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Prevalence and risk factors of under-five mortality due to severe acute malnutrition in Africa: a systematic review and meta-analysis

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Abstract

Background Despite a global drop of under-five mortality by 59% between 1990 and 2019, it remains high in Low- and Middle- income Countries (LMICs)with a preponderance in Sub-Saharan Africa (SSA), Southern and Central Asia. Besides preterm and intrapartum complications, undernutrition contributes 45% of the deaths in these developing regions. In Africa, under-five mortality due to severe acute malnutrition (SAM) has stagnated at 10–40%, higher than WHO targets and the SDGs projections.

Methods We searched MEDLINE (via PubMed), Scopus, Web of Science, Science direct, Google Scholar, Cochrane Library and Open Grey databases for literature reporting under-five mortality due to SAM in Africa from 2014 to 2024. Estimates of the primary and secondary outcomes were pooled using a random-effects meta-analysis due to the anticipated between study heterogeneity.

Results Fifty-two out of 82 studies (63.4%) analyzed reported an overall under-five mortality of 11% (95%CI: 0.08–0.13). Diarrheal diseases, human immunodeficiency virus (HIV) and pneumonia were the three most frequently reported risk factors associated with mortality by 21 (40.1%), 20 (38.5%), and 14 (26.9%) studies, respectively. No significant regional variation was found.

Conclusion Under-five mortality due to SAM in Africa is still high as reported in the included studies. There were no regional variations. Diarrheal diseases, HIV and pneumonia were the most frequently reported risk factors associated with under-five mortality due to SAM in Africa.

Keywords Under-five, Mortality, Severe malnutrition, Risk factors, Africa

Introduction

According to UNICEF, a child born in SSA is on average 18 times more likely to die before their fifth birthday than their counterparts in other developed regions like Australia and New Zealand, whilst the risk of death for under-five in the highest-mortality country is 80 times that of the lowest-mortality country [1]. Overall, Under-five mortality declined by 60% from 93 deaths per 1000 live births between 1990 and 2022 to 37 deaths per 1000 live births in 2022. However, about 13,400 children under-five years still die daily from preventable causes which is unacceptably high [2]. This burden has remained prevalent mainly in the low- and middle-income regions of the

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world. More than 80% of the reported 5.2 million under-five deaths in 2019 were from SSA and Southern and central Asia [3]. Globally, Africa has the highest under-5 mortality rates. Data from the continent shows that 1 child in 13 dies before reaching five years of age, placing it 20 years behind the world average which achieved a 1 in 13 rate in 1999 [3]. Roser Max (2023) on his 'Our World in Data' web report, noted that amidst significant global improvements in childhood survival, for children up-to 15 years of age, from 50% to an impressive 96%, Africa, specifically SSA, still records the highest mortality rates of between 10 and 20% as compared to world regions with the lowest rates of between 0 and 5% [4]. This trend in under-five mortality in SSA is projected to even get worse if no interventions are put in place. Child population groups in low- and middle-income regions are growing and data already shows a worsening mortality trend in SSA from 31% in 1990 to 58% in 2021 [5]. This continues to diminish the possibility of achieving the Sustainable Development Goals (SDGs) Target 3.2 that aims to end preventable deaths of newborns and children under five years old by 2030 in all countries in the world. Since 1990, 163 out of 200 countries in the globe reduced their under-five mortality by half with 38 out of the 95 countries (40%) that reduced this mortality by two thirds being in the low- or lower-middle-income countries [6]. This suggests that focusing on the preventable causes of death in this age group can significantly reduce the mortality rates even in the resource-constrained regions of the world. In fact, the 2022 World Health Organization (WHO) report identified three African countries; Nigeria, DR Congo and Ethiopia among the five countries in the world where half of all the under-five deaths in 2020 occurred [7] representing West, Central and East African regions respectively.

Aside from preterm birth and intrapartum complications, acute malnutrition (undernutrition) has been found to underlie up to 45% of under-five mortality [8, 9]. Malnutrition is a term that incorporates both under and over nutrition. Undernutrition describes wasting, stunting, underweight, inadequate vitamins or minerals while over nutrition includes overweight, obesity, and resulting diet-related non-communicable diseases [10]. This review focused on children under five years old who are undernourished as it accounts for nearly half of their deaths in the LMICs [10]. Children with severe acute malnutrition are at a higher risk of death from infectious diseases like malaria, meningitis, diarrhea, pneumonia, tuberculosis and other infectious diseases as compared to their well-nourished counterparts. Severe acute malnutrition in these children is associated with chronic periods of ill-health with intermittent hospitalizations which often results in significant morbidity and mortality [9]. Diagnosis of malnutrition is made by assessing the child's anthropometric measurements (Mid Upper Arm Circumference (MUAC) and Weight-for-Height Z (WHZ) score) or by physically assessing for bilateral pitting oedema also known as "Kwashiorkor" or severe wasting also known as "Marasmus" [11]. As per WHO diagnostic criteria, a child between the ages of 6 to 59 months is diagnosed with SAM if their MUAC is <115 mm or their WHZ score is calculated to be ≤ -3 SD. For moderate malnutrition, the MUAC cut off is 115 mm to 124 mm or a WHZ of > -3 SD to ≤ -2 SD [11]. The cause of malnutrition in children is usually multi-factorial and is one of the important preventable causes driving the high under-five mortality.

