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INCIDENCE AND PREDICTORS OF SEVERE ACUTE MALNUTRITION MORTALITY RATE AMONG CHILDREN AGED 6-59 MONTHS ADMITTED AT PAWE GENERAL HOSPITAL, NORTHWEST ETHIOPIA 2021

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Keywords:	Severe acute malnutrition, Predictors of mortality, Under-five-Children, Ethiopia,
Abstract:	Abstract: Severe acute malnutrition (SAM) is defined by very low weight for height (below -3z scores of the median WHO growth standards), by visible severe wasting, or by the presence of nutritional edema. Mortality magnitudes for under-five children were well documented in Ethiopia, nevertheless lacking information on the predictors when death occurs during inpatient treatment. The aim of understanding to time when under-five children with inpatient SAM die and its predictors could be vital to develop the time-relevant intervention. Methods : A retrospective cohort study was conducted among 568 under-five children from January 1 st , 2015 up to December 31 st , 2019 at Pawe general hospital. Epi Data version 3.2 and Stata (SE) R- 14 software were used for data entry and analysis, respectively. The Kaplan–Meier survival curves and log-rank test were performed to compare significant survival and death experiences among study participants. Bi-variables Cox-regression model was built to select candidate variables at P <0.25. Adjusted hazard ratio (AHR) with a 95% confidence interval (CI) was used to estimate a significant predictor for inpatient SAM mortality at P<0.05 Result:- Five-hundred sixty-eight (N=568) admitted SAM cases were included in this study. The mean age of participants was 27.4 (SD± 16.5) months, and the overall incidence density rate (IDR) of inpatient mortality was 16.03 per 100 (95%CI: 13.86; 20.04) person-days risk of observation. Cases at baseline being admitted with vomiting (AHR=5.1; 95%CI: 1.35-21.1, P<0.026), diarrhea (AHR=2.79; 95%CI: 1.46-5.4; P<0.002), nasogastric therapy (NGT) (AHR=3.22; 95%CI; 1.65- 6.26, P<0.001) , anemic (AHR= 1.89; 95% CI: 1.15- 3.2; P<0.012) , and being re-admitted(relapsed) SAM case (AHR=1.7; 95%CI: 1.12 - 2.8, P<0.037) were independent predictors for inpatient SAM mortality. Conclusion:- The overall SAM mortality rate was high among children treated in stabilizing centers as compared with the national standard of protocol(<10%). Cases at baseline admitted with vomiting, diarrhea, NGT, anemic and re-admitted (Relapsed SAM cases) were highly associated with mortality incidence. Health education on early medical seeking behavior for clinicians, caregivers, and adherence to the routine regimens may improve child inpatient treatment survival besides boosting up the strategy to minimize attrition rate after case admission.
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This is to inform you as members of Ethiopia University the problem is solved based on original studies results and decisions come accordingly by scientific communication. We authors understand to submit our new research on your journals. As you know, Sever acute malnutrition is a silent crisis of killing of in Ethiopia. The problem is a more worse and had devastating impact on under- five children. Besides, to risks of death, there is a growing consensus of once life span long-lasting scary consequences into adulthood for imped school competency and productivity. Therefore, we authors provide entitled incidence rate and predictors of severe acute malnutrition mortality among 6-59 months children admitted in stabilizing center at Pawe general hospitals, northwest, Ethiopia 2020 for publications.
Furthermore, the finical support for this research was obtained from Debre Markos university graduate school as MPH student research support fund. The role the funders

information entered here is included in the Methods section of the manuscript. **Format for specific study types** **Human Subject Research (involving human participants and/or tissue)** • Give the name of the institutional review board or ethics committee that approved the study • Include the approval number and/or a statement indicating approval of this research • Indicate the form of consent obtained (written/oral) or the reason that consent was not obtained (e.g. the data were analyzed anonymously) **Animal Research (involving vertebrate animals, embryos or tissues)** • Provide the name of the Institutional Animal Care and Use Committee (IACUC) or other relevant ethics board that reviewed the study protocol, and indicate whether they approved this research or granted a formal waiver of ethical approval • Include an approval number if one was obtained • If the study involved *non-human primates*, add *additional details* about animal welfare and steps taken to ameliorate suffering • If anesthesia, euthanasia, or any kind of animal sacrifice is part of the study, include briefly which substances and/or methods were applied **Field Research** Include the following details if this study involves the collection of plant, animal, or other materials from a natural setting: • Field permit number • Name of the institution or relevant body that granted permission	took in the study, Funders had no role in this study as I am MPH candidate in the abovementioned university funders has no role except giving support for their students on the time of research. In addition, no authors mentioned in this study had received any salary for this particular study. In this study, including me all authors received no specific funding for this work Lastly , we have also added Academic editors (Mr. Bob Taylors) comment with Author response for reviewers issue raised during June re-submission. Thanks for your understand 1*Corresponding Author Fassikaw Kebede (BSC, MPH) Lecturer at school of Public health College of Health science Woldia University FK = fassikaw123@gmail.com Institutional email = fassikaw.k@wldu.edu.et Web address URL: http://www.wldu.edu.et
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Lastly , we have also added Academic editors (Mr. Bob Taylors) comment with Author response for reviewers issue raised during June re-submission. Thanks for your understand

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INCIDENCE AND PREDICTORS OF SEVERE ACUTE MALNUTRITION MORTALITY RATE AMONG CHILDREN AGED 6-59 MONTHS ADMITTED AT PAWE GENERAL HOSPITAL, NORTHWEST ETHIOPIA 2021

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Abstract: Severe acute malnutrition (SAM) is defined by very low weight for height (below -3z scores of the median WHO growth standards), by visible severe wasting, or by the presence of nutritional edema. Mortality magnitudes for under-five children were well documented in Ethiopia, nevertheless lacking information on the predictors when death occurs during inpatient treatment. The aim of understanding to time when under-five children with inpatient SAM die and its predictors could be vital to develop the time-relevant intervention.

Methods: A retrospective cohort study was conducted among 568 under-five children from January 1st, 2015 up to December 31st, 2019 at Pawe general hospital. Epi Data version 3.2 and Stata (SE) R- 14 software were used for data entry and analysis, respectively. The Kaplan–Meier survival curves and log-rank test were performed to compare significant survival and death experiences among study participants. Bi-variables Cox-regression model was built to select candidate variables at *P*<0.25. Adjusted hazard ratio (AHR) with a 95% confidence interval (CI) was used to estimate a significant predictor for inpatient SAM mortality at P<0.05

Result:-Five-hundred sixty-eight (N=568) admitted SAM cases were included in this study. The mean age of participants was 27.4 (SD± 16.5) months, and the overall incidence density rate (IDR) of inpatient mortality was 16.03 per 100 (95%CI: 13.86; 20.04) person-days risk of observation. Cases at baseline being admitted with vomiting (AHR=5.1; 95%CI: 1.35-21.1, P<0.026), diarrhea (AHR=2.79; 95%CI: 1.46- 5.4; P<0.002), nasogastric therapy (NGT) (AHR=3.22; 95%CI; 1.65- 6.26, P<0.001) , anemic (AHR= 1.89; 95% CI: 1.15- 3.2; P<0.012) , and being re-admitted(relapsed) SAM case (AHR=1.7; 95%CI: 1.12 - 2.8, P<0.037) were independent predictors for inpatient SAM mortality.

Conclusion:-The overall SAM mortality rate was high among children treated in stabilizing centers as compared with the national standard of protocol(<10%). Cases at baseline admitted

with vomiting, diarrhea, NGT, anemic and re-admitted (Relapsed SAM cases) were highly associated with mortality incidence. Health education on early medical seeking behavior for clinicians, caregivers, and adherence to the routine regimens may improve child inpatient treatment survival besides boosting up the strategy to minimize attrition rate after case admission.

Keywords: Severe acute malnutrition, Predictors of mortality rate, Children, Ethiopia

Introduction

Malnutrition remains one of the most common causes of morbidity and mortality in children throughout the world. It has been responsible for directly or indirectly 60%of the 10.9 million death annually among under-five children. Two-third of these deaths occurred during the first year of life **[1-4].** Childhood under-nutrition incorporates a combination of nutrition disorders that include underweight, wasting, stunting, and micronutrient deficiency[5, 6]. Underweight (Weight-For-Age ≤- 3 Z score), is a composite measure of wasting and stunting, while wasting (Weight For Height ≤- 3 Z score) is acute malnutrition due to a recent failure to receive nutrition's and may be affected by recent episodes of diarrhea and other acute illnesses[3, 5]. Although SAM usually affects all segments of a population, infants and young children are most vulnerable as they have higher nutritional requirements for growth and development[7]. It is one of the leading causes of morbidity and mortality among infants and young children all over the world and more frequently in sub-Saharan Africa and South Asia[8]. The peak age for SAM is 6–18 months, which is the time of fast growth and brain development[9]. Globally in 2018, 1 in 12 of the estimated 52 million children under five had SAM[10], and 2.9 million of those children were admitted for inpatient treatment [10, 11]. The Sub-Saharan African countries account for the most proportions of case fatality rate[12]. Despite the availability of

outpatient treatment, the number of children with SAM seeking admission at stabilizing centers (SC) increasing. However,50% of children with SAM die due to inappropriate care after being admitted to stabilizing center [13]. One important reason is poor adherence to SAM therapeutic guidelines [1], and another is the late presentation for treatment centers [14]. Malnutrition in Ethiopia is a long-term silent killing crisis, especially for infants, and children which contribute to an estimated 270,000 deaths each year [15]. According to the Health and Health-Related Indicators (HHRI) of 2014 in Ethiopia, SAM was the third leading cause of mortality and accounted for 8.1%of the death of under-five children [5, 16, 17]. Despite launching the Seqota declaration to end the death of SAM by 100% access to adequate food[18], SAM is still a reason for 20% of pediatric hospital admissions, and 30%of inpatient death [19]. This is the main challenge of successful treatment outcomes in developing countries like Ethiopia and generating a local based data for reason to death is highly important to meet the goal of therapeutic feeding centers. The aim of understanding when inpatient death occurred during treatment and determining its predictors should be vital to develop a time-relevant intervention. Therefore, the aim of this research is to assess incidence and predictors of severe acute malnutrition mortality rate for children admitted in Pawe general hospital, North West Ethiopia 2021.

Methods

Study setting, population, and design

A facility-based retrospective cohort study was conducted on 568 under-five children who were admitted for SAM treatment at Pawe General Hospital from January 1st, 2015 to December 31, 2019. Pawe general hospital is located in Metekel Zone Pawe especially Woreda, 565 km in North West direction of Addis Ababa, the capital city of Ethiopia [20, 21]. According to the 2019 national population projection, this region has an estimated 1.21 million population[22].

The Pediatric ward is among the five inpatient departments found in Pawe general hospital with 252 beds for inpatient treatment and a separate stabilizing center for children with SAM. Ethiopia adopted a set of world health organizations for severe malnutrition treatment guidelines of under-five children using three phases; the first phase (phase I), the transition phase, and phase II. In all phases admitted children are treated empirically for infections, hypoglycemia, and hypothermia and resuscitated to restore electrolyte balance. The hospital provides service for total catchment populations and nearby regions like Amhara both northeast and Westside. Following the time of SAM admission, from 1st January 2015, up to 31st December 2019, there were a total of 578 Under-five children had been registered for SAM inpatient treatments.

Sample size determination

We determined the sample size for this study both by single population proportion and survival analysis formula using the following assumption; n =(Za/2)2P (1-P)/d2 and considering a 95% confidence level (Z a/2 = 1.96), the margin of error 5%, overall mortality rate 46%[6], and 15 % addition for incomplete data and yields 454. Whereas, the sample size for the second objective was achieved using STATA/SE version-14 by considering two-sided significance level ($\alpha = 5\%$), $Za_{1/2}$ = Z value at 95% confidence interval = 1.96, Power ($\mathbf{Z_B}$)=80%, and P = % cumulative occurrence of death rate, 1.65 HR.

The final sample size $(n) = \frac{\text{Event}}{P(\text{Event})} = \frac{(Z_{a/2}+Z_B)2}{\theta^2 p(1-p)} = \frac{(za/2+ ZB)}{P(1-p)(\ln HR)2}$ [23]

$\theta = \ln(HR)$

$HR = e^{\theta}$

e = event

P (e) = probability of event

P = Mortality rate 46%from [6].

HR= hazard ratio (AHR)0.6 from [6].

By inserting all parameters into the STATA (SE)\14 gives 448. However, the five years multi-chart recoded reviewed only 578 records were there and those are manageable and included all for final analysis.

Outcome ascertainment

In this study, the outcome of interest was inpatient death due to SAM, and death was defined as following after admission to report of death during treatment observation. Variables like age, sex, residence, vaccination status, vomiting, breastfeeding, NGT, medication administration, admission types, malnutrition types, and mid-upper are circumference status, medical comorbidity, etc., were considered as independent variables for the development of the checklist.

Operational words

Admission criteria:-According to WHO management of SAM a children who are 6–59 months of age, Weight-for-height ≤–3 Z-score, or mid-upper-arm circumference <115 mm, or presence of bilateral edema, and failed appetite test should be admitted for inpatient care[24].

Discharged /declared Cured: According to WHO management of SAM a children who are 6–59 months of age, during inpatient treatment declared as cured when weight-for-height/length is ≥–2 Z-score and they have had no edema for at least 2 weeks, or. The mid-upper-arm circumference is >115 mm and they may have had no edema for at least 2 weeks or [7].

