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Research Article

Anemia and Determinants among Severely Malnourished Children Admitted to Amhara Regional Referral Hospitals, Northwest Ethiopia

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Abstract

Background: Anemia is the commonest micronutrient deficiency disorder is seen among severely malnourished infants and children. The problem is a double burden in this group of the population that could make the outcome of Severe Acute Malnutrition (SAM) treatment very challenging and unfavorable. However, the magnitude and factors of anemia among infants and children suffering from SAM are not well studied. Therefore, this study was aimed at determining the prevalence of anemia and associated factors among children aged younger than five years with SAM admitted to Amhara region referral hospitals.

Method: A facility-based cross-sectional study was conducted that included a total of 1,301 infants and children with SAM in the three referral hospitals of the Amhara region. Data were extracted using data extraction checklist for each hospital. Descriptive statistics were presented using tables and texts. The binary logistic regression analysis was employed. Multivariable logistic regression analysis was conducted to show an association between the dependent and independent variables. Multicollinearity was assessed using the Variance Inflation Factor (VIF). Hosmer and Lemeshow test was used to check the goodness of fit for the chosen model.

Adjusted odds ratio and its 95% confidence interval were reported for variables with a p-value <0.05.

Results: The prevalence of anemia was 41.43% (95% CI: 38.78 to 44.13). Nearly, half (47) of under-six month children were anemic. Rural residence (AOR=1.56; 95% CI: 1.14 to 2.12) and HIV infection (AOR=2.00; 95% CI: 1.04 to 3.86) were significantly associated with higher odds of anemia. Being on exclusive breastfeeding (AOR=0.57; 95% CI: 0.39 to 0.83) was significantly reduced the odds of anemia.

Conclusion: This data confirm that anemia among infants and children who were severely malnourished are a public health problem in the Amhara region. Under-six years-old infants and children were at higher risk of anemia. Being a rural resident and HIV infection have raised the occurrence of anemia, whereas, exclusively breastfed reduced the occurrence of anemia. Therefore, it is valuable for policymakers and planners to strengthen preventive strategies of HIV infection and treat them once the problem has occurred. Infants and children residing in the rural areas demand special attention through delivering nutrition education.

Keywords: Anemia; Infants and children; SAM; Amhara region

Abbreviations

AIDS: Acquired Immunodeficiency Syndrome; AOR: Adjusted Odds Ratio; COR: Crude Odds Ratio; CI: Confidence Interval; HIV: Human Immunodeficiency Virus; IQR: Inter-quartile Range; MUAC: Mid Upper Arm Circumference; SAM: Sever Acute Malnutrition; SD: Standard Deviation; TB: Tuberculosis; WHO: World Health Organization; WHZ; Weight for Height Z score

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Introduction

Anemia is a hematological disorder that could happen to all ages of individuals, but it's most prevalent and severe among reproductive-age women and children, sick infants and children, and those children suffering from other nutritional deficiency disorders [1]. Good hemoglobin concentration in human blood is an indicator of rich trace minerals fundamentally, iron; this is because iron is an essential mineral to synthesis hemoglobin which is an important messenger that transports essential nutrients and oxygen to different parts of the human body [2]. Anemia is attributable to Vitamin B12 deficiency, Vitamin B9 deficiency and other infectious diseases [3,4], but iron deficiency shares 50% of all causes of anemia and this is primarily associated with the poor dietary intake [5]. A hemoglobin concentration of below 11 g/dl is defined as anemia [6]; following this, the body starts to show deprived of nutrients and oxygen, as a result. Anemia contributes to several clinical problems like heart failure, poor cognitive performance, macronutrient deficiency, and other micronutrient deficiencies [7,8]. Childhood anemia might occur as a result of macronutrient deficiency(s), or it precipitates the development of under-nutrition owing to the poor synthesis of macronutrients [5,9].

This hematological disorder is commonly seen among infants and children suffering from SAM, making the problem double burden. The defining characteristics of SAM are the presence of bilateral pitting edema or severe wasting (weight-for-height/length 70%/<3 standard deviation), or Mid Upper Arm Circumference (MUAC) of below 11.5 cm (children older than 6 months) [10]. SAM is the complicated form of under-nutrition that has affected about 18.7 million children in the globe, of which amazingly 18.5 million are from lower and middle-income countries [11]. In Ethiopia, SAM is registered as the third cause of childhood mortality that contributed to 8.1% of under-five years-old mortalities [12]. SAM and anemia have an interplay association [9,13]. In other words, SAM could contribute to developing anemia and vice-versa [14]. Anemia is the commonest co-morbid medical problem seen among SAM and commonly referred to as 'complicated SAM' which prolongs the recovery time, and increases the likelihood of mortality as compared to anemic children without SAM [15-18].