Rationale

Children under five years in Sub-Saharan Africa have been identified to carry the highest burden of the overall global under-five mortality. Despite the reported impressive decline of under-five mortality rates in other regions of the world by up to 59% in the preceding two decades in 2019, the mortality rates in this region have remained high. This study aimed to provide the current status of under-five mortality due to SAM in Africa by conducting a systematic review of the studies done in Africa from 2014 to 2024. The results also serve as a measure of child health in this region as well as gauge the achievement of the sustainable development goal (SDG)−3.2 which aims to end preventable deaths of under-five and lower the mortality to at least 25 per a thousand live births for all countries by 2030.

Methods

Protocol registration

Before searching the databases for articles and records, a protocol that described the research processes was developed. It stipulated the databases to be searched, study eligibility criteria and the methodology to be followed through to the final analysis. The Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used to guide the reporting of the results of this systematic review and meta-analysis. The protocol for this review was registered on the International Prospective Register of Systematic Reviews (PROSPERO) platform, registration number CRD42024504966.

Eligibility criteria

The eligibility (inclusion and exclusion) criteria of studies were defined in advance in the protocol. Observational studies published in the peer-reviewed literature were eligible for inclusion. Studies were included if they reported mortality related to SAM and /or its prevalence

in children aged 0 to 59 months in Africa, had a sample size of 300 or more, were published between 2014 and 2024, and were in English. A sample size of 300 and above is usually considered a reliable rule-of-thumb when the researcher does not know the true effect size and it is often used to produce accurate results in prevalence studies [12].

Information sources

Literature was searched from the following electronic databases; MED-LINE (via PubMed), Cochrane Library (including the Cochrane Central Register of Controlled Trials (CENTRAL), Google Scholar and Scopus. The Open Grey database was searched for gray literature. A hand-search of reference lists of included studies was conducted to source additional studies.

Search strategy

A study search strategy was developed with the guidance of a health sciences subject matter librarian. Search strings were designed to be sensitive to terms and keywords related to SAM and under-five mortality outcomes. The search was restricted by applying filters to retrieve studies published from 2014 to 2024. A pilot of the search strategy was conducted in PubMed thereafter an optimized search strategy was adapted for other databases each time applying appropriate search syntaxes specific to each database.

Selection process

Search outputs retrieved from the databases were transferred to Microsoft Excel database for duplicate records removal. Two reviewers (JK and PK) independently screened titles and abstracts of every unique record retrieved from the search for eligible studies. Following title and abstract screening, full texts of potentially eligible studies were selected for full-text assessment. Discrepancies were resolved through discussion to reach a consensus. The screening process is as outlined in the PRISMA flow diagram, Fig. 1.

Data extraction process

After two reviewers independently screened titles, abstracts, and full texts of studies identified as eligible as per the protocol's inclusion and exclusion criteria, the two reviewers (JK and PK) then independently extracted data from included studies and evaluated their quality. Data was then extracted into a pre-designed data extraction form in Microsoft Excel, cleaned and exported for analysis in STATA statistical software from Stata Corp, version 15.

Data items

Data items extracted included: (i) study characteristics; study title, author identification, year of publication, study design, study participants and sample characteristics, Place where the study was conducted, (ii) Study objectives and outcomes; study main findings, SAM prevalence and mortality rates reported, study limitations and study conclusion.

Risk of bias assessment

Studies meeting the inclusion criteria were assessed for quality using the Hoy quality Assessment tool [13]. The tool is appropriate for assessing the quality of studies reporting prevalence data. Two reviewers independently undertook the quality of studies assessments. Discrepancy in the quality of a study assessed by two reviewers was resolved through discussion before arriving at a consensus.

Effect measures

The prevalence of deaths due to SAM among under-five children were computed and a synthesis of the risk factors associated with under-five mortality due to SAM done.

Data synthesis methods

Pooling of the prevalence of mortality due to SAM among under-five children reported by different studies using random effects models due to high heterogeneity among the included studies was done. Heterogeneity was assessed in the meta-analysis using Higgins & Thompson's I^2 Statistic with significance defined at 10% α-level. I^2 statistics of between 25% and less than 50% was considered low heterogeneity. I^2 statistics of between 50% and less than 75% was considered moderate heterogeneity and I^2 statistics of greater than 75% was considered substantial heterogeneity [14]. Results for the pooled estimates were presented in forest plots while results of individual studies are shown in tables.

Data analysis

Meta-analysis was conducted to pool primary and secondary outcomes reported by studies meeting the review's inclusion criteria. Estimates were pooled using a random-effects meta-analysis due to the anticipated between study heterogeneity. The random-effects model assumed that the effect estimates followed a normal distribution, considering both within-study and between-study variation. Forest plots were generated to illustrate primary outcome findings graphically.