Defaulted/Abscond/Lost from following up:-when severe acute malnutrition diagnosed &admitted children absent from stabilizing center for consecutive 2 days after started treatment[5].

Anemia in children:- was defined and classified based on the mean amount of red blood cell or Hgb levels mainly classified into two ways; Anemia(Hgb) <11 g/dL and No anemia(Hgb) ≥11 g/dL[25].

Data collection instrument and quality controls

A structured English version checklist was developed and used for data extraction from admitted children's medical records on the Federal Ministry of Health (FMOH) severe acute malnutrition [7]. One day of training was given for three diploma nurses and One BSC public health officer for data collection tools, data extraction system, and the objectives of the study. To assure the quality of data, the data collection checklist was 5% of the total sample size was pretested. After the pretest, necessary modification of the data collection tool was incorporated. Strict follow-up and supervision were carried out during data collection by principal investigators and feedback was given daily. The collected data were reviewed &checked for completeness before data entry.

Data processing and analysis

The collected data were entered using Ep-iData version 4.2 statistical software and exported to STATA (SE) R-14 version statistical software for further analysis. The proportional hazard assumption was checked for each variable and no variable was found with Schoenfeld residual test <0.05. The Kaplan–Meier survival curves and log-rank test were performed to compare significant experience among survival /death study participants. Variables with P-value < 0.25 in bi-variable Cox regression analysis were included into multivariable Cox regression model. Finally, a variable with an adjusted hazard ratio (AHR) it 95% confidence interval (CI) at P-value <0.05 were considered as significant predictors for inpatient mortality admitted children. The model fitness was checked using the Nelson- Aalen cumulative hazard rate relative to Cox-Snell residuals.

Ethical statement and consent to participation

Ethical clearance was obtained from the institute of ethical review committee from Debre Markos University, College of Health Sciences (Ref. No: HSC/984/16/12). A formal letter was

submitted to Pawe General Hospital for permission to be done entitled of the research articles, *Incidence, and predictors of severe acute malnutrition mortality rate children 6-59 months admitted in stabilizing center at Pawe general hospital, North West (2015-2019)***.** Finally**,** Pawe hospital rechecked for ethical compatibility and permitted data access. According to national research ethical review guideline:-https://www.ccghr.ca/wp-content/uploads/2013/11/national-research-ethics-review-guidline[26] if the study was conducted through individual file records reviewed, no need for consent from the mothers or caregivers of the study subject. However, all data set were kept confidential anonymously. The institution of the ethical review committee of Debre Marko's University was also waived consent from the caregiver for all secondary data.

Result:

Baseline Socio-demographic and clinical characteristics

After excluding 10(1.74%) individual files due to incompleteness, we reviewed 568 files of SAM cases registered for treatment from 1st January 2015 to December 31 /2020. Out of the included participants, slightly more than half, 324(57.04%) of participant children were females, and the majority, 356 (62.68 %) them were found in the age group 6-24 months. The mean age of the participants was 26.28 (SD= ±16.04) months. Seventy-eight percent of cases were from rural residents, and more than half 361(63.56%) of them were on breastfeeding. Moreover, 169(29.86%) &119(21.02%) SAM cases were admitted during 2019&2015 years, respectively **(Figure 1)**.

Descriptive result of severe acute Malnutrition

Nearly four in five, 457(80.46%) of the participant cases were new severe acute malnu8tration cases of the total 568SAM cases 318(55.9%) were admitted due to wasting; while the remaining 153(26.94), and 97(17.08) were due to Marasmus-Kwashiorkor and edematous (Kwashiorkor),

respectively. Nearly seventeen percent (68.3% of wasting cases were observed in the 6-24 months age groups. Of the total of 97(17.08) edematous cases, nearly half (48.9%) of them were cured (**Table1).**

Co-morbidity and Antibiotics

Moreover, 296(52.18%) of children had pneumonia during admission, while nearly two in five 217 (38.2%) of admitted cases had skin dermatitis. Of all 568 participants, 307 (54.35%) had multiple (more than two) comorbidity during admission, for instance, SAM with diarrhea (11.17%) plus pneumonia (10.55%), and SAM with anemia (19.3%) plus vomiting (14.8%). More than half of 53.32% of the admitted cases had altered body temperature (≥37.5 °C). In addition, 470 (82.75%) and 242 (42.61%) children received vitamin A and deworming syrup during inpatient care, while only 22.8% of children received intravenous fluid **(Table 2).**

Treatment outcomes of the stabilizing centers

At the end of this study period, 326 (57.39%) admitted under-five children had been cured, while the remaining 106 (18.66 %) lost from follow-up, 46 (8.10%) transferred out, and the remaining 91 (16.03%) children died. During in-patient treatment of cases, the majority of deaths, 38 (41.11%), were reported during Phase I within 24-144 hours after admission whilst 124 (38.6%) of SAM children were cured in phase II **(Table3).**

The incidence rate of SAM mortality

The study participants were followed for 5108 Person per Month (PMOS) risk observation. The overall incidence of the mortality rate was 16.03 per 100 (95%CI: 13.86; 20.04) person-day observations**.** The median duration from admission to death was 13 (IQR=±8) days. The proportion of new death during inpatient treatment at the end of 1st week, 2nd week, 3rd week, and

end of follow up were, 28/91(30.76%),26/91(28.57%), 16/91(17.5%), 18/91(19.78%), and 3/91(3.3%), respectively.

Log rank estimate of mortality and death Hazard

The log-rank test estimate revealed that the mortality among SAM admitted children were significantly varied among the covariates. The Kaplan Meier survival curve together with the log-rank test shows the effect of each variable on mortality of SAM admitted children on different covariates (**Table4).**

Baseline categorical variables like anemia, vomiting, diarrhea, and NGT during admission had significant times of survival differences when compared to their counterpart. For instance, the mean survival time for those who had anemia during admission was 18.6 (95%CI; 17.38, 19.9) days and it was 27.5 95%CI; 25.8 29.1) days for those who had no anemia during SAM admission (P-value, <0.0001). The mean survival time for newly admitted SAM children was 24.4(95%CI; 22.9, 25.7) days, while it was 6.4 (95%CI; 4.6, 8.2) days (p-value<0.0001) **(Figure 2-8).**

Predictors of SAM Mortality

During bi-variable Cox regression analysis was running 17 variables were run and subsequently, 11 variables were transferred into multivariable Cox regression by p-value <0.25 criteria of regression. After adjustment of potential confounding, five variables found significant predictors for SAM inpatient mortality. The risks of death for children admitted with NGT was three times (AHR=3.22; 95%CI; 1.65- 6.26, P<0.001) increased as compared with children without NGT. Death risk for Re-admitted SAM diagnosed cases were nearly two-times increased as compared with new admission case (AHR=1.7; 95%CI: 1.03—2.8, P<0.037). Hazards of death for children having vomiting during admission was five times increased as compared with no

vomiting case at admission nearly five times (AHR=5.1; 95%CI:1.35—21.1, P<0.026). Likewise, the death hazard for children admitted with anemia was twice increased as compared with children with no anemia (AHR= 1.89; 95% CI: 1.15—3.2; P<0.012). The risk of death for SAM diagnosed and admitted children with diarrhea was nearly three times higher as compared with no diarrhea at admission (AHR=2.79;95%CI:1.46--5.4 ;P<0.002) (**Table 5).**

Discussion

This study was primarily intended to estimate the incidence of inpatient SAM mortality rate and its potential predictors after admitted children in stabilizing centers from 1st January 2015 up to December 31, 2019. These studies have indicated that at the end of follow up 326 (57.39%) SAM cases had been cured, while the remaining 106 (18.66 %) lost from follow-up, 46 (8.10%) transferred out, and 91(16.03%) cases have died. The overall incidence density rate (IDR) of mortality was 16.03 per 100 (95%CI: 13.86; 20.04) person-days risks of observations. This was higher than the national SPHERE reference (<10%) [12] and might be due to delayed presentation to the health institution (SC), early discontinuation of treatment due to insufficient financial means admissions [5], and poor adherence to WHO SAM guidelines [1, 27]. However, our finding is not consistent and higher than reported in Mekele hospital 3.8%[3], Tigray general hospitals 6.65%[3], Dilla referral hospital 7.57%[1], Bahir-dare referral hospital 7.7%[28], Southern hospital 10.8%[29]. The difference might be due to all these are specialized universities and referral hospitals, which provide excellent and comprehensive treatment care, unlike the counterpart of the pastoralist community in our studied hospital. In sum, the median time to death was reported as 13 (IQR=8) days. This is not consistent and higher than reported in Gondere hospital 12 days[5], but lower than findings in southern hospitals 17 days [29], Mekele referral hospital 41.2 days[3], and Shebedino hospital 36 days [2]. Unfortunately, the economic

constraints of care supporters to buy additional drugs and food exposed for early loss from inpatient care. This is a real scenario in our study setup; more than 18.66%of admitted cases were lost from follow-up. Regarding predictors for inpatient mortality, the hazard of death for anemic children during admission was two-fold increased as compared with the counter group. This is comparable and consistent with the finding in Gonder referral hospitals [5], and Nekemte Referral Hospital [30]. In contrast to our study reported, the study result has no association role for anemia prevention by oral medications(e.g., vitamin A= 82.75% and folic acid =76.94 %), but a study result in NRH [30] revealed a significant association dearth of deworming (P=0.031) prevention versus anemia incidence (0.042) [30]. A child may experience more than one episode of SAM, depending on the improvement of the underlying factors during inpatient treatment [31] similar to this, our research finding revealed SAM relapses have a two-fold hazard of death. In line with the study finding in Lusaka, Zambia [32], Gonder referral hospital [33], Southern Ethiopia hospital [2], and Irena [32], SAM children admitted with diarrhea had an increased risk of death, consistent with our two-fold increase in death, which may be due to combination of fluid and electrolyte loss and possible hypovolemic shock. Moreover, the hazard of death among children with vomiting at admission is three times increased as compared with the counter group. This is consistent with the study finding at North Gonder hospital [33]. Both vomiting and diarrhea are associated with shifting of physiological fluids homeostatic and easily loss of continuity for children whatever medication administration orally. This could be due to the shrinking of the intracellular potassium pumping balance of the body homeostatic. On the other hand, the hazards of death for children at baseline admitted with nasal-gastric therapy (NGT) were two times increased as compared with no NGT admissions. Unlike in our research reported, there is no positive association between admitted SAM cases with shock, vomiting, and poor

adherence, however, study finding in Dilla referral hospital [13], and Gonder referral Hospital [5] had significant associations for the cause of inpatient mortality of Vomiting (P<0.001), altered breathing(P<0.001), and admission with NGT (P<0.038).

Limitations

The possible limitation of this study is that since it is a record review, it failed to consider a broad range of factors like some biochemical indices and the socioeconomic status of caregivers. Therefore, the interpretation and application of the finding for decision and policy direction should account for these inherent limitations of the study.

Conclusion: The overall SAM mortality rate was high among children treated in stabilizing centers as compared with the national standard of protocol. Cases at baseline admitted with vomiting, diarrhea, NGT, and re-admitted had highly associated for mortality incidence. Health education on early medical seeking behavior and adherence on the routine regimens may improve child survival besides to boost up a strategy to minimize attrition after admission

Abbreviation

AHR, adjusted hazard ratio; CHR, crude hazard ratio; CI, confidence interval; FMOH, Ethiopian Federal Ministry of Health; MUAC, mid-upper arm circumference; SC, stabilizing center; SAM; severe acute malnutrition; NGT, nasal gastric intubation for feeding; WFH, weight for height; SD, standard deviation.

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Supporting information

All relevant data are within the paper and its **Supporting Information files.**

Conflict of interest

The authors declare that there are no conflicts of interest for this study

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Author's contribution

Conceptualization; Fassikaw Kebede , Tsehay kebede ,

Data cu ration: Fassikaw Kebede, Tsehay kebede,

Formal analysis; Fassikaw Kebede, Tsehay kebede

Methodology; Fassikaw Kebede,

Software; Fassikaw Kebede, Belete Negese, Tsehay kebede

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Table1: Socio-demographic and clinical characteristics of SAM admitted children in Pawe General Hospital, North West Ethiopia (2015-2019)(n=568).

Variables	Characters	Frequency %
Sex	Male	244(42.96)
	Female	324 (57.2)
Residence	Urban	126(22.18)
	Rural	442(77.82)
Age	Between 6-24 month	355(62.68)
	Between 24-48 month	160(28.17)
	Above ≥48 month	53(9.15)
SAM types	Wasting(Marasmic)	318(55.99)
	Marasmus Kwashiorkor	153(26.94)
	Kwashiorkor(Edematous)	97(17.08)
Skin dermatitis	Absent	353(61.8)
	Present	217(38.2)
Vomiting	Absent	281(47.89)
	Present	296(52.13)
Altered body temperatures ≥37.5C^0	Absent	265(46.65)
	Present	303(53.35)
Diarrheal	Absent Present	257(45.2) 311(54.75)
Pneumonia	Absent	272(47.89)
	Present	296(52.11)
Anemia	Absent	399(70.75)
	Present	169(29.75)
Breastfeeding status	No breastfeed	207(36.4)
	Yes breastfeed	361(63.56)
Admission type	New admission	457(80.46)
	Re-admission	111(19.54)
Nasogastric tube during admission	Present	243(41.02)
	Absent	325(58.98)
Vitamin A supplementation	Given	470 (82.7)
	Not given	98(17.25)
Folic acid	Given	406 (71.48)
	Not given	162 (28.52)
Blood transfusion during admission	Given	123 (21.65)

	Not given	445 (78.35)

Table2:-Performance indicator of stabilizing center with compared *Sphere reference* for Incidence rate and predictors of Under-five SAM children in Pawe General Hospital (n=568).

