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Undernutrition and its determinants among Ethiopian adolescent girls: A protocol for systematic review and meta-analysis.

Wubet Worku Takele¹, Achenef Asmamaw Muche², Zeleke Abebaw Mekonnen³, Yehualashet Fikadu Ambaw⁴, and Fasil Wagnew⁵

¹Department of Community Health Nursing, School of Nursing, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia
Email: wubetakele380@gmail.com

²Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia
Email: ashua2014@gmail.com

³Department of Health informatics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia
Email: Zelekeabebaw7@gmail.com

⁴Department of compressive Nursing, School of Nursing, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia
Email: fekaduambaw14@gmail.com

⁵Department of Nursing, College of Medicine and Health Sciences, Debre Markos University, Debre Markos, Ethiopia
Email: fasilw.n@gmail.com

Corresponding author: wubetakele380@gmail.com

¹Department of Community Health Nursing, School of Nursing College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia.

Abstract

The sequelae of undernutrition on adolescent girls are not only limited to them, it's rather a great threat to the health of their upcoming children. Ethiopia, however, the national pooled prevalence and determinant factors of undernutrition among adolescent girls are not known. Hence, we will aim to determine the pooled prevalence and determinants of undernutrition through a systematic review and meta-analysis of the results of the existing primary studies.

Method: Published articles will be searched through databases (Medline, and PubMed). Electronics searching engines such as Google Scholar and Google will be used. To identify qualified eligible studies, the Joana Brig's Institute (JBI) quality appraisal checklists will be used. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist will be followed to maintain the scientific rigorous of the study. The presence of heterogeneity will be examined through forest plot as well as I^2 heterogeneity test. To identify the influential studies, sensitivity analysis will be done. The Dersimonian and Laird random effect model will be used provided that substantial heterogeneity will be noted. Subgroup analysis by region, study year, and will be conducted. Publication bias will be examined through observing the funnel plot as well as objectively by Egger's regression test. If Egger's test found to be statistically significant (p -value <0.05 , trim and fill (Duval and Tweedie's) analysis will performed. Presence of statistical association among variable will be declared using P -value of <0.05 and effect sizes with corresponding of 95% CI.

Ethics and Dissemination: Since this is a systematic review and meta-analysis, ethical clearance will not be a concern. The results of the study will be published in a reputable peer-reviewed journal and presented at scientific research conferences.

Systematic review registration: This protocol has been registered at the international prospective register of Systematic Review and meta-analysis. The registration number is CRD42018106180.

Introduction

According to the World Health Organization (WHO), adolescent is defined as the age group of 10-19 years[1]. This segment of the populations are neither small children nor young adults which occupies the second most critical stages of rapid physical growth in human life which exposes to undernutrition following high nutritional requirement[2]. Similarly, many macro and micronutrients are demanded associated with onset of maturity, menstruation, change in body size, and participating in various sport activities[3, 4]. Throughout this period adolescents have to acquire the necessary nutrients needed to attain about 15%-25% of their final adult height[5], 45% of increments in bone mass, and precisely, a half of adult's weight [6]. In Ethiopia, children and adolescent together accounts for nearly a half (48%) of Ethiopian population, of which about a quarter are girls[7].

In developing countries, though the issue of undernutrition is not as severe as young infants and children, it is also a major public health problem among adolescents which interferes the completion of normal growth and development [8-10]. This problem gradually exposes to poor schooling performance[11], delayed menstruation and puberty [8, 12], limits work at maximum productivity[13]. In addition, it arrests the healthy growth and development of the prospective children linked with intergenerational cycle [14] and increases the risk of developing obesity[15]. Making free of adolescent girls from protein-energy malnutrition prevents anemia and giving birth to low birth weight babies[16]. Furthermore, undernutrition weakens the immunity and make them vulnerable to tremendous infectious diseases as well as prolongs the recovery time from illness [17, 18].

Even though progressive economic growth has been observed in developing countries, malnutrition and particularly undernutrition is still a public health challenge affecting a lot of adolescents[19, 20]. In these countries, the magnitude of undernutrition is reported as a threat for the future generation. For instance, in Asia stunting estimated to be between 28.5% and 50.3%[21-23], and thinness it is found to be between 32% and 55%[21, 22]. In Africa, undernutrition was ranged between 10%-57.8%[24, 25] In particular of Ethiopia, according to a report made by United Nation International Children's

Emergency Fund (UNICEF), about a third (33%) of adolescent girls are underweight [26]. Another multiple local studies have also showed that undernutrition is ranged 21.6%-58.3% [19, 27, 28].

Plenty of previous original studies have greatly shown that multiple factors affecting undernutrition. Accordingly, the likelihood of undernutrition was increased among adolescent girls living in a rural area[27], having family members of greater than five, consuming of impure water, meal frequency of fewer than 3 times in a day[29], consuming poorly diversified diet, living in food-insecure households[30], and poor household income[31].

Ethiopia has been devising many efforts to combat the burden of undermatron by targeting of the most vulnerable population (children, pregnant women, adolescents) through designing of National Nutrition Program (NNP), 1000 days, and other healthcare strategies which could improve the nutritional status of the population.

Even though multiple original studies done in various parts of Ethiopia pointed out the prevalence as well as determinant factors of undernutrition, those findings are reported inconclusive way. Therefore, this study is aimed to determine the pooled prevalence and associated factors of undernutrition among Ethiopian adolescent girls. Understanding the national pooled estimate and predictors of undernutrition could enable nutritionists, policy makers, and nutrition programmers to evaluate the existing strategies. Furthermore, it may help to establish new national as well as site-specific nutrition and healthcare projects to break the intergenerational cycle which might help to end undernutrition.

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Objectives

General Objective: To systematically collect and summarize the available evidence on the pooled prevalence of undernutrition and its determinants among adolescent girls in Ethiopia.

Specific objectives

- ✓ To review and estimate the pooled prevalence of undernutrition (stunting, and wasting) among adolescent girls in Ethiopia.
- ✓ To review and determine the pooled effect sizes of the determinants of undernutrition (stunting, and wasting) among adolescent girls in Ethiopia.