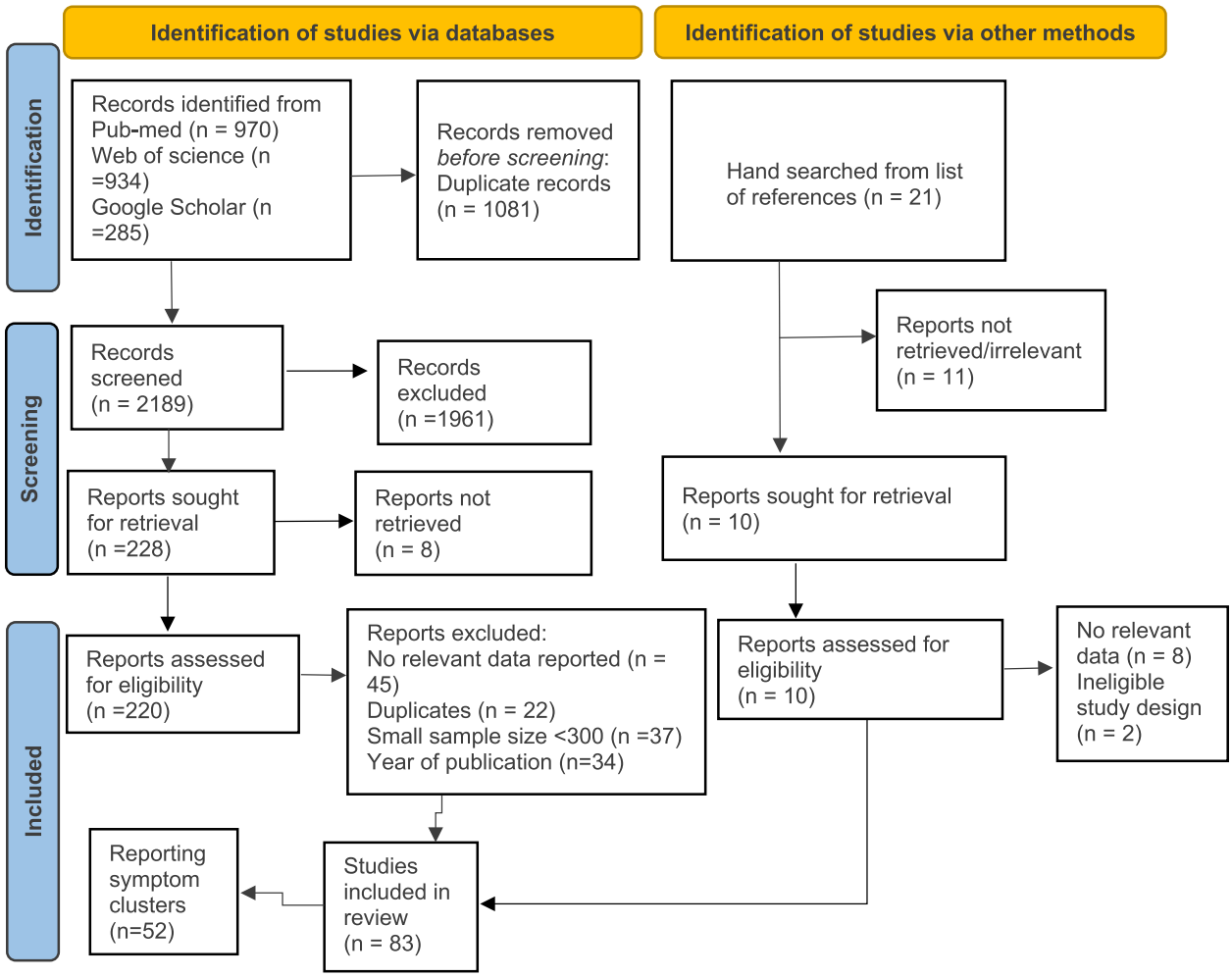

Fig. 1 PRISMA flow diagram for included studies, databases searched, registers and other sources

Meta-analysis was performed using the metaprop command in STATA version 15.

Study selection process

From 3 databases searched, 2189 records were retrieved. 22 duplicate records were excluded after merging the records from the 3 databases. After duplicate title and abstract screening, 1939 records were excluded because they did not meet the review's inclusion criteria. 220 articles were retrieved for full text screening. 8 articles were not found for retrieval. After full-text screening, 82 original research articles met the inclusion criteria and were included in the final analysis. The study selection process is summarized in a PRISMA flow diagram (Fig. 1).

Results

Characteristics of included studies

Included studies comprised of cohort and cross-sectional studies that were done in Africa. Fifty-eight studies (69.9%) were from East Africa, fourteen (16.9%) from West Africa, six studies (7.2%) from Southern Africa, three studies (3.6%) from Central Africa and two studies (2.4%) were multi-regional. Thirty-six studies (43.4%) were done in Ethiopia, six (7.2%) in Uganda, five (6.0%) in Nigeria while Tanzania, South Africa and Malawi contributed four (4.8%) studies each. A total of 52 out of the 82 screened studies (63.4%) reported mortality rates of children under-five due to SAM. Fifty-three studies (63.9%) were conducted in hospital while thirty studies (36.1%) were conducted in the community. 590,497 was the total sample size of all the included studies with the largest study comprising 189,195 participants (32.0%). The largest and smallest studies in the East African region had a sample size of 13,827 and 324 and a total sample size of 53,129. In West Africa, the largest study had 2224 participants and the smallest 377 participants with a total sample size of 6,107. In the Southern Africa region, the largest and smallest studies had 86,219, and