Performance indicator	**Five years Performance of Stabilizing center**	**SPHERE project reference value**		
		Overall	Acceptable	Alarming
Treatment cure rate	57.38%	77.9%	>75%	<50%
Incidence of death rate(IDR)	16.7%	12.3%	<15%	>25%
lost from follow up	18.36%	5.5%	<10%	>15%
Transfer out	8.7%	4.8%	____	____

Table3: Proportions of SAM treatment outcome by phase after being admitted to stabilizing center in Pawe general Hospital (2015-2019 (n=568).

Indicators	**Phase 1**	**Transition phase**	**Phase 2**	**Treatment outcome by phases(N=568)**
Death rate	**38(41.11)**	**24(26.4)**	**29(31.50)**	**91**
Treatment cure rate	**97 (29.56)**	**105(32.39)**	**124(38.60)**	**326**
Lost follow up	**9(8.50)**	**34 (32.81)**	**63 (60.0)**	**106**
transferred out	**3(6.52)**	**5(10.8)**	**38(82.6)**	**46**

Table-4: Log-rank estimate selected variable for SAM admitted children in Pawe General Hospitals in North West Ethiopia, 2021.

Categories	**log rank test estimated**	**P - Value**
Age(years)	$\mathbf{X^2 = 64.36}$	**P-value = 0.053**
Sex(Male/ female)	$\mathbf{X^2 = 2.71}$	**P -value = 0.099**
Residence(Urban /rural)	$\mathbf{X^2 = 3.23}$	**P -value = 0.63**
Admission types(New/ Re-admission)	$\mathbf{X^2 = 37.02}$	**P - value = 0.001**
Had NGT during admission (present /absent)	$\mathbf{X^2 = 50.22}$	**P -value = 0.001**
Measles vaccine (Taking /Missed)	$\mathbf{X^2 = 10.98}$	**P -value = 0.009**
Parenteral Antibiotics (Given/ Not given)	$\mathbf{X^2 = 9.16}$	**P -value = 0.003**
Vitamin A supplementation (Given/Not Given)	$\boldsymbol{X^2 = 1.82}$	**P -value =1.7891**
Anemia during admission (Present /Absent)	$\boldsymbol{X^2 = 46.89}$	**P -value =0.001**
Vomiting during admission (Present /Absent)	$\boldsymbol{X^2 = 23.02}$	***P -value =0.001***
Diarrhea during admission (Present/Absent)	$\boldsymbol{X^2 = 38.9}$	***P -value =0.001***
Comorbidity during admission (Present /Absent)	$\boldsymbol{X^2 = 2.15}$	***P -value =0.645***

Table 5: Bi-variable and multivariable Cox regression for predictors of SAM mortality among children to Pawe general hospital since 2015-2019 (n=568), North West Ethiopia.

Covariate	Categories	Survival status		CHR(95%CI)	AHR(95%CI)	P-value
		Death	Censored			
Age of children	6-24 Month	**68**	**186**	**1**		
	24-48 month	**22**	**145**	**0.9(0.57--1.4)**	**1.2(0.73-- 2.01)**	**0.443**
	≥48 month	**1**	**46**	**0.61(0.59 -4.4)**	**2.1 (0.82- -3.9)**	**0.27**
Sex	Male	**30**	**214**	**1.13(0.89--1.43)**	**0.96 (0.61 --1.53)**	**0.859**
	Female	**61**	**263**	**1**	**1**	
Admission types	**New**	**67**	**183**	**1**	**1**	
	Re-admission	**24**	**294**	**1.7(2.4 --- 6.1)**	**1.7 (1.03—2.8)**	**0.037***
NGT during Admission	**Yes**	**79**	**164**	**2.3(2.3--6.99)**	**3.22(1.65—6.26)**	**0.001***
	No	**12**	**313**	**1**	**1**	
Vomiting	**Yes**	**88**	**208**	**2.34(1.28 ---4.3)**	**5.1(1.35---21.2)**	**0.026***
	No	**3**	**269**	**1**	**1**	
Anemia	**Present**	**64**	**105**	**4.2(2.6---3.67)**	**1.89(1.15–3.12)**	**0.012***
	Absent	**27**	**372**	**1**	**1**	
Diarrhea	**Yes**	**79**	**232**	**5.6(2.99—10.6)**	**2.79(1.46—5.4)**	**0.002***
	No	**12**	**245**	**1**	**1**	

Figure 2: Overall Kaplan Meier their estimated survival of SAM admitted children in Pawe general hospitals since 2015-2019 (N=568).

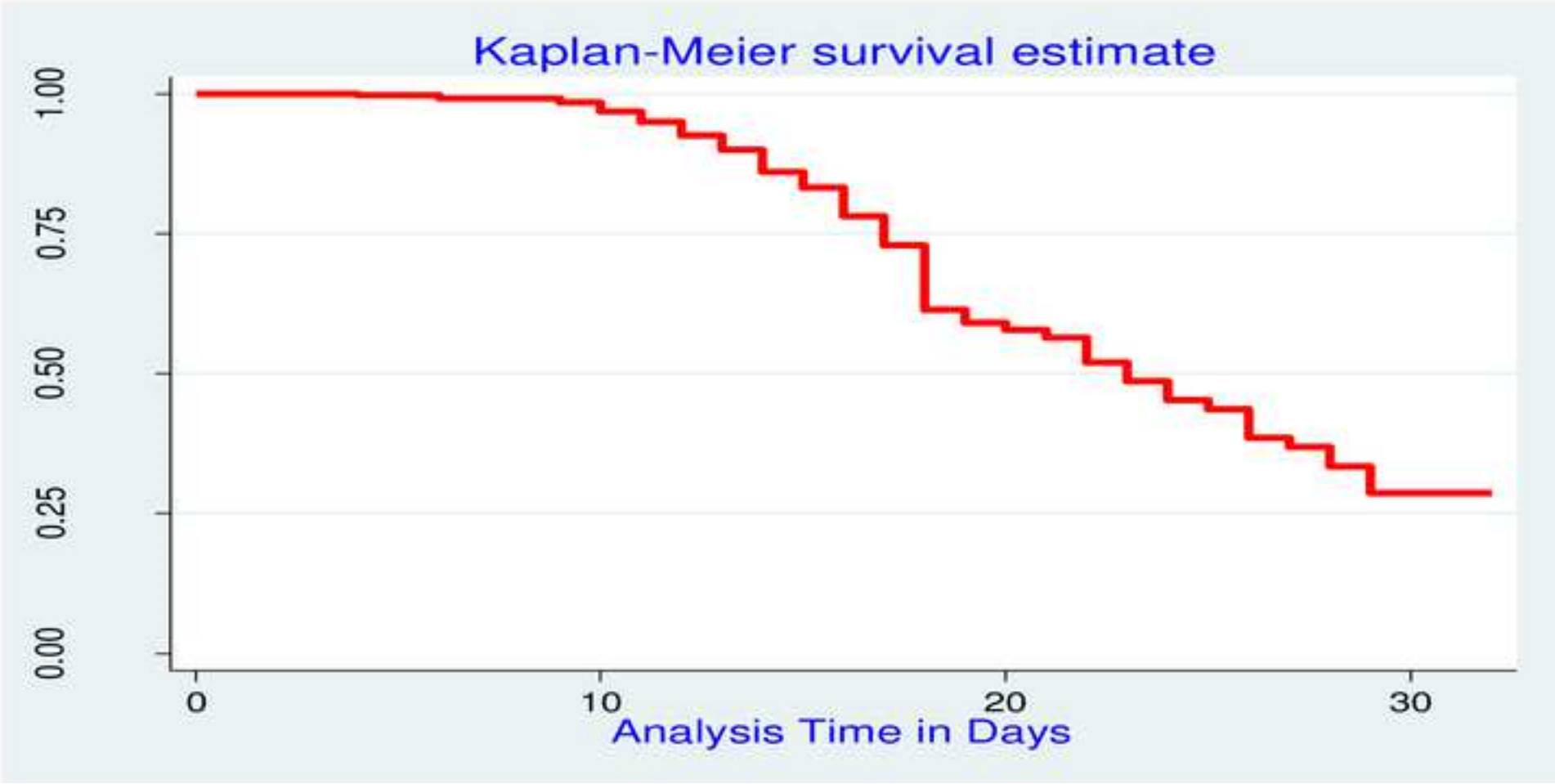


Figure:3 Difference in Hazard of death based on Vomiting status of SAM admitted children in Pawe general hospital since 2015-2019 (N=568).

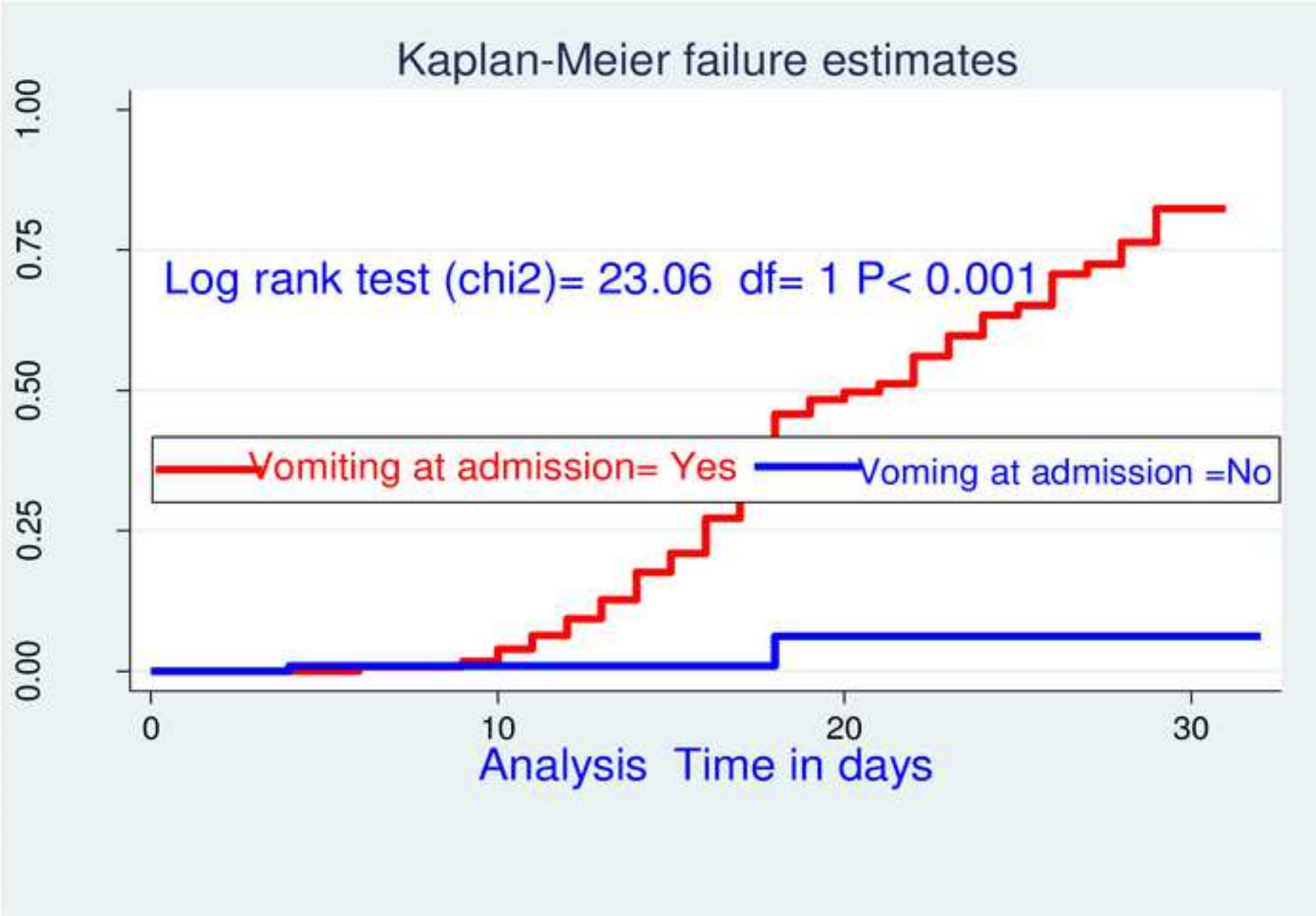


Figure:6 Difference in Hazard of death based on nasogastric therapy status during SAM admitted children in Pawe general hospital since 2015-2019 (N=568).

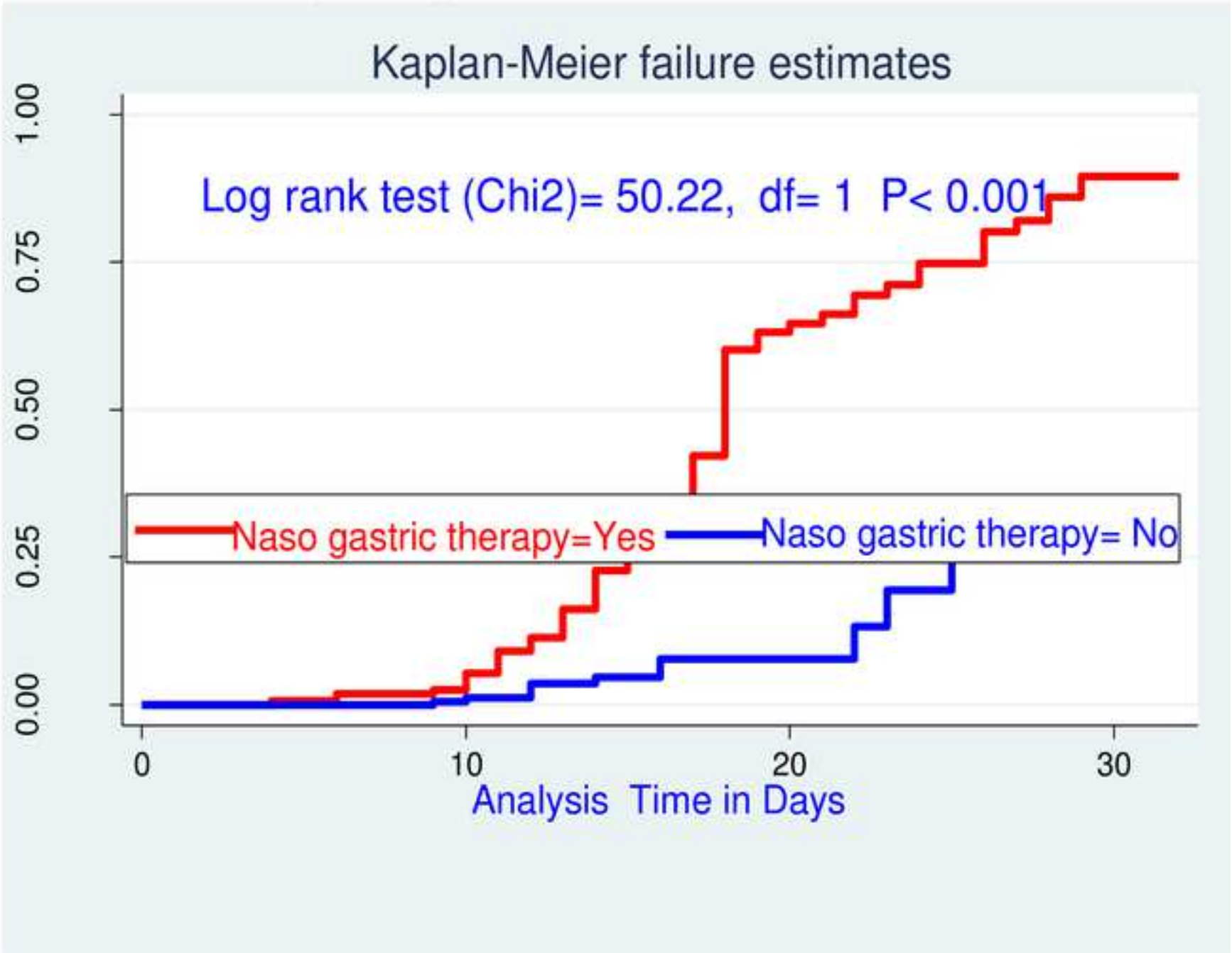


Figure 7; Difference in Hazard of death based on hemoglobin status of SAM admitted children in Pawe general hospital since 2015-2019 (N=568).

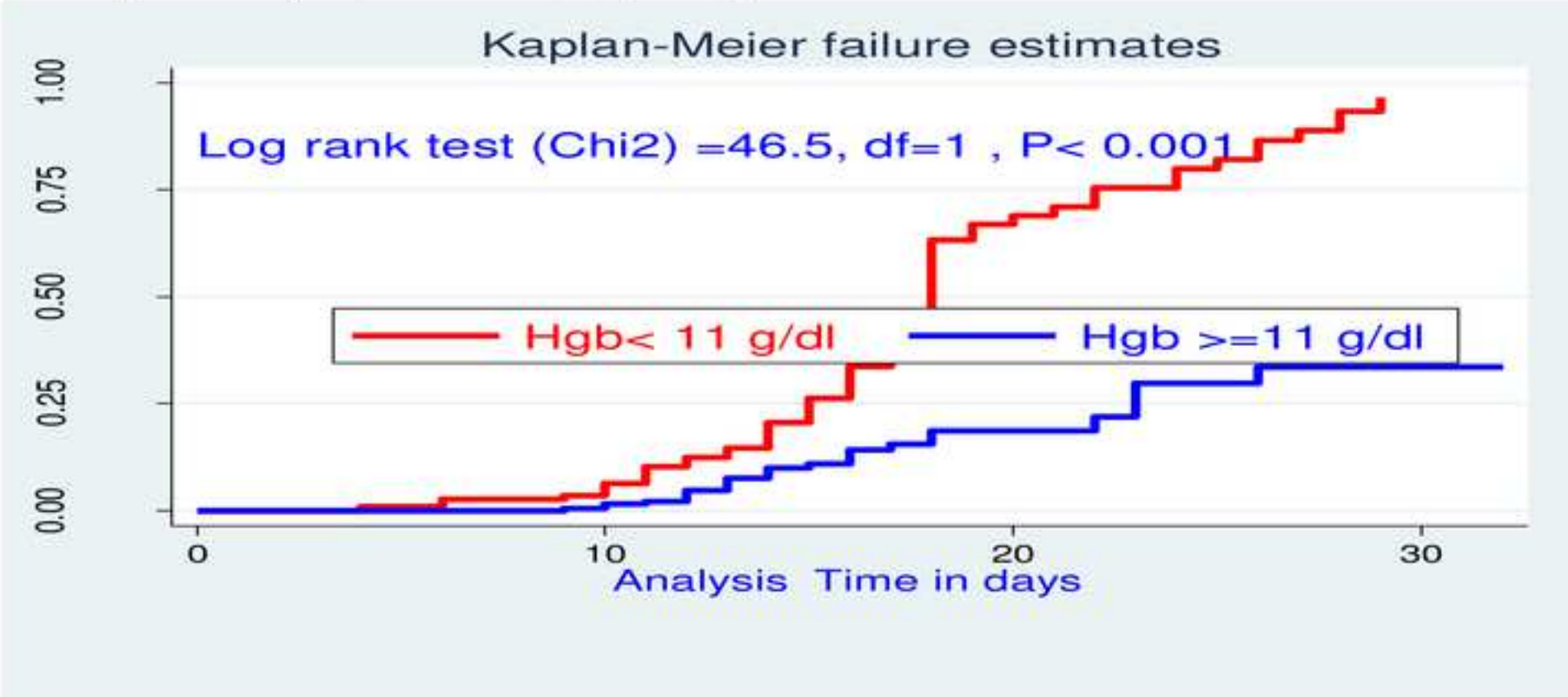


Figure5; Difference in Hazard of death based on admission type children treated in Pawe general hospital since 2015-2019 (N=568).

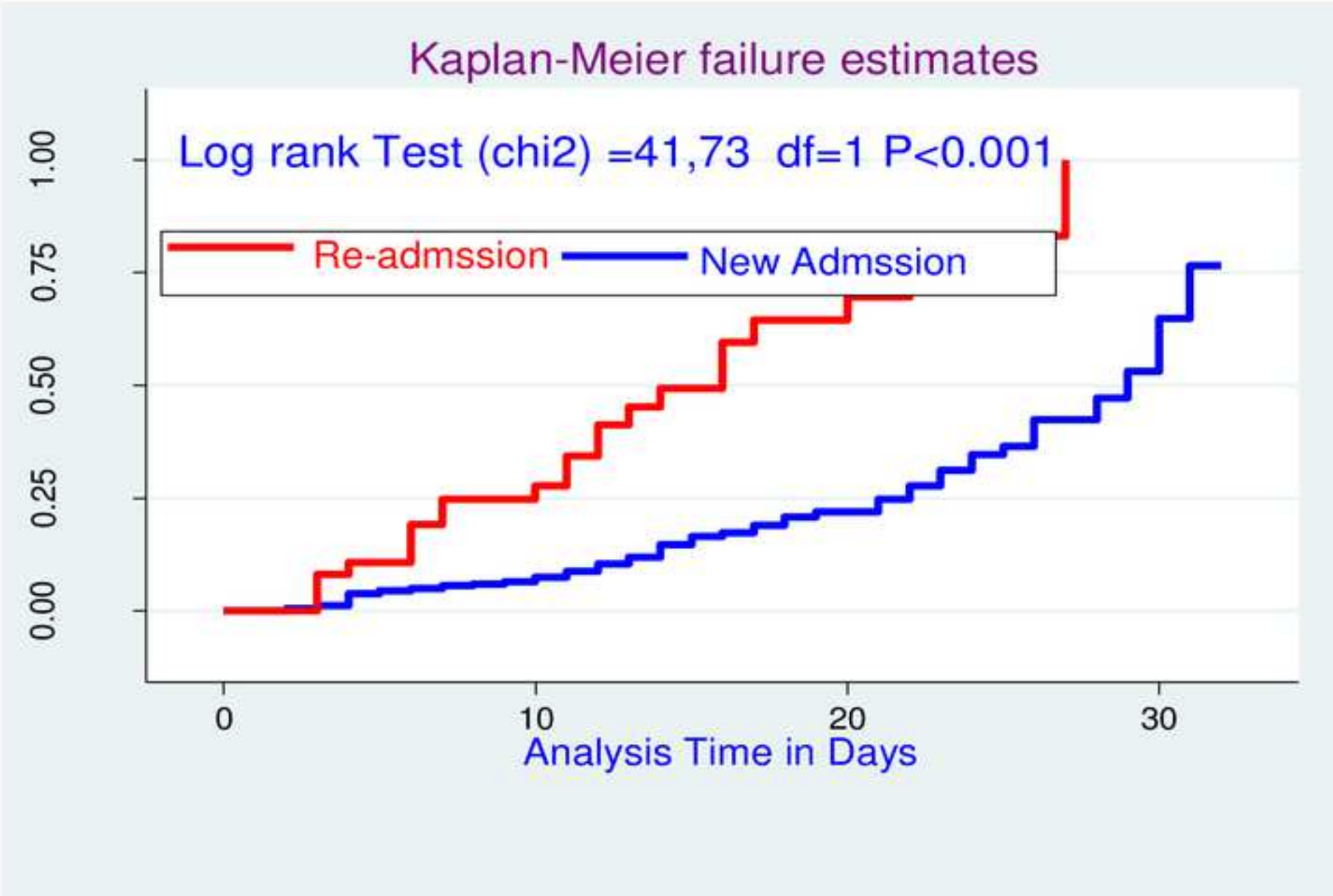


Figure 8; Difference in Hazard of death based on diarrheao during SAM admitted children in Pawe general hospital since 2015-2019 (N=568).

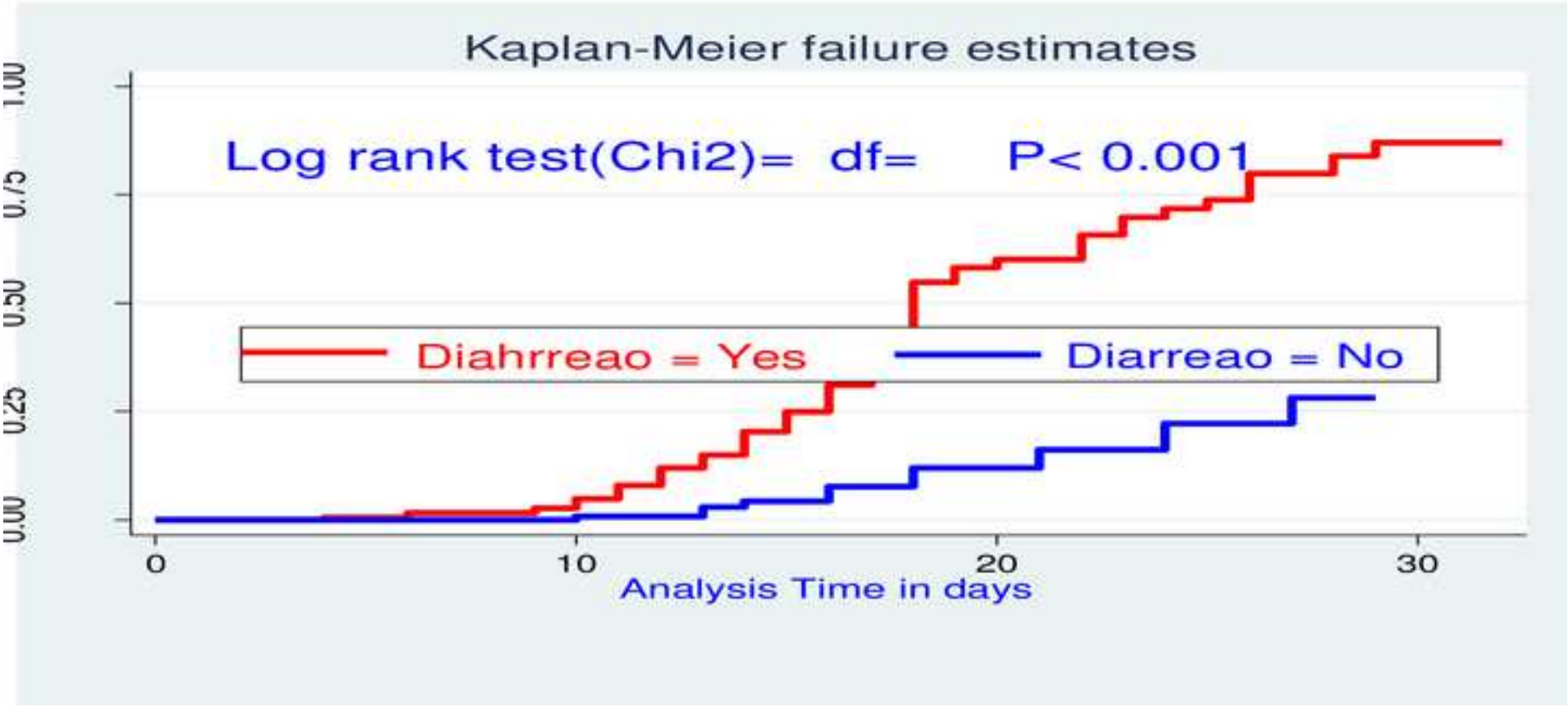


Figure4; Difference in Hazard of death based on breast feeding status of SAM admitted children in Pawe general hospital since 2015-2019 (N=568).

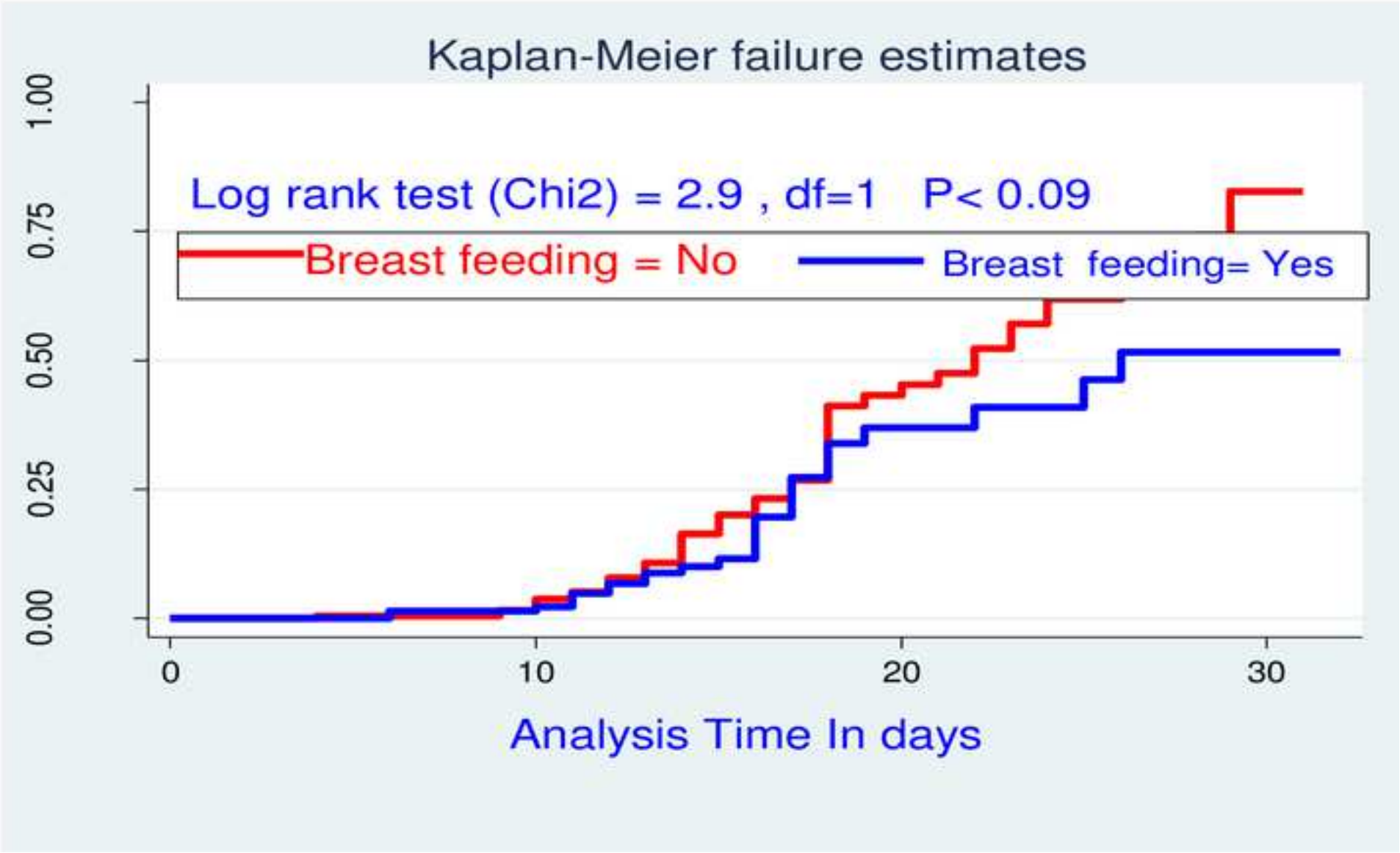
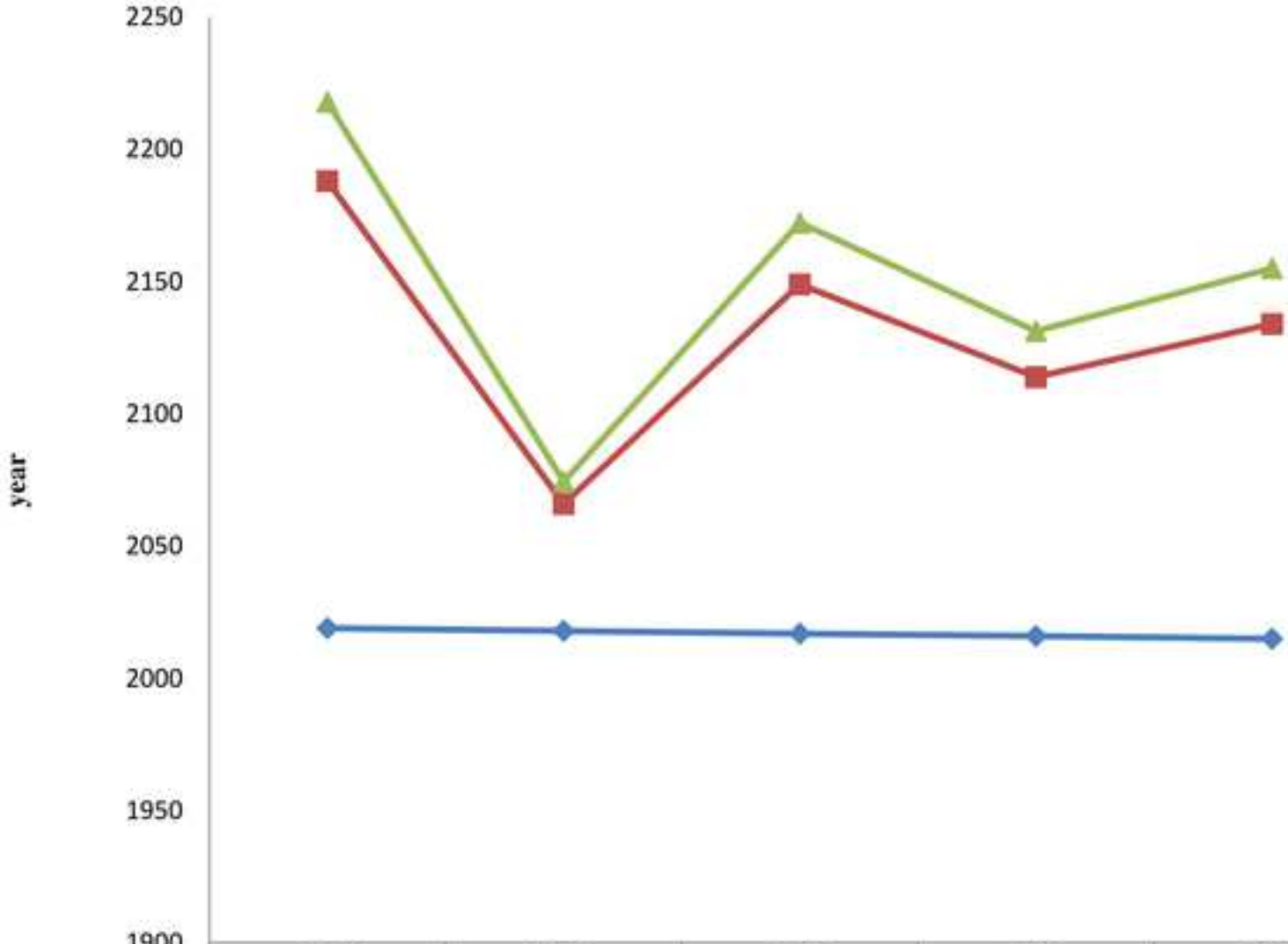


Figure.1 Number of severe acute malnutrition children addmited in Pawe General Hospital from 2015-2019



	2019	2018	2017	2016	2015
percent	29.86	8.48	23.32	17.31	21.02
Frequency	169	48	132	98	119
YEAR	2019	2018	2017	2016	2015

English version of Data collection check lists

Final Data set(S1) as supporting information

INCIDENCE AND PREDICTORS OF SEVERE ACUTE MALNUTRITION MORTALITY RATE AMONG CHILDREN AGED 6-59 MONTHS ADMITTED AT PAWE GENERAL HOSPITAL, NORTHWEST ETHIOPIA 2021

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Abstract: Severe acute malnutrition (SAM) is defined by very low weight for height (below -3z scores of the median WHO growth standards), by visible severe wasting, or by the presence of nutritional edema. Mortality magnitudes for under-five children were well documented in Ethiopia, nevertheless lacking information on the predictors when death occurs during inpatient treatment. The aim of understanding to time when under-five children with inpatient SAM die and its predictors could be vital to develop the time-relevant intervention.

Methods: A retrospective cohort study was conducted among 568 under-five children from 1 January 2015 up to December 31, 2019, at Pawe general hospital. Epi Data version 3.2 and Stata/14 software were used for data entry and analysis, respectively. The Kaplan–Meier survival curves and log-rank test were performed to compare significant survival and death experiences among study participants. Bi-variables Cox-regression model was built to select candidate variables at *P*<0.25. Adjusted hazard ratio (AHR) with a 95% confidence interval (CI) was used to estimate a significant predictor for inpatient mortality at P<0.05

Result: - Five-hundred sixty-eight (N=568) admitted SAM cases were included in this study. The mean age of ~~the~~ participants was 27.4 (SD± 16.5) months the median time to death was 3 ~~with~~reported as 13 (IQR=8) days. The ~~-~~overall incidence density rate (IDR~~)~~) of ~~of SAM~~ inpatient mortality was found ~~was~~16.03 per 100 (95%CI: 13.86; 20.04) person-days risk observation. Cases at baseline admitted with ~~Admission~~ ~~with~~ nasogastric therapy (NGT) (AHR=3.22; 95%CI; 1.65- 6.26, P<0.001), vomiting (AHR=5.1; 95%CI: 1.35-21.1, P<0.026), diarrhea (AHR=2.79; 95%CI: 1.46- 5.4; P<0.002), anemia (AHR= 1.89; 95% CI: 1.15- 3.2; P<0.012) , and re-admitted/relapsed SAM cases (AHR=1.7; 95%CI: 1.12 - 2.8, P<0.037) were significantly associated with inpatient mortality of SAM children.

Conclusion:-The overall SAM mortality rate was high among children treated in stabilizing center as compared with national standard of protocol(<11%). Cases at baseline admitted with vomiting, diarrhea, NGT, and re-admitted had highly associated for mortality incidence. Health education on early medical seeking behavior for care ~~and~~givers and adherence on the routine regimens may improve child inpatient treatment survival beside to boost up strategy to minimize attrition ~~after~~rate after case admission.

Keywords: Severe acute malnutrition, Predictors of mortality rate, Children, Ethiopia

Introduction

Malnutrition remains one of the most common causes of morbidity and mortality in children throughout the world. It has been responsible for directly or indirectly 60%of the 10.9 million death annually among under-five children. Two-third of these deaths occurred during the first year of life **[1-4].** Childhood under-nutrition incorporates a combination of nutrition disorders that include underweight, wasting, stunting, and micronutrient deficiency[5, 6]. Underweight (Weight-For-Age ≤- 3 Z score), is a composite measure of wasting and stunting, while wasting (Weight For Height ≤- 3 Z score) is acute malnutrition due to a recent failure to receive nutrition's and may be affected by recent episodes of diarrhea and other acute illnesses[3, 5].

