



OPEN ACCESS

EDITED BY

Margarida Liz Martins,
Coimbra School of Health Technology,
Portugal

REVIEWED BY

Masresha Leta,
Haramaya University, Ethiopia
Gayathri Abeywickrama,
University of Winchester, United Kingdom

*CORRESPONDENCE

Bekahegn Girma
✉ bekahegn@du.edu.et

RECEIVED 21 January 2025

ACCEPTED 20 May 2025

PUBLISHED 03 June 2025

CITATION

Girma B and Rahman A (2025) Malnutrition among lactating women in sub-Saharan Africa: an analytic review of spatial distribution, burden and determinants. *Front. Public Health* 13:1564581. doi: 10.3389/fpubh.2025.1564581

COPYRIGHT

© 2025 Girma and Rahman. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Malnutrition among lactating women in sub-Saharan Africa: an analytic review of spatial distribution, burden and determinants

Bekahegn Girma^{1*} and Azizur Rahman²

¹School of Nursing and Midwifery, Debre Berhan University, Debre Berhan, Ethiopia, ²School of Computing, Mathematics and Engineering, Charles Sturt University, Wagga Wagga, NSW, Australia

Malnutrition, encompassing both underweight and obesity, poses a significant public health challenge for women worldwide, spanning across developed and developing nations. Sub-Saharan Africa (SSA) bears a notably high burden of underweight, despite recent years have seen a noticeable increase in obesity rates. Lactating women are especially vulnerable to malnutrition. This analytic review aimed to compile current knowledge on the spatial distribution, prevalence, and contributing factors of malnutrition among lactating mothers in Sub-Saharan Africa, highlighting research gaps. This review systematically searched previous primary studies and reports from databases including PubMed, MEDLINE, PsycINFO, Web of Science, HINARI, EMBASE, African Journal of Online (AJOL), Scopus and Google Scholar. Various significant findings were synthesized in textual descriptions, figures and tables. The prevalence of underweight among lactating women in sub-Saharan Africa exhibits considerable disparity, spanning from 5.6 to 54.8%. However, there was no comprehensive summarized evidence for this issue in the region. Additionally, our findings emphasize a deficiency in comprehending the geographic distribution and factors influencing malnutrition among lactating women in sub-Saharan Africa. The burden of overweight in SSA was 15.9% among reproductive women; this burden is going to be increased. However, there were no studies conducted among the most vulnerable women, lactating women. Similarly, despite the spatial distribution of obesity/overweight among reproductive women in SSA was known, there were no evidences for lactating women who have high risk for malnutrition as pregnant women. Hence, conducting population-wide, representative, and comprehensive research utilizing Demographic Health Survey data from countries in sub-Saharan Africa is imperative to fully comprehend the extent of the problem and effectively address the burden of malnutrition in this vulnerable population. Additionally, identifying hotspot areas of malnutrition specifically among lactating women within sub-Saharan Africa through spatial distribution analysis is essential for allocating resources appropriately, addressing a critical concern in the region and helps to reduce morbidity and mortality.

KEYWORDS

sub-Saharan Africa, lactating mothers, spatial distribution analysis, underweight, overweight/obesity

1 Introduction

Malnutrition entails an imbalance between nutrient intake and the essential nutrients required for optimal health and bodily function. It can be classified as undernutrition, overnutrition, or micronutrient deficiencies (1). The scope of this review addressed only the burden, spatial distribution and factors associated with underweight and obesity/overweight among lactating women. Underweight is delineated by a body mass index (BMI) of below 18.5 kg/m², while obesity is identified as a BMI exceeding 30 kg/m² (2) and if BMI is between 25 and 29.9 kg/m² it is called overweight. According to prevailing literature in nutrition and women's health, malnutrition can occur across the life course of women, including adolescence, pregnancy, lactation, and postmenopausal stages, each presenting unique nutritional challenges and health implications (3).

Globally, in 2022, approximately 390 million reproductive women were underweight, while 2.5 billion were deemed overweight and 890 million suffered from obesity (4). Underweight in mothers who breastfeed is a serious problem worldwide, especially in developing nations. Research indicates that a significant percentage of lactating mothers are underweight, with prevalence rates in Africa ranging from 1.25 to 30% (5). Malnutrition among lactating mothers poses significant health risks not only to mothers themselves but also to their infants, contributing to intergenerational cycles of undernutrition and poor health outcomes (6). Therefore, this review addressed a critical area of concern within public health and maternal-child nutrition.

Studies have documented regional disparities in malnutrition prevalence. Additionally, research has identified a range of determinants, including socioeconomic factors, cultural practices, and access to healthcare, influencing nutritional outcomes among lactating mothers (7).

However, the extent of evidences about the spatial distribution, burden and factors associated with underweight, obesity and overweight among lactating women at SSA level was unknown. Therefore, this study aimed to extensively review the current evidences on this area and show research gaps which need future investigation.

2 Methodology

In this review, peer-reviewed articles, academic dissertations, and reports that described malnutrition among lactating mothers in SSA were searched, reviewed and included. Furthermore, it encompassed observational studies, systematic reviews, and meta-analyses written in English. Lastly, interventional studies were also considered to see programs effectiveness.

A comprehensive exploration spanned various databases, including PubMed, MEDLINE, PsycINFO, HINARI, EMBASE, African Journal of Online (AJOL), Scopus, Web of Science, Google Scholar, and Google. Our search strategy involved a combination of pertinent keywords and Medical Subject Headings (MeSH terms) pertaining to malnutrition, lactating women, and SSA. Identified articles were sifted for determinants according to specified terms.

Abbreviations: BMI, Body Mass Index; DBM, Double Burden of Malnutrition; DHS, Demographic and Health Surveys; SSA, Sub-Saharan Africa; WHO, World Health Organization.

Additionally, primary article references were scrutinized. Statistical analysis was done using Stata version 16 software.

Lastly, the general topic of this research project gyrated around understanding the complex dynamics of malnutrition (underweight, obesity and overweight) among lactating women in SSA who breastfeed their under 2 years child. Therefore, studies which conducted to see the spatial distributions, burden and determinants that influence the nutritional status in this population were considered.

3 Review results

Double burden of malnutrition (DBM) refers to the simultaneous presence of both undernutrition and overweight or obesity within individuals, households, and populations (8). DBM poses a momentous public health dare in low- and middle-income countries (LMICs) found in Asia (9) and Africa (10).

As shown in Figure 1, the African region is the most affected (11). In Africa, the DBM among children and women of reproductive age has been extensively studied, with numerous comprehensive and summarized pieces of evidence available (10, 12–21).

However, the extent of evidence available on the malnutrition burden among lactating women was limited. Consequently, the subsequent sections review critically the exact of knowledge on spatial distribution, burden and factors associated with underweight and obesity/overweight among lactating women in SSA.

3.1 Spatial distributions of underweight and obesity

Spatial distribution is the arrangement or pattern of objects in physical space and the study of the relationships between them. It is one of the fundamental concepts in geography, urban planning, ecology, health, and other fields (22). By analyzing spatial distribution, researchers can gain insights into processes such as diffusion, migration, urbanization, and resource allocation (23, 24). Population distribution is primarily influenced by a multitude of factors. These

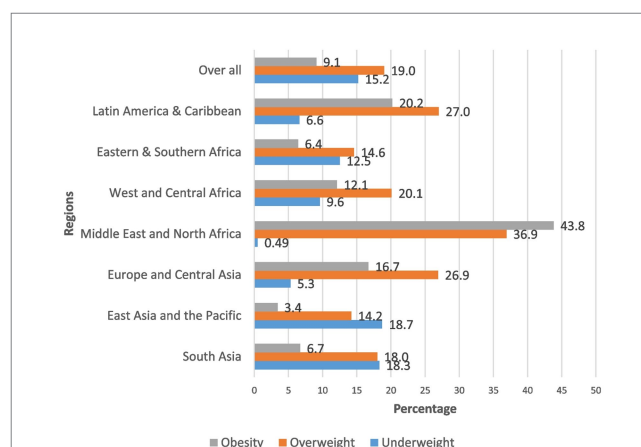


FIGURE 1

The global burden of malnutrition reported by a study conducted by Alem et al. (11).

include climate, landforms, topography, cultural and political considerations (25).