Table 1 Characteristics of included studies

Study	Study design	Sample size	Country	Region	Population
Chane et al. 2014 [13]	A retrospective cohort study	324	Ethiopia	East Africa	All under-five children admitted with SAM, 154(47.5) males and 170(52.5%) females.
Gebremichael et al. 2014 [14]	A retrospective cohort study	469	Ethiopia	East Africa	Children aged 6—59 months with complicated SAM, male 269, female 200
Musa et al. 2014 [15]	A cross-sectional study	411	Sudan	East Africa	Children 0–59 months, 52.6% girls and 47.4% boys
Kerac et al. 2014 [16]	A prospective cohort study	1024	Malawi	East Africa	Children (median age 21.5 months, IQR 15–32) admitted to nutrition ward for inpatient care
Munthali et al. 2015 [17]	A retrospective cohort study	9540	Zambia	East Africa	All 0–60 months of age children admitted to patient nutrition unit, 5,148 (53.9%) males and 4386 (46%) females
Desta et al. 2015 [18]	A retrospective cohort study	411	Ethiopia	East Africa	Children aged 0–59 months admitted with complicated SAM. 212 (51.1%) males. 301 (72.5%) were rural residents
Duru et al. 2015 [19]	A cross-sectional study	406	Nigeria	West Africa	Under-five children in rural communities, Female 51.2%, male 48.8%
Gebremichael et al. 2015 [20]	A retrospective cohort study	420	Ethiopia	East Africa	Children with SAM aged 6 to 59 months managed at stabilization centers. Male 226 (53.8), female 194 (46.2)
Jarso et al. 2015 [21]	A retrospective cohort study	947	Ethiopia	East Africa	Children 0 to 18 years, 58.6% male. 68.1% were 6–59 months, median age of 24 months. 60.8% had oedematous malnutrition (kwashiorkor or marasmic-kwashiorkor)
Mdala et al. 2015 [22]	A descriptive retrospective review	4898	Namibia	Southern African	All children under five years (8 days- 5 years) who died in the hospital, 25 (41.7%) males, 35(58.3%) females
Sylla et al. 2015 [23]	A retrospective cohort study	393	Senegal	West Africa	Under 5-year-old hospitalized children in the pediatric ward
Asfaw e al. 2015 [24]	A cross-sectional study	778	Ethiopia	East Africa	Undernourished children 6–59 months, male 384(49.4), female 394(50.6)
Semali et al. 2015 [25]	A cross-sectional study	678	Tanzania	East Africa	Under-five children
Ocheke et al. 2015 [26]	A cross-sectional study	379	Nigeria	West Africa	Children 6 to 59 months seen at the paediatric emergency, 224 (59.1%)males, 155 (40.9%) females
Adama et al. 2016 [27]	A case–control study	433	Burkina-Faso	West Africa	Children 0 to 59 months, dead or recovered, who suffered from SAM with or without complications.Male 237, female 196
Adal et al. 2016 [28]	A retrospective cohort study	450	Ethiopia	East Africa	The Source population were All children aged less than five year with severe acute malnutrition admitted to stabilization centers (SC) in DURH from 2013- 2015. 272(60.4%) males
Oumer et al. 2016 [29]	A retrospective cohort study	617	Ethiopia	East Africa	0–59 months children with admitted with SAM, 345 (55.9%) were male

Table 1 (continued)

Study	Study design	Sample size	Country	Region	Population
Kanan et al. 2016 [30]	A retrospective cohort study	593	Sudan	East Africa	All children aged less than 5-years admitted with SAM, 305 males (51.4%). male: female ratio of 1: 0.9
Fentahun et al. 2016 [31]	A cross-sectional study	633	Ethiopia	East Africa	Children aged 6–59 months, male 339 (53.6%) female 294 (46.4%)
Juma et al. 2016 [32]	A prospective cohort study	63,237	Tanzania	East Africa	Children under-five seen in hospital and 3 rural health facilities, boys 53.6%
Yohannes et al. 2017 [33]	A retrospective cohort study	500	Ethiopia	East Africa	Under-five children admitted with SAM, 51.4% were males
Admasu et al. 2017 [34]	A retrospective cohort study	340	Ethiopia	East Africa	Under-five children admitted with complicated SAM, 179(52.6%) were male
Girum et al. 2017 [35]	A retrospective cohort study	545	Ethiopia	East Africa	Children aged 5 years admitted with SAM, 290, (53.2%) were males, and 330 (60.6%) were aged 2 years
Donatus et al. 2017 [36]	A cross-sectional study	380	Nigeria	West Africa	Children 0–59 months in Ekureku community
Wagnew et al. 2018 [37]	A retrospective cohort study	527	Ethiopia	East Africa	All under-five children with SAM admitted, 277 (52.56%) were male
Darsene et al. 2017 [38]	A cross-sectional study	811	Ethiopia	East Africa	Children aged 6–59 months, male 432 (53.2%)
Leidman et al. 2019 [39]	A cross-sectional study	7791	Nigeria	West Africa	Children 0–59 months
Acevedo et al. 2017 [40]	A cross-sectional study	533	Swaziland	Southern African	Under-five year children, 309 boys and 244 girls
Lugangira et al. 2017 [41]	A cross-sectional study	1130	Tanzania	East Africa	Children aged 2–59 months admitted, male 552 (48.8% female 547 (48.4%)
Endris et al. 2017 [42]	A cross-sectional study	3095	Ethiopia	East Africa	children aged 0–59 months, 50.1% females
Awoke et al. 2018 [43]	A cross-sectional study	311	Ethiopia	East Africa	Children aged under 5 years living in a rural district, males 32(50.0%), controls 118(47.8%), total 150(48.2%),females 32(50.0%), controls 129(52.2%), total 161(51.8%)
Nabukeera et al. 2018 [44]	A prospective cohort study	400	Uganda	East Africa	Children aged 6–59 months admitted with SAM, boys (57.5%)
Guesh et al. 2018 [45]	A retrospective cohort study	556	Ethiopia	East Africa	All SAM under-five children admitted
Abdulah et al. 2018 [46]	A cross-sectional study	52,464	Somalia	East Africa	Under five years old children. 63% of MAM, and 36% of SAM & about 1% of acute malnutrition with oedema
Gachau et al. 2018 [47]	A retrospective cohort study	5306	Kenya	East Africa	All children aged 1–59 months admitted with SAM
Fitzgerald et al. 2018 [48]	A retrospective cohort study	700	Malawi	East Africa	Pediatric deaths recorded in the hospital's death registry for children aged 1 day to 16.5 years,
Willcox et al. 2018 [49]	A cross-sectional study	762	Mali	West Africa	Children younger than 5 years
Wilcox et al. 2018 [49]	A cross-sectional study	442	Uganda	East Africa	Children younger than 5 years

