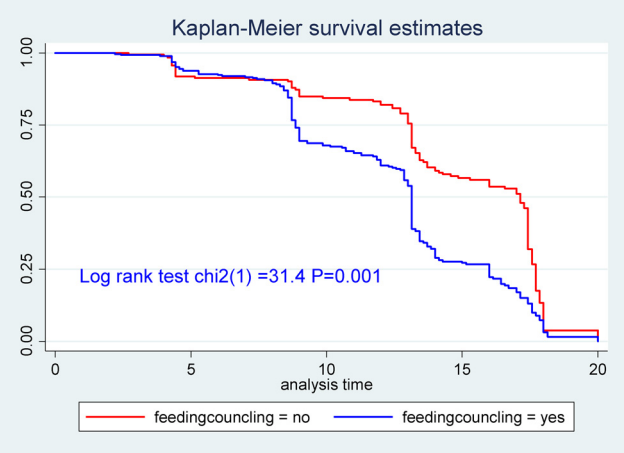

Fig. 2. Kaplan-Meier survival difference having caregivers got feeding counselling by healthcare providers after started MAM treatment in Gubalafto district, North East Ethiopia.

10·3 % finding in the South Wollo Zone[23] but inconsistent and lower than the previous description of 16·5 % in North West Ethiopia[24], and 24·1 % Sokoto, Nigeria[25]. Nevertheless, this finding is higher than previously reported 2·2 % in the Hadiya Zone of Southern Ethiopia[2,3]. The possible reason for the variation can be due to the differences in the study period, settings, sample size and counselling barriers of healthcare providers during treatment. On the other hand, early healthcare-seeking behaviour and commitment of the family of children influenced the length of long-term treatment intensity in OTP centres.

Furthermore, the median time to develop attrition was found to be 13 (IQR ±9) weeks. Which was lower than the national protocol of mean time to wait upon target weight achieved in the RUTF centre[19]. Moreover, the qualities of the clinical healthcare service, specifically the cost of the accessorial drug at baseline admission contributed to the intention to caregiver self-discharged. Regarding predictors for attrition rate, variables like residences, and counselling on how to feed their children at baseline were significantly associated with attrition from RUTF centres. Consistent with previous findings in North Shewa, Oromia Region[10], Washington University, St. Louis[26] and Bihar, India[17] caregivers did not get feeding counselling when RUTF treatment at treatment increased intention to attrition from the centre. When caregivers did not get feeding counselling for children at baseline, there was nearly three times the increased attrition rate from the treatment centre as compared with those who had advice on how to feed their children (AHR 2·78; CI 1·34, 5·78; $P = 0·001$). This might be due to the topographically Gubalafto Woreda was in long-term duration and was a war centre for the past 3 years since (2019–21)[16] is a home for a refugee population in the catchment area. This might expose the caregiver population to be food insecure and lack home assets as a farmer and hard to be stable after admission of their dyads due to fear of continual transportation fees and cost of accessory drugs during inpatient treatment of MAM, and they prefered self-discharged with or without treatment progression. Moreover, the risk of attrition rate for under-five who were from rural residences nearly two times increased as compared with urban children (AHR 1·61; CI 1·18, 2·18; $P = 0·00$). This finding is in line with previous reports in South Gondar[4,27] and Pawe Hospital[6]. This might be in some instant family education status has an impact on the intention for long-term treatment outcome of their dyads. In these cases, educated mothers have an awareness regarding their child's health, and they might be active unless their child has not obtained the targeted weight and will not interrupt the ongoing treatment even though who were from rural residents.

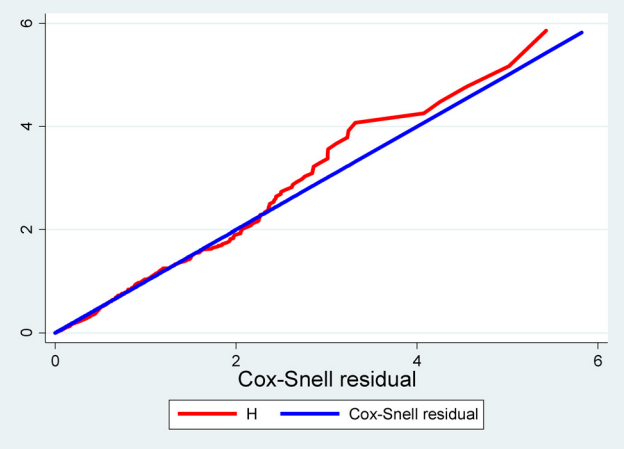

Fig. 3. The overall model adequacy attrition rate among children aged 6–59 months started MAM in Gubalafto district, North East Ethiopia.

