



## **Prevalence and Causes of Undernutrition among Under-five Sudanese Children: A Mini-review**

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### **Authors' contributions**

*This work was carried out in collaboration between both authors. Author SOHK contributed to the literature search, discussion of the findings. Author AEOE contributed to the literature search, wrote the draft of the manuscript and critically reviewed the manuscript for its intellectual content. Author AEOE had the responsibility to submit the manuscript. Both authors read and approved the final version of the manuscript.*

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### **ABSTRACT**

**Background:** Malnutrition among under-five children have significant interest for the health authorities in Sudan. This is considered by the fact that the prevalence of underweight children in Sudan is among the highest in the world and it is essential to determine its prevalence and causes, as this problem affects the future of the under-five children and the community as general. This review aimed to assess the prevalence and causes of undernutrition among under-five children in Sudan.

**Methods:** Published data such as peer-reviewed articles, published dissertations and official reports on malnutrition and its causes among under-five Sudanese children during the last twenty years, were collected from Science Direct, Google Scholar, PubMed, and others. The information restored was reviewed and analyzed for inconsistency.

**Results:** Data shows that the prevalence of under-nutrition among under-five children was high and diverse widely, and the majority of the studies were carried out in Khartoum state, which showed the prevalence of wasting (3.3 to 21.1%) stunting (20.3 to 51.0%), severe stunting (12.9 to

25.2%) and underweight and severe underweight represent 24.4 to 35.0% and 6.6 to 48.0%, respectively. The prevalence rate of malnutrition was reported to be 14.1, 23.6, and 10.7% in South Darfur IDP camps, while in North Darfur it was 14.7, 48.9, and 35.6%, for wasting, stunting, and underweight, respectively. In El Fau, Gadarif state the prevalence of moderate and severe malnutrition of the under-five children were 6% and 3.3%. Many causes were reported for malnutrition among the under-five children including bad feeding practices, childhood diseases, hygiene and sanitation, and low socioeconomic status.

**Conclusion:** The prevalence rate of undernutrition among the under-five Sudanese children was very high, and stunting is the main shape of malnutrition. Many causes were contributed to under-five malnutrition and improvement in infant feeding and better maternal education are significant to get a high nutritional status of the children.

*Keywords: Malnutrition; wasting; stunting; prevalence rate; under-five children; Sudan.*

## 1. INTRODUCTION

Usually, undernutrition with all its types (wasting, stunting, underweight, and micronutrient deficiencies) has been reported as the most common form of malnutrition. The Global Hunger Index (1992–2017) showed a significant reduction in under-five child mortality in all parts of the world but a less significant reduction in the prevalence of wasting and stunting between children. Yet, the rates of reduction in undernutrition for children and adults are yet too sluggish to reach the Sustainable Development Goals (SDG) goals by 2030 [1].

Undernutrition can be classified into four classes as wasting (low weight-for-height), stunting (low height-for-age), underweight (low weight-for-age, those children who are underweight may be stunted, wasted, or both), and deficiencies in vitamins and minerals (insufficient intake of micronutrients) [2]. In 2018 around 5.3 million under-five age children died in the world, and in African countries, the risk for under-five age children to die before reaching the five years of age is the highest (76/1,000 live births) according to GHO [3]. According to Sudan millennium development goals [4] 31.0% of the under-five year Sudanese children are moderately or severely underweight, 32.5% suffer from moderate or severe chronic malnutrition and 14.8% suffer from global acute malnutrition (GAM).

Sudan is one of the largest countries in Africa with a total population of 44.3 million inhabitants [5]. Children constitute a significant percentage of the Sudanese population (about 50%), which makes their nutrition and health status of paramount importance. Other than health, undernutrition is also an influencer of social and economic enhancement in developing countries.

It is predicted that malnutrition in all its forms costs about 3.5 trillion US\$ per year. According to UNICEF [5] about 2.3 million Sudanese children experience malnutrition and around half of all deaths of children under-five years old are directly linked to malnutrition. Children who experience acute malnutrition were estimated to be 694,000. In addition to that, the prevalence of malnutrition was more than 15% in more than 60% of the country's states; generally, one in six children in Sudan is acutely malnourished. In 2018, the child mortality rate for Sudan was 60.5 deaths per 1,000 live births [5].