Table 1 (continued)

Study	Study design	Sample size	Country	Region	Population
Nigatu et al. 2018 [50]	A cross-sectional study	645	Ethiopia	East Africa	Children aged 6–59 months, underweight and severely underweight, male 336 (52.1%)
Bamford et al. 2018 [51]	A retrospective cohort study	86,219	South Africa	Southern African	Under 5 years admitted with or associated with diarrhoea, pneumonia and SAM, data from District Health Information System (DHIS)
Grellety et al. 2018 [52]	A cross-sectional study	76,887	18 African countries	Multi-region	6–60 month old SAM children admitted for treatment to in-patient, out-patient or supplementary feeding facilities in 18 African countries
Abate et al. 2020 [53]	A cross-sectional study	711	Ethiopia	East Africa	children aged 6 to 59 months, admitted to Hiwot Fana Specialized University Hospital, Pediatric ward, Nutrition Rehabilitation Unit from 2013 to 2015
Desyibelew et al. 2019 [54]	A cross-sectional study	401	Ethiopia	East Africa	Under-5 children admitted with SAM, 223 (55.6%) were male
Nambuusi et al. 2019 [55]	A cross-sectional study	7878	Uganda	East Africa	Data on all-cause U5M obtained from women birth histories available in the Uganda DHS
Dapi Nzefa et al. 2019 [56]	A cross-sectional study	388	Cameroon	Central Africa	Children under five in Bandja village. 49.5% boys and 50.5% girls
Boah et al. 2019 [57]	A cross-sectional study	2720	Ghana	West Africa	Children 0–59 months, males (52.12%), resident in rural settings were 60.84%
Gebre et al. 2019 [58]	A cross-sectional study	840	Ethiopia	East Africa	All children aged 6–59 months, males 476 (56.7%), females 364 (43.3%)
Humbwavali et al. 2019 [59]	A cross-sectional study	749	Angola	Central Africa	Children under 2 years in a sub-urban area
Harris et al. 2019 [60]	A prospective descriptive study	13,827	Malawi	East Africa	All paediatric inpatient deaths (0- 12 years)
Mwangome et al. 2019 [61]	A birth cohort study	1103	Burkina Faso	West Africa	Infants 0 to 6 months, 533 (48%) were female
Ngwalangwa et al. 2019 [62]	A prospective cohort study	1359	Malawi	East Africa	Severely ill children age 2 days–17 years treated in the pediatric emergency resuscitation room, 794 (58.4%) were males
Wete et al. 2019 [63]	A cross-sectional study	361	Ethiopia	East Africa	Orphans aged 6–59 month in Dilla town, females 189(52.4%)
Gavhi et al. 2020 [64]	A cross-sectional study	956	South Africa	Southern African	Children under five years admitted with SAM, 50.2% were males
Banga et al. 2020 [65]	A prospective cohort study	338	Uganda	East Africa	Under 5 years of age with SAM, males 169 (81.25%),females 120 (92.31%)
Abate et al. 2019 [66]	A retrospective cohort study	600	Ethiopia	East Africa	Children from birth to 59 months managed for SAM under the OTP, 50.8% were males. Children

Table 1 (continued)