Studies have shown that anemia is the commonest micronutrient deficiency disorder observed among severely malnourished children and the magnitude is quite distinct from the general population. Amazingly, the prevalence of anemia among these population ranges from 81.1% to 95% [7,15,19], and in Ethiopia, it's estimated to be between 16.4% and 61.3% [18,20-22].

In cognizant of the nutritional problem among infants and children, Ethiopia is working on improving childhood nutrition through designing various strategies like 1000 days (conception time through two-years-old of babies), essential nutrition action, the Sekota declaration, and National Nutrition Program (NNP). However, studies are not generated sufficiently while the role of repeated scientific investigations are paramount as scientific reports are largely required to show the burden of the problem as well as the contributing factors.

Even though different studies have been conducted in this region, their findings are contradicting and cannot be inferred to the region. Therefore, a summarized figure that could reflect the regional prevalence of anemia and contributing factors among severely malnourished infants and children is imperative to pass a balanced decision. In doing so, it would be possible to urge the responsible bodies to think over the issue and take appropriate actions. Moreover, the results of this study would stimulate clinicians' to stringently follow infants and children suffering from SAM and to take appropriate interventions as early as possible.

Material and Methods

Study design, period, and setting

An institution-based cross-sectional study was conducted among infants and children who were hospitalized between October 2012 and September 2016 to inpatient treatment centers of SAM in the Amhara regional referral hospitals. Even though we planned to gather data from the six referral hospitals of the region, only the University of Gondar, Debre birhan, and Felege hiwot referral hospitals were included as the data from other institutions were poorly recorded and important predictors have not been available. Clinicians working in these hospitals are recommended to follow the national treatment protocol developed while admitting and treating infants and children. Furthermore, these hospitals have separated inpatient treatment centers whereby severely malnourished children are admitted and receive appropriate nutritional and medical care.

Study population and sample

The study considered infants and children who were admitted to the three aforementioned hospitals in SAM inpatient treatment centers. Only children whose anemic status was diagnosed at admission or before starting the transition phase management were recruited as children who were at the transition phase obviously start to receive therapeutic feedings like Ready to Use Therapeutic Feeding (RUTF), which has trace minerals and could affect the estimation. Moreover, infants and children whose anemic status was ascertained using a hemoglobin test were enrolled in the study. About 401, 373, and 527 were from Felegehiwot, Debrebirhan, and University of Gondar referral hospitals, respectively; making a total sample size of 1,301.

Variables of the study

The outcome variable was anemia and it was ascertained biochemically using hemoglobin level; accordingly, a hemoglobin concentration of less than 11 g/dl was defined as anemia [6]. Although the abovementioned criterion is for infants and children younger than six months, we also used the same cut-off for children younger than as there is no standard for this population and it's commonly used in the clinical set-up [23].

Infant's and children's nutritional status was measured by using different guidelines that were applicable by the time. SAM was diagnosed as either the presence of severe wasting (weight-for-Height/length 70%/<3 SD), and/or bilateral pitting edema of both feet and/or MUAC of below 11.5 cm (for only children older than six months) [10,24]. Socio-demographic factors: the place of health facility, sex of the child, age of the child, and residence were included.

Clinical factors such as breastfeeding status, vaccination status, and presence of diarrhea, presence of pneumonia, type of SAM, HIV status, antibiotic intake, folic acid supplementation and vitamin A supplementation were the independent variables.

Breastfeeding status

Breastfeeding status was taken from the chart and a child who breastfeeds for the first six months without adding other foods other than medicines were considered exclusively breastfed [25].

Immunization status

Immunization status was explained as unimmunized, fully immunized, unknown, and incompletely vaccinated, according to the World Health Organization (WHO) [26]. Children who didn't receive any vaccine during their immunization time according to the evidence recorded in the medical recording chart was considered unimmunized. Infants and children who did not receive at least one of the recommended vaccines were categorized as incompletely immunized. Whereas, fully vaccinated was defined as infants and children who have completed and received the vaccine according to their age. Unknown vaccination status was declared whenever there was no attachment of vaccination card in the medical recording chart and mother not sure of the immunization. However, for those infants younger than 12 months, their immunization status was considered as fully immunized provided they received age-appropriate immunization, and incomplete if they missed one of the immunization schedules.