Shetty [6] defined malnutrition as all changes from fair and ideal nutritional status, such as calorie undernutrition and obesity, and the terms malnutrition and undernutrition are usually used interchangeably. WHO [2] reported that undernutrition (wasting, stunting, underweight), insufficient vitamins or minerals, overweight, obesity, and uncommunicable diseases related to diet, are types of malnutrition. In the same fact sheet WHO [2] showed that 462 million of the population worldwide are underweight, of them 47, 14.3, and 144 million are wasted, severely wasted, and stunted under-five age children, respectively. In low- and middle-income countries undernutrition is linked to about 45% of deaths among under-five children [2].

There is an essential need to determine the burden of undernutrition, determining its prevalence, cause factors and assess the effectiveness of the different strategies to fight malnutrition among under-five children. Although undernutrition is acknowledged as one of the major health problems in Sudan, there is a lack of review data on the prevalence and causes of this problem to compare the situation in all parts of Sudan. Therefore, this review discusses the prevalence and causes factors for under-five

malnourished children in Sudan, in addition, to proposing different strategies to reducing and preventing this health problem.

## 2. METHODS

The data was collected from Science Direct, Google Scholar, PubMed, and others (e.g. Web of Science and Scopus). The search was limited to original articles published between 2000 and 2020, this includes peer-reviewed articles, books, published dissertations, official reports, and conference papers, the keywords used for the search were under-five children, malnutrition, undernutrition, wasting, stunting, kwashiorkor, marasmus, miasmic-kwashiorkor, determinants, causes, Sudan\* [Note that the asterisk (\*) is a truncation symbol to search a term in a text to uncover articles with " under-five children", "malnutrition" and "undernutrition" and so on in the article or abstract]. Studies excluded were in which malnutrition as undernutrition, wasting, stunting was not used, the group under study was not under-five children, conference abstracts, unpublished data, and articles without full texts. After matching (for duplication), articles that were concerned with under-five children malnutrition in Sudan were selected (30 articles, first selection). Secondly, all articles concerning prevalence and/or causes of undernutrition among under-five children were selected (17 articles).

## 3. RESULTS AND DISCUSSION

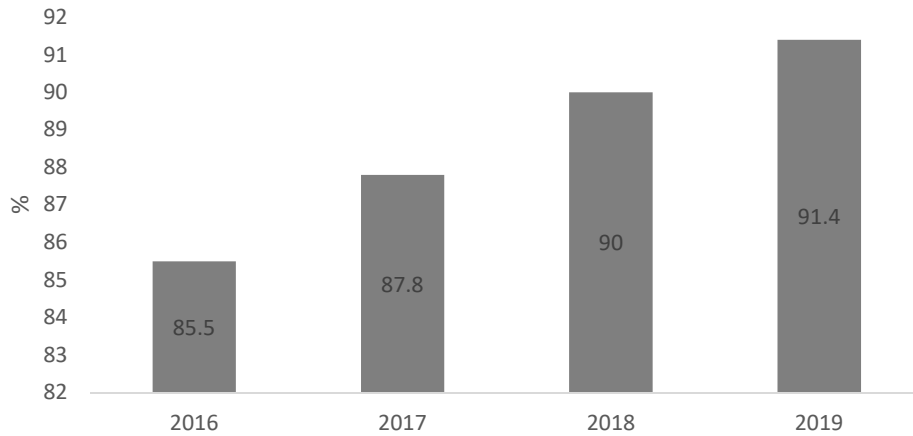
### 3.1 Prevalence of Undernutrition

Internationally, children's development is known as a crucial public health index for monitoring nutritional status and health in populations. Additionally, children who experience delayed growth due to poor diets and/or frequent infections be likely to have high risks of illness and death [7]. The under-five children are distinguished for special care because the first five years of life are important for brain development. The growth of the children during this age period is normally used as an indicator for adequate nutrition and health, and to the general development of the children. The UN's Sustainable Development Goal 3, aims to end all types of malnutrition by the year 2030, plus reaching internationally agreed goals on stunting and wasting in children under-five years of age by 2025.

Under-five children undernutrition is one of the most crucial public health dilemmas in

developing countries mainly Sub-Saharan Africa [8]; and according to WHO [2], malnutrition is associated with more than half of the children who die after the first month of life, and almost half of those deaths occurred in sub-Saharan Africa. In Sudan, under-five malnutrition is one of the most significant public health issues, UNICEF-Sudan in its Nutrition Annual Report [9] showed that Sudan has been considered as one of the biggest numbers of malnourished children in the world. Noticeable that 2.7 million children under-five subjected to malnutrition, who suffer from severe acute malnutrition represent greater than half a million (Fig. 1). In Sudan since 1987 the number of children suffers from malnutrition haven't been improved, and the national prevalence rate of global acute malnutrition is 14.1% and locates Sudan above the WHO threshold (the WHO threshold for wasting is if global acute malnutrition is from 10 to < 15%) [9].

Different studies have been administrated to determine the prevalence of undernutrition among under-five years old children in different parts of Sudan, this manuscript reviews the studies during the last twenty years (2000 – 2020) (Table 1). During the period covered in this review, the majority of the studies were conducted in Khartoum state, with only one study in each River Nile state, Gerdarif state, North Darfur, and South Darfur. This showed that only 5 states were investigated for the prevalence of under-five malnutrition while the remaining 13 states were not investigated. Clinical evaluation as well as anthropometric measurements were used to evaluate the nutritional status of the children. Almost all the studies used the WHO standard to determine the prevalence of malnutrition (Table 2). In Khartoum state the prevalence of wasting (weight-for-height) was reported to range from 3.3 to 21.1% [10-14], stunting (height-for-age) ranged from 20.3 to 51.0%, severe stunting from 12.9 to 25.2% [11-14], while underweight (weight-for-age) and severe underweight represent 24.4 to 35.0% and 6.6 to 48.0%, respectively [11,13,14]. In the studies which used the clinical assessment to determine the prevalence of undernutrition among the under-five children the prevalence of marasmus was from 68.6 to 71.7%, kwashiorkor 23.8 to 25.5%, and miasmic-kwashiorkor 3.4 to 7.6% [15,16]. A high prevalence rate was reported for stunting (51%) in Khartoum state. The observed difference in the prevalence rate of undernutrition may be due to sampling size studied and the location of the study, as the studies were carried out in different locations



**Fig. 1. Percentage of under-five Sudanese children suffering from severe acute malnutrition during the period 2016 to 2019**

Source: UNICEF-Sudan [23]

such as hospitals, localities, displaced camps, and orphan homes within Khartoum state.

Furthermore, very few studies had been carried out to assess the prevalence of underweight among under-five children in other states. In the year 2004, in South Darfur state. A study was carried out in three internally displaced person camps (IDP camps) namely Kass, Kalma, and Muhajiria to assess the mortality and nutritional status of under-five children [17]. In this study, the prevalence rate of malnutrition was reported to be 14.1, 23.6, and 10.7% in the three camps Kass, Kalma, and Muhajiria, respectively [17]. In 2017, in rural and urban areas Tawila administrative unit, Tawila locality in North Darfur state a study was conducted to estimate the malnutrition status among the under-five children [18]. Results revealed that the prevalence of wasting, stunting, and underweight was 14.7,

48.9, and 35.6%, respectively [18], and the predominant nutritional hassle was stunting. Abdalla et al [19] conducted a study in three villages in El Fau, Gadarif state to determine the nutritional status of the under-five children, they reported 40%, 6%, and 3.3% for mild, moderate and severe malnutrition prevalence, respectively. The only study conducted in the northern states of Sudan was in four rural areas in the River Nile state, 1635 under-five children participated in this study through Multistage Cluster sampling. This study, which carried in the River Nile rural areas showed that the prevalence of stunting, wasting, and underweight malnutrition were 42.5, 21, and 32.7%, respectively [20], these results indicated that stunting was the main nutritional problem in this part of north Sudan. From all these studies it can be concluded that stunting was the main nutritional problem in Sudan.

**Table 1. Studies on malnutrition among under-five children in Sudan**

Location	Age group (months)	Prevalence %	Year of study	Type of undernutrition	Reference
Khartoum	0 - 59	11.3	2001	Wasting	[10]
Omdurman	0 - 59	11.3	2001	Wasting	[10]
Khartoum North	0 - 59	4.9	2001	Wasting	[10]
Kass camp/ South Darfur	6 – 59	14.1	2004	Malnutrition	[17]
Kalma camp/ South Darfur	6 – 59	23.6	2004	Malnutrition	[17]
Muhajiria camp/ South Darfur	6 – 59	10.7	2004	Malnutrition	[17]
El Fau/ Gadarif state	6 - 60	40.0	2003	Mild malnutrition	[19]
El Fau/ Gadarif state	6 - 60	6.0	2003	Moderate malnutrition	[19]

Location	Age group (months)	Prevalence %	Year of study	Type of undernutrition	Reference
El Fau/ Gadarif state	6 - 60	3.3	2003	Severe malnutrition	[19]
Khartoum state	6 - 59	19.0	2009	Wasting	[11]
Khartoum state	6 - 59	35.0	2009	Underweight	[11]
Khartoum state	6 - 59	51.0	2009	Stunting	[11]
Alrawakeeb valley Khartoum	24 - 60	27.5	2010	Severe malnutrition	[30]
Alrawakeeb valley Khartoum	24 - 60	35.0	2010	Mild or moderate malnutrition	[30]
Omdurman Pediatrics Hospital/ Khartoum	0 – 60	71.7	2011	Marasmus	[15]
Omdurman Pediatrics Hospital/ Khartoum	0 – 60	25.5	2011	Kwashiorkor	[15]
Omdurman Pediatrics Hospital/ Khartoum	0 – 60	3.4	2011	Miasmic-kwashiorkor	[15]
Dar El Salam/ Ombada locality/ Khartoum	0 – 60	21.1	2013	Wasting	[12]
Dar El Salam/ Ombada locality/ Khartoum	0 – 60	24.9	2013	Stunting	[12]
Khartoum state	0 – 60	19.0	2008-2010	Acute malnutrition (wasting)	[13]
Khartoum state	0 – 60	35.0	2008-2010	Underweight	[13]
Khartoum state	0 – 60	51.0	2008-2010	Chronic malnutrition (stunting)	[13]
Omdurman Pediatric Hospital	0 - 59	68.6	2014	Marasmus	[16]
Omdurman Pediatric Hospital	0 - 59	23.8	2014	Kwashiorkor	[16]
Omdurman Pediatric Hospital	0 - 59	7.6	2014	Miasmic-kwashiorkor	[16]
Rural areas/ River Nile State	0 – 60	42.5	2014	Stunting	[20]
Rural areas/ River Nile State	0 – 60	32.7	2014	Underweight	[20]
Rural areas/ River Nile State	0 – 60	21.0	2014	Wasting	[20]
Khartoum locality/ Khartoum state	0 - 59	3.3	2017	Wasting	[28]
Khartoum locality/ Khartoum state	0 - 59	6.6	2017	Severe underweight,	[28]
Khartoum locality/ Khartoum state	0 - 59	12.9	2017	Severe stunting	[28]
Mygoma Home for Orphans/ Khartoum	0 – 60	24.4	2011	Underweight	[14]
Mygoma Home for Orphans/ Khartoum	0 – 60	48.0	2011	Severe underweight	[14]
Mygoma Home for Orphans/ Khartoum	0 – 60	20.3	2011	Stunting	[14]
Mygoma Home for Orphans/ Khartoum	0 – 60	25.2	2011	Severe stunting	[14]
Tawila/ North Darfur	6 - 59	14.7	2017	Wasting	[18]
Tawila/ North Darfur	6 – 59	48.9	2017	Stunting	[18]
Tawila/ North Darfur	6 - 59	35.6	2017	Underweight	[18]

**Table 2. Classification for assessing of malnutrition among under-five children**

<b>Classification</b>	<b>Index</b>	<b>Definition</b>	<b>Z-score</b>
Wasting (Acute malnutrition)	Weight-for-height (W/H)	W/H is normally used as an indicator of current nutritional status. Moderate and severe - below minus two SDs (<-2 SD) from median W/H of reference population	0.85 to 1.10
Stunting (Chronic malnutrition)	Height-for-age (H/A)	Stunting is linked with long-term factors e.g. chronic malnutrition, mainly protein-energy malnutrition, and frequent illness. Moderate and severe, below minus two SDs from median H/A of reference population (<-2 SD)	1.10 to 1.30
Underweight (Any protein-energy malnutrition)	Weight-for-age (W/A)	Reflects acute as well as chronic malnutrition. Moderate and severe, below minus two standard deviations(SDs) from median W/A of reference population; severe, below minus three SDs (<-3 SD) from median W/A of the reference population	1.00 to 1.20

Source: WHO [2]

Sanchez-Montero and Salse Ubach [21] estimate the prevalence of moderate to severe wasting among under-five children in Sudan to be 16% during the period 2003 to 2008 and concluded that Sudan is one the ten countries with the highest number of under-five children with wasting worldwide. The same national rate of prevalence of wasting (16%) was reported also by UNICEF and CBS [22]. According to UNICEF [23], Sudan encounters a malnutrition load among its under-five children, and the national prevalence of under-five stunting and wasting are 38.2% and 16.8%, respectively, which are higher than the developing country averages of 25% and 8.9% respectively. Wasting is greatly linked with seasonal changes in food availability in addition to disease prevalence [22]. WHO [24] reported that the prevalence of stunting becomes more apparent after infancy (2<sup>nd</sup> year of life); simultaneous with the introduction of the family diet, as children start to feed themselves and hence, can easily be at risk of foodborne diseases and/or unavailability of food quantitatively. UNICEF-Sudan [9] reported that stunted and wasted children are highly doubtful to reach their full educational and productive potential, particularly if these conditions are existing before the age of two. This influences the economic growth and development of both the individuals and their countries. Therefore, undernutrition is a serious burden that should be addressed.

### 3.2 Causes of Undernutrition

Globally, unavailability of food or an unbalanced diet and illness are the main cause of undernutrition. Besides, many other factors play a crucial role in the development of undernutrition among under-five children, such as inadequate household food security, maternal and child care, health services availability, environmental conditions, and many socioeconomic factors [2]. The causes of under-five malnutrition can be categorized into three categories namely, immediate causes that act on the individual, underlying causes that act on households and societies, and basic causes that act on whole communities but have a major or lower effect on particular groups within the community (Fig. 2) [25].

In Sudan, poor nutrition is the main threat to the survival and development of children under-five years of age, and insufficient dietary intake is one of many immediate causes of undernutrition in the country. Only 15% of children aged 6-23 months were getting the minimum acceptable diet (MAD), according to Multiple Indicator Cluster Survey 2014 [26]; this is mainly due to deficient variety of their diets although food hesitancy is also an issue. This situation is differing from one state to another across Sudan, some states with having less than 5% of children aged 6-23 months were getting the MAD [5]. The

economic crisis in Sudan, which increases food costs and leads to poverty, and a lack of essential nutrients in foods, in addition to poor water and sanitation conditions along with high disease prevalence, are the main causes of undernutrition [5]. These immediate factors were due to several underlying factors, i.e. household food insecurity, maternal education, and availability and access to health services. The above mentioned underlying factors are affected by the basic socioeconomic and political situations [27]. Bajari [28] reported that maternal age, employment and family monthly income, infection diseases, health-seeking behavior are the main causes of undernutrition in Khartoum locality. Jomah [29] suggested three causes of malnutrition among under-five children, breastfeeding, hygiene and sanitation of supplementary feeding, and maternal health and nutrition. Abdalla et al [19] in their study in rural areas in Sudan concluded that poverty and insufficient family income, unhealthy drinking water, and unsanitary environment are the principal causes of under-five malnutrition. Abu et al [18] suggested effective management of childhood diseases and the supply of healthy water and sanitation to reduce the high prevalence of under-five malnutrition.

Musa et al [12] revealed that socioeconomic factors, unbalanced diet, and mothers' knowledge and feeding practices are the reasons behind the boost of the prevalence of malnutrition. In their report on the prevalence and determinants of undernutrition in rural areas in north Sudan Sulaiman et al [20] reported that low socioeconomic status, bad domestic sanitation, big family size, lack of family planning, and sudden weaning are the risk factors for undernutrition. Kanan and Swar [16] recommend exclusive breastfeeding, breastfeeding with supplementary feeding up to the first two years of life, health education, availability and access to nutritious food, and healthy water supply and sanitation systems and hygiene pursuit as factors to reduce undernutrition among under-five children.

### 3.3 Proposed Strategies for Reducing Under-five Malnutrition in Sudan

Malnutrition remains one of the most important causes of morbidity among under-five children. Therefore, it is very important to determine its prevalence rate among the under-five children, with the support of different WHO nutritional assessment methods, weight for age is the

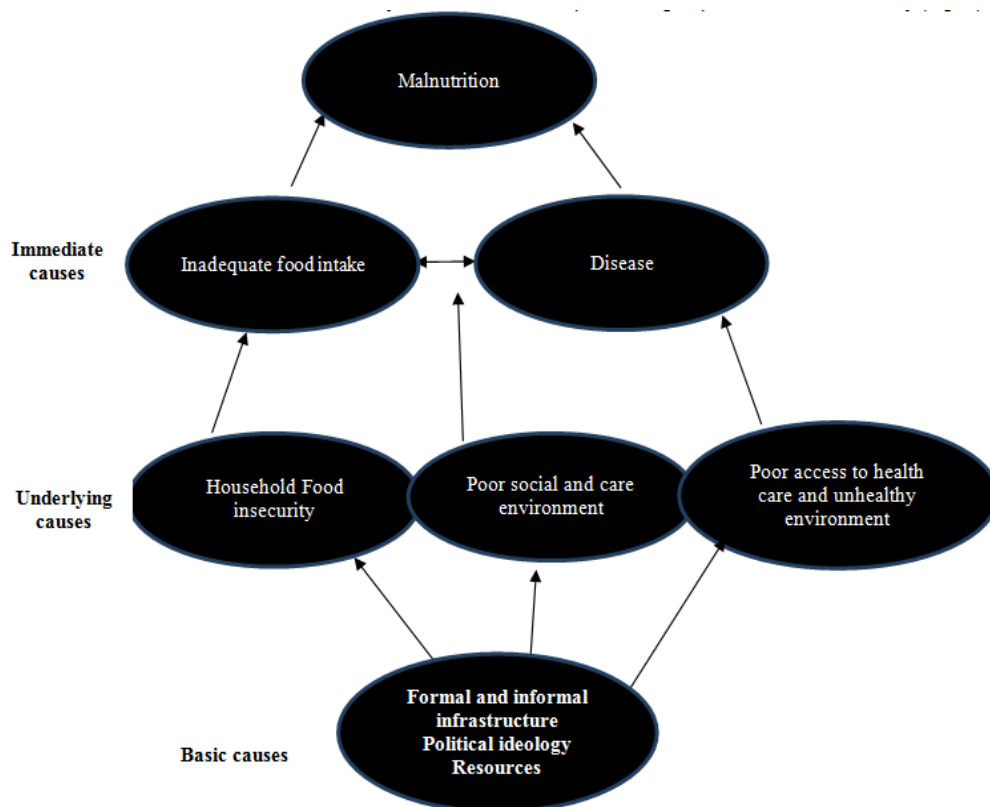


Fig. 2. Causes of malnutrition in community adopted from UNICEF [25]

simple and easily indicator which can be used (growth chart). This determination of the prevalence should be accompanied and strengthened with exclusive breastfeeding, complementary feeding practices, regular growth monitoring, infection control, immunization, mothers' nutrition education. Regarding the underlying causes of malnutrition such as income poverty and other socioeconomic status factors, need the participation of all the stakeholders concerned to solve these problems and tackle malnutrition among under-five children in Sudan. In summary, nutrition policy, and planning along with political commitment are required to improve and to ensure equitable distribution of health facilities to easy and early detection of malnutrition, provide nutrition education for all, and before then improve production and supplies of food.

#### 4. CONCLUSION

This review showed that the prevalence of undernutrition among the under-five Sudanese children is very high, and stunting is the dominant nutritional problem. Khartoum state showed the highest prevalence rate of stunting (51%) among the other states. During the last twenty years, the majority of studies on undernutrition were carried out in Khartoum state, with only one study in the other three states out of the 18 states of Sudan. This indicated that more efforts are needed to study the situation and cause of undernutrition in all parts of Sudan. Many factors were reported for undernutrition among the under-five Sudanese children such as bad feeding practices, childhood diseases, hygiene and sanitation, and low socioeconomic status. Accordingly, to maintain a high nutritional status of the under-five Sudanese children improvements in child feeding and child feeding practices, and better maternal education are essential. Therefore, intervention programs are required to prevent malnutrition, and to address the underlying causes of malnutrition among the under-five children, this needs engagement and coordination of different sectors including the federal and state ministry of health, UN agencies, and the community.

#### CONSENT

It is not applicable.

#### ETHICAL APPROVAL

Ethics approval for this study was not required since the data is secondary and is available in the public domain.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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