Study	Study design	Sample size	Country	Region	Population
Ashine et al. 2020 [67]	A retrospective cohort study	346	Ethiopia	East Africa	Children aged 6 –59 months admitted with SAM. Female 135 (39%), male 211 (61%)
Kebede et al. 2020 [68]	A retrospective cohort study	423	Ethiopia	East Africa	Under-5 children (1–59 months) with SAM, 241(57%) were males. 289(68.3%) were urban residents
Kambale et al. 2020 [69]	A cross-sectional study	633	DR Congo	Central Africa	SAM children aged 1 month-18 years, 332 (51.2%) males. Sex-ratio (M/F) 1.1
Abdilahi et al. 2020 [70]	A cross-sectional study	529	Ethiopia	East Africa	Children 6 to 59 months of age and their mothers living in the study area. 299 (52.7%) females, 250 (47.3%) males
Mdimu et al.2017 [71]	A cross-sectional study	400	Tanzania	East Africa	Children under five years of age (6–59 months) residing in Ngorongoro district, 49% Boys
Carboo et al. 2020 [72]	A cross-sectional study	2224	Ghana	West Africa	0–59 months treated for complicated SAM in two hospitals
Bitew et al. 2021 [73]	A retrospective cohort study	610	Ethiopia	East Africa	All under-five children admitted with SAM, 312 (51.1%) were females
Kassaw et al. 2021 [74]	A retrospective cohort study	488	Ethiopia	East Africa	All under-five children admitted with SAM, male 245 (51.5) female 231 (48.5). 321(67.4%) from rural area
Oumer et al. 2021 [75]	A retrospective cohort study	665	Ethiopia	East Africa	Under-five children admitted with complicated SAM
Kitila et al. 2021 [76]	A cross-sectional study	4901	Ethiopia	East Africa	Under-five age children registered on the admission and discharge book of pediatric ward with complete information. Male 2968 60.6, Female 1933 39.4
Mann et al. 2021 [77]	A cross-sectional study	12,996	Nigeria	West Africa	Children aged 0–59 months. Data from 2018 Nigeria Demographic and Health Survey were used. 49.0% females and 51.0% males
Dangarembizi et al. 2021 [78]	A prospective cohort study	745	Zimbabwe & Zambia	East Africa	Children aged < 60 mo admitted with complicated SAM. Male 390/745 (52.4%)
Muwanguzi et al. 2021 [79]	A retrospective observational study	634	Uganda	East Africa	SAM children aged 1–5 years, males 59%
Compaoré et al. 2021 [80]	A descriptive retrospective study	377	Burkina-Faso	West Africa	Deaths of SAM children under five years old, registered. 187 (49.6%) boys and 190 (50.4%) girls
Kebede et al. 2021 [81]	A cross-sectional study	974	Ethiopia	East Africa	Children under the age of 5 years from the Amhara Region, 51.3% were males
Feleke et al. 2021 [82]	A cross-sectional study	7521	Ethiopia	East Africa	Orphan children 6–59 months living in the Gambella city
Adedokun et al. 2021 [83]	A cross-sectional study	189,195	31 SSA countries	Multi-region	Under-five children from 31 African countries
Asare et al. 2021 [84]	A prospective cohort study	601	Ghana	West Africa	SAM children aged 0–59 months, 310 boys and 291 girls

Table 1 (continued)

Study	Study design	Sample size	Country	Region	Population
Kiarie et al. 2021 [85]	A cross-sectional study	630	South Sudan	East Africa	Children aged 6 to 59 months, 310 (49.2%) being girls
Mandla et al. 2022 [86]	A retrospective cohort study	93	South Africa	Southern African	Children aged 6 to 59 months, 52 (56%) females and 41 (44%) males
Kebede et al. 2022 [87]	A retrospective cohort study	568	Ethiopia	East Africa	Children 6 to 59 months, 324 (57.04%) were females, 244(42.96) males
Anato. 2017 [88]	A cross-sectional study	384	Ethiopia	East Africa	6–59 months-old children, 144 (37.5) female and 208 (54.2) male
Shifera et al. 2022 [89]	A cross-sectional study	457	Ethiopia	East Africa	0 to 59 months, Male 213 (46.61%),Female 244 (53.39%)
Okidi et al. 2022 [90]	A cross-sectional study	240	Uganda	East Africa	Children aged 6–59 months
Ndlovu et al. 2022 [91]	A retrospective cohort study	2328	South Africa	Southern African	Under-five children who died in this period
Sturgeon et al. 2023 [92]	An observational cohort study	745	Zambia	East Africa	Children aged 0–59 months, admitted with SAM
Wutor et al. 2023 [93]	A cross-sectional study	647	Gambia	West Africa	All under-5 children deaths who were residents of any of the two HDSSs, 324 (50.1%) females, 321 (49.6%) males

93 participants, respectively, with a total sample size of 95,027 (Tables 1).

Prevalence of under-five mortality due to SAM in Africa

The overall prevalence of under-five mortality was 11%; 95%CI: 0.08–0.13 (Fig. 2a). The largest and smallest studies had a sample size of 86,219 and 93 participants and a reported mortality rate of 11% and 6% respectively. Fifty-two studies that reported under-five mortality of children due to SAM in Africa were from four African regions (East, West, Southern and Central Africa). Thirty-one studies (37.8%) did not report data on mortality.

Prevalence of under-five mortality due to SAM by region

In East Africa, the overall mortality rate was 11%; 95%CI:0.07–0.15, with a mortality rate range of 2% and 46% (Fig. 2b). In West Africa, the overall mortality rate was 11%; 95%CI:0.05–0.18. The mortality rate range for this region was 2% to 29% (Fig. 2c). Finally, the Southern Africa region had an overall mortality rate of 13%; 95%CI:0.06–0.22. The mortality rate range for this region was 1% to 35% (Fig. 2d).

Risk factors of under-five mortality due to SAM

Of the 83 studies that were analyzed, 52 studies (62.7%) reported risk factors associated with under-five mortality due to SAM in Africa. Gastroenteritis or diarrheal diseases, HIV and pneumonia were the three most reported risk factors associated with mortality by 21 (40.1%), 20 (38.5%), and 14 (26.9%) studies, respectively. Other risk factors identified included severe anemia, sepsis, tuberculosis (TB), shock, malaria, reduced appetite/inability to feed/needing nasogastric tube feeding and dehydration in that order.