Clinical forms of malnutrition

Type of SAM was described using the clinical presentations as marasmus, Kwashiorkor, and mixed form (marasmic-kwash) [27]; infants and children who had no edema, but the presence of fat wastage, and other supplementary clinical presentations were explained as marasmic. Infants and Children who had edema, muscle wastage, and clinical manifestations were declared as having Kwashiorkor form of malnutrition. Lastly, infants and children who had mixed form of clinical presentation were diagnosed as having marasmic-kwashiorkor.

HIV and tuberculosis infection

HIV infection status of infants and children was considered using the confirmatory tests as per the national test algorism. Infants and children aged under eighteen months whose HIV status was ascertained by Polymerization Chain Reaction (PCR) and their result was positive was considered positive for HIV infection. For children older than eighteen months whose HIV status was diagnosed using any confirmatory test and recorded as positive were declared as positive for HIV infection [28]. Similarly, only confirmed Tuberculosis (TB) infection was considered.

Data collection procedure, quality assurance, and extraction procedure

The data were collected using a data extraction sheet comprised of all covariates. Prior to the commencement of the data collection, a two days training was given to two data collectors and one supervisor to each hospital aiming at briefing the objectives of the study and what kind of data should be extracted. A pretest was administered in order to understand the variables that are available in the medical registering chart. Data reported the hemoglobin status analyzed through HemoCue-HB 201 and hematological analyzer machine was extracted. The completeness of the data was checked on a daily basis. Finally, the data sets from the three hospitals were merged.

Data processing and analysis

The collected data were entered into Epi-data version 4.4.3.1 and exported to STATA version 14 and recoding, cleaning, and analyses were done accordingly. All continuous independent variables were categorized. The outcome variable was dichotomized and coded as "0" and "1", representing not anemic and anemic, respectively. For continuous variables age, for instance, the histogram was used to determine which measure of central tendency is appropriate. Descriptive statistics such as frequency, percentages, and measures of central tendency with their appropriate corresponding measure of dispersion were used. Tables and texts were used to present the findings.

Furthermore, the binary logistic regression analysis was applied to identify factors associated with anemia. Variables with a p-value less than 0.2 in the bi-variable analysis were transferred to multivariable analysis to control the possible effects of confounders and to identify the significant variables as well. Hosmer and Lemeshow goodness of fit test was used.

The interaction of independent variables was checked by a multicollinearity test using the Variance Inflation Factor (VIF). Finally, the presence of an association between the independent and dependent variables and the direction as well as the strength was established by the AOR with its 95% CI for variables with p-value< 0.05. The difference in outcome among hospitals was checked by Intra Class Correlation (ICC) and no significant difference was observed. As a result, the model without considering variability was used.

Results

Socio-demographic characteristics of SAM children

A total of 1,301 SAM children's charts were reviewed. The median age of children was 16 months (Interquartile range (± IQR) of 9 to 24 months). Of all respondents, 527 (40.51%) were from the University of Gondar referral hospital. More than half (54.57%) of children were females. Nearly two-thirds (64.43%) of SAM children were from rural residence. Only 81 (6%) and about 507 (40%) of SAM children were fully vaccinated and had diarrhea, respectively. Just over one-third (33.59%) of SAM children had pneumonia. One hundred seven (8.22%) and 54 (4.15%) of SAM children had TB and HIV, respectively. In addition, 393 (42.86%) and 859 (65.82%) took antibiotics and folic acid, respectively (Table 1).

Prevalence of anemia among SAM children

The prevalence of anemia among under-five years-old infants and children suffering from SAM was 41.43%, 95% CI: (38.78%, 44.13%). The prevalence of anemia varied among different age categories. A third of severely malnourished infants and children younger than six months were anemic, 36.15%, 95% CI: (27.92%, 45.04%). Furthermore, nearly equal proportion of infants and children aged 6 to 23 months and 2 years and above experienced anemia; 41.73%, 95% CI: (38.42, 45.10) and 42.81%, 95% CI: (37.19, 48.56), respectively.

Factors associated with anemia among 6 to 59 months children with SAM

In the bi-variable logistic regression analysis age, residence, exclusive breastfeeding, type of SAM, pneumonia, tuberculosis status, HIV status, taking antibiotics, and taking vitamin A were entered into multivariable logistic regression model. After adjustment for other variables residence, exclusive breastfeeding, and HIV status were significantly associated with anemia.

The odds of anemia among rural dwellers were 56% higher than urban residents (AOR=1.56; 95% CI: (1.14, 2.12)). Similarly, infants and children who have contracted HIV infection were two times higher to develop anemia as compared to their counterparts, (AOR=2.00; 95% CI: (1.04-3.86)). The odds of anemia among exclusively breastfed children was decreased by 43%, compared to their exclusively breastfed counterparts, (AOR=0.57; 95%CI: (0.39, 0.83)) (Table 2).