An analysis using data from the 2016 Ethiopian DHS focused on the geographic distribution of underweight among women of reproductive age identified regions with high burden; Amhara, Tigray, Gambella, and Afar regions (26). Another spatial study conducted among reproductive women in Ethiopia also identified hotspot regions; Tigray, Afar and Amhara (27). Besides, a study conducted in Ethiopia among women also indicated notable hotspot areas in the Eastern and northeastern part of the country (28).

Geospatial research among reproductive-age women in SSA identified significant regions where overweight/obesity and anemia co-occur (29). Several hotspot regions of co-existence were found in Nigeria, South Africa, Mali Cameroon, Mauritania, Tanzania, Liberia and Benin. Conversely, cold spot areas were observed in Burundi, Ethiopia, Guinea, Uganda, Sierra Leone, Madagascar and Rwanda (29). Another study done in Ghana mapped the distribution of undernutrition among non-pregnant women, highlighting clusters in the western Northern region and hotspots of overweight/obesity in several other areas (30).

A nationwide study conducted using data from the Nigerian DHS also examined the spatial distribution of obesity/overweight. It revealed significant variation across ethnic groups and states of residence, with the highest prevalence observed in Cross River State, in southeastern Nigeria, and the lowest in Osun State, situated in southwestern Nigeria (31). All the above studies were conducted among reproductive age women and we did not find any summarized evidence about the spatial distributions of malnutrition among lactating women in SSA. Therefore, a population based geospatial study among lactating women should be conducted using the national DHS data to identify the hotspot countries in the SSA.

3.2 Prevalence of underweight among lactating women in SSA

Globally, statistics reveal that approximately 13% of women are underweight. This prevalence is significantly higher in economically disadvantaged nations, with rates ranging from 20 to 25% for underweight (32–34). Pregnant and lactating women are more vulnerable than others (35). The global burden of undernutrition among lactating women is a substantial public health concern, particularly in low-and middle-income countries (LMICs). Recent estimates from the World Health Organization (WHO) indicate that about 22% of lactating women worldwide are affected by undernutrition (36). In SSA countries, this problem presents a grave concern. Consequently, the region grapples with alarmingly high morbidity and mortality rates (37), exacerbated by its susceptibility to both natural and manmade disasters, precipitating socio-economic adversities (5, 38).

The occurrence of undernutrition among lactating women shows considerable variation across different regions and countries, with Sub-Saharan Africa (SSA) shouldering a disproportionate share of the burden. In this region, the prevalence of chronic undernutrition ranges from 10 to 20%, while acute undernutrition ranges from 20 to 25% (39). We analyzed primary studies conducted in Sub-Saharan

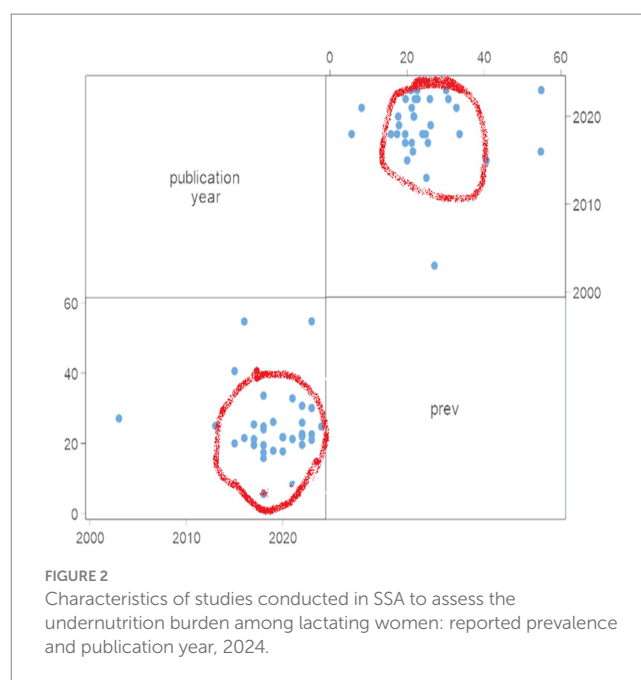


FIGURE 2
Characteristics of studies conducted in SSA to assess the undernutrition burden among lactating women: reported prevalence and publication year, 2024.

Africa. Most of these studies were conducted since 2015 and reported a prevalence of undernutrition between 20 and 30% (Figure 2). The combined prevalence was 24.45% (Figure 3).

A study conducted in Uganda using DHS data evaluated the extent of undernutrition among lactating women and revealed that 8.2% of lactating women were underweight (40). Moreover, in Ethiopia, there are over 30 studies have been conducted to gauge the extent of undernutrition among lactating women and the prevalence has been found to vary considerably, ranging from 5.6 to 54.8% (41, 42) (Table 1). Another systematic review conducted in Ethiopian also reported a pooled prevalence of underweight of 23.84% (43).

However, most of the included studies were conducted in Ethiopia. There wasn't evidence in the other countries found in SSA and the current combined prevalence could not show the burden in SSA. Therefore, to determine the burden of undernutrition in SSA, a meta-analysis should be conducted using the national DHS data of the member countries since studies included in this study only might not be representative.

3.3 Factors influencing underweight in lactating women

Factors contributing to undernutrition among lactating women are multifaceted and include socio-economic disparities, inadequate dietary intake, food insecurity, limited access to maternal healthcare services, and cultural practices (44, 45). Moreover, environmental factors such as climate change and natural disasters exacerbate food insecurity and further compound the risk of undernutrition among vulnerable populations (36).

A mini-review conducted in Ethiopia identified place of delivery, dietary diversity, income, food security, nutritional education programs, and antenatal care as determinants of undernutrition (46). Educational status emerged as a substantial factor for underweight

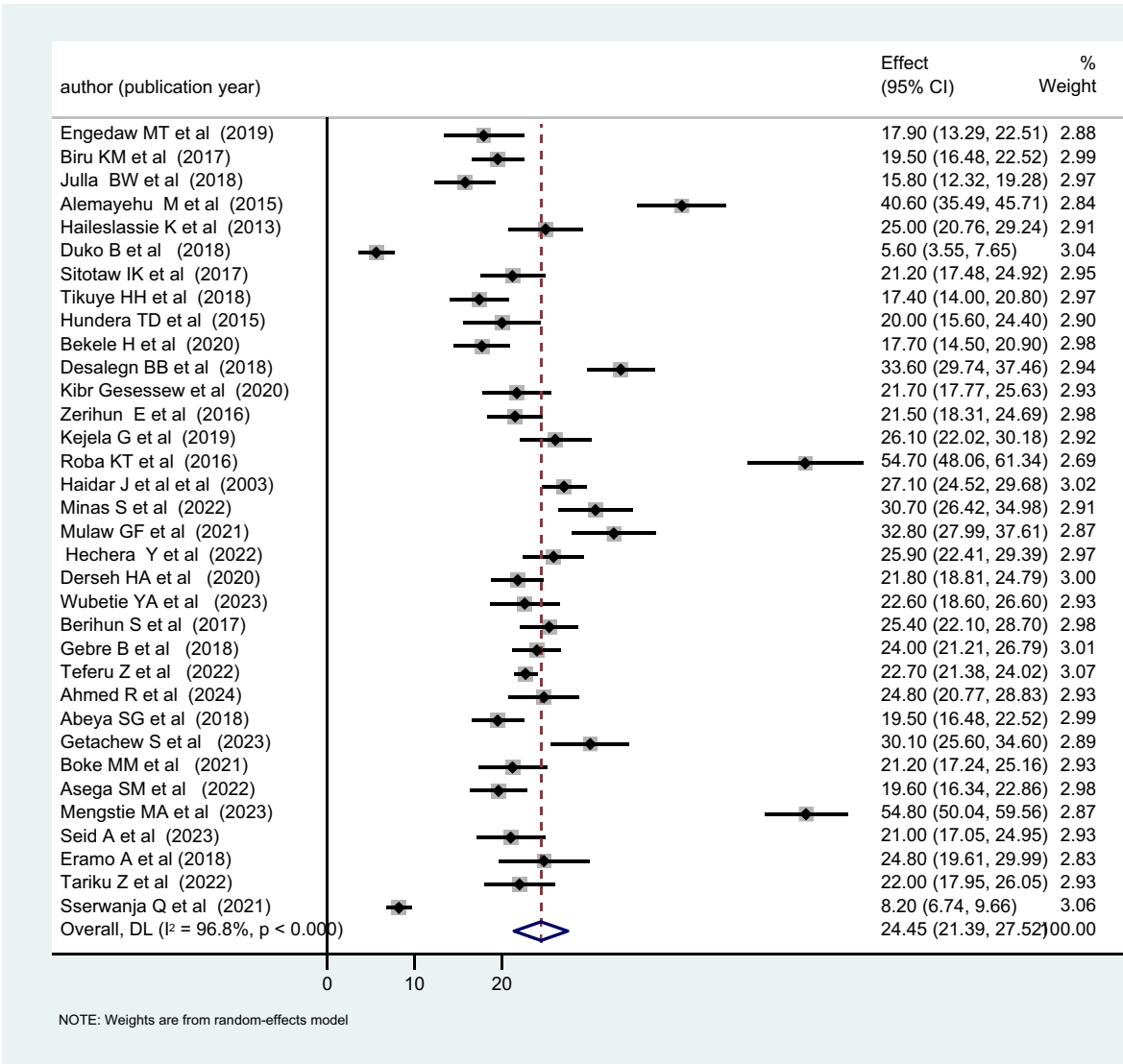


FIGURE 3 Underweight pooled prevalence in lactating women across SSA, 2024.

among lactating women in a meta-analysis coxswained in Ethiopia (43).

To reveal determinants that affect nutrition during lactation, different studies conducted in SSA were searched, and many factors that are described in the above paragraphs were scrutinized and included. In summary, the determinants are individual and community-level determinants (Table 1). In our review, the most frequently cited determinants included age at first marriage, dietary diversity score, educational status, family size, food insecurity, income, additional meals, and birth interval (Figure 4).

However, the factors mentioned above are identified from primary local studies, implying they may not fully capture the determinants of undernutrition in SSA. Almost all of the factors are reported from one nation, Ethiopia. Therefore, it is crucial to analyze individual and community-level determinants using comprehensive and representative population-based DHS data of SSA countries. This analysis should employ a multi-level approach, as it is a robust method

for understanding the complex and interconnected determinants of undernutrition in SSA (47).

3.4 Prevalence and determinants of obesity among lactating women

A study conducted in 32 Sub-Saharan African countries, utilizing DHS data, revealed a pooled obesity prevalence of 6.6% among women. The lowest rate was observed in Madagascar, at 1.1%, while the highest was recorded in Lesotho, at 15.8%. Also, residency and wealth index are reported as determinants for obesity (48).

Another study using DHS data from 24 African countries found increasing obesity rates among urban women of reproductive age. Significant increases were observed across all countries, with notable trends in 17 nations. In Ghana, obesity rates boosted from 1993 to 2014, while Egypt recorded the highest commonness at 39%

TABLE 1 Studies reported the burden and factors influencing underweight among lactating women in Sub-Saharan Africa, 2024.

Author	Publication year	Country	Design	Sampling	Sample size	prevalence	Measurement	Determinants
Engedaw et al. (64)	2019	Ethiopia	Cross sectional	Systematic random	266	17.9	BMI	Occupation status, feeding frequency and post-natal care
Julla et al. (65)	2018	Ethiopia	Cross sectional	Simple random	422	15.8	BMI	Educational, occupational, marital statuses and family size
Alemayehu et al. (66)	2015	Ethiopia	Cross sectional	Census	355	40.6	BMI	Dietary diversity score
Hailelassie et al. (67)	2013	Ethiopia	Cross sectional	Simple random	400	25	BMI	Length of marriage, ANC frequency, Size of farm land, child age and maize cultivation
Duko et al. (41)	2018	Ethiopia	Cross sectional	Simple random	484	5.6	BMI	Residency, age
Sitotaw et al. (68)	2017	Ethiopia	Cross sectional	Stratified sampling	464	21.2	BMI	Maternal age, extra food during lactation time, occupation and Vitamin A intake
Tikuye et al. (39)	2018	Ethiopia	Cross sectional	Multi stage sampling	478	17.4	BMI	Birth interval, food insecurity, access to nutrition information, workload and educational status.
Biru et al. (69)	2017	Ethiopia	Cross sectional	Simple random	662	19.5	BMI	–
Hundera et al. (70)	2015	Ethiopia	Cross sectional	Simple random	317	20	BMI	Family size and income
Bekele et al. (71)	2020	Ethiopia	Cross sectional	Systematic random	545	17.7	BMI	Dietary diversity, food insecurity, extra meal, place of delivery and income
Kibr et al. (72)	2020	Ethiopia	Cross sectional	Simple random	423	21.7	BMI	Eating motivation, mood concern and meal price
Desalegn et al. (35)	2018	Ethiopia	longitudinal	Multi stage sampling	575	33.6	BMI	–
Zerihun et al. (73)	2016	Ethiopia	Cross sectional	Simple random	638	21.5	BMI	Maternal age, educational status and income
Kejela et al. (74)	2019	Ethiopia	Cross sectional	Systematic random	445	26.1	BMI	Educational status, parity, ANC visit frequency, toilet availability and family size
Roba et al. (75)	2016	Ethiopia	Cross sectional	Simple random	216	54.7	BMI	Parity, region and number of children in the household
Haidar et al. (76)	2003	Ethiopia	Cross sectional	Simple random	1,140	27.1	BMI	–

(Continued)

TABLE 1 (Continued)

Author	Publication year	Country	Design	Sampling	Sample size	prevalence	Measurement	Determinants
Sserwanja et al. (40)	2021	Uganda	Cross sectional	Multi stage	1,356	8.2	BMI	No education, not working and region
Minas et al. (77)	2022	Ethiopia	Cross sectional	Multi stage	446	30.7	BMI	Chat chewing, not taking additional weight, and hand washing after toilet use
Mulaw et al. (78)	2021	Ethiopia	Cross sectional	Systematic	366	32.8	BMI	Minimum dietary diversity, and short birth interval
Hechera et al. (79)	2022	Ethiopia	Cross sectional	Simple	607	25.9	BMI	Family size, polygamy, history of abortion and Income
Derseh et al. (80)	2020	Ethiopia	Cross sectional	Multistage	733	21.8	BMI	Dietary diversity, food insecurity, marital status, age at first pregnancy and parity
Wubetie et al. (81)	2023	Ethiopia	Cross sectional	Systematic	420	22.6	BMI	Income, latrine facility, food insecurity, number of meals, dietary diversity and potable water source
Berihun et al. (82)	2017	Ethiopia	Cross sectional	Multistage	668	25.4	BMI	Family size, health education, age of first pregnancy and place of delivery
Gebre et al. (83)	2018	Ethiopia	Cross sectional	Systematic	900	24	MUAC	ANC and feeding support
Teferu et al. (84)	2022	Ethiopia	Cross sectional	Population survey	3,848	22.7	BMI	Age, residence, toilet facilities, and poverty.
Ahmed et al. (85)	2024	Ethiopia	Cross sectional	Multi stage	442	24.8	BMI	Dietary diversity, food insecurity, extra meal and nutrition information
Adugna et al. (86)	2021	Ethiopia	Case control	Consecutive	389	–	BMI	Age at first pregnancy, breastfeeding age and site of delivery,
Abeya et al. (87)	2018	Ethiopia	Cross sectional	Multi stage	662	19.5	BMI	Pregnancy during advice and utilization postnatal service
Getachew et al. (88)	2023	Ethiopia	Cross sectional	Systematic	400	30.1	BMI	Early marriage, extra meal, not using contraceptives, dietary diversity and food insecurity
Boke et al. (89)	2021	Ethiopia	Cross sectional	Simple	410	21.2	BMI	ANC visit, age, income and dietary diversity
Asega et al. (90)	2022	Ethiopia	Cross sectional	Multi-stage	570	19.6	BMI	Family size, age of first pregnancy, health education and maternal education

(Continued)

TABLE 1 (Continued)

Author	Publication year	Country	Design	Sampling	Sample size	prevalence	Measurement	Determinants
Mengstie et al. (91)	2023	Ethiopia	Cross sectional	Simple random	420	54.8	BMI	Family size, dietary diversity, birth interval and meal frequency
Seid et al. (92)	2023	Ethiopia	Cross section	systematic	408	21	BMI	Maternal age, marital status, food insecurity and dietary diversity
Eramo (93)	2018	Ethiopia	Cross sectional	Simple random	266	24.8	BMI	ANC follow-up, income, Educational status and extra meals
Tariku et al. (94)	2022	Ethiopia	Cross sectional	Simple random	401	22	BMI	Maternal age, dietary diversity, education status, and family size and extra meal during lactation

in 2014. Obesity rates doubled in Burkina Faso, Niger, Benin, Rwanda, Kenya, Ivory Coast, and Uganda and tripled in Malawi, Tanzania, Zambia, and Mali. Conversely, Madagascar and Ethiopia had the lowest obesity prevalence, ranging from 1 to 4% (49).

Furthermore, a separate study conducted in Tanzania documented the obesity prevalence among women, which stood at 9.1% in 2004. This prevalence has shown a consistent and gradual increase over time. Additionally, the study identified age, parity, and socioeconomic status as key determinants of obesity (50).

While studies have explored obesity among women in SSA, the lack of research on the prevalence and determinants of obesity specifically among lactating women in the region is a significant gap. Understanding and addressing obesity among lactating women in SSA, influenced by cultural perceptions, limited access to healthcare resources, and insufficient research focus, could have a profound impact. It has not received the same level of research attention as in other parts of the world (51).

Closing the gap in understanding and addressing obesity among lactating women in SSA requires interdisciplinary efforts involving healthcare professionals, policymakers, researchers, and community stakeholders. This includes promoting culturally sensitive healthcare practices, improving access to healthcare services, prioritizing maternal health and nutrition research, and implementing evidence-based interventions to support healthy weight management during the postpartum period. Furthermore, longitudinal large-scale studies should be conducted to assess the prevalence and determinants of obesity among lactating women in SSA. Addressing these factors can help mitigate the impact of obesity on maternal and child health outcomes in Africa.

3.5 Interventional studies conducted in SSA

There were not many interventional studies in sub-Saharan Africa (SSA) that explicitly target obesity, overweight, and underweight among lactating women. Nonetheless, a number of observational studies provide light on the dietary difficulties this demographic faces and offer possible solutions.

According to a Ghanaian study, shorter risks of maternal obesity were linked to longer breastfeeding durations. The odds of being obese were significantly lower for women who breastfed for more than 18 months than for those who did not (52).

The results of observational research indicate that encouraging prolonged breastfeeding may help lower mother obesity, despite the paucity of direct interventional studies. Additionally, resolving the double burden of malnutrition among lactating women in SSA may require addressing socioeconomic variables at the individual and societal levels. There were studies conducted to the rural urban inequality of this problem among lactating women.

There were an additional interventional studies conducted in SSA which displayed on Table 2.

4 Discussion

This analytic review paper has aimed to assess the existing knowledge and identify research gaps on the spatial distributions, burden and factors of malnutrition among lactating women in SSA. Even though some studies have been conducted among reproductive-age women at the national level to describe the spatial distribution of malnutrition, no representative research has been conducted focusing on lactating women in SSA. However, investigating the spatial distribution of malnutrition helps to design new interventions and allocate resources, especially for Africa, where the malnutrition burden is high (53). This might be because the region is highly burdened with many communicable and non-communicable diseases. As a result, the concern given to lactating women has become less (54–56).

Although the exact pooled magnitude of underweight among lactating women in SSA remains unknown and most of the included studies were conducted in one country, based on our review, it spans a broad range of 5.6 to 54.8% and the pooled prevalence was 24.45%. This range and pooled prevalence notably exceeds the prevalence reported globally and in studies conducted in developed countries (57). The disparity in prevalence could