Discussion

The analysis found a prevalence of under-five mortality due to SAM across the continent of Africa of 11% (110 deaths per 1000 live births), which is still high.

In terms of the African regions, we did not find much difference in the mortality rates across the board, even though Southern Africa was at 13% while East Africa and West Africa were at 11% each. In this analysis there were no studies that were included from North Africa as most studies in this region are not published in English. Our analysis, however, found a high variability in the mortality rate range between studies of 1%- 46%. It is possible that this observed variability may have been due to the differences in the sample sizes of individual studies that ranged from 89,195 to 93 participants, the data sources-30 studies (36.1%) were conducted in the community, while 53 (63.9%) were conducted in the hospital- and the different study follow up periods that ranged from 4 weeks to 16 years.

A similar variability was observed by Burke et al. (2016) in his study that reported only 8–15% mortality difference across country borders with an in-country difference accounting for 74–78% of the overall variation of

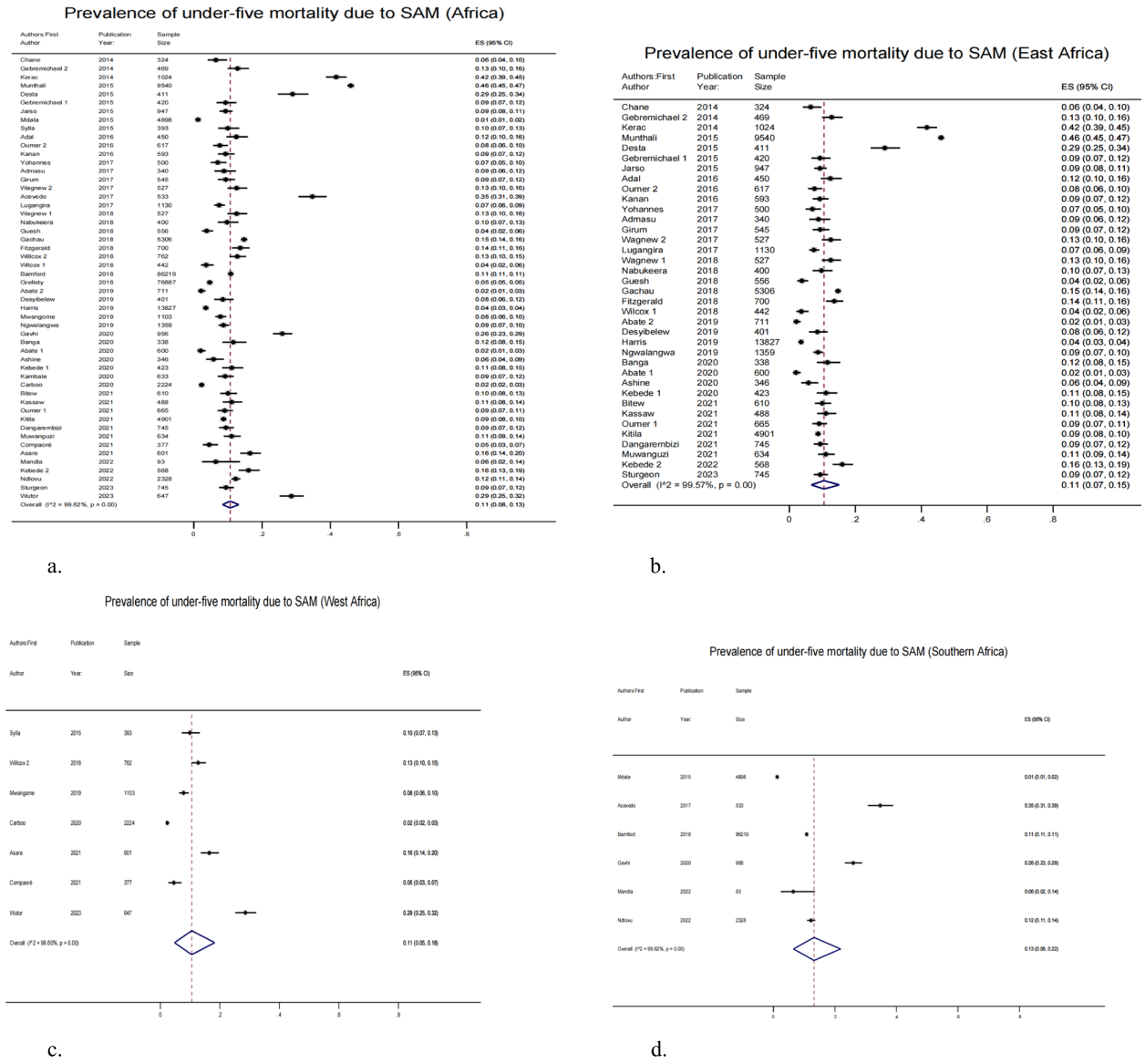

Fig. 2 **a** Under-five mortality due to SAM in Africa. **b** Under-five mortality due to SAM in East Africa. **c** Under-five mortality due to SAM in West Africa. **d** Under-five mortality due to SAM in Southern Africa

under- five mortalities which points to local over national factors driving mortality patterns [15].

The most reported mortality risk factors included diarrhea, HIV, pneumonia, severe anemia, sepsis, tuberculosis, shock, malaria, reduced appetite/ inability to feed/needing nasogastric tube feeding and dehydration. These risk factors were similar to those reported by Karunaratne et al. in their systematic analysis of predictors of inpatient mortality among children hospitalized for SAM [16].

HIV was reported in studies published during the initial 7 years (2014- 2021) out of the 10 years of the review period (2014- 2024) which may be due to the reported decline of new HIV infections in Africa [17]. UNAIDS reported the same trend with new HIV infections reducing by up to 50% in some countries in Sub Saharan Africa since 2009 [18].

The trends for the other mortality risk factors remained the same over the review period. These trends were comparable with results from several other studies. Gebremichael et al. found the leading cause of death of children with SAM to be dehydration secondary to diarrhea (12 (30.8%) [19] while Adama et al. reported diarrhoeal disease as one of the determinants

of mortality with the highest OR of 4.6(95%CI 2.6–8.2) [20]. Desta et al. also reported diarrhea as the commonest co-infection with SAM in children at 44.6% [21]. Abate et al. also reported diarrhoeal disease as being present in 14 of the 15 deaths in the study period [22]. Diarrhea was also reported as the most common clinical presentation by Kanan et al. [23].

Pediatric HIV was reported by Adama et al. as a determinant of mortality with an OR of 10.9(95%CI 5.6–21.5) [20]. Desyibelew et al. reported HIV/AIDSas one of the factors significantly associated with time to death in children with SAM [24]. Chane et al. identifies HIV infection as a predominant factor that compromised recovery rate and increased mortality rate [25]. Kerac et al. reported that mortality was greatest among HIV sero-positive children accounting for 62%(274/445) of the reported deaths [26] which was also reported by Dangarembizi et al. who found an almost fourfold higher mortality in HIV-positive compared with HIV-negative children [27].

Gavhi et al. found 1.6 times higher odds of dying for children who had lower respiratory tract infections (LRTIs) also known as Pneumonia (95% CI 1.3–2.0, $p < 0.001$) compared to those that had no LRTIs [28]. Harris et al. lists pneumonia second in the five leading causes of death [29].

Other risk factors of mortality listed in the studies that reported mortality in SAM children included age less than 24 months, children who had impaired consciousness, hypoglycaemia, convulsions, hypothermia, hypokalaemia, severe wasting and those that had a MUAC < 115mm. Intravenous fluid infusion, blood transfusion and not adhering to medical and nutritional therapies were also identified as factors that contributed to mortality reported by other studies [14, 28

This systematic review and meta-analysis sought to assess the current mortality rate of children under-five years with SAM in Africa and the associated risk factors. The high overall mortality of 11% that we found, falls in the same range as was reported by Nduhukire et al. of 10% to 40% in many facilities in Sub Saharan Africa [15]. This is despite the complete roll-out of the WHO guidelines [16] for management of children under-five years (6–59 months) with SAM whether admitted in hospital or being managed in the outpatient therapeutic clinic (OTP) clinics. The implementation of these guidelines aimed to lower the mortality rate associated with SAM to below 10% in a bid to achieve the Sustainable Development Goals (SDGs) Target 3.2; to end preventable deaths of newborns and children under five years old by 2030 in all countries in the world. This SDG also seeks to reduce the prevalence of wasting to < 5% by 2025 and < 3% by 2030 [17]. The result of this review reveals that the achievement of this goal may not be realizable in the remaining one year and six years' time, respectively.

Strengths and limitations of the study

We conducted a comprehensive literature search including records from different databases to ensure robustness of the findings. A variety of the included studies were analytical with the ability to infer causality between the risk factors and SAM. However, the review included only records and articles published in the English language which might bias the regional representation and comparisons. Furthermore, some of the studies were retrospective and hence the quality of data only relied upon the available medical participant records which could have affected the outcomes.

Conclusions

The under-five mortality rate of children who suffer from severe acute malnutrition in Africa is still high. This was observed across the regions with no regional variability in East, West and Southern Africa. This review identified diarrheal diseases/ gastroenteritis, HIV and pneumonia as the top three leading risk factors of under-five mortality due to SAM in Africa. More efforts need to be focused on this group of children in order to reduce this death rate especially by addressing the preventable causes including proper nutrition for children and optimal breastfeeding, full vaccination, encouraging good sanitation and PMTCT of HIV.

Abbreviations

LRTIs	Lower Respiratory Tract Infections
MAM	Moderate Acute Malnutrition
MUAC	Mid Upper Arm Circumference
OTP	Outpatient Therapeutic Program PMTCT: Prevention of Mother-To-Child Transmission
SAM	Severe Acute Malnutrition
WHZ	Weight -for-Height Z score

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Availability of data and materials

The data used is publicly available as published articles.

Authors' contributions

JK prepared the protocol, extracted the evidence from the source articles, provided the critical interpretation of the results and led the writing and editing of the manuscript. PK led the literature searches, contributed to the methodology and critical evaluation of the results. PK, AA and JB reviewed and provided feedback on the manuscript throughout its development. All authors read and approved the final manuscript.

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Data availability

Data generated from the review are included in this article whereas original data is publicly available in the included articles. Processed and unprocessed

data extracted from included studies and used for the analyses are available upon request. Original articles are publicly accessible through the databases we searched.

Declarations

Ethics and approval consent to participate

Ethics and approval consent to participate were not relevant as the data used was publicly available.

Consent for publication

Not applicable.

Competing interests

The author declares that there is no competing interest.

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