Discussion

It's an established truth that malnutrition is a lingering public health concern affecting the lives of children and women in developing countries like Ethiopia. Anemia is one of the disregarded and overlooked medical problem happened to severely malnourished infants and children; it's an added nutritional problem that could stop infants and children to recover from their illness. Carrying out studies among this disadvantaged population is imperative to understand the problem and take corrective measures accordingly. The aim of this study was to assess the prevalence of anemia among under-five children with SAM in the Amhara region.

The prevalence of anemia among under-five years-old infants

Table 1: Socio-demographic and Baseline characteristics of SAM children in Amhara region, northwest Ethiopia, 2016.

Variables	Frequency	Percentage
Place of health facility		
Bahirdar	401	30.82
Debrebirhan	373	28.67
Gondar	527	40.51
Sex		
Male	591	45.43
Female	710	54.57
Age of child		
Under 6 months	130	9.99
6-23 months	865	66.49
2 years and above	306	23.52
Residence		
Rural	837	64.43
Urban	462	35.57
Breast feeding		
No	241	18.52
Yes	1.06	81.48
Immunization status		
Unimmunized	90	6.92
Incompletely immunized	495	38.05
Fully immunized	81	6.23
Unknown	635	48.8
Diarrhea		
No	794	61.03
Yes	507	38.97
Pneumonia		
No	864	66.41
Yes	437	33.59
Type of SAM		
Marasmus	888	68.26
Kwashiorkor	273	20.98
Marasmic-kwash	140	10.76
Tuberculosis		
Yes	107	8.22
No	1194	91.78
HIV status		
Positive	54	4.15
Negative	885	68.02
Unknown	362	27.82
Antibiotics		
Given	393	42.86
Not given	524	57.14
Folic Acid		
Given	859	65.82
Not given	446	34.18
Vitamin A		
Given	763	83.3
Not given	153	16.7

and children with SAM was 41.43% (38.78%, 44.13%) which is a public health pressing problem requiring the attention of clinicians and policymakers. In addition, the study gives an insight that anemia could be the reason for mortality and delayed recovery. Rural residence, exclusive breastfed and having HIV infection was factors affecting anemia. This finding is lower than a study from Vavuniya, Sri Lanka (55.5%) [29]. The study from Sir Lanka was done from a single district (Vavuniya), in which more than 70% of SAM children were from socially deprived society. However, the current study is mainly conducted in cities despite there was the high potential of incorporating children from rural areas because of referrals. Similarly, the current study is lower than a study from Columbia (51.1%) [30]. This could be the inclusion of children under 6 months old who are less likely to be anemic compared with children above the age of 6 months; under-six children are believed to be at lower risk of anemia [31,32].

Table 2: Factors associated with anemia among SAM children aged 6 to 59 months in Amhara Regional State, North West Ethiopia, 2016.

Variables	Anemia		COR (95% CI)	AOR (95% CI)
	Yes	No		
Age				
< 24 months	333	504	1	1
> 2 months	205	257	1.21 (0.96, 1.52)	1.08 (0.81,1.45)
Residence				
Rural	300	372	1.51 (1.12, 2.04)	1.56 (1.14, 2.12)
Urban	89	167	1	1
Exclusively breastfed				
No	121	120	1	1
Yes	418	642	0.65 (0.49, 0.86)	0.57 (0.39, 0.83)
Type of SAM				
Marasmus	334	554	1	1
Kwashiorkor	140	133	1.75 (1.33, 2.29)	1.12 (0.76, 1.63)
Marasmic-kwash	65	75	1.44 (1.01, 2.06)	1.24 (0.81, 1.89)
Pneumonia				
Absent	371	493	1	1
Present	168	269	0.83(0.66, 1.05)	0.87 (0.64, 1.22)
Tuberculosis				
No	488	706	1	1
Yes	51	56	1.32 (0.89, 1.96)	1.38 (0.87, 2.19)
HIV				
Negative	355	530	1	1
Positive	31	23	2.01(1.15, 3.51)	2.00 (1.04, 3.86)
Unknown	153	209	1.09 (0.85, 1.40)	1.03 (0.72, 1.46)
Amoxicillin				
Given	181	212	1.31 (1.01, 1.72)	1.25 (0.93, 1.66)
Not given	206	318	1	1
Vitamin A				
Not given	133	151	1	1
Given	254	379	0.76 (0.57, 1.01)	0.86 (0.63,1.19)

This study is also lower than a study from Guinea-Bissau 80.2% [7]. Giunea-Bissau's study was conducted in a rural area in which most children would have a potential risk of working in agricultural areas, in which there is a high prevalence of soil-transmitted hookworm infections that could increase the risk of anemia [33].