Although SAM usually affects all segments of a population, infants and young children are most vulnerable as they have higher nutritional requirements for growth and development[7]. . It is one of the leading causes of morbidity and mortality among infants and young children all over the world and most frequently in sub-Saharan Africa and south Asia[8]. The peak age for SAM is 6–18 months, which is the time of fast growth and brain development. However, it is increasingly becoming common that SAM may occur in infants less than six months of age

with many disadvantaged populations while starting to feed semi-solid and solid foods to children as young as two months[9]. Globally in 2018, 1 in 12 of the estimated 52 million children under five had SAM."~~Globally in 2018, 52 Million under-five years- children in one in twelve of this age group- are suffering from SAM~~ [10], and 2.9 million of those children were admitted for inpatient treatment ~~of SAM~~ [10, 11]. The Sub-Saharan African countries account for the most proportions of case fatality rate[12]. Despite the availability of outpatient treatment, the number of children with SAM seeking admission at stabilizing centers (SC) increasing. However, 50% of children with SAM die due to inappropriate care during inpatient treatment[13]. One important reason is poor adherence for SAM therapeutic guidelines (a faulty case management) ~~The one underline reason is health care provider's poor adherence to world health organization SAM- therapeutic guidelines~~ [1], and another is late presentation for treatment contributes for high mortality burden ~~besides to late coming of the patient for treatment~~[14]. Malnutrition in Ethiopia is a long-term silent killing crisis, especially for infants, ~~and~~and children ~~children yet~~ contribute to an estimated 270,000 deaths ~~of under-five children~~ in each year [15]. According to Health and Health-Related Indicators (HHRI) 2014, SAM was the third leading cause of mortality and accounted for 8.1%of the death of under-five children [5, 16, 17]. Despite Ethiopia launching the Seqota declaration to end death of SAM ~~up severe acute malnutrition~~ ~~death by~~by 100% access to adequate food[18], SAM is still a reason for 20% of pediatric hospital admissions[19]. This is the main challenge of successful treatment outcome in developing countries like Ethiopia and generating a record based data for reason to death is highly important to meet the goal of therapeutic feeding centers. The aim of understanding when inpatients death occurred during care and determining its predictors should be vital to develop the time-relevant intervention. So this research was intended to come up with information about

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incidence of SAM mortality rate, and predictors for the time to death among children with severe acute malnutrition admitted to therapeutic feeding unit in Pawe general hospital.

Methods

Study setting, population, and design

A facility-based retrospective cohort study was conducted on 68 under-five children who were admitted for SAM treatment at Pawe General Hospital Metekel Zone Pawe woreda Northwest from 1st January 2015 up to December 31, 2019. Pawe general hospital is located 565 km away from Addis Ababa, the capital city of Ethiopia[20, 21]. According to the 2019 national population projection, this region has an estimated 1.21 million population[22]. The Pediatric ward is among the five inpatient departments found in Pawe general hospital with 252 beds for inpatient treatment ~~The Pediatric ward is among the five inpatient departments found in Pawe general hospital with 252 beds for inpatient treatment~~ [23, 24]~~.~~ and a separate stabilizing center for children with SAM."~~Thought, the stabilizing center is separately built with single-based beds for children in SAM patient's treatments.~~ Ethiopia adopted a protocol of world health organizations for severe malnutrition treatment guidelines of under-five children using three phases; the first phase (phase I), the transition phase, and phase II. In all phases admitted children are treated empirically for infections, hypoglycemia and hypothermia and resuscitated to restore electrolyte balance."~~In all phases admitted children were, treated and prevented for infections, resuscitated, restored electrolyte balance, hypoglycemia, and hypothermia~~. The hospital provides service for total catchment populations and nearby regions like Amhara both northeast and Westside. ~~It started providing ART service with aid from the Regional Health Bureau and the Ministry of Health in April 2007.~~ Following the time of SAM

admission, from 1st January 2015, up to 31st December 2019, there were a total of 578 Under-five children had been registered for SAM inpatient treatments.

Sample size determination

We determined the sample size for this study both by single population proportion and survival analysis formula using the following assumption; n =(Za/2)2P (1-P)/d2 and considering a 95% confidence level (Z a/2 = 1.96), the margin of error 5%, overall mortality rate 46%[6], and 15 % addition for incomplete data and yields 454. Whereas sample size for the second objective was achieved using STATA/SE version-14 by considering

Two-sided significance level (α = 5%),

$Za_{1/2}$ = Z value at 95% confidence interval = 1.96,

Power (Z_B)=80%, and P = % cumulative occurrence of death rate, 1.65 HR.

The final sample siz (n) =Event = $\frac{(Z_{a/2}+Z_B)2}{P(Event)\ \theta^2 p(1-p)} = \frac{(za/2+ ZB)}{p(1-p)(lnHR)2}$ [25]

θ = ln(HR)

HR= e^{θ}

e = event

P (e) = probability of event

P = Mortality rate *46%*from [6]

HR= hazard ratio (AHR)0.6 from [6].

By inserting all parameters into the STATA (SE)\14 gives 448. However, the five years multi-chart recoded reviewed only 578 records were there and those are manageable and included all for final analysis.

Outcome ascertainment

~~In this study,~~

"In this study, the outcome of interest was inpatient death due to SAM."

~~the outcome of interest is the SAM inpatient death~~, and death was defined as following after ~~inpatient~~ admission to report of death during treatment observation. Variables like age, sex, residence, medical comorbidity, vaccination status, vomiting, breastfeeding, NGT, medication

administration, admission types, malnutrition types, and mid-upper are circumference status, etc were considered as independent variables for the development of the checklist.

Operational words

Admission criteria:-According to WHO management of SAM a children who are 6–59 months of age, Weight-for-height ≤–3 Z-score, or mid-upper-arm circumference <115 mm, or presence of bilateral edema, and failed appetite test should be admitted for inpatient care[26].

Discharged /declared Cured: According to WHO management of SAM a children who are 6–59 months of age, during inpatient treatment declared as cured when weight-for-height/length is ≥–2 Z-score and they have had no edema for at least 2 weeks, or. The mid-upper-arm circumference is >115 mm and they may have had no edema for at least 2 weeks or [7].

Defaulted/Abscond/Lost from following up:-when severe acute malnutrition diagnosed &admitted children absent from stabilizing center for consecutive 2 days after started treatment[5].

Anemia in children:- was defined and classified based on the mean amount of red blood cell or Hgb levels mainly classified into two ways: ~~No~~ anemia <11 and no anemia >=11 g/dL~~>11 g/dL, and Anemia≤10.9 g/dl~~ [27].

Data collection instrument and quality controls

A structured English version checklist was developed and used for data extraction from admitted children's medical records on the Federal Ministry of Health (FMOH) severe acute malnutrition [7]. One day of training was given for three diploma nurses and One BSC public health officer for data collection tools, data extraction system, and the objectives of the study. To assure the quality of data, the data collection checklist was 5% of the total sample size was pretested. After the pretest, necessary modification of the data collection tool was incorporated. Strict follow-up

and supervision were carried out during data collection by principal investigators and feedback was given daily. The collected data were reviewed &checked for completeness before data entry.

Data processing and analysis

The collected data were entered using Ep-iData version 4.2 statistical software and exported to STATA (SE) R-14 version statistical software for further analysis. The proportional hazard assumption was checked for each variable and no variable was found with Schoenfeld residual test <0.05. The Kaplan–Meier survival curves and log-rank test were performed to compare significant experience among survival /death study participants.Variables with P-value < 0.25 in bi-variable Cox regression analysis were included into multivariable Cox regression model. Finally, a variable with an adjusted hazard ratio (AHR) it 95% confidence interval (CI) at P-value <0.05 were considered as significant predictors for inpatient mortality admitted children. The model fitness was checked using the Nelson- Aalen cumulative hazard rate relative to Cox-Snell residuals

Ethical statement and consent to participation

Ethical clearance was obtained from the institute of ethical review committee from Debre Markos University, College of Health Sciences (Ref. No: HSC/984/16/12). A formal letter was submitted to Pawe General Hospital for permission to be done entitled of the research articles, incidence, and predictors of severe acute malnutrition mortality rate children 6-59 months admitted in stabilizing center at Pawe general hospital, North West (2015-2019**).** Finally**,** Pawe hospital rechecked for ethical compatibility and permitted data access. According to national research ethical review guideline:-https://www.ccghr.ca/wp-content/uploads/2013/11/national-research-ethics-review-guidline[28] if the study was conducted through individual file records reviewed, no need for consent from the mothers or caregivers of the study subject. However, all

data s[illegible]ere kept confidential anonymously. The institution of the ethical review committee of Debre Marko's University was waived consent from the caregiver for all secondary data.

Result:

Baseline Socio-demographic and clinical characteristics

After excluding 10(1.74%) individual files due to incompleteness, we reviewed 568 files of SAM cases ~~admitted children~~ registered for treatment from 1st January 2015 to December 31 /2020. Out of the included participants, slightly more than half, 324(57.04%) of partic[illegible]pant children were females, and n[illegible]ajority, ~~–~~356 (62.68 %) of them were fo[illegible] in age group 6-24 months ~~years~~. The mean age of the participants was ~~children found~~ 26.28 (SD = ±16.04) months. Seventy-eight percent of cases ~~children~~ were from r[illegible]resident, and majority ~~of them~~ 361(63.56%) of them ~~them~~ were on breast feeding during admission. Moreover, 169(29.86%) &119(21.02%) SAM cases were admitted during 2019&2015 years ~~respectively~~, respectively **(Figure 1)**.

De[illegible]otive sever acute Malnutrition profiles

Nearly four in five ~~Majority~~, 457(80.46%) of t[illegible]participant cases were new sever acute malnu8tration cases ~~admissions whereas; the remaining 111(19.6%) were relapsed / re-admitted SAM cases. Of~~of the total 568SAM cases 318(55.9%) were admitted due to wasting; while the remaining 153(26.94), and 97(17.08) were due to Marasmus-Kwashiorkor and edematous (Kwashiorkor), respectively. [illegible]y seventeen percent (68.3% of wasting cases were observed in the 6-24 months age groups. Of the total of 97(17.08) edematous cases, nearly half (48.9%) of them were cured (**Table1).**

Co-morbidity and Antibiotics

~~The majority=~~,Moreover, 296(52.18%) of children had pneumonia during admission, while nearly two in five 217 (38.2%) of admitted cases had skin dermatitis. Of all 568 participants, 307 (54.35%) had multiple (more than two) comorbidity during admission, for instance, SAM with diarrhea (11.17%) plus pneumonia (10.55%), and SAM with anemia (19.3%) plus vomiting (14.8%). More than half of 53.32% of the admitted cases had altered body temperature (≥37.5 °C). In addition, 470 (82.75%) and 242 (42.61%) children received vitamin A and deworming syrup during inpatient care, while only 22.8% of children received intravenous fluid (**Table 2).**

Treatment outcomes of the stabilizing centers

At the end of this study period, 326 (57.39%) admitted under-five children had been cured, while the remaining 106 (18.66 %) lost from follow-up, 46 (8.10%) transferred out, and the remaining 91 (16.03%) children died. During in-patient treatment of cases,~~–~~majority of deaths, 38 (41.11%), were reported during Phase I within 24-144 hours after admission whilst 124 (38.6%) of SAM children were cured in phase II (Table3). "

~~the majority of 38(41.11%) deaths were reported at Phase I within 24-144 hours after admission. Inversely, 124(38.6%) SAM admitted children declared as cured at phase II **(Table3).**~~

Incidence rate of SAM mortality

The study participants were followed for 5108 Person per Month (PMOS) risk observation. The overall incidence of the mortality rate was 16.03 per 100 (95%CI: 13.86; 20.04) person-day observations**.** The median duration from admission to death was 13 (IQR=±8) days. The proportion of new death during inpatient treatment at the end of 1st week, 2nd week, 3rd week, and end of follow up were ~~found~~, 28/91(30.76%),26/91(28.57%), 16/91(17.5%), 18/91(19.78%), and 3/91(3.3%), respectively.

The log-rank estimate of mortality and hazard difference

The log-rank test estimate revealed that the mortality among SAM admitted children were significantly varied among the covariates. The Kaplan Meier survival curve together with the log-rank test shows different in hazards of death for SAM admitted children on different covariate (**Table4).**

Baseline categorical variables like anemia, vomiting, diarrhea, and NGT during admission had significant survival differences when compared to their counterpart. *For instance, the mean survival time for those who had anemia during admission was 18.6 (95%CI; 17.38, 19.9) days and it was 27.5 95%CI; 25.8 29.1) days for who had no anemia during SAM admission (P-value, <0.0001) (Figure??).*

Likewise, the mean survival time of those who had no diarrhea was 27.8 (95%CI; 26.04, 29.1) days while it was 12.2(95%CI; 9.0, 14.81) days for those who had diarrhea (p-value<0.001).The mean survival time for new admitted SAM children was 24.4(95%CI; 22.9, 25.7) days, while it was 6.4 (95%CI; 4.6, 8.2) days (p-value<0.0001).

(Figure 2-5).

Predictors of SAM Mortality

During bi-variable Cox regression analysis was running 17 variables were run and subsequently, 11 variables were transferred into multivariable Cox regression by p-value <0.25 criteria of regression. After adjustment of potential confounding, five variables found significant predictors for SAM inpatient mortality. The risks of death for children admitted with NGT was three times (AHR=3.22; 95%CI; 1.65- 6.26, P<0.001) increased as compared with children without NGT.

Death risk for Re-admitted SAM diagnosed cases were nearly two-times increased as compared with new admission case (AHR=1.7; 95%CI: 1.03—2.8, P<0.037). Hazards of death for children having vomiting during admission was five times increased as compared with no vomiting case at admission nearly five times (AHR=5.1; 95%CI:1.35—21.1, P<0.026). Likewise, the death hazard for children admitted with anemia was twice increased as compared with children with no anemia (AHR= 1.89; 95% CI: 1.15—3.2; P<0.012). The risk of death for SAM diagnosed and admitted children with diarrhea was nearly three times higher as compared with no diarrhea at admission (AHR=2.79;95%CI:1.46--5.4 ;P<0.002) (**Table 5).**

4.0. Discussion

This study was primarily intended to estimate incidence of inpatient SAM mortality rate and its potential predictors after admitted children in stabilizing center registered from 1st January 2015 up to December 31, 2019in pawe general hospital.the study have indicated that , at the end of follow up

~~At the end of the study~~ peri~~od,~~ 326 (57.39%) SAM admitted children had cured, while the remaining 106 (18.66 %) lost from follow-up, 46 (8.10%) transferred out, and 91(16.03%) cases were died. The overall incidence density rate (IDR) of ~~SAM~~ mortality was 16.03 per 100 (95%CI: 13.86; 20.04) person-days observations.

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-This was higher than the national SPHERE reference (<11%) [12] and might be due to delayed presentation to the health institution (SC), early discontinuation of treatment due to insufficient financial means admissio[5] , and poor adherence to WHO SAM guidelines [1, 29].

However, our finding is not consistent and higher than ~~with~~ finding reported in Mekele hospital 3.8%[3], Tigray general hospitals 6.65%[3], Dilla hospital 7.57%[1], Bahir-dare referral hospital 7.7%[30], Southern hospital 10.8%[31]. The difference might be due to a[th]ese are specialized universities and referral hospitals, which provide excellent and comprehensive treatment care, unlike the counterpart of the pastoralist community our study general hospitals.

In[a], ~~sum,~~ the median time to death was reported as 13 (IQR=8) days. This is ~~was~~ not consistent and highe~~r~~ than reported in Gondere ~~specialized university~~ hospital 12 days[5], but lower than findings in southern hospitals 17 days [31], Mekele referral hospital 41.2 days[3], and Shebedino hospital 36 days [2]. Unfortunately, the economic constraints of care supporters to buy additional drugs and food exposed for early loss from inpatient care. This is a real scenario in our study setup; more than 18.66%of admitted cases were lost from follow-up.

~~Regarding~~Regarding ~~predictors~~to predictors for inpatient ~~of~~ mortality, the hazard of death for anemic children during admission was two-fold increased as compared wi[e] counter group. This is comparableand consistence with the finding in Gonder referral hospitals [5], and Nekemte Referral Hospital ~~(NRH)~~ [32]. In[ ]trast to ~~to~~our study reported ~~this~~, the study result have no association role for anemia prevention by oral medications(e.g., vitamin A= 82.75% and folic acid =76.94 %), but a study result in NRH [32] revealed a significant association dearth of deworming (P=0.031) prevention versus anemia incidence (0.042) [32].

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A child may experience more than one episode of SAM, depending on the improvement of the underlying factors during inpatient treatment ~~A child may experience more than one episode of SAM relapsing, depending on the improvement of the underlying factors during inpatient~~ [33] in line to this ~~,~~our research finding revealed SAM relapses have a two-fold hazard of death.

In line with the study ~~, conducted at Northwest Ethiopia~~ finding in Lusaka, Zambia [34], Gonder referral hospitals [35], Southern Ethiopia. [2], and Irena [34],SAM children admitted with baseline diarrhea had an increased risk of death, consistent with our two-fold increase in death, which may be due to combination of fluid and electrolyte loss and possible hypovolemic shock. Moreover, the hazard of death among children with vomiting at admission is three times increased as compared with no vomiting case.This is Consistent with the study finding at North Gonder [35]. Both vomiting and diarrhea are associated with shifting of physiological fluids homeostatic and easily loss of continuity for children whatever medication administration orally. This could be due to the shrinking of the intracellular potassium pumping balance of the body homeostatic. On the other hand, the hazards of death for children at baseline admitted with nasal-gastric therapy (NGT) were two times increased as compared with no NGT admissions. ~~Unlike~~Unlike in our researches ~~research findings~~ hospitals ~~of Fikre et. al~~[30], ~~,~~ there is no positive association between admitted SAM cases with shock, vomiting, and poor adherence, however study finding in Dilla referral hospitals [13], and Gonder referral Hospitals [5] had significant associations of inpatient mortality with Vomiting (P<0.001), altered breathing(P<0.001), and admission with NGT (P<0.038).

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Limitations

The possible limitation of this study is that since it is a record review, it failed to consider a broad range of factors like some biochemical indices and the socioeconomic status of care givers. Therefore, the interpretation and application of the finding for decision and policy direction should account for these inherent limitations of the study.

~~it failed to consider a broad range of factors like some biochemical and individual bases economic status of caregivers' might introduce a high array of missing confounders. As such, the interpretation and application of the finding for decision and policy direction should account for these inherent limitations of the study~~.

Conclusion: The overall SAM mortality rate was high among children treated in stabilizing center as compared with national standard of protocol. Cases at baseline admitted with vomiting, diarrhea, NGT, and re-admitted had highly associated for mortality incidence. Health education on early medical seeking behavior and adherence on the routine regimens may improve child survival beside to boost up strategy to minimize attrition after admission

Abbreviation

AHR, adjusted hazard ratio; CHR, crude hazard ratio; CI, confidence interval; FMOH, Ethiopian Federal Ministry of Health; MUAC, mid-upper arm circumference; SC, stabilizing center; SAM; severe acute malnutrition; NGT, nasal gastric intubation for feeding; WFH, weight for height; SD, standard deviation.

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Supporting information

All relevant data are within the paper and its Supporting Information files.

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~~With reasonable request, we will send it is in the hand of the main authors~~

Conflict of interest

The authors declare that there are no conflicts of interest for this study

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Author's contribution

Conceptualization; Fassikaw Kebede Tsehay kebede

Data ~~curation~~cu ration: Fassikaw Kebede Tsehay kebede

Formal analysis; Fassikaw Kebede, Tsehay kebede

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Table1: Socio-demographic and clinical characteristics of SAM admitted children in Pawe General Hospital, North West Ethiopia (2015-2019)(n=568).

Variables	Characters	Frequency %
Sex	Male	244(42.96)
	Female	324 (57.2)
Residence	Urban	126(22.18)

	Rural	442(77.82)
Age	Between 6-24 month	355(62.68)
	Between 24-48 month	160(28.17)
	Above ≥48 month	53(9.15)
SAM types	Wasting(Marasmic)	318(55.99)
	Marasmus Kwashiorkor	153(26.94)
	Kwashiorkor(Edematous)	97(17.08)
Skin dermatitis	Absent	353(61.8)
	Present	217(38.2)
Vomiting	Absent	281(47.89)
	Present	296(52.13)
Altered body temperatures ≥37.5C^0	Absent	265(46.65)
	Present	303(53.35)
Diarrheal	Absent Present	257(45.2) 311(54.75)
Pneumonia	Absent	272(47.89)
	Present	296(52.11)
Anemia	Absent	399(70.75)
	Present	169(29.75)
Breastfeeding status	No breastfeed	207(36.4)
	Yes breastfeed	361(63.56)
Admission type	New admission	457(80.46)
	Re-admission	111(19.54)
Nasogastric tube during admission	Present	243(41.02)
	Absent	325(58.98)
Vitamin A supplementation	Given	470 (82.7)
	Not given	98(17.25)
Folic acid	Given	406 (71.48)
	Not given	162 (28.52)
Blood transfusion during admission	Given	123 (21.65)
	Not given	445 (78.35)

Table2:-Performance indicator of stabilizing center with compared *Sphere reference* for Incidence rate and predictors of Under-five SAM children in Pawe General Hospital (n=568).

Performance indicator	**Five years Performance of Stabilizing center**	**SPHERE project reference value**

		Overall	Acceptable	Alarming
Treatment cure rate	57.38%	77.9%	>75%	<50%
Incidence of death rate(IDR)	16.7%	12.3%	<15%	>25%
lost from follow up	18.36%	5.5%	<10%	>15%
Transfer out	8.7%	4.8%	____	____

Table3: Proportions of SAM treatment outcome by phase after being admitted to stabilizing center in Pawe general Hospital (2015-2019 (n=568).

Indicators	**Phase 1**	**Transition phase**	**Phase 2**	**Treatment outcome by phases(N=568)**
Death rate	**38(41.11)**	**24(26.4)**	**29(31.50)**	**91**
Treatment cure rate	**97 (29.56)**	**105(32.39)**	**124(38.60)**	**326**
Lost follow up	**9(8.50)**	**34 (32.81)**	**63 (60.0)**	**106**
transferred out	**3(6.52)**	**5(10.8)**	**38(82.6)**	**46**

Table-4: Log rank estimate of variables among SAM admitted children at Pawe General Hospitals in North West Ethiopia, 2021.

Categories	**log rank test estimated**	**P - Value**
Age(years)	**X^2= 64.36**	**P-value = 0.053**
Sex(Male/ female)	**X^2= 2.71**	**P -value = 0.099**
Residence(Urban /rural)	**X^2 = 3.23**	**P -value = 0.63**

Admission types(New/ Re-admission)	**X^2 = 37.02**	**P - value = 0.001**
Had NGT during admission (Yes/No)	**X^2 = 50.22**	**P -value = 0.001**
Measles vaccine (Taking /Missed)	**X^2 = 10.98**	**P -value = 0.009**
Iv fluid (Given/No given)	**X^2 = 2.38**	**P -value = 0.123**
Parenteral Antibiotics (Given/ Not given)	**X^2 = 9.16**	**P -value = 0.003**
Vitamin A supplementation (Given/Not Given)	***X^2 =1.82***	**P -value =1.7891**
Anemia during admission (Present /Absent)	***X^2 = 46.89***	**P -value =0.001**
Folic acid supplementation (Given /Not Given)	***X^2 =2.016***	***P -value =0.152***
Vomiting during admission (Present /Absent)	***X^2 =23.02***	***P -value =0.001***
Diarrhea during admission (Present/Absent)	***X^2 =38.9***	***P -value =0.001***
Comorbidity during admission (Present /Absent)	***X^2 =2.15***	***P -value =0.645***

Table 5: Bi-variable and multivariable Cox regression for predictors of SAM mortality among children to Pawe general hospital since 2015-2019 (n=568), North West Ethiopia.

Covariate	Categories	Survival status				
		Death	Censored	CHR(95%CI)	AHR(95%CI)	P-value
Age of children	6-24 Month	**68**	**186**	**1**		
	24-48 month	**22**	**145**	**0.9(0.57--1.4)**	**1.2(0.73-- 2.01)**	**0.443**
	≥48 month	**1**	**46**	**0.61(0.59 -4.4)**	**2.1 (0.82- -3.9)**	**0.27**
Sex	Male	**30**	**214**	**1.13(0.89--1.43)**	**0.96 (0.61 --1.53)**	**0.859**
	Female	**61**	**263**	**1**	**1**	
Admission types	**New**	**67**	**183**	**1**	**1**	
	Re-admission	**24**	**294**	**1.7(2.4 --- 6.1)**	**1.7 (1.03—2.8)**	**0.037***
NGT during Admission	**Yes**	**79**	**164**	**2.3(2.3--6.99)**	**3.22(1.65—6.26)**	**0.001***
	No	**12**	**313**	**1**	**1**	

Vomiting	**Yes**	**88**	**208**	**2.34(1.28 ---4.3)**	**5.1(1.35---21.2)**	**0.026***
	No	**3**	**269**	**1**	**1**	
Anemia	**Present**	**64**	**105**	**4.2(2.6---3.67)**	**1.89(1.15–3.12)**	**0.012***
	Absent	**27**	**372**	**1**	**1**	
Diarrhea	**Yes**	**79**	**232**	**5.6(2.99—10.6)**	**2.79(1.46—5.4)**	**0.002***
	No	**12**	**245**	**1**	**1**	

Version =4
Date = 17 September2021

Author's response to reviews

Titles:-INCIDENCE AND PREDICTORS OF SEVERE ACUTE MALNUTRITION MORTALITY RATE AMONG 6-59 MONTHS CHILDREN IN PAWE GENERAL HOSPITAL NORTHWEST ETHIOPIA 2021

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DR Walter RJ Taylor Comment
Academic editor of ***PLoS ONE Journal***

Additional Editor Comments PONE-D-21-11027-R3 Submission

INCIDENCE AND PREDICTORS OF SEVERE ACUTE MALNUTRITION MORTALITY RATE AMONG CHILDREN AGED 6-59 MONTHS ADMITTED AT PAWE GENERAL HOSPITAL STABILIZATION CENTER, NORTHWEST ETHIOPIA 2021,PLOS ONE

	Comment	Part	Correction	Amendment
#1	"During SAM inpatient treatment recovery, transfer out, lost follow-up, and death was found 326 (57.39%), 106(18.66%), 46 (8.10%), and 91(16.02%), respectively. The overall incidence of the mortality rate was 16.03 per 100 (95%CI: 13.86; 20.04) person-days observations **"*why you put two different rates for mortality"*** ***"Operational words" with Definitions***"	**Abstract**	***Accepted and corrected***	Accepted & amended
#2	"or mid-upper-arm circumference ≤115 mm, or presence of bilateral edema, and failed appetite test should be admitted for inpatient care[23].The current MUAC definition is <115 mm. Please change. The cited reference is fine.	**Methods**	***Accepted and corrected***	Amended Look Page 6 Reference (23)
#3	The Sphere cut off is <10% but <11% in the Abstract. Please correct.	**Abstract**	***Accepted & incorporated***	**Accepted Look 2&11**

#4	A majority usually means > 50% so please amend this sentence. Why not say that mortality in your series was high and half the deaths occurred within 2 weeks. Then list the key factors and suggest clinical care be focused preferentially on these risk factors	**Conclusion**	**Accepted**	
#5	*Table 1. I cannot find the drug "Permaquinin" on Google or in the Ethiopian Guidelines for treating SAM. Please tell us the name of this drug.*	**Table 3**	It is cut out from interpretation, But you can read about Primaquine on ***For further more please read it or brows it*** *https://en.wikipedia.org/wiki/Primaquine*	**Amended**
#6	Table 2. Please explain what "Waiting time" means.	**Table 2**	***Interpreted as hospital length of stay during treatment***	**Amended**
#7	Table 4. This is unclear. Is it showing an overall survival rate for all the children? If so, 21.09% survival is much less than the reported survival in the paper:"At the end of this study period, 326 (57.39%) admitted under-five children had been cured	**Table 4**	**Removed & corrected and interpreted**	**Amended**
#8	Figures. Labelling of the Y axes of the 3 figures has been cut away. Please make sure we can see the labels.		**It is re interpreted based on your request**	**Accepted and amended**
#9	Figure 3. This makes no sense to me. It shows a very low survival rate. I suggest you either remove this Figure or put in the correct KM curve.	**Figure 3**	***Changed based on your queries and re- interpreted***	**Amended**
#10	Figure 7. Analysis is not spelt correctly on the X-axis.	**Figure 7**	**Removed and re interpreted what you want to changed**	**Accepted and amended**

Reviewer reports:

Reviewer #1:		**Area**	**Response of Authors**	**Status**
#1	Abstract as grammatical errors	Abstract	We made the extensive grammatical correction and rephrasing with by authors and senior researcher consultation.	Accepted &Amended
#2	Was the study conducted in one or many hospitals author said ' hospitals'	Title &Study area	The study conducted only one hospital i.e. Pawe General Hospital	Fully amended
#3	Provide more details about the Stabilizing Center. Is this award treating both admission illness and nutrition deficiency or for SAM children?	Study area	-After SAM cases diagnosed in the pediatrics ward then transferred to stabilizing center -which is isolated built for the only treatment of SAM cases and their complications -Pediatrician and Trained health personnel were used supervised overall SC treatment based on national protocol	Amended % Incorporated
#4	Understudy population, the study recruited children under management between 2008 and 2012. This is an approximately ten years old cohort. Is there a valid reason for not studying the latest cohort	Study period & Study population	-In fact, the SAM observation cohort was registration on a computer-based on Ethiopian colander (EC) which is late almost 7 years. -However, we have changed and edited our mother document based on Gregorian calendar (GC) form;- -**Marked corrected study periods and study population is as follows.** **"**A retrospective cohort study was conducted in 568 under-five children who were admitted for SAM treatment at Pawe General Hospital ***from 1st January 2015 up to December 31, 2019***."	Accepted
#5	Explain clearly the sample size estimation. What is a½ **=0.05?** What were the cases and non-exposed groups?	Samples size	We determined the minimum sample size by Survival sample size by STATA(SE)\14 sample size calculation The sample size for the second objective was determined using STATA/SE version-14 by considering the following statistical assumptions two-sided significance level (α = 5%), Za/2 = Z value at 95% confidence	Accepted

			interval = 1.96, power($\mathbf{Z_B}$)=80%, and P = % cumulative occurrence of death rate, 1.65 HR. Accordingly, a total of 440 SAM children's records were recruited. *Final* Sample size was (n) =Event / P (Event) = $\mathbf{(Z_{a/2}+Z_B)2}$ / $\mathbf{\theta^2 p(1-p)}$ **n= e / p (e)** θ = ln(HR) HR= e^{θ} Where ZB = power of the study. Za/2 = Z value at 95% confidence interval e = event P (e) = probability of eventP =cumulative mortality rate from previous research *46%[6]*, HR= hazard ratio from previous research (AHR) 1.6 [6]	
#6	Again, the sample size estimated was 596, which is different from the numbers reported so far.	Sample size issue	We already calculated by single population proportion formula of sample size by using listed assumptions The final sample size was calculated as 578;	Amended
#7	The inclusion criteria contradict what is explaining in the study population about the period of recruitment. Here it is mentioned children with SAM treated 2015-2019 were eligible	Inclusion criteria	The study period is changed and the inclusion criteria issue is resolved as following "All SAM admitted & treatment started children from January 1st, 2015, up to December 30, 2019, were considered as the study population and included"	Amended
#8	**What** was the discharge criterion from the Stabilizing Center?	Outcome ascertainment	A child reached: weight-for-height/length is ≥–2 Z-score, and they have had no edema for at least 2 weeks, And/or MUAC (Mid-upper-arm circumference) is >115 mm and they have had no edema for at least 2 weeks.- If there are no danger signs for >15 min.	Fully amended
#9	How were the z-scores calculated?	Methodolog	-It is the probability of a score occurring within a standard normal distribution curve: tells how many standard deviations from the mean your score. -The formula for calculating a z-score is $z = (x-\mu)/\sigma$, where x is the raw score, μ is the population mean, and σ is the population standard deviation. -you can use the z-table and the normal distribution graph to give you a visual about how a z-score of 2.0 means "higher than average"	Accepted
#10	-How was the survival analysis conducted? -How was exposure time defined? -Which statistical software has used Any testing of non-	Data analysis part	-Time-to-event (TTE) data is unique because the outcome of interest is not only whether or not an event occurred, but also when the event occurred. -There needed 4 main methodological considerations, target event, the time origin, the time scale, and to describe how participants will exit	Accepted

	informative censoring assumption		-Time origin is the point at which follow-up time starts in the case of our study(January 1st, 2015-December 30 2019. we used STATA(SE) version 14 all survival analysis and assumption test - Informative censoring is analogous to non-ignorable missing data, which will bias the analysis. -There is no definitive way to test whether censoring is non-informative censoring is reasonable. -In some instances proposed random sub-sample of censored subjects is followed to determine failure times when incomplete information is available about the survival time of SAM cases.	
#11	Why were 568 children recruited out of the 596 eligible children?	Sample size issue	-We used for analysis 568 samples out of 578, and 10 participant cards were excluded due to treatment outcomes were not registered.	Corrected & incorporated
#12	**"**457(80.46%) of admitted children were new admissions." What does this mean?	Result part	-Which means '457 cases were new admissions for stabilizing center? -The remaining 111(19.54) cases were relapse SAM cases & Re-admitted twice within	No changed as it is
#13	The authors reported the defaulted and recovered, these are new terms not defined in the methods	Operational words	We made correction and incorporated	Amended
#14	The authors report "307 (54.35%) admitted children had at least one form of comorbidity" does this mean the remaining children were uncomplicated SAM? Why would uncomplicated SAM be admitted to the hospital?	Result part	Thanks! this is an expression error -All 568 SAM admitted children had manifold cases diagnosing and responsible for admission -Of this 307 (54.35%) had more than two concomitant cases diagnosing and admitting for eg, (commonly SAM with Pneumonia)+ anemia, or diarrhea or vomiting, etc.	Amended
#15	How was anemia defined?	Operational	Anemia:-was defined and classified based on the mean amount of red blood cell or Hgb levels and classified into two ways:- No anemia >11 g/dL, and Anemia≤10.9 g/dl	Amended
#16	Were the 432 children managed with antimalarial have a positive slide for malaria?	Result report	*Read* *https://reference.medscape.com/drug/primaquine-342691*	Amended
#17	Provide the length of time (days) that children were on F75 and F100.	Result	SAM inpatient waiting in Stabilizing center was based on three phases of treatments. **Phase -1=** In a separate room or space -starter formula for inpatient management	Accepted

			-Only F-75% formula milk used -Weight is measured & plotted on the chart. - Standard clinical signs (vomiting, dehydration, cough, respiration, and liver size were measure - Amount of F-75 to give during Phase 1 is based on the class of weight (Kg). -took2-6observation with clinical improvement consideration. -**Transition phase**= - Use only the F100 formula -Daily surveillance of the child remains the same in Phase 1. -F-100 milk given are based on the class of weight (Kg) - Frequency of feeds should normally be 6 per day. -Routine antibiotics also continued as necessary - A maximum of 4-5 days with considerations of clinical improvement of cases **Phase -2= Use** F-100 milk -Every morning assessed temperature, vomiting, dehydration, respiration, etc. -Determined by clinical improvement starting from 2 days of entry----).	
#18	"In addition, more than half of the 326 (57.51%) and 104 (18.31%) cases were declared as cured and absent" What does absent mean?	Result & operation words	Look result part of Table-2:- -After admitted and started SAM treatment Within five years cohort -326 (57.38%) cases had been cured, 91(16.73%) cases had died, **46(8.09)** cases- had been transferred out.**105(18.3**%)cases had lost from follow-up (Abscond) were the similar operational definition for Ethiopia FMOH SAM Guidelines. You can read **https://motherchildnutrition.org/resources/pdf/mcn-ethiopia-sam-guidelines.pdf**.	Accept and changed
#19	"The overall mortality incidence rate of severe acute malnutrition during the study period was found (IDR=16.73; 95%CI: 13.86--20.04)."Check the 95% CI correct.	Result part	-We repeatedly assessed what you requested to check the result of the incidence rate. Nevertheless, the result is what we had already reported and similar with – -There is no result deviation both in STATA (SE) version R/14 software and in SPSS version 16.	Amended
#20	"At the end of three weeks (29 days of follow-up) treatment" three weeks have 21days and not 29 days. Were children on follow-up for a fixed 3 weeks?	Result report	We corrected the grammatical errors	Accepted &Amended
#21	-"Thus, within five years of risk observation, 473 children had censored results & gives 505 person-per-day observations (PDOs)." -What does this mean? You have not explained who and when censoring was done	Result part	-We remove the term person per day of observation(PDOs) expression from the document incorporated on the mother document You can look at page 12, from line 8	Accepted and incorporated

#22	Why are P-values reported as P≤ rather than the standard P<?	Predictors	We corrected and incorporated	Accepted and amended
#23	-What was the rationale for including F-75 and F-100 in the regression models?-It does not make sense to include these in the models	Result part	We authors corrected and incorporated on the final model.	Accepted and amended
#24	-How long did the children spend in the hospital? How long after admission did the deaths occur? Deaths in the first 3 days)and late deaths?	Result part	Maximum of 40 days but in our set up maximum 29 days please let me invited to see (Tables -4) Life tables	Amended

Part II= reviewer #2

Reviewer #2 comments		Area of comment	Authors response	Status
#1	-The introduction focuses on malnutrition broadly as well as SAM specifically, but sometimes it is unclear which of these definitions the authors are referring to. -It might be beneficial if the authors mainly focus on SAM and the rationale for examining predictors of mortality in children with SAM.	Introduction	-We accepted & rephrasing part of the introduction part. It is attractive now -Let me invited you to read and check it.	accepted & changed
#2	This analysis used data from 2008 and the end of 2012. (However, later on, the inclusion criteria are stated between 2015-2019 so it is unclear what years were used.)If the admissions were between 2008 and 2012, what are the potential limitations of using data from several years ago, and why were more recent data not considered	Inclusion criteria	Thanks for point of view -SAM treatment outcome registration in the facility was based on Ethiopian colander (EC)registration , which is late almost -7 years from G.C. -However, we have changed and edited all years based on the Gregorian calendar in our mother document-based **"**A retrospective cohort study was conducted in 568 under-five children who were admitted for SAM treatment at Pawe General Hospital **from 1st January 2015 up to December 31, 2019."**	Accepted
#3	The authors should also discuss changes in treatment protocols over time, as updates to the WHO	Operational words	-This is recommendations below were confirmed as current WHO to SAM	

	guidelines were released in 2013 for example. -It would also be important to explain the admission criteria for this treatment center		management of children who are 6–59 months of age -Weight-for-height ≤–3 Z-score, or -Mid-upper-arm-circumference<115 mm, or presence of bilateral edema, & failed appetite test were admission criteria -However, visible severe wasting is not included as a diagnostic criterion.	Accepted & incorporated
#4	In the abstract and the introduction, the authors use the idiom "lion's share" which may not be familiar to all readers, so perhaps this could be changed to more common terminology and to specify whether this is about the absolute number of deaths or mortality in the comparison group	Abstract & Introduction	-We had changed the term “lions share” substituted by phrases “largest proportions”	Accepted and incorporated
#5	: In the abstract, is also unclear what the authors mean by "not take in" the F-75/F-100 formula. Do the authors mean feeding difficulties or loss of appetite, or that children were not provided these formulas?	Abstract	-We build another model and removed those due to confounding,	Accepted incorporated
#6	The sample size calculation is unclear and appears that it may be appropriate for a prospective study rather than a retrospective analysis and explained.	Sample size	We determined the minimum sample size using a single population proportion formula [n =[(Za/2)2P (1-P)]/d2] by assuming 95% confidence level (Z a/2 = 1.96), margin of error 5% overall SAM mortality rate from previous research46%[6], and 15 % addition for missing/incomplete data. The final sample size was 442. However, when the five years multi-chart was reviewed, 578 records were there and all were considered for analysis.	
#7	The terms kwashiorkor and marasmus should be replaced by edematous malnutrition and severe wasting, respectively	Result	We accepted and changed terms on result and discussion par.t	Accepted & changed
#8	The authors describe the mean weights of children with SAM, yet it would be more useful to provide z-scores if possible since it is difficult to interpret weights alone.	Result	-We made, as it is mean weight as it is rather Z-score calculation for all is tedious readers	Not changed