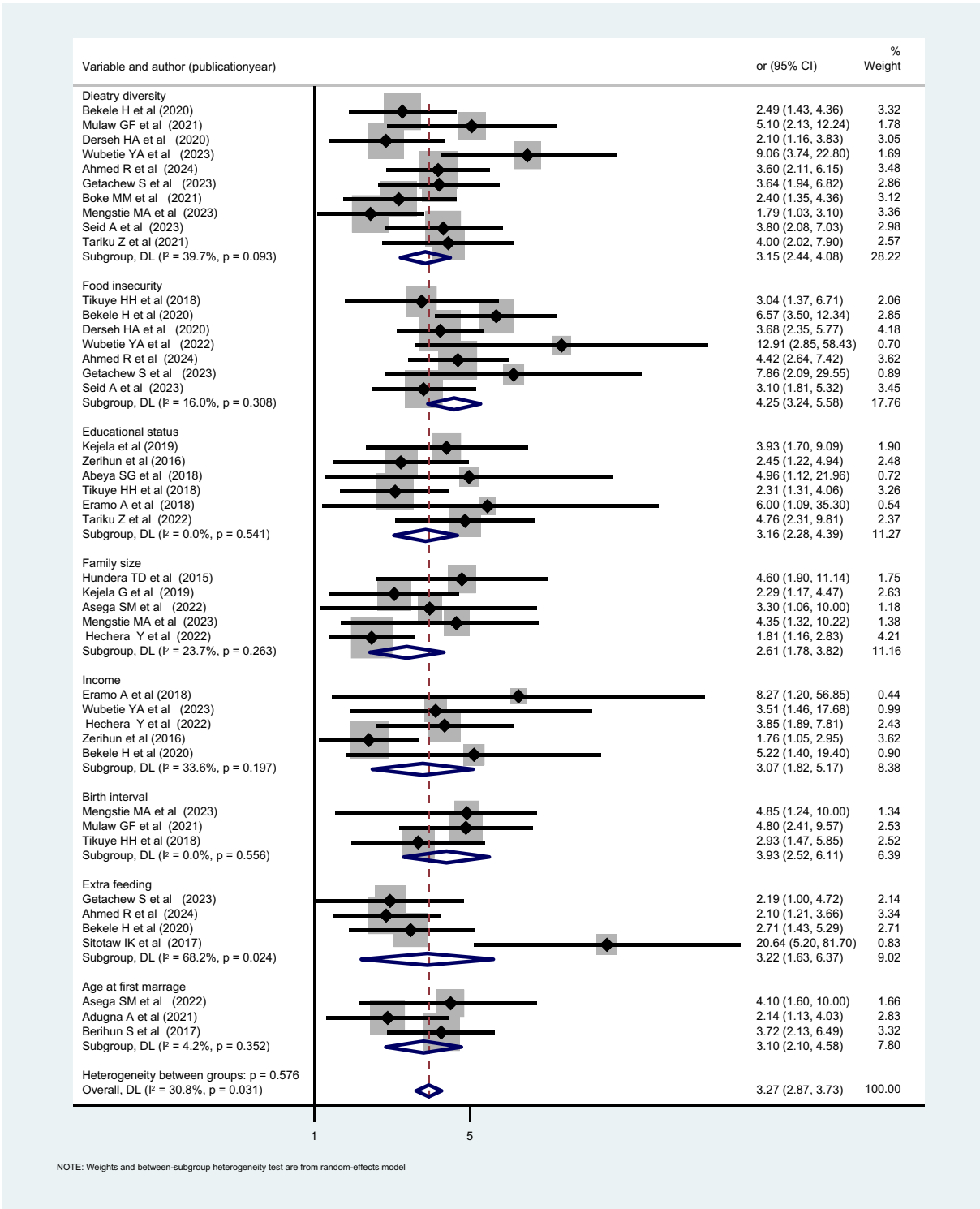


FIGURE 4
Significant determinants for underweight among lactating women in SSA, 2024.

be attributed to several factors unique to SSA, including disparities in healthcare service quality, lower utilization rates of antenatal and postnatal care, and limited access to nutritional counseling and education compared to developed countries (58, 59).

This review highlights numerous determinants identified by primary studies in SSA, encompassing individual and community-level factors. However, the meta-analysis-based review fails to identify the most pertinent and high-level determinants and their effects. Additionally, the extracted determinants are often sourced from local

TABLE 2 Summary table for interventional studies conducted among lactating women, 2024.

Country/region	Intervention type	Key outcomes	Reference
Rwanda	Integrated nutrition-specific and nutrition-sensitive program	maternal nutrition knowledge and practices	Habtu et al., 2022 (95)
Uganda	Nutrition Assessment, Counseling, and Support (NACS)	Enhanced maternal nutrition practices	Namukose et al., 2024 (96)
Kenya	Home-based nutritional counseling	exclusive breastfeeding rates	Kimani-Murage et al., 2017 (97)
Ethiopia	Nutrition education and home gardening	Improved dietary diversity	Kuma et al., 2023 (98)

studies conducted in one country that may not represent broader populations. A population-based multinational study utilizing multilevel analysis of DHS data across SSA countries is warranted to address this gap.

Moreover, our literature review encompasses studies examining the prevalence and factors influencing obesity among women in SSA, revealing a range of 1.1 to 39%. This prevalence is comparable to that observed in high-income countries (60–62), presenting a significant concern and contributing to the DBM in the region. So far, no specific studies have been conducted among lactating women in sub-Saharan Africa. This could be because poverty, food insecurity, and undernutrition provide significant economic obstacles. These significant matters take precedence over obesity treatment, which is frequently perceived as a problem connected to income.

The burden of malnutrition in SSA has been well studied. However, the magnitude was high even compared to other developing countries in Asia, like Bangladesh (wasting of 10%) (63). This could be because a large number of Africans live below the poverty line, there is high food insecurity, and there is conflict in the region.

Despite this was review, it had limitations. Firstly, studies included in this review were mostly from one country which raises generalizability issue.

5 Conclusion

This study revealed the absence of evidences on the spatial distribution, burden and factors affecting underweight, obesity and overweight among lactating women in SSA. Moreover, this literature review underscores the critical need for focused attention on malnutrition (underweight and overweight/obesity) among lactating women in SSA. Despite the absence of representative studies in this vulnerable group, our findings reveal a wide prevalence range of underweight and obesity, indicative of significant challenges.

Factors contributing to this include healthcare disparities, limited access to nutritional resources, and the broader burden

of disease in the region. Addressing these issues requires a multifaceted approach, including population-based multinational studies and utilization of data from sources like the DHS. Furthermore, the underexplored prevalence of obesity among lactating women underscores the urgent need for further research. This research is crucial to thoroughly understanding the extent of this issue and effectively addressing the problem in this vulnerable population. Identifying hotspot areas of malnutrition specifically among lactating women within sub-Saharan Africa through spatial distribution analysis is essential for allocating resources appropriately, addressing a critical concern in the region and helps to reduce morbidity and mortality. Therefore, to fill this gap studies using representative datasets like DHS data at SSA level is essential and future researchers should also give focus to lactating women nutrition since they are more vulnerable.

Author contributions

BG: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. AR: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

- Musimenta N, Onyango R. Factors associated with malnutrition occurrence among children under 5 years in KIHENDA village HOIMA district. A cross-sectional study. *SJ Pediatrics and Child Health Africa*. (2024) 1:9. doi: 10.51168/yfancr93
- Organization, W.H. Global nutrition monitoring framework: Operational guidance for tracking progress in meeting targets for 2025. WHO (2017).
- Saunders J, Smith T. Malnutrition: causes and consequences. *Clin Med (Lond)*. (2010) 10:624–7. doi: 10.7861/clinmedicine.10-6-624
- Organization, W.H. Global status report on noncommunicable diseases 2014. Geneva, Switzerland: World Health Organization (2014).
- Lartey A. Maternal and child nutrition in sub-Saharan Africa: challenges and interventions. *Proc Nutr Soc*. (2008) 67:105–8. doi: 10.1017/S0029665108006083
- Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, et al. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet*. (2008) 371:243–60. doi: 10.1016/S0140-6736(07)61690-0
- Girma W, Genebo T. Determinants of nutritional status of women and children in Ethiopia. Calverton, Maryland, USA: ORC Macro (2002).
- Organization, W.H. The double burden of malnutrition: Policy brief. Geneva, Switzerland: World Health Organization (2016).
- Hossain MI, Rahman A, Uddin MSG, Zinia FA. Double burden of malnutrition among women of reproductive age in Bangladesh: a comparative study of classical and Bayesian logistic regression approach. *Food Sci Nutr*. (2023) 11:1785–96. doi: 10.1002/fsn3.3209
- Seifu BL, Mare KU, Legesse BT, Tebeje TM. Double burden of malnutrition and associated factors among women of reproductive age in sub-Saharan Africa: a multilevel multinomial logistic regression analysis. *BMJ Open*. (2024) 14:e073447. doi: 10.1136/bmjopen-2023-073447
- Alem AZ, Yeshaw Y, Liyew AM, Tessema ZT, Worku MG, Tesema GA, et al. Double burden of malnutrition and its associated factors among women in low and middle income countries: findings from 52 nationally representative data. *BMC Public Health*. (2023) 23:1479. doi: 10.1186/s12889-023-16045-4
- Akombi BJ, Chitekwe S, Sahle BW, Renzaho AMN. Estimating the double burden of malnutrition among 595,975 children in 65 low-and middle-income countries: a Meta-analysis of demographic and health surveys. *Int J Environ Res Public Health*. (2019) 16:2886. doi: 10.3390/ijerph16162886
- Amugsi DA, Dimbuene ZT, Kyobutungi C. Correlates of the double burden of malnutrition among women: an analysis of cross sectional survey data from sub-Saharan Africa. *BMJ Open*. (2019) 9:e029545. doi: 10.1136/bmjopen-2019-029545
- Nyanhanda T, Mwanri L, Mude W. Double burden of malnutrition: a population level comparative cross-sectional study across three sub-Saharan African countries-Malawi, Namibia and Zimbabwe. *Int J Environ Res Public Health*. (2023) 20:5860. doi: 10.3390/ijerph20105860
- Okyere J, Budu E, Aboagye RG, Seidu AA, Ahinkorah BO, Yaya S. Socioeconomic determinants of the double burden of malnutrition among women of reproductive age in sub-Saharan Africa: a cross-sectional study. *Health Sci Rep*. (2024) 7:e2071. doi: 10.1002/hsr.2.2071
- Alaba OA, Chiwire P, Siya A, Saliu OA, Nhakaniso K, Nzeribe E, et al. Socio-economic inequalities in the double burden of malnutrition among under-five children: evidence from 10 selected sub-Saharan African countries. *Int J Environ Res Public Health*. (2023) 20:5489. doi: 10.3390/ijerph20085489
- Christian AK, Dake FA. Profiling household double and triple burden of malnutrition in sub-Saharan Africa: prevalence and influencing household factors. *Public Health Nutr*. (2022) 25:1563–76. doi: 10.1017/S1368980021001750
- Harper A, Goudge J, Chirwa E, Rothberg A, Sambu W, Mall S. Dietary diversity, food insecurity and the double burden of malnutrition among children, adolescents and adults in South Africa: findings from a national survey. *Front Public Health*. (2022) 10:948090. doi: 10.3389/fpubh.2022.948090
- Steyn NP, Nel JH. Prevalence and determinants of the double burden of malnutrition with a focus on concurrent stunting and overweight/obesity in children and adolescents. *Curr Nutr Rep*. (2022) 11:437–56. doi: 10.1007/s13668-022-00417-0
- Were JM, Stranges S, Creed IF. Fertility is a key predictor of the double burden of malnutrition among women of child-bearing age in sub-Saharan Africa. *J Glob Health*. (2020) 10:020423. doi: 10.7189/jogh.10.020423
- Were JM, Stranges S, Wilk P, Ali S, Sharma I, Vargas-Gonzalez JC, et al. The double burden of malnutrition among women of reproductive age and preschool children in low-and middle-income countries: a scoping review and thematic analysis of literature. *Nutrition*. (2023) 111:112053. doi: 10.1016/j.nut.2023.112053
- Rahman A, Harding A. Small area estimation and microsimulation modeling. London, England and Wales: Chapman and Hall/CRC (2016).
- Fabro AYY. Spatial distribution of nitrate health risk associated with groundwater use as drinking water in Merida. *Mexico Applied Geography*. (2015) 65:49–57. doi: 10.1016/j.apgeog.2015.10.004
- Rahman A, Harding A, Tanton R, Liu S. Simulating the characteristics of populations at the small area level: new validation techniques for a spatial microsimulation model in Australia. *Computational Statistics & Data Analysis*. (2013) 57:149–65. doi: 10.1016/j.csda.2012.06.018
- Murigi MW. Factors influencing spatial distribution of small and medium size enterprises within Nairobi County, Kenya. Nairobi, Kenya: University of Nairobi (2016).
- Tusa BS, Weldeesenbet AB, Kebede SA. Spatial distribution and associated factors of underweight in Ethiopia: an analysis of Ethiopian demographic and health survey, 2016. *PLoS One*. (2020) 15:e0242744. doi: 10.1371/journal.pone.0242744
- Kassie Tesema A, Liyew AM, Alem AZ, Yeshaw Y, Tesema GA, Teshale AB. Spatial distribution and determinants of undernutrition among reproductive age women of Ethiopia: a multilevel analysis. *PLoS One*. (2021) 16:e0257664. doi: 10.1371/journal.pone.0257664
- Kibret KT, Chojenta C, D'Arcy E, Loxton D. Spatial distribution and determinant factors of anaemia among women of reproductive age in Ethiopia: a multilevel and spatial analysis. *BMJ Open*. (2019) 9:e027276. doi: 10.1136/bmjopen-2018-027276
- Getnet M, Sisay WS, Alem AZ. Spatial distribution and associated factors of co-occurrence of overweight/obesity and Anemia among women in the reproductive age in sub-Saharan Africa: a multilevel analysis, DHS 2016–2021. *PLoS One*. (2024) 19:e0299519. doi: 10.1371/journal.pone.0299519
- Nyarko SH, Bitew F, Amu H. Spatial and temporal inequalities in undernutrition among non-pregnant women in Ghana: a multilevel analysis. *Spatial Demography*. (2022) 10:193–207. doi: 10.1007/s40980-020-00074-3
- Kandala N-B, Stranges S. Geographic variation of overweight and obesity among women in Nigeria: a case for nutritional transition in sub-Saharan Africa. *PLoS One*. (2014) 9:e0101103. doi: 10.1371/journal.pone.0101103
- Organization, W.H. The state of food security and nutrition in the world 2019: safeguarding against economic slowdowns and downturns, vol. 2019. Rome: FAO (2019).
- Kennedy E, Tessema M, Hailu T, Zerfu D, Belay A, Ayana G, et al. Multisector nutrition program governance and implementation in Ethiopia: opportunities and challenges. *Food Nutr Bull*. (2015) 36:534–48. doi: 10.1177/0379572115611768
- Organization, W.H. Nutrition of women in the preconception period, during pregnancy and the breastfeeding period. *Provisional Agenda Item*. (2012) 13:A65.
- Desalegn BB, Lambert C, Riedel S, Negese T, Biesalski HK. Ethiopian orthodox fasting and lactating mothers: longitudinal study on dietary pattern and nutritional status in rural Tigray, Ethiopia. *Int J Environ Res Public Health*. (2018) 15:1767. doi: 10.3390/ijerph15081767
- Canton H. Food and agriculture organization of the United Nations—FAO In: The Europa directory of international organizations 2021. edited by Europa Publications London, England and Wales: Routledge (2021). 297–305.
- Rahman A. Geospatial, socioeconomic, demographic and health determinants of childhood mortality in Bangladesh. *Demography India: Population Society Econ Environ Interactions*. (2019) 48:74–85.
- Lindsay K, Gibney E, McAuliffe F. Maternal nutrition among women from sub-Saharan Africa, with a focus on Nigeria, and potential implications for pregnancy outcomes among immigrant populations in developed countries. *J Hum Nutr Diet*. (2012) 25:534–46. doi: 10.1111/j.1365-277X.2012.01253.x
- Tikuye HH, Gebremedhin S, Mesfin A, Whiting S. Prevalence and factors associated with undernutrition among exclusively breastfeeding women in Arba Minch Zuria District, southern Ethiopia: a cross-sectional community-based study. *Ethiop J Health Sci*. (2019) 29:913–922. doi: 10.4314/ejhs.v29i1.13
- Sserwanja K, Kawuki J, Mutisya LM, Musaba MW, Kagwisagye M, Kato IA, et al. Underweight and associated factors among lactating women in Uganda: evidence from the Uganda demographic health survey 2016. *Health Sci Reports*. (2021) 4:e356. doi: 10.1002/hsr.2.356
- Duko B, Gebrie M, Hailu D. Factors associated with nutritional status among lactating mothers at Shashemene Woreda, west Arsi zone, Oromia, Ethiopia: a comparative cross-sectional study. *Int J Nutrition Metabolism*. (2018) 10:37–46. doi: 10.5897/IJNAM2018.0243
- Roba KT. Anemia and undernutrition among children aged 6–23 months in two agroecological zones of rural Ethiopia. *Pediatric Health, Med Therapeutics*. (2016) 7:131–40. doi: 10.2147/PHMT.S109574
- Girma B, Nigussie J, Molla A, Mareg M. Under-nutrition and associated factors among lactating mothers in Ethiopia: a systematic review and Meta-analysis. *Matern Child Health J*. (2022) 26:2210–20. doi: 10.1007/s10995-022-03467-6
- Nguyen PH, Scott S, Avula R, Tran LM, Menon P. Trends and drivers of change in the prevalence of anaemia among 1 million women and children in India, 2006 to 2016. *BMJ Glob Health*. (2018) 3:e001010. doi: 10.1136/bmjgh-2018-001010
- Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet*. (2013) 382:427–51. doi: 10.1016/S0140-6736(13)60937-X
- Sserwanja Q, Kawuki J. Prevalence of underweight and associated factors among lactating women in Ethiopia: a mini-review. *J Adv Med Med Res*. (2020) 32:1–9. doi: 10.9734/jammr/2020/v32i830459
- Rahman A. Estimating small area health-related characteristics of populations: a methodological review. *Geospatial. Health*. (2017) 12:3–14. doi: 10.4081/gh.2017.495
- Neupane S, KC P, Doku DT. Overweight and obesity among women: analysis of demographic and health survey data from 32 sub-Saharan African countries. *BMC Public Health*. (2015) 16:1–9. doi: 10.1186/s12889-016-2698-5

49. Amugsi DA, Dimbuene ZT, Mberu B, Muthuri S, Ezech AC. Prevalence and time trends in overweight and obesity among urban women: an analysis of demographic and health surveys data from 24 African countries, 1991–2014. *BMJ Open*. (2017) 7:e017344. doi: 10.1136/bmjopen-2017-017344
50. Villamor E, Msamanga G, Urassa W, Petraro P, Spiegelman D, Hunter DJ, et al. Trends in obesity, underweight, and wasting among women attending prenatal clinics in urban Tanzania, 1995–2004. *Am J Clin Nutr*. (2006) 83:1387–94. doi: 10.1093/ajcn/83.6.1387
51. Hu FB. Overweight and obesity in women: health risks and consequences. *J Women's Health*. (2003) 12:163–72. doi: 10.1089/154099903321576565
52. Tuoyire DA, Tampah-Naah AM. Association of breastfeeding duration with overweight and obesity among women in Ghana. *Front Global Women's Health*. (2024) 5:1251849. doi: 10.3389/fghw.2024.1251849
53. Nel JH, Steyn NP. The nutrition transition and the double burden of malnutrition in sub-Saharan African countries: how do these countries compare with the recommended lancet commission global diet? *Int J Environ Res Public Health*. (2022) 19:16791. doi: 10.3390/ijerph192416791
54. Gouda HN, Charlson F, Sorsdahl K, Ahmadzade A, Ferrari AJ, Erskine H, et al. Burden of non-communicable diseases in sub-Saharan Africa, 1990–2017: results from the global burden of disease study 2017. *Lancet Glob Health*. (2019) 7:e1375–87. doi: 10.1016/S2214-109X(19)30374-2
55. Bigna JJ, Noubiap JJ. The rising burden of non-communicable diseases in sub-Saharan Africa. *Lancet Glob Health*. (2019) 7:e1295–6. doi: 10.1016/S2214-109X(19)30370-5
56. Akinwusi PO. Communicable disease-related sudden death in the 21st century in Nigeria. *Infection Drug Resistance*. (2013) 6:125–32. doi: 10.2147/IDR.S47959
57. Shrimpton R, Rokx C. The double burden of malnutrition. A review of global evidence. Washington, DC: World Bank (2012).
58. Eshetu HB, Aragaw FM, Negash WD, Belachew TB, Asmamaw DB, Tareke AA, et al. Assessing postnatal care for newborns in sub-Saharan Africa: a multinational analysis. *PLoS One*. (2024) 19:e0298459. doi: 10.1371/journal.pone.0298459
59. Alemayehu M, Medhanyie AA, Mulugeta A. A review of evidence on barriers to and facilitators of the utilization of reproductive, maternal and neonatal health services among pastoralist communities in sub-Saharan Africa. *Ethiop J Heal Dev*. (2018) 1021–6790.
60. McPherson K. Reducing the global prevalence of overweight and obesity. *Lancet*. (2014) 384:728–30. doi: 10.1016/S0140-6736(14)60767-4
61. Swinburn B, Hovmand P, Waterlander W, Allender S. The global syndemic of obesity, undernutrition, and climate change. *Clin Obesity Adults Children*. (2022):409–27. doi: 10.1002/9781119695257.ch31
62. Abarca-Gómez L, Abdeen ZA, Hamid ZA, Abu-Rmeileh NM, Acosta-Cazares B, Aciun C, et al. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. *Lancet*. (2017) 390:2627–42. doi: 10.1016/S0140-6736(17)32129-3
63. Rahman A, Chowdhury S, Hossain D. Acute malnutrition in Bangladeshi children: levels and determinants. *Asia Pac J Public Health*. (2009) 21:294–302. doi: 10.1177/1010539509335399
64. Engidaw MT. Chronic energy deficiency and its associated factors among lactating women in Debre Tabor general hospital, northcentral Ethiopia. *J Family Med Health Care*. (2019) 5:1–7. doi: 10.11648/j.jfmhc.20190501.11
65. Julla BW, Haile A, Ayana G, Eshetu S, Kuche D, Asefa T. Chronic energy deficiency and associated factors among lactating mothers (15–49 years old) in Offa Woreda, Wolayita zone, SNNPRs. *Ethiopia World Scientific Res*. (2018) 5:13–23. doi: 10.20448/journal.510.2018.51.13.23
66. Alemayehu M, Argaw A, Mariam AG. Factors associated with malnutrition among lactating women in subsistence farming households from Dedo and Seqa-Chekorsa districts, Jimma zone, 2014. *Develop Country Stud*. (2015) 5:117–8.
67. Haillessie K, Mulugeta A, Girma M. Feeding practices, nutritional status and associated factors of lactating women in Samre Woreda, south eastern zone of Tigray. *Ethiopia Nutrition J*. (2013) 12:1–11. doi: 10.1186/1475-2891-12-28
68. Sitotaw IK, Haillessie K, Adama Y. Comparison of nutritional status and associated factors of lactating women between lowland and highland communities of district Raya, Alamata, southern Tigray. *BMC Nutr*. (2017) 3:1–12. doi: 10.1186/s40795-017-0179-6
69. Biru K, Jima A, Abeya S. Prevalence of chronic energy malnutrition and maternal health service utilizations among lactating mothers. Eastern Ethiopia: Walsh Medical Media (2017).
70. Hundera TD. Nutritional status and associated factors among lactating mothers in Nekemte referral hospital and health centers. *Ethiopia Int J Nutr Food Sci*. (2015) 4:216–22.
71. Bekele H, Jima GH, Regesu AH. Undernutrition and associated factors among lactating women: community-based cross-sectional study in Moyale District, Borena zone, Southern Ethiopia. *Advan Public Heal*. (2020) 2020:1–10. doi: 10.1155/2020/4367145
72. Gesesew K. Nutritional status and associated drivers of food choice among lactating women in Debre Birhan town, North Shoa zone, Amhara region, Ethiopia: a community based cross-sectional study. *Int J Nutrition Metabolism*. (2020) 12:16–24. doi: 10.5897/IJNAM2020.0268
73. Zerihun E, Egata G, Mesfin F. Under nutrition and its associated factors among lactating mothers in rural ambo district, west Shewa zone, Oromia region, Ethiopia. *East African J Health Biomed Sci*. (2016) 1:39–48.
74. Kejela G., Under nutrition and associated factors among lactating mothers in southern Ethiopia: Institution based cross-sectional study. (2019).
75. Roba KT, O'Connor TP, Belachew T, O'Brien NM. Seasonal variation in nutritional status and anemia among lactating mothers in two agro-ecological zones of rural Ethiopia: a longitudinal study. *Nutrition*. (2015) 31:1213–8. doi: 10.1016/j.nut.2015.03.007
76. Haidar J, Muroki NM, Omwega AM, Ayana G. Malnutrition and iron deficiency anaemia in lactating women in urban slum communities from Addis Ababa, Ethiopia. *East Afr Med J*. (2003) 80:191–4. doi: 10.4314/eamj.v80i4.8640
77. Minas S, Ayele BH, Sisay M, Fage SG. Undernutrition among khat-chewer and non-chewer lactating women in chiro district, eastern Ethiopia: comparative cross-sectional study. *SAGE Open Med*. (2022) 10:20503121221100143. doi: 10.1177/20503121221100143
78. Mulaw GF, Mare KU, Anbesu EW. Nearly one-third of lactating mothers are suffering from undernutrition in pastoral community, Afar region, Ethiopia: community-based cross-sectional study. *PLoS One*. (2021) 16:e0254075. doi: 10.1371/journal.pone.0254075
79. Hechera Y, Dona A. Prevalence of undernutrition and its associated factors among lactating women in the Shebedino District, Sidama regional state, Ethiopia. *Inquiry: J Health Care Organization, Provision, and Financing*. (2022) 59:00469580221087883. doi: 10.1177/00469580221087883
80. Almar Derseh H, Zeleke LB, Endalifer ML, Muhammad EA, Derso T. Undernutrition and associated factors among lactating mothers in Dega Damot Woreda, Northwest Ethiopia. *J Nutrition Metabolism*. (2020) 2020:4627278. doi: 10.1155/2020/4627278
81. Wubetie BY, Mekonen TK. Undernutrition and associated factors among lactating mothers in rural Yilmana Densa District, Northwest Ethiopia: a community-based cross-sectional study. *Food Sci Nutr*. (2023) 11:1383–93. doi: 10.1002/fsn.3176
82. Berihun S, Kassa GM, Teshome M. Factors associated with underweight among lactating women in Womberma woreda, Northwest Ethiopia; a cross-sectional study. *BMC Nutr*. (2017) 3:1–7.
83. Gebre B, Biadgilign S, Taddese Z, Legesse T, Letebo M. Determinants of malnutrition among pregnant and lactating women under humanitarian setting in Ethiopia. *BMC Nutr*. (2018) 4:1–8. doi: 10.1186/s40795-018-0222-2
84. Teferu Z, Tekalegn Y, Sahiledengle B, Zembaba D, Desta F, Seyoum K, et al. Individual and community-level determinants of underweight among lactating mothers in Ethiopia: a multilevel analysis. *PLoS One*. (2022) 17:e0267821. doi: 10.1371/journal.pone.0267821
85. Ahmed R, Ejeta Chibsa S, Hussien MA, Bayisa K, Tefera Kefeni B, Gezimu W, et al. Undernutrition among exclusive breastfeeding mothers and its associated factors in Southwest Ethiopia: a community-based study. *Women Health*. (2024) 20:17455057241231478. doi: 10.1177/17455057241231478
86. Adugna A., Degu A., Predictors of underweight among lactating mothers in Dangila District, North West Ethiopia. (2021).
87. Abeya S, Biru K, Jima A. Factors associated with underweight among lactating mothers in Adama district, Oromia region, Ethiopia. *J Orthop Bone Res*. (2018) 1:101.
88. Getachew S, Belayneh F, Lejore E, Ayele A, Belayneh T. Malnutrition and associated factors among lactating women in Dale District, Sidama, Ethiopia. *J Health, Med Nurs*. (2023) 9:64–78. doi: 10.47604/jhmn.1989
89. Boke MM, Yesuf A, Gutema BT. Prevalence of undernutrition and associated factors among lactating mothers of Angecha District, Kembata Tembaro zone, southern Ethiopia. *J Nutrition Metabolism*. (2021) 2021:1–8. doi: 10.1155/2021/6691982
90. Sewalem M.A., Assessment of Nutritional Status and Associated Factors Among Lactating Mothers in Burie Town, North West Ethiopia. (2022).
91. Mengstie MA, Worke MD, Belay Y, Chekol Abebe E, Asmamaw Dejenie T, Abdu Seid M, et al. Undernutrition and associated factors among internally displaced lactating mothers in Sekota camps, northern Ethiopia: a cross-sectional study. *Front Nutr*. (2023) 10:1108233. doi: 10.3389/fnut.2023.1108233
92. Seid A, Cherie HA. Dietary diversity, nutritional status and associated factors among lactating mothers visiting government health facilities at Dessie town, Amhara region, Ethiopia. *PLoS One*. (2022) 17:e0263957. doi: 10.1371/journal.pone.0263957
93. Eramo A. Determinants of underweight among lactating mothers in Anlemo woreda, Hadiya Zone, Southern Ethiopia. Addis Ababa, Ethiopia: Addis Ababa University (2018).
94. Tariku Z, Tefera B, Samuel S, Derese T, Markos M, Dessu S, et al. Nutritional status and associated factors among lactating women in Dire Dawa. *Ethiopia J Obstet Gynaecol Res*. (2022) 48:1183–92. doi: 10.1111/jog.15198
95. Subandoro A.W., Holschneider S., Ruel-Bergeron J., Operationalizing multisectoral nutrition programs to accelerate progress: A nutrition governance perspective. World Bank Group (2021).
96. Namukose S, Maina GW, Kiwanuka SN, Makumbi FE. Effect of nutrition assessment, counselling and support integration on mother-infant nutritional status, practices and health in Tororo and Butaleja districts, Uganda: a comparative non-equivalent quasi-experimental study. *J Health Popul Nutr*. (2024) 43:84. doi: 10.1186/s41043-024-00559-7
97. Kimani-Murage EW, Griffiths PL, Wekesah FM, Wanjohi M, Muhia N, Muriuki P, et al. Effectiveness of home-based nutritional counselling and support on exclusive breastfeeding in urban poor settings in Nairobi: a cluster randomized controlled trial. *Glob Health*. (2017) 13:1–16. doi: 10.1186/s12992-017-0314-9
98. Kuma MN, Tamiru D, Belachew T. Effects of nutrition education and home gardening interventions on feto-maternal outcomes among pregnant women in Jimma zone, Southwest Ethiopia: a cluster randomized controlled trial. *PLoS One*. (2023) 18:e0288150. doi: 10.1371/journal.pone.0288150