In this study, rural residence was associated with higher odds of anemia among under-five children in Amhara regional state, depicting rural children are disadvantageous over children residing in urban area in experiencing not only anemia but also other macro and micronutrient deficiencies following anemia and exacerbate the energy depletion and consequently, lead to death [34]. Studies have shown that the sequelae of anemia are diverse like deficiencies of other important micronutrients and other extra nutrition medical problems [35]. Likewise, these children could encounter poor neurodevelopment and incapable of carrying out tasks demanding cognitive performance [8,36]. This finding is supported by a multicenter study from Burkina Faso, Ghana, and Mali [37]. Similarly, a study from Uganda showed that rural residence was at higher risk of anemia due to poor access to health services, including health education [38], which would help them to keep their self and environmental hygiene. The other reason could be due to less availability and access to nutrient-rich food items for children in rural areas [39].

The current data suggest that exclusive breastfeeding decreases the odds of anemia. On the other hand, previous studies revealed that the duration of exclusive breastfeeding is one of the risk factors of anemia [40]. In other words, the longer the breastfeeding the higher to experience anemia. Likewise, those existing literature speculated that exclusively breastfeeding for six months exposes to anemia associated; as a child rises the nutrient requirement is higher and the infant iron storage that acquired from the mother through the placenta become depleted, which might not be compensated by the breast milk as it contains a small amount of iron [41,42]. To-that-end studies suggest supplementing iron at this stage could limit the development of childhood anemia [43,44]. Taking all the arguments among the current and the previous studies, further study that involve high-level study is highly recommended.

Furthermore, HIV infection has doubled the odds of developing anemia. There are a wide range of mechanisms how HIV infection would contribute to anemia: HIV infection resulted in the reduction of Red Blood Cell (RBC) production, increases RBC destruction, and ineffective RBC production as a result of involving the hematopoiesis sites such as bone marrow [45-47]. The other mechanism is that the infection reduces the erythropoietin concentrations [48,49]. Likewise, some Antiretroviral Therapy (ART) drugs like, Zidovudine (AZT) usually results anemia as this drug compromises the production of RBCs [50,51]. Cell proliferation of organs in this population is less competent as compared with healthy counterparts. Furthermore, vitamin B12 deficiency is another problem observed among HIV infected humans, which is an indispensable vitamin that supports the role of iron in the synthesis of hemoglobin [52]. This vitamin deficiency is commonly seen in malnourished individuals secondary to gastric malfunction and the problem is a vicious cycle. Therefore, it's possible to draw an inference that HIV infection worsen childhood anemia among children with SAM because of the dual effects of poor RBC production and effect of AZT side effect. The study implies that apart from weakening the immunity and opening a great opportunity for other opportunistic infections, HIV infection jeopardizes the bod's capability of generating RBCs and interferes the production of hemoglobin. In addition, HIV infection shortens the lives of individuals and it's notable that this infection would significantly reduce the survival of children developing SAM. Thus, early treatment and prevention of HIV infection would prevent anemia on top of other life-threatening comorbidities.

The strength of this study was including multi-center sites of the region. This could fortify the generalizability of the study findings to the region. As the data were collected from different sites, the study considered a clustering effect. However, this study faces some limitations; it's obvious that it's difficult to establish cause-effect relationship because of the cross-sectional nature of the study. This study was based on secondary data; therefore, the study suffers from incomplete data and some charts of the children were removed.

Conclusion

The study suggested that anemia is a public health problem among under-five years-old infants and children with SAM in the Amhara region. Being a rural resident and HIV Infection has raised the occurrence of anemia. On the other hand, exclusive breastfeeding reduced the development of the problem. Therefore, it is valuable for policymakers and planners to strengthen the preventive strategies of HIV infection and give a special focus on rural residents. In addition, clinicians working in maternal and child health departments are recommended to treat HIV infection before causing further damages. Although the current finding comes up with evidence showing the protective effect of exclusive breast feeding on anemia prevention, it contradicted the existing literature and it's quite impossible to draw a conclusion using our study. Therefore, future scholars in the area are recommended to conduct a study using high-level study design practice in order to clear the equivocal conclusions.

Ethical Approval

Ethical clearance was secured from the ethical review committee of the three referral hospitals. Additionally, permission letter was also obtained from the respective hospitals. As the study was conducted through a review of records, no consent was asked from the mothers or caregivers of the study subjects. The confidentiality and privacy of the patient record was ensured by avoiding names and identification number from extraction form and using codes instead.

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