Limitations of the study

The retrospective nature of data collection may miss significant variables like household, economic assets and food security status of the family and this leads to based interpretations of the result. Therefore, the application of our findings for clinical decisions and policy should take into account these limitations in addition to the lack of qualitative approaches for some predictors.

Conclusion

Nearly one in every eleven MAM treatment-admitted children developed attrition (lost to follow-up) after the onset of treatment. Living in a rural residence, caregivers who did not get child feeding counselling were significantly associated with attrition rates. Hence, serious counselling both in baseline and during consecutive follow-ups was highly needed on nutrition diversification for virtuous treatment outcomes of children.

Acknowledgements

Firstly, we would like to express our deepest gratitude to the Ethical Review Board of Woldia University College of Health Science research, community service, technology transformation and university–industry linkage approved ethically to conduct this research. Lastly, we would like to thank data collectors, supervisors and data clerk staff for their unreserved collaboration during data collection.

The authors declared that there is no financial support for doing this research.

All authors worked and contributed to this manuscript as follows as Y. M.; Conceptualisation Formal analysis, Investigation, Methodology, Project administration, Resources, Software, F. K.; Formal analysis, Methodology, Resources, Software, Visualisation, Writing – original draft.

The authors declare that no competing interests exist.

Before starting the data collection process, the study was ethically permitted by the Ethical Review Board (IRB) of Woldia University College of Health Science ethically with 0015/2015. The Ethical Review Board (IRB) of Woldia University waived the written informed consent from participant cases since the authors had no physical contact with the caregiver and their children during data collection.

References

1. Audrey P, Nirmala N, Andrew C, *et al.* (2019) Mortality and recovery following moderate and severe acute malnutrition in children aged 6–18 months in rural Jharkhand and Odisha, eastern India. *PLoS Med* **16**, e1002934. doi:10.1371/journal.pmed.1002934.
2. Lambebo A, Tamiru D & Belachew T (2021) Time to relapse of severe acute malnutrition and risk factors among under-five children treated in the health posts of Hadiya Zone, Southern Ethiopia. *J Nutr Sci* **10**, e105.
3. Lambebo A, Temiru D & Belachew T (2021) Frequency of relapse for severe acute malnutrition and associated factors among under five children admitted to health facilities in Hadiya Zone, South Ethiopia. *PLoS ONE* **16**, e0249232.
4. Mulugeta DB) Rural children remain more at risk of acute malnutrition following exit from community based management of acute malnutrition program in South Gondar Zone, Amhara Region, Ethiopia: a comparative cross-sectional study. *PeerJ* **8**, e8419. doi:107717/peerj8419. Published 7 February 2020.
5. Fassikaw K, Nemera E, Belete N, *et al.* (2021) Predictors for a cure rate of severe acute malnutrition 6–59 month children in stabilizing center at Pawe General Hospital, Northwest Ethiopia: Retrospective Cohort Study. *Int J Child Health Nutr* **10**, 34–43. doi:10.1046/j.1365-2702.2001.0049.
6. Fassikaw K, Tsehay K, Belete N, *et al.* (2022) Incidence and predictors of severe acute malnutrition mortality in children aged 6–59 months admitted at Pawe General Hospital. *PLoS ONE* **17**, e0263236. doi:10.1371/journal.pone.0263236.
7. Zebenay Workneh B (2020) Treatment outcomes of severe acute malnutrition and predictors of recovery in under-five children treated within outpatient therapeutic programs in Ethiopia: a systematic review and meta-analysis. *BMC Pediatrics* **20**, 335. doi:101186/s12887-020-02188-5.
8. Kebede F (2022) Time to readmission and associated factors after post treatment discharge of severe acute malnourished under-five children in Pawe General Hospital. *J Health Popul Nutr* **41**, 29.
9. Stobaugh HC, Mayberry A, McGrath M, *et al.* (2019) Relapse after severe acute malnutrition: a systematic literature review and secondary data analysis. *Matern Child Nutr* **15**, e12702. doi:10.1111/mcn.12702.
10. Amare B, Addisu Waleligne T & Biachew Asmare Y (2022) Time to recovery and determinants of uncomplicated severe acute malnutrition among 6 to 59 months children from the outpatient therapeutic feeding program in North Shewa Zone of Oromia Region, Ethiopia: a prospective follow-up study. *Nutr Metab* **15**, 1. doi:101177/11786388221106.
11. UKAIDS & OXFAM (2017) Recovery, relapse and episodes of default in the management of acute malnutrition in children in humanitarian emergencies. A systematic review. Humanitarian Evidence Programme. https://www.gov.uk/dfid-research-outpu.
12. Wagnew F, Dessie G, Takele WW, *et al.* (2019) A meta-analysis of inpatient treatment outcomes of severe acute malnutrition and predictors of mortality among under-five children in Ethiopia. *BMC Public Health* **19**, 1175.
13. Bisrat G, Kulkarni U & Mariam YG (2016) Assessment of the nutritional status and associated factors of orphans and vulnerable preschool children on care and support from nongovernmental organizations in Hawassa Town. *Glob J Med Res* **16**, 2249–4618. Version 10 Year 2016 Online ISSN & Print ISSN: 0975-5888.
14. Tesfay W, Abay M, Hintsa S, *et al.* (2020) Length of stay to recover from severe acute malnutrition and associated factors among under-five years children admitted to public hospitals in Aksum, Ethiopia. *PLoS ONE* **15**, e0238311. doi: 10.1371/journal.pone.0238311
15. O'Sullivan NP, Lelijveld N & Rutishauser-Perera A (2018) Follow-up between 6 and 24 months after discharge from treatment for severe acute malnutrition in children aged 6–59 months: a systematic review. *PLoS ONE* **13**, e0202053. doi:10.1371/journal.pone.0202053.
16. Biruk Beletew A, Ayelign Mengesha K & Mesfin Kassa W (2020) Treatment outcome of severe acute malnutrition and associated factors among under-five children in outpatient therapeutics unit in Gubalafto Woreda, North Wollo Zone, Ethiopia, 2019. *PLoS ONE* **15**, e0238231. doi:10.1371/journal.pone.0238231.
17. Burza S, Mahajan R, Marino E, *et al.* (2016) Seasonal effect and long-term nutritional status following exit from a community-based management of severe acute malnutrition program in Bihar, India. *Eur J Clin Nutr* **70**, 437–444.
18. Belachew T & Nekatibeb H (2007) Assessment of outpatient therapeutic programme for severe acute malnutrition in three regions of Ethiopia. *East Afr Med J* **84**, 577–588.
19. Binyam A & Tariku D (2019) Time of recovery and associated factors of children with severe acute malnutrition treated at outpatient therapeutic feeding program in Dire Dawa, Eastern Ethiopia. *PLoS ONE* **14**, e0217344. doi:10.1371/journal.pone.0217344.
20. Hasan A, Mohammod JC, Sayeda RM, *et al.* (2012) A follow-up experience of 6 months after treatment of children with severe acute malnutrition in Dhaka, Bangladesh. *J Trop Pediatr* **58**. doi:10.1093/tropej/fmr083.
21. Dale NM, Salim L, Lenters L, *et al.* (2018) Recovery and relapse from severe acute malnutrition after treatment: a prospective, observational cohort trial in Pakistan. *Public Health Nutr* **21**, 2193–2199.
22. Fassikaw K, Tadesse T, Nemera E, *et al.* (2022) Time to recovery from severe acute malnutrition and its predictors among children aged 6–59 months at Asosa general hospital, Northwest Ethiopia. A retrospective follow up study. *PLoS ONE* **17**, e0272930. doi: 10.1371/journal.pone.0272930
23. Hassen SL, Astatkie A, Mekonnen TC, *et al.* (2019) Survival status and its determinants among under-five children with severe acute malnutrition admitted to inpatient therapeutic feeding centers in South Wollo Zone, Amhara Region, Ethiopia. *J Nutr Metab* **2019**, 2643531.
24. Wondim A, Tigabu B & Kelkay MM (2020) Time to recovery from severe acute malnutrition and its predictors among admitted children aged 6–59 months at the therapeutic feeding center of Pawe General Hospital, Northwest Ethiopia: a retrospective follow-up study. *Int J Pediatr* **2020**, 8406597.
25. Adegoke O, Arif S, Bahwere P, *et al.* (2020) Incidence of severe acute malnutrition after treatment: a prospective matched cohort study in Sokoto, Nigeria. *Matern Child Nutr.* doi:10.1111/mcn.13070.
26. Chang CY, Trehan I, Wang RJ, *et al.* (2013) Children successfully treated for moderate acute malnutrition remain at risk for malnutrition and death in the subsequent year after recovery. *J Nutr* **143**, 215–220. doi:10.3945/jn.112.1680.
27. Dereje Birhanu A, Afework Mulugeta B & Bazzano AN (2020) Predictors of relapse of acute malnutrition following exit from community-based management program in Amhara Region, Northwest Ethiopia. *PLoS ONE* **5**, e0231524. doi:10.1371/journal.pone.0231524.