Methods

Protocol registration and review reporting

This systematic review and meta-analysis have been registered at the international prospective register of Systematic Review and meta-analysis (PROSPERO) with the registration number CRD42018106180. This review protocol was prepared based on the recommended guideline for PRISMA-P, 2015[32]. While reporting of the method, and findings of the study, authors will strictly adhere to the PRISMA checklist along with the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) [33, 34] which will greatly aid to keep the scientific rigorous of the study. Primary studies will be qualitatively described in terms of prevalence, study setting, sample size, and other relevant characteristics. The procedure of screening and selection of eligible studies will be presented using PRISMA flow diagram. The results of the meta-analysis of the study will be illustrated through figures and texts.

Information source and search strategy

Initially, databases were searched for same systematic review to avoid duplications. The website (<http://www.library.UCSF.edu>) and Cochrane/Wiley library explored to confirm whether previous systematic review or meta-analysis exists.

To access published primary studies, PubMed/MEDLINE, Scopus, HINARI, and other databases sources will be used. Grey literature were searched using Google and Google Scholar. In addition, reference lists of relevant studies were identified and the full-text articles reviewed for inclusion. During the searching process to decrease the irrelevant studies, searching will be restricted to only “human studies” and “English language” in the advanced search. Corresponding authors will be contacted via mail or other means of communication for articles with difficulty of accessing full-texts. The key search terms that we will be used are: “nutritional status”, “undernutrition”, “stunting”, “wasting” “malnutrition” “determinant factors”, “associated factors”, “school girls”,

“adolescent girls”, and “Ethiopia”. These all terms will be searched in advance search of databases through “MeSH terms” and “All fields” by linking “AND” and “OR” Boolean operator terms as appropriate. The searching activity will be done by (WWT, AAM, and FYA) and the processes of searching will be completed by September, 28/2018.

Eligibility criteria

Inclusion criteria

- All observational studies, including cross-sectional, analytical cross-sectional, case-control, and cohort studies will be considered.
- All articles published only in the English language will be enrolled.
- As long as articles done in Ethiopia and reporting the prevalence as well as associated factors of all forms of undernutrition (stunting and wasting), they will be included without time restriction.

Exclusion criteria

- Studies conducted among the special population as studies done among adolescents living with HIV/AIDs, tuberculosis (TB), and mental disorder will be excluded.
- Despite contacting of the corresponding author(s), articles with the absence of full -text and difficulty of extracting data will be excluded.
- Studies done in Healthcare facilities will be excluded.
- Studies with methodological limitations like very small sample size, poor recording of cross-tabulation results of the factors, and other problems will be excluded.

Study screening and selection processes

First of all, all articles accessed from databases and electronics search engines will be exported to endnote version 6 and duplication will be identified and removed. Secondly, the remaining articles will be evaluated in the context of the topic, the study participants,

language and study area. Thirdly, irrelevant topics, studies conducted out of Ethiopia, and articles documented other than the English language will be rejected. Finally, abstracts and full text of the remaining studies will be reviewed. Nevertheless, if the article's full-text will not be accessed they will be excluded.

Risk of bias and quality assessment

Using the standardized Joanna Briggs Institute (JBI) critical appraisal checklists prepared for cohort studies, case-control, cross-sectional^[35] and analytical cross-sectional studies, the quality of article's will be assessed^[36]. The quality assessment will be done by three independent reviewers (WW, FW, and ZA). Any scoring disagreements happened between the assessors, a thorough evaluation of the sources of the discrepancy will be assessed and agreed accordingly. Persistent disagreement despite a detailed review, the average of those reviewers will be taken. After transforming the scores into a percentage, only studies scored $\geq 50\%$ will be considered for the systematic review and meta-analysis of the prevalence. For risk factors, each predictor in accordance with each outcome variables will be critically appraised and included into the review. Moreover, all original studies quality results will be placed in the separate column of the data extraction format.

Data collection process

Once the eligible studies are identified, two independent reviewers (AA, and ZA) will take part in the extraction of relevant data by using a prepared format on the Microsoft Excel spreadsheet. The variables which will be extracted are; Author(s) name, sample size, response rate, the year of the study done, publication year, a region where the study was conducted, the age group of the study participants(if applicable), religion, and other parameters. For prevalence studies, the prevalence, logarithm of prevalence, standard error of logarithm of the prevalence will be computed. For predictors, relevant explanatory variables of the odds ratio, logarithms of the odds ratio, and the standard error of the logarithms of odds ratio will be calculated. For any difficulties encountered

during data extraction, corresponding authors will be contacted by any means of communication.

Outcome variable

According to the WHO, stunting and wasting are defined as height-for-age, BMI-for-age, and weight-for-age of below -2 standard deviation, respectively[37, 38].

Data analysis and assessment of publication bias

Extracted data will be exported to STATA/SE version 14 (STATA Corporation, College Station, Texas, USA) for further analysis. The existence of heterogeneity among studies will be examined through the forest plot as well as I^2 heterogeneity test[39]. I^2 values of 25%, 50%, and 75% will be interpreted as presence of low, medium, and high heterogeneity, orderly. I^2 heterogeneity test of $\geq 50\%$ and P-value of <0.05 will be declared as the assistance of heterogeneity among studies. Thus, the Dersimonian laired random effect model will be employed[40]. To identify the methodological, sample size and other influences of the studies, using the “metaninf” command, sensitivity analysis will be carried out[41]. Accordingly, for extreme outlier studies, after reviewing of the extracted data, either articles will be excluded or other necessary measures will be taken. Subgroup analysis will be employed based on region, and year of study. Publication bias will be detected by inspecting of the symmetry of the funnel plot using “metafunnel” command [42], and objectively through Egger’s regression test using “metabias” command[43]. Asymmetry of the funnel plot or statistical significance of Egger’s regression test (p-value <0.05) will be a suggestive existence of publication bias. Therefore, using “metatrim” command, a nonparametric trim and fill (Duval and Tweedie’s) method of analysis will be done and the result will be reported accordingly[44]. Using the Laired random effect model, the pooled prevalence of stunting, wasting, and underweight will be reported separately. The presence of association between the explanatory and the outcome (stunting, wasting, and

underweight) variables will be estimated based on the effect size. Furthermore, all statistical interpretation will be reported based on 95% CI.

Discussion

Adolescent girls are the most liable population to undernutrition associated with highest macro and micronutrient requirements. They are the prospective mothers of children in that scholars, nutrition programmers and other concerned bodies shall to turn their face towards them. Despite these established facts, they are the most ignored population. The deleterious effects of undernutrition are numerous as it leads to poor educational achievement, adverse pregnancy outcomes, morbidity, and delayed first menstruation. In Ethiopia, most adolescent girls are victimized of both acute and chronic forms of undernutrition with prevalence ranging from 21.6% [19] to 58%[28]. Which implies a deep-rooted problem which could jeopardizes the health of many adolescents and darkening the quality of the health of their prospective children and making the problem to be the concern of next generation. Designing a wide-ranging of nutritional strategies and promoting of health care services are greatly required to terminate undernutrition. To do so, generating national prevalence and risk factors supported by concert evidence is quite essential. Therefore, authors presumed that, this systematic review and meta-analysis will provide a conclusive finding using a comprehensive systematic and meta-analysis approach.

Strength and limitation of this study

- The scientific rigorous of the study will be maintained by strictly following the standardized reporting checklist of the PRISMA.
- The cortical appraisal will be performed by three reviewers

- Presence of substantial heterogeneity (in terms of the region where studies are done, year of the, and another parameter discrepancy) among individual studies which will make the difficulty of pooling results will be a threat for this study.
- Only articles published in the English language will be considered

Amendments

As long as the authors strongly believe that some amendments are necessary, modifications will be made and the detail of amendments including the reasons of modification and the date of amendment done will be clearly announced.

Abbreviations

EDHS	Ethiopian Demographic Health Survey
JBI	Joana Brig's Institute
NNP	National Nutrition Program
WHO	World Health Organization

Declaration

Acknowledgment

The authors are would like to acknowledge the University of Gondar librarians.

Ethics approval and consent to participate

Not applicable

Competing of interest

The authors have declared that no any competing interest

Consent for publication

Not applicable

Funding

Not any funding received for this work

Availability of Data and materials

Not applicable since it is protocol

Authors' contribution

WWT and YFA: Conceived the research idea, write the methodology and introduction.

WWT, ZAM, and AAM: Prepared the protocol.

WWT, AAM, and FW: Doing on the searching process

WWT, ZAM, and FW: Appraise the quality of the studies, extract the data, and analyze the data.

All authors have reviewed and approved the protocol for publication.

¹WWT is a Lecturer, Department of Community Health Nursing, College of Medicine and Health Sciences at the University of Gondar, Ethiopia. WW has a Bachelor of Science Degree in Nursing and Master's Degree in Public Health Human Nutrition.

²AAM is a Lecturer, Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences at the University of Gondar. AAM has Bachelor of Science Degree in Nursing, and Master's Degree in Epidemiology and Biostatistics

³ZAM is a Lecturer, Department of Health informatics, Institute of Public Health, College of Medicine and Health Sciences at Debre markose University, FW has Bachelor of Science Degree in Nursing, MSc in Pediatrics and Child Health Nursing.

⁴YFA is a Lecturer, Department of comprehensive nursing, School of Nursing, College of Medicine and Health Sciences at the University of Gondar, Ethiopia. YFA has Bachelor of Science Degree in Nursing and Master's in general public Health.

⁵FW is a Lecturer, Department, Department of Nursing, College of Medicine and Health Sciences at Debre markose University, FW has Bachelor of Science Degree in Nursing, MSc in Pediatrics and Child Health Nursing.

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PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item
ADMINISTRATIVE INFORMATION		
Title:		
Identification	1a	Identify the report as a protocol of a systematic review
Update	1b	If the protocol is for an update of a previous systematic review, identify as such
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number
Authors:		
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments
Support:		
Sources	5a	Indicate sources of financial or other support for the review
Sponsor	5b	Provide name for the review funder and/or sponsor
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol
INTRODUCTION		
Rationale	6	Describe the rationale for the review in the context of what is already known
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)
METHODS		
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review
Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated
Study records:		
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review

Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2 , Kendall's τ)
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)

*** It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

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**Undernutrition and its determinants among Ethiopian adolescent girls:
A protocol for systematic review and meta-analysis.**

Wubet Worku Takele¹, Achenef Asmamaw Muche², Zeleke Abebaw Mekonnen³, Yehualashet Fikadu Ambaw⁴, and Fasil Wagnew⁵

¹Department of Community Health Nursing, School of Nursing, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia
Email: wubetakele380@gmail.com

²Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia
Email: ashua2014@gmail.com

³Department of Health informatics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia
Email: Zelekeabebaw7@gmail.com

⁴Department of compressive Nursing, School of Nursing, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia
Email: fekaduambaw14@gmail.com

⁵Department of Nursing, College of Medicine and Health Sciences, Debre Markos University, Debre Markos, Ethiopia
Email: fasilw.n@gmail.com

Corresponding author: wubetakele380@gmail.com

¹Department of Community Health Nursing, School of Nursing College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia.

Abstract

The sequelae of undernutrition on adolescent girls are not only limited to them, rather they are a great threat to the health of their upcoming offspring. In Ethiopia, however, the national pooled prevalence and determinants of undernutrition among adolescent girls are not known. Therefore, we have aimed to determine the pooled prevalence and determinants of undernutrition among adolescent girls in Ethiopia.

Method: Published articles will be searched through databases, such as Medline and PubMed. Electronics search engines, like Google Scholar and Google will be used. To identify the eligible studies, the Joana Brig's Institute (JBI) quality appraisal checklists prepared for different study designs will be used. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist will be used to maintain the scientific robustness of the study. The presence of heterogeneity among studies will be examined by forest plot as well as I^2 heterogeneity test. Potential causes of heterogeneity will be explored by carrying out sensitivity and sub-group analyses. The Dersimonian and Laird random-effects model will be used provided that substantial heterogeneity is observed. Publication bias will be examined by observing funnel plots as well as objectively by Egger's regression test. If the funnel plot is asymmetric and/or Egger's test found to be statistically significant (p -value <0.05), the trim and fill (Duval and Tweedie's) analysis will be performed. Presence of statistical association between dependent and independent variables will be declared if p -value is < 0.05 with the 95% CI.

Ethics and Dissemination: Since this is a systematic review and meta-analysis, ethical clearance will not be a concern. The results of the study will be published in a reputable peer-reviewed journal and presented at different scientific research conferences.

Systematic review registration: This protocol has been registered at the international prospective register of Systematic Review and meta-analysis. The registration number is CRD-42018106180.

Introduction

According to the World Health Organization (WHO), the adolescent is defined as the age group of 10-19 years [1]. This segment of the population is neither young children nor young adults, which occupies the second most critical stage in human life [2]. In this stage, many macro and micronutrients are highly demanded associated with the onset of maturity, menstruation, and participating in various sports activities [3, 4]. Likewise, this is the period in which some important body dimensions are increased; for instance, about 15%-25% of their final adult stature [5], 45% of increments in bone mass, and half of the adult's weight [6]. In Ethiopia, children and adolescents together account for nearly half (48%) of the Ethiopian population, of which about a quarter are girls [7].

In developing countries, though the burden of undernutrition among adolescents is not considered as severe as young infants and children, nowadays, it's becoming a major public health problem among adolescents which interferes the completion of normal growth and development [8-10]. This problem gradually exposes them to poor schooling performance [11], delayed menstruation [8, 12], and limits work at maximum productivity [13]. In addition, in the one hand, undernutrition at this age would result in growth and development failure to their prospective children owing to the nature of its intergenerational cycle [14]. On the other hand, it increases the risk of developing overnutrition [15]. Making free of adolescent girls from Protein-Energy Malnutrition (PEM) prevents anemia and giving birth to low birth weight babies [16]. Furthermore, undernutrition weakens the immunity, thereby it increases susceptibility to infection and also prolongs the recovery time from illness [17, 18].

Even though progressive economic growth has been observed in developing countries, undernutrition is still a public health challenge affecting lots of adolescents [19, 20]. In these countries, the magnitude of undernutrition is reported in a problematic manner. For instance, in Asia stunting estimated to be between 28.5% and 50.3% [21-23], and thinness it's amounted to be between 32% and 55% [21, 22]. In Africa, it's ranged from 10% to 57.8% [24, 25] in particular of Ethiopia, according to a report revealed by the United Nation International Children's Emergency Fund (UNICEF), about a third (33%) of

adolescent girls are underweighted [26]. Likewise, local studies have also shown that undernutrition is ranged from 21.6% to 58.3% [19, 27, 28].

Plenty of previous primary studies have largely shown that undernutrition attributed to multiple factors. The likelihood of developing undernutrition is increased among adolescent girls who are living in a rural area [27], having family size of greater than five, consumed impure water, ate food fewer than 3 times per day [29], consuming poorly diversified diet, living in food-insecure households [30], and poor household income [31].

Systematic review and meta-analysis believed to reveal a concert evidence in which the findings initiate policymakers and nutrition programmers to design and implement a well-compressive nutritional intervention to mitigate the burden of undernutrition among Ethiopian adolescent girls. Even though multiple primary studies have done in various parts of Ethiopia that pointed out the prevalence, as well as factors of undernutrition, those findings are reported in an inconclusive way. Therefore, this study is aimed to determine the pooled prevalence and associated factors of undernutrition among Ethiopian adolescent girls using a compressive strategy of systematic review and meta-analysis.

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3 **Objectives**

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6 **General Objective:** To systematically collect, review and summarize the available

7 evidence on the prevalence and determinants of undernutrition among adolescent girls in

8 Ethiopia, 2018.

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12 **Specific objectives**

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- 15 ✓ To review and estimate the pooled prevalence of undernutrition
- 16 (underweight/wasting) among adolescent girls in Ethiopia, 2018.
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- 18 ✓ To review and determine the pooled effect sizes of the determinants of
- 19 undernutrition (stunting and underweight/wasting) among Ethiopian adolescent
- 20 girls, 2018.
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Methods

Protocol registration and review reporting

This systematic review and meta-analysis have been registered at the international prospective register of Systematic Review and meta-analysis (PROSPERO) with the registration number of CRD42018106180. This review protocol was prepared based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA-P), 2015 [32]. While reporting the method and findings of the study, authors will strictly adhere to the PRISMA checklist and the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) [33, 34], which will largely aid to keep the scientific robustness of the study. Primary studies will be qualitatively described in terms of the prevalence, study setting, sample size, and other relevant characteristics. The procedures of screening and selection of eligible studies will be presented using the PRISMA flow diagram. The results of the meta-analysis of the study will be illustrated through figures and texts.

Information source and search strategy

Initially, databases were searched for the same systematic review to avoid duplications. The website (<http://www.library.UCSF.edu>) and Cochrane/Wiley library explored to confirm whether previous systematic review or meta-analysis exists.

To access published primary studies, PubMed, MEDLINE, Scopus, and HINARI database sources will be used. Grey literature will be searched using Google and Google Scholar. In addition, reference lists of the retrieved studies will be probed to access articles that are not retrieved through databases as well as electronics search engines.

During the searching process to suppress the number of irrelevant studies, searching will be restricted to only “human studies” and “English language” in the advanced search. Corresponding author(s) will be contacted via mail or other means of communication for the article(s) with hard to access the full-texts. The key search terms that we will use are: “nutritional status”, “undernutrition”, “stunting”, “wasting” “malnutrition” “determinants”, “associated factors*”, “school girls”, “adolescent girls”, and “Ethiopia”. In the advanced

searching databases, the searching strategy will be built based on the above-mentioned terms using the “Medical Subject Headings (MeSH)” and “All fields” by linking “AND” and “OR” Boolean operator terms as appropriate. The searching activity will be done by (WWT, AAM, and FYA) and the whole process is expected to be completed by September, 28/2018.

Eligibility criteria

Inclusion criteria

- All observational studies, including cross-sectional, analytical cross-sectional, case-control, and cohort studies will be considered.
- All articles published only in the English language will be enrolled.
- As long as articles done in Ethiopia and reporting the prevalence as well as associated factors of all forms of undernutrition (stunting and underweight/wasting), they will be included without time restriction.

Exclusion criteria

Studies with one of the following criteria listed below will be excluded:

- Studies conducted among the special population as studies done among adolescents living with Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDs), Tuberculosis (TB), and mental disorder.
- Despite contacting the corresponding author(s), articles with the absence of full - text and difficulty of extracting data.
- Studies were done in Healthcare facilities as illness greatly affects the nutritional status of the study participants.
- Studies with methodological limitations like incorrect outcome ascertainment criteria.

Study screening and selection processes

First of all, articles accessed from databases and electronics search engines will be exported to endnote version 6 so that duplication will be easily identified and removed. Secondly, the remaining articles will be evaluated in the context of the topic, the study participants, language and study area. Thirdly, irrelevant topics, studies conducted out of Ethiopia, and articles documented other than the English language will be rejected. Finally, the abstracts and the full-texts of the remaining studies will be reviewed. Nevertheless, if the article's full-text will not be accessed, they will be excluded.

Patient and public involvement

The central objective of this protocol is simply qualitatively reviewing and pooling of the findings of the previous studies, which are conducted by varies scholars. Thus, patients, as well as patient advisors, will not be part of the study.

Risk of bias and quality assessment

The quality assessment appraisal will be made by three independent reviewers (WWT, FW, and ZA). The quality of each article will be assessed using the standardized Joana Brig's Institute (JBI) critical appraisal tool prepared for cohort studies, case-control, cross-sectional [35], and analytical cross-sectional studies [36]. For cohort, case-control, and analytical cross-sectional studies, the ten, eight, and eleven question items will be used, respectively. For simple cross-sectional studies, a tool having nine question items will be employed.

All tools are "Yes" and "No" type of questions and scores will be given 1 and 0 for "Yes" and "No" responses, respectively. Scores will be summed and transformed into a percentage. Only studies scored $\geq 50\%$ will be considered for both systematic review and meta-analysis of the prevalence. For any scoring disagreements, which might happen between the assessors, the sources of the discrepancy will be investigated by a thorough revision. For persistent disagreement in spite of the detailed review, the average scores of the reviewers will be calculated. Similarly, for determinants, each factor with each

outcome variable will be critically appraised. Similar cutoff point what we will use for prevalence studies will be applied for factors. Moreover, the quality results of primary studies will be placed in the separate column of the data extraction format.

Data collection process

Once eligible studies are identified, two independent reviewers (AA and ZA) will extract the relevant data using the prepared format on Microsoft Excel spreadsheet. Information like primary author(s) name, sample size, number of undernourished(stunting, wasting/thinness) cases, response rate, the study year, publication year, study setting/region, the age groups of study participants(if applicable), study design, and pertinent associated factors will be extracted.

For prevalence studies, the prevalence, the logarithm of the prevalence, the standard error of logarithm of the prevalence will be computed. Likewise, for determinants, the odds ratio, logarithms of the odds ratio, and the standard error of the logarithms of odds ratio will be calculated. For any difficulties encountered during data extraction, the corresponding author(s) will be contacted by any means of communication.

Outcome variable

According to the WHO, stunting and underweight are defined as height-for-age, and BMI-for-age of below -2 Standard Deviation (SD), respectively [37, 38].

Data analysis and assessment of publication bias

The extracted data will be exported to STATA/SE Version 14 (STATA Corporation, College Station, Texas, USA) for further analysis. The existence of heterogeneity among studies will be examined by the forest plot as well as I^2 heterogeneity test [39]. The I^2 values of 25%, 50%, and 75% will be interpreted as the presence of low, medium, and high heterogeneity, respectively. I^2 heterogeneity test of $\geq 50\%$ and a p-value of < 0.05 will be declared as the presence of heterogeneity. Thus, the Dersimonian laired random-effects model will be employed [40]. To identify the influential studies that resulted in

variation, sensitivity analysis will be carried out using the “metaninf” command [41]. Then after, for extreme outlier study(s), the extracted data will be checked for any error that might happen during the process of extraction. Finally, if the data are free of errors, article(s) will be excluded from the analysis. Similarly, subgroup analyses will be employed by assuming the region and year of the study as grouping variables and sources of variation.

Using the “metafunnel” command [42] and objectively by Egger’s regression test publication bias will be detected [43]. Accordingly, asymmetry of the funnel plot and/or statistical significance of Egger’s regression test ($p\text{-value} < 0.05$) will be suggestive of publication bias. Therefore, using “metatrim” command, a nonparametric trim and fill (Duval and Tweedie’s) method of analysis will be done [44].

Using the Laired random-effects model, the pooled prevalence of stunting, and wasting/underweight will be reported. The presence of an association between the determinants and the outcome (stunting, and wasting/underweight) variables will be estimated based on the effect size. Furthermore, all statistical interpretations will be reported based on the 95% CI.

Discussion

Adolescent girls are the most liable population to undernutrition associated with the highest macro and micronutrient requirement. In addition, the deleterious effects of undernutrition are numerous as it leads to poor educational achievement, adverse pregnancy outcomes, morbidity, and delayed first menstruation.

In Ethiopia, most adolescent girls are victimized of both acute and chronic forms of undernutrition with prevalence ranging from 21.6% [19] to 58%[28]. This implies a deep-rooted problem which could jeopardize the health of many adolescents and making the problem hard to halt. Despite these established facts, they are the most ignored population. Therefore, designing a wide range of nutritional strategies and promoting healthcare services are greatly required to terminate undernutrition. To realize this, estimating the national prevalence and determinants using high-level evidence is quite

imperative. Therefore, this systematic review and meta-analysis will provide a summarized finding using a comprehensive systematic and meta-analysis approach.

Ethics and Dissemination: Since this is a systematic review and meta-analysis, ethical clearance will not be a concern. The results of the study will be published in a reputable peer-reviewed journal and presented at scientific research conferences.

Strength and limitation of this study

- The scientific plausibility of the study will be maintained by stringently following the standardized reporting checklists for PRISMA.
- The cortical appraisal will be performed by three reviewers
- The presence of heterogeneity linked with diversified study area/region where studies were done and other parameters amongst primary studies could be a threat to pool the findings.
- Only articles published in the English language will be considered

Amendments

As long as the authors strongly believe that some amendments are necessary, modifications will be made and the detail of amendments, including the reasons of modification and the date of amendment done will be clearly noted.

Abbreviations

EDHS	Ethiopian Demographic Health Survey
JBI	Joana Brig’s Institute
NNP	National Nutrition Program
WHO	World Health Organization

Declaration

Acknowledgment

The authors would like to acknowledge the University of Gondar librarians.

Ethics approval and consent to participate

Not applicable

Competing of interest

The authors have declared that no any competing interest

Consent for publication

Not applicable

Funding

Not any funding received for this work

Availability of Data and materials

Not applicable since it is protocol

Authors' contribution

WWT and YFA: Conceived the research idea, write the methodology and introduction.

WWT, ZAM, and AAM: Prepared the protocol.

WWT, AAM, and FW: Doing on the searching process

WWT, ZAM, and FW: Appraise the quality of the studies, extract the data, and analyze the data.

All authors have reviewed and approved the protocol for publication.

¹WWT is a Lecturer, Department of Community Health Nursing, College of Medicine and Health Sciences at the University of Gondar, Ethiopia. WW has a Bachelor of Science Degree in Nursing and Master's Degree in Public Health Human Nutrition.

²AAM is a Lecturer, Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences at the University of Gondar. AAM has Bachelor of Science Degree in Nursing, and Master's Degree in Epidemiology and Biostatistics

³ZAM is a Lecturer, Department of Health informatics, Institute of Public Health, College of Medicine and Health Sciences at Debre Markos University, FW has Bachelor of Science Degree in Nursing, MSc in Pediatrics and Child Health Nursing.

⁴YFA is a Lecturer, Department of comprehensive nursing, School of Nursing, College of Medicine and Health Sciences at the University of Gondar, Ethiopia. YFA has a Bachelor of Science Degree in Nursing and Masters in general public Health.

⁵FW is a Lecturer, Department, Department of Nursing, College of Medicine and Health Sciences at Debre Markos University, FW has Bachelor of Science Degree in Nursing, MSc in Pediatrics and Child Health Nursing.

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PRISMA 2009 Checklist

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Section/topic	#	Checklist item	Reported on page #
TITLE: Undernutrition and its determinants among Ethiopian adolescent girls: A protocol for systematic review and meta-analysis.			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria; participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3-4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and if available, provide registration information including registration number. Prospero CRD-42018106180	6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6-7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	7
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	9
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9-10

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Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	9
Page 1 of 2			
Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	9-10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	9-10
RESULTS			Not applicable (NA)
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	-
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICO, follow-up period) and provide the citations.	-
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	-
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	-
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	-
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	-
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	-
DISCUSSION			NA
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	-
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	-
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	-
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data; role of funders for the systematic review).	12



PRISMA 2009 Checklist

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For more information, visit: www.prisma-statement.org. Page 2 of 2

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BMJ Open

Undernutrition and its determinants among Ethiopian adolescent girls: A protocol for systematic review and meta-analysis.

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Undernutrition and its determinants among Ethiopian adolescent girls: A protocol for systematic review and meta-analysis.

Wubet Worku Takele¹, Achenef Asmamaw Muche², Zeleke Abebaw Mekonnen³, Yehualashet Fikadu Ambaw⁴, and Fasil Wagnew⁵

¹Department of Community Health Nursing, School of Nursing, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia.

Email: wubetakele380@gmail.com

²Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia.

Email: ashua2014@gmail.com

³Department of Health informatics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia.

Email: Zelekeabebaw7@gmail.com

⁴Department of compressive Nursing, School of Nursing, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia.

Email: fekaduambaw14@gmail.com

⁵Department of Nursing, College of Medicine and Health Sciences, Debre Markos University, Debre Markos, Ethiopia.

Email: fasilw.n@gmail.com

Corresponding author: wubetakele380@gmail.com

¹Department of Community Health Nursing, School of Nursing College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia.

Abstract

The sequelae of undernutrition on adolescent girls are not only limited to them, rather they are a great threat to the health of their upcoming offspring. In Ethiopia, however, the national pooled prevalence and determinants of undernutrition are not known. Therefore, this study is aimed at determining the pooled prevalence and determinants of undernutrition among adolescent girls in Ethiopia.

Method: Published articles will be retrieved through databases, such as Medline and PubMed. Electronics search engines, like Google Scholar and Google will be used. To identify the eligible studies, the Joanna Briggs Institute (JBI) quality appraisal checklists prepared for different study designs will be used. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist will be used to maintain the scientific robustness of the study. The presence of heterogeneity among studies will be examined by forest plot as well as I^2 heterogeneity test. Potential causes of heterogeneity will be explored by carrying out sensitivity and sub-group analyses. The DerSimonian and Laird random-effects model will be used provided that heterogeneity is observed. Publication bias will be examined by observing funnel plots, as well as objectively by Egger's regression test. If the funnel plot is asymmetric and/or Egger's test found to be statistically significant (p -value <0.05), the trim and fill (Duval and Tweedie's) analysis will be performed. The presence of a statistical association between independent and dependent variables will be declared if the p -value is < 0.05 with the 95% CI.

Ethics and Dissemination: Since this is a systematic review and meta-analysis, ethical clearance will not be a concern. The results of the study will be published in the peer-reviewed reputable journal and presented at different scientific research conferences.

Systematic review registration: This protocol has been registered at the international prospective register of Systematic Review and meta-analysis. The registration number is CRD-42018106180.

Strength and limitations of this study

- The critical appraisal will be performed by three reviewers.

- The presence of heterogeneity among studies could be a threat to pool the findings.
- Only articles published in the English language will be considered

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Introduction

According to the World Health Organization (WHO), adolescent is defined as the age group of 10-19 years [1]. This segment of the population is neither young children nor young adults, which occupies the second most critical stage in human life [2]. In this stage, many macro and micronutrients are highly demanded associated with the onset of maturity, menstruation, and participating in various sports activities [3, 4]. Likewise, this is the period in which some important body dimensions are increased; for instance, they attained about 15% to 25% of their final adult's stature [5], 45% of increments in bone mass, and half of the adult's weight [6]. In Ethiopia, children and adolescents together account for nearly half (48%) of the Ethiopian population, of which about a quarter are girls [7].

In developing countries, though the burden of undernutrition among adolescents is not considered as severe as young infants and children, nowadays, it's becoming a major public health problem, which interferes the completion of normal growth and development [8-10]. This problem gradually exposes them to poor schooling performance [11], delayed menstruation [8, 12], and limits work at maximum productivity [13]. In addition, in the one hand, undernutrition at this age contributes growth and developmental failure to their prospective children associated with the nature of its intergenerational cycle [14]. On the other hand, it increases the risk of developing overnutrition [15]. Making free of adolescent girls from Protein-Energy Malnutrition (PEM) prevents anemia and giving birth to low birth weight babies [16]. Furthermore, undernutrition weakens the immunity, thereby it increases susceptibility to infection and also prolongs the recovery time from illness [17, 18].

Even though progressive economic growth has been observed in developing countries, undernutrition still remains as a public health challenge affecting lots of adolescents [19, 20]. In these countries, the magnitude of undernutrition is reported in a problematic manner. For instance, in Asia stunting estimated to be between 28.5% and 50.3% [21-23], and thinness it's amounted to be between 32% and 55% [21, 22]. In Africa, it's ranged from 10% to 57.8% [24, 25], in particular of Ethiopia, according to a report revealed by the United Nation International Children's Emergency Fund (UNICEF), about a third

(33%) of adolescent girls are underweight [26]. Likewise, some local studies have also shown that undernutrition is ranged from 21.6% to 58.3% [19, 27, 28].

Plenty of previous primary studies have largely shown that undernutrition attributed to multiple factors. The likelihood of developing undernutrition is increased among adolescent girls who are residing in a rural area [27], have consumed impure water, poorly diversified diet, food fewer than 3 times per day, and having a family size of greater than five[29]. Likewise, those who are living in food-insecure [30] and poor household income family are at higher risk[31].

Even though multiple primary studies have been done in various parts of Ethiopia that determined the prevalence, as well as factors of undernutrition, those findings are reported in an inconclusive way. Therefore, this study is aimed to determine the pooled prevalence and associated factors of undernutrition among Ethiopian adolescent girls. The findings may urge policymakers and nutrition programmers to design and implement a well-compressive nutritional intervention to mitigate the burden of undernutrition among this segment of the population.

Objectives

General Objective: To systematically collect, review and summarize the available evidence on the prevalence and determinants of undernutrition among adolescent girls in Ethiopia.

Specific objectives

- ✓ To review and estimate the pooled prevalence of undernutrition (stunting and underweight/wasting) among adolescent girls in Ethiopia.
- ✓ To review and determine the pooled effect sizes of the determinants of undernutrition (stunting and underweight/wasting) among Ethiopian adolescent girls.

Methods

Protocol registration and review reporting

This systematic review and meta-analysis have been registered at the international prospective register of Systematic Review and meta-analysis (PROSPERO) with the registration number of CRD42018106180. This review protocol was prepared based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA-P), 2015 [32]. While reporting the method and findings of the study, authors will strictly adhere to the PRISMA checklist and the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) [33, 34], which will largely help to maintain the scientific rigor of the study. All eligible original studies will be qualitatively described in terms of the prevalence, study setting, sample size, and other relevant characteristics as part of the review. The procedures of screening and selection of eligible studies will be presented using the PRISMA flow diagram. The results of the meta-analysis will be illustrated through figures and texts.

Information source and search strategy

Initially, databases were searched to check for the same systematic review in order to avoid duplications. The website (<http://www.library.UCSF.edu>) and Cochrane/Wiley library explored to confirm whether previous systematic review and/or meta-analysis exists. To access published primary studies, PubMed, MEDLINE, Scopus, and HINARI database sources will be used. Grey literature will be retrieved using Google and Google Scholar. In addition, the reference lists of the retrieved studies will be probed to collect articles that are not accessible through databases, as well as electronics search engines.

During the searching process, to suppress the number of irrelevant studies, searching will be restricted to only “human studies” and “English language” in the advanced search. The corresponding author(s) will be contacted via mail, or other means of communication for the article(s) with hard to access the full-texts. The key search terms that we will be used are: “nutritional status”, “undernutrition”, “stunting”, “wasting” “malnutrition” “determinants*”, “associated factors”, “school girls”, “adolescent girls”, and “Ethiopia”. In

the advanced searching databases, the searching strategy will be built based on the above-mentioned terms using the “Medical Subject Headings (MeSH)” and “All fields” by linking “AND” and “OR” Boolean operator terms as appropriate. The searching activity will be done by (WWT, AAM, and FYA) and the whole process is expected to be completed by September, 28/2018.

Eligibility criteria

Inclusion criteria

- All observational studies, including cross-sectional, analytical cross-sectional, case-control, and cohort studies.
- All articles published only in the English language.
- As long as articles were done in Ethiopia and reporting the prevalence, as well as associated factors of all forms of undernutrition (stunting and underweight/wasting), they will be included without time restriction.

Exclusion criteria

Studies with one of the following criteria listed below will be excluded:

- Studies conducted among the special population, as studies done among adolescent girls living with Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDs), Tuberculosis (TB), and mental disorders.
- Despite contacting the corresponding author(s), articles with the absence of full - text and difficulty of extracting data.
- Studies were done in Healthcare facilities, as illness greatly affects the nutritional status of the study participants.
- Studies with methodological limitations like incorrect outcome ascertainment criteria.

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Study screening and selection processes

First of all, articles gathered from different sources will be exported to endnote version 6 and duplication will be identified and removed. Secondly, the remaining articles will be evaluated in the context of the topic, the study participants, language and study area. Thirdly, irrelevant topics, studies conducted out of Ethiopia, and articles documented other than the English language will be rejected. Finally, the abstracts and the full-texts of the remaining studies will be reviewed. Nevertheless, if the study's full-text will not be accessed, they will be excluded.

Patient and public involvement

The central objective of this protocol is simply qualitatively reviewing, describing and pooling of the findings of the previous studies, which are conducted by varies scholars. Thus, patients, as well as patient advisors will not be part of the study.

Risk of bias and quality assessment

The quality assessment appraisal will be performed by three independent reviewers (WWT, FW, and ZA). The quality of each article will be assessed using the standardized Joanna Briggs Institute (JBI) critical appraisal tool prepared for cohort studies, case-control, cross-sectional [35], and analytical cross-sectional studies [36]. For cohort, case-control, and analytical cross-sectional studies, the ten, eight, and eleven question items will be used, respectively. For simple cross-sectional studies, a tool having nine question items will be employed.

All tools are “Yes” and “No” type of questions and scores will be given 1 and 0 for “Yes” and “No” responses, respectively. Scores will be summed and transformed into a percentage. Only studies scored $\geq 50\%$ will be considered for both systematic review and meta-analysis of the prevalence. For any scoring disagreements, which might happen between the assessors, the sources of the discrepancy will be investigated by a thorough revision. For persistent disagreements in spite of the detailed review, the average scores of the reviewers will be calculated. Similarly, for determinants, each factor with each

outcome variable will be critically appraised. The similar cutoff point that we will be using for prevalence studies will be applied to factors. Moreover, the quality results of primary studies will be placed in the separate column of the data extraction format.

Data collection process

Once the eligible studies are identified, two independent reviewers (AA and ZA) will extract the relevant data using the prepared format on Microsoft Excel spreadsheet. Information like primary investigator's name, sample size, number of undernourished (stunted, underweighted/ wasted) cases, response rate, the study year, publication year, study setting/region, the age groups of study participants (if applicable), study design, and pertinent associated factors will be extracted.

For prevalence studies, the prevalence, the logarithm of the prevalence, the standard error of logarithm of the prevalence will be computed. Likewise, for determinants, the odds ratio, logarithms of the odds ratio, and the standard error of the logarithms of odds ratio will be calculated. For any difficulties that might be encountered during data extraction, the corresponding author(s) will be contacted by any means of communications.

Outcome variable

According to the WHO, stunting and underweight/wasting are defined as height-for-age, and BMI-for-age of below -2 Standard Deviation (SD), respectively [37, 38].

Data analysis and assessment of publication bias

The extracted data will be exported to STATA/SE Version 14 (STATA Corporation, College Station, Texas, USA) for further analysis. The existence of heterogeneity among studies will be examined by the forest plot, as well as I^2 heterogeneity test [39]. The I^2 values of 25%, 50%, and 75% will be interpreted as the presence of low, medium, and high heterogeneity, respectively. I^2 heterogeneity test of $\geq 50\%$ and a p-value of < 0.05 will be declared as the presence of heterogeneity. Thus, the DerSimonian Laird random-effects model will be employed [40]. To identify the influential studies that resulted in

variation, sensitivity analysis will be carried out using the “metaninf” command [41]. Then after, for extreme outlier study(s), the extracted data will be checked for any error that might happen during the data extraction processes. Finally, if the data are free of errors, article(s) will be excluded from the analysis. Similarly, subgroup analyses will be employed by assuming the region and the year of the study as grouping variables and sources of variation.

Using the “metafunnel” command [42] and objectively by Egger’s regression test, publication bias will be detected [43]. Accordingly, asymmetry of the funnel plot and/or statistical significance of Egger’s regression test ($p\text{-value} < 0.05$) will be suggestive of publication bias. Therefore, using “metatrim” command, a nonparametric trim and fill (Duval and Tweedie’s) method of analysis will be done [44].

Using the Laird random-effects model, the pooled prevalence of stunting, and wasting/underweight will be reported. The presence of an association between the determinants and the outcome (stunting, and wasting/underweight) variables will be estimated based on the effect size. Furthermore, all statistical interpretations will be reported based on the 95% CI.

Moreover, the findings of the qualitative studies will be combined and an integrative approach of quantitative-qualitative meta-synthesis will be carried out.

Discussion

Adolescent girls are the most liable population to undernutrition associated with the highest macro and micronutrient requirements. In addition, the deleterious effects of undernutrition are numerous, for instance, it could lead to poor educational achievement, adverse pregnancy outcomes, morbidity, and delayed at first menstruation.

In Ethiopia, most adolescent girls are victimized of both acute and chronic forms of undernutrition with prevalence ranging from 21.6% [19] to 58%[28]. This implies a deep-rooted problem which could jeopardize the health of many adolescents and making the problem hard to halt. Despite these established facts, they are the most ignored population. Therefore, designing a wide range of nutritional strategies and promoting healthcare services are highly required to terminate undernutrition. To realize this, estimating the national prevalence and determinants using high-level evidence is quite imperative. Therefore, this systematic review and meta-analysis will provide a summarized finding.

Ethics and Dissemination: Since this is a systematic review and meta-analysis, ethical clearance will not be a concern. The results of the study will be published in a reputable peer-reviewed journal and presented at scientific research conferences.

Amendments

As long as the authors believe that some amendments are necessary, modifications will be made and the detail of amendments, including the reasons of modification and the date of amendment done will be clearly noted.

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Abbreviations

EDHS	Ethiopian Demographic Health Survey
JB	Joanna Briggs Institute
NNