

Factors Associated with Adolescent Undernutrition and Public Health Interventions to Address it in Sub-Saharan Africa: A Coping Review

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Master programme	Masters of Science in Public Health
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Research Questions	<ol style="list-style-type: none"> 1. What factors are associated with undernutrition in adolescent girls in Sub-Saharan Africa? 2. What are public health interventions to address undernutrition in adolescent girls in Sub-Saharan Africa?

Introduction

In the context of global malnutrition, the nutritional status of adolescent girls has gained significant attention due to its crucial role in human development¹. Adolescence, a vital phase marked by substantial physical and physiological changes, poses distinct challenges for girls, especially concerning undernutrition². Sub-Saharan Africa bears a significant burden of malnutrition, with 64 million children under the age of five experiencing stunting and 10 million facing wasting as of 2023, according to joint estimates from UNICEF, WHO, and the World Bank³. Additionally, in West, Central, Eastern, and Southern Africa combined, 24 million adolescent girls have been reported to have a height below 150cm, indicating pervasive undernutrition among this demographic⁴.

Undernutrition in adolescence results from inadequate food intake and a complex interplay of factors, leading to various health complications⁵. Micronutrient deficiencies, notably iron deficiency anaemia, are significant concerns in this demographic⁶. One of the numerous factors that contribute to this problem is early marriage⁷. To address these issues and achieve Sustainable

¹ WORLD HEALTH ORGANIZATION (2019) *UNITED NATIONS DECADE OF ACTION ON NUTRITION 2016-2025*.

² Philip, T.J., Stephanie, V.W., Natasha, L., Eilise, B., Bridget, F., Rachael, M. and Emily, M. (2022) *Women's nutrition: A summary of evidence, policy and practice including adolescent and maternal life stages*, Emergency Nutrition Network (ENN): Kidlington, Oxford, UK.

³ United Nations Children's Fund (UNICEF), W.H.O.W. and Bank, I.B.f.R.a.D.T.W. (2023) *Levels and trends in child malnutrition: UNICEF / WHO / World Bank Group Joint Child Malnutrition Estimates: Key findings of the 2023 edition*, New York: UNICEF and WHO.

⁴ United Nations Children's Fund (UNICEF). *Undernourished and Overlooked: A Global Nutrition Crisis in Adolescent Girls and Women*. UNICEF Child Nutrition Report Series, 2022, UNICEF, New York, 2023.

⁵ Yilma, B., Endris, B.S., Mengistu, Y.G., Sisay, B.G. and Gebreyesus, S.H. (2021) 'Inadequacy of nutrient intake among adolescent girls in south central Ethiopia', *J Nutr Sci*, 10, e90, available: <http://dx.doi.org/10.1017/jns.2021.62>.

⁶ Christian, P. and Emily (2018) 'Adolescent Undernutrition: Global Burden, Physiology, and Nutritional Risks', *Annals of Nutrition and Metabolism*, 72(4), 316-328, available: <http://dx.doi.org/10.1159/000488865>.

⁷ Development Initiatives (2018) *2018 Global Nutrition Report: Shining a light to spur action on nutrition*, Bristol, UK: Development Initiatives.

Development Goal 2.2, it is crucial to understand the multifaceted influences on undernutrition. The socio-ecological model, utilised by social scientists and public health professionals, categorises effects on human behaviour and health into four interconnected levels: individual characteristics (such as knowledge and attitudes), interpersonal relationships (within and beyond the family), community factors (including physical and social resources), and broader societal norms and policies⁸. Considering these multi-level influences, this study aims to comprehensively explore the factors contributing to undernutrition within this population, offering a holistic understanding essential for effective public health interventions.

Methodology

We employed a scoping review approach to map and synthesise literature on the topic, identifying key concepts and gaps⁹. We focused on research concerning undernutrition in adolescent girls aged 10 to 19 in sub-Saharan African countries.

Undernutrition encompassed various forms, specifically wasting, stunting and thinness (underweight). We used a broad range of search terms to identify articles for review, including nutritional status, undernutrition, and micronutrient deficiencies, because anthropometric measures for adolescents are not universally agreed.

Geographically, the research concentrated on Sub-Saharan African countries and applied strict language and publication criteria. The selected studies needed to be in English and published in peer-reviewed articles or reviews, while the scope was limited to peer-reviewed articles published between 2000 and 2023 to ensure the information remained current and from reliable sources.

Out of 4091 articles, 40 met these criteria, most included studies were from East and West African countries, and although the geographical distribution of studies varied, we found that Ethiopia (n = 27) accounted for almost 70% of the included studies. The remaining articles were distributed between Benin (n = 2), Ghana (n = 2), Mali (n = 2), Nigeria (n = 2) and Senegal (n = 2).

Results

1. Undernutrition and its various forms

The assessment of undernutrition and its various forms in adolescents involves multiple anthropometric indicators and reference standards. These measurements serve as vital tools in understanding the nutritional status of adolescents, although establishing globally applicable and consistent standards remains a challenge¹⁰.

Body Mass Index-for-age (BMI-for-age) is used to assess thinness and is calculated as weight in kilograms divided by height in meters squared; it is widely employed to evaluate thinness, overweight, and obesity in adolescents aged 10-19 years. In adolescents, the BMI-for-age is more appropriate than BMI alone. This is assessed by taking the BMI for the adolescent and looking at where that BMI fits within the range of BMIs for adolescents of the same age (in a reference population dataset). The cut-off for thinness is typically <-2 BMI-for-Age Z-scores. Other cut-offs using reference populations are also in use, and efforts are needed to harmonise measurement definitions¹¹. Mid-Upper Arm Circumference (MUAC) is another measure of thinness in

⁸ CDC 'About Violence Prevention', April 9 2024. Available at: https://www.cdc.gov/violence-prevention/about/?CDC_AAref_Val=https://www.cdc.gov/violenceprevention/about/social-ecologicalmodel.html

⁹ Daudt, H.M., Van Mossel, C. and Scott, S.J. (2013) 'Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework', *BMC Medical Research Methodology*, 13(1), 48, available: <http://dx.doi.org/10.1186/1471-2288-13-48>.

¹⁰ Natasha Lelijveld, P., Rukundo K Benedict, P., Stephanie V Wrottesley, P., Prof Zulfiqar A Bhutta, M., Elaine Borghi, P., Prof Tim J Cole, F., Trevor Croft, M., Prof Edward A Frongillo, P., Chika Hayashi, M., Sorrel Namaste, D., Deepika Sharma, M., Alison Tumilowicz, P., Prof Jonathan C Wells, P., Prof Majid Ezzati, F., Prof George C Patton, M. and Emily Mates, M. (2022) 'Towards standardised and valid anthropometric indicators of nutritional status in middle childhood and adolescence', *The Lancet*, available: [http://dx.doi.org/https://doi.org/10.1016/S2352-4642\(22\)00196-1](http://dx.doi.org/https://doi.org/10.1016/S2352-4642(22)00196-1).

¹¹ Ibid.

adolescents, with severe wasting often indicated by MUAC<16 cm¹². Weight-for-Height Z-score (WHZ) is also utilised, reflecting the relationship between a child's weight and height. Many, however, argue that both MUAC and WHZ should be adjusted for age in adolescents. Stunting or low height-for-age (<-2 Z-scores) is also used for adolescents but generally reflects cumulative malnutrition from the past that can no longer be addressed, meaning it is less useful than measures of thinness, which can be addressed¹³. Stunting assessment involves healthcare workers measuring a child's or adolescent's height and determining their age. Using a lookup table or growth chart, the Height-for-Age Z-scores (HAZ) are determined to classify individuals as non-stunted (HAZ ≥ -2), stunted (HAZ < -2), or severely stunted (HAZ < -3). This standardized approach helps identify stunting levels consistently based on height relative to age¹⁴. Other measures include iron deficiency anaemia (haemoglobin <120 g/ litre of blood); and other forms of non-iron related anaemia and micronutrient deficiencies, which employ different measures, depending on the deficiency involved¹⁵.

In the selected articles, various forms of undernutrition were explored, with stunting being the most frequently studied type, followed by thinness as measured by BMI-for-age (underweight). Other undernutrition types mentioned included iron deficiency anaemia, iron deficiency, micronutrient deficiency, and wasting. Seven articles specifically focused on general undernutrition (Table 1).

Undernutrition/Types of undernutrition	Number of articles
Stunting	20
Thinness (Underweight)	17
Anemia/iron deficiency anemia	10
General undernutrition	7
Iron deficiency	3
Micronutrient deficiency	2
Wasting	2

Table 1: Types of Undernutrition in Adolescent Girls in Sub-Saharan Africa.

2. Factors associated with adolescent girls' undernutrition.

Across all the levels of the socioecological model, the factors most frequently cited by authors as associated with undernutrition predominantly revolve around diet and dietary behaviours. Conversely, the least discussed factors include adolescent employment status, marital status, and elements related to the food and agricultural system.

At the individual level, diet and dietary behaviour factors and age stand out as the 2 most significant factors. At the relationship level, aspects such as family size, family structure, food security, peer pressure, parents' employment status, and income emerge with the highest number of mentions in the literature.

At the community level, factors like water source and residence are the most frequently highlighted, underscoring their crucial roles in understanding undernutrition dynamics within communities. At the societal level, health services and medical care emerge

¹² WHO (2011) 'Integrated Management of Adolescent and Adult Illness district clinician manual: Hospital care for adolescents and adults – Guidelines for the management of illnesses with limited resources'.

¹³ Natasha Lelijveld, P., Rukundo K Benedict, P., Stephanie V Wrottesley, P., Prof Zulfiqar A Bhutta, M., Elaine Borghi, P., Prof Tim J Cole, F., Trevor Croft, M., Prof Edward A Frongillo, P., Chika Hayashi, M., Sorrel Namaste, D., Deepika Sharma, M., Alison Tumilowicz, P., Prof Jonathan C Wells, P., Prof Majid Ezzati, F., Prof George C Patton, M. and Emily Mates, M. (2022) 'Towards standardised and valid anthropometric indicators of nutritional status in middle childhood and adolescence', *The Lancet*, available: [http://dx.doi.org/https://doi.org/10.1016/S2352-4642\(22\)00196-1](http://dx.doi.org/https://doi.org/10.1016/S2352-4642(22)00196-1).

¹⁴ Chanyarungrojn, P.A., Lelijveld, N., Crampin, A., Nkhwazi, L., Geis, S., Nyirenda, M. and Kerac, M. (2023) 'Tools for assessing child and adolescent stunting: Lookup tables, growth charts and a novel appropriate-technology "MEIRU" wallchart - a diagnostic accuracy study', *PLOS Glob Public Health*, 3(7), e0001592, available: <http://dx.doi.org/10.1371/journal.pgph.0001592>.

¹⁵ WHO *Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System*, Geneva, World Health Organization, 2011(WHO/NMH/NHD/MNM/11.1), available: <http://www.who.int/vmnis/indicators/haemoglobin> [accessed].

as the key factors receiving substantial attention from researchers, indicating their broader implications in the context of undernourishment studies (Table 2).

Level	Sub-level factors	Numbers of articles
Individual	Diet and dietary behaviour	22
	Age	18
	Health status	9
	Educational status	7
	Household chores and time constraints	7
	Beliefs and religion	5
	Awareness of nutrition	3
	Employment status	2
Relationship	Adolescent girls' marital status	2
	Family size, structure, food security and Peer pressure	17
	Parents' employment status and Income (socio-economic status)	15
Community	Parent's educational level	5
	Water Source and Residence	13
Societal	Media exposure and Community awareness	6
	Health services and medical care	6
	Food and Agricultural System	2

Table 2: As reported by articles reviewed, factors associated with adolescent girls' undernutrition in sub-Saharan Africa.

1. Interventions related to undernutrition and its various forms.

Among the body of articles we examined, interventions related to undernutrition and its various forms were mentioned in a total of five of the articles. The identified interventions encompassed a spectrum of approaches, including targeted supplementation, food fortification, educational initiatives, and integrated programmes (Table 3). Among the five studies testing these interventions, four showed statistically significant improvements. The fifth study did not directly report significance but referenced similar studies that achieved positive outcomes with these interventions.

Intervention type	Specific intervention	Location	Study design	Outcomes measured
Nutrition education ¹⁶	(Triple benefit) health education intervention package on knowledge, attitude, and food security to reduce malnutrition in adolescent girls.	Nigeria	Quantitative cluster randomized controlled trial (209 intervention group/ 209 control group).	The study shows that there is a noticeable and statistically significant difference in knowledge, attitude, and food security between the experimental and control groups at both three and six months after the intervention.

¹⁶ Shapu, R.C., Ismail, S., Lim, P.Y., Ahmad, N., Garba, H. and Njodi, I.A. (2022) 'Effectiveness of Triple Benefit Health Education Intervention on Knowledge, Attitude and Food Security towards Malnutrition among Adolescent Girls in Borno State, Nigeria', *Foods*, 11(1), 20, available: <http://dx.doi.org/doi:10.3390/foods11010130>.

Micronutrient supplementation ¹⁷	Community-based weekly iron-folic acid supplementation (WIFAS) on serum ferritin, serum folate, and haemoglobin concentration to address Iron Deficiency Anemia in young girls.	Ethiopia	Quantitative Randomized-controlled trial (113 intervention group/113 control group).	In the intervention group, Hb, SF, and SFol levels increased significantly, while the control group showed no such changes. After a three-month weekly iron-folic acid supplementation, iron stores decreased, and more adolescents in the intervention group had elevated SF levels compared to the control group. Adjusting for confounding factors, the intervention group showed improvements in serum folate, serum ferritin, and haemoglobin levels compared to the control group.
Food fortification ¹⁸	Adolescent girls received multiple-micronutrient-fortified biscuits (MMBs) fortified with 11 vitamins (vitamins B-1, B-2, B-6, B-12, A, D, K-1, and E and niacin, folate, and ascorbic acid) and 7 minerals (zinc, calcium, iron, copper, iodine, selenium, and magnesium).	Ghana	Mixed method: Qualitative cross-sectional survey (interviews and Focus groups) and Quantitative Randomized placebo-controlled trial (310 intervention group/310 control group).	The study suggested that girls, both before and after their first menstrual period, might experience better health outcomes, including improved blood iron levels, cognitive function, height, and overall well-being, if certain factors like plasma ferritin and retinol-binding protein are increased.
Nutrition education ¹⁹	In-school nutrition education program on pulses, also called grain legumes: pulses (sources of zinc and iron) + cereals =complete protein food	Ethiopia	Quantitative quasi-experimental (66 intervention group/66 control group).	Pulse-based nutrition education significantly improved knowledge, attitude, and practice scores in the intervention group. Prevalence of underweight (BMI-for-age) decreased from 13.6% to 3%.
Nutrition education + Dietary modification ²⁰	A combined nutrition education program and diet modifications to treat Iron Deficiency Anemia in a boarding school in southern Benin.	Benin	Quantitative quasi-experimental (34 intervention group/34 control group).	Post-intervention, the intervention group showed higher hemoglobin and serum ferritin levels, lower incidence of Iron Deficiency Anemia (IDA), and greater nutrition knowledge scores than the control group.

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¹⁷ iso, Y.H., Belachew, T., Abuye, C., Workicho, A. and Baye, K. (2021) 'A community-based randomized controlled trial providing weekly iron-folic acid supplementation increased serum- ferritin, -folate and hemoglobin concentration of adolescent girls in southern Ethiopia', *Sci Rep*, 11(1), 9646, available: <http://dx.doi.org/doi:10.1038/s41598-021-89115-5>.

¹⁸ Azupogo, F., Abizari, A.R., Osendarp, S.J.M., Feskens, E.J. and Brouwer, I.D. (2021) 'TenTwenty-Ghana: Study Design and Methods for an Innovative Randomized Controlled Trial with Multiple-Micronutrient-Fortified Biscuits among Adolescent Girls in Northeastern Ghana', *Current Developments in Nutrition*, 5(2), 20, available: <http://dx.doi.org/doi:10.1093/cdn/nzaa184>.

¹⁹ Dansa, R., Reta, F., Muluaem, D., Henry, C.J. and Whiting, S.J. (2019) 'A Nutrition Education Intervention to Increase Consumption of Pulses Showed Improved Nutritional Status of Adolescent Girls in Halaba Special District, Southern Ethiopia', *Ecol Food Nutr*, 58(4), 353-365, available: <http://dx.doi.org/doi:10.1080/03670244.2019.1602042>.

²⁰ Alaofé, H., Zee, J., Dossa, R. and O'Brien, H.T. (2009) 'Effect of a nutrition education program and diet modification in Beninese adolescent girls suffering from mild iron deficiency anemia', *ibid*.48(1), 21-38, available: <http://dx.doi.org/doi:10.1080/03670240802293675>.

Discussion

Based on the factors that the reviewed studies report to be associated with adolescent undernutrition, a modified socioecological model was created, as presented in Figure 1.

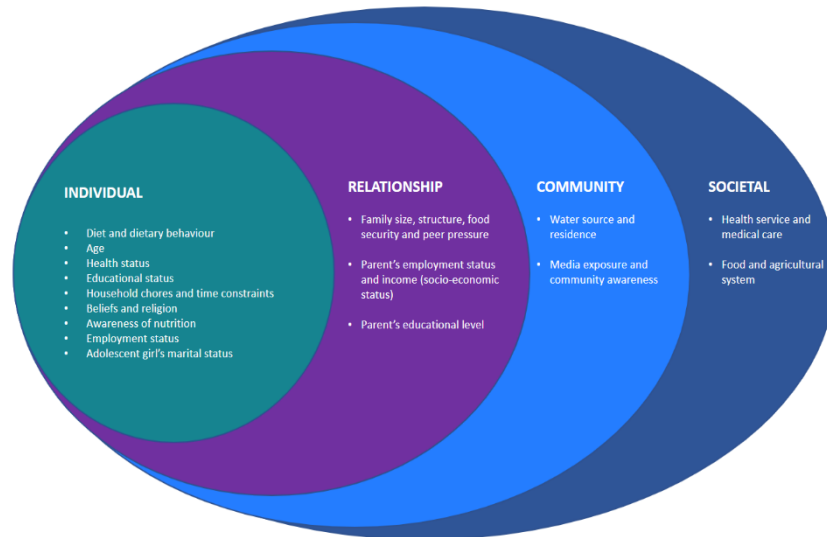


Figure 1: Socio-ecological model of undernutrition among adolescent girls in sub-Saharan Africa

Key observations on factors influencing adolescent nutrition

- Studies have had a strong focus on individual dietary behaviour factors and less on broader societal factors. There is a need for a more balanced approach; effective interventions must address individual dietary choices and family dynamics and consider systemic factors such as healthcare accessibility and food system dynamics.
- The prevalence of articles concentrating on parental education, employment, and income underscores the robust exploration of socio-economic factors. However, it is essential to note that socio-economic considerations often intersect with broader societal factors. This overlap highlights the intricate exchange between individual and societal elements, necessitating an integrated approach to address undernutrition comprehensively. For example, in a country with a strong patriarchal culture like Ethiopia, it has been observed that teenage girls from households experiencing food insecurity are more vulnerable to undernutrition and face unfair treatment based on their gender. This is especially true when there is insufficient food to feed the entire family due to unfavourable economic conditions²¹. Addressing these disparities, perhaps through targeted educational and economic empowerment programs, could be key to improving adolescent nutrition outcomes.
- Understanding local beliefs and traditions is vital for designing culturally sensitive and effective programs, as emphasized by numerous articles that delved into the topics of beliefs, religion, and cultural taboos. This substantial exploration indicates a significant consideration of cultural and social dimensions within the scope of undernutrition interventions.

Conclusion

The study maps a complex web of factors from the published literature associated with undernutrition in adolescent girls, spanning individual, relational, community, and societal levels. Improving nutrition among adolescent girls requires comprehensive strategies designed to address these diverse factors.

²¹ Hadley, C., Lindstrom, D., Tessema, F. and Belachew, T. (2008) 'Gender bias in the food insecurity experience of Ethiopian adolescents', *Soc Sci Med*, 66(2), 427-38, available: <http://dx.doi.org/10.1016/j.socscimed.2007.08.025>.

Future studies on adolescent growth and nutrition should adopt integrated, system-wide approaches, transcending a singular focus on physiological systems. Interventions need to be adaptive, considering the unique needs, preferences, and socio-economic, relational, and cultural context of adolescents to tailor effective strategies addressing undernutrition and promoting positive health outcomes during this distinct life stage. Additional research is essential for a comprehensive understanding of factors influencing undernutrition in sub-Saharan African adolescent girls and evaluating the appropriateness and effectiveness of interventions in these understudied areas²².

²² Salam, R.A., Hooda, M., Das, J.K., Arshad, A., Lassi, Z.S., Middleton, P. and Bhutta, Z.A. (2016) 'Interventions to Improve Adolescent Nutrition: A Systematic Review and Meta-Analysis', *J Adolesc Health*, 59(4S), S29-S39, available: <http://dx.doi.org/10.1016/j.jadohealth.2016.06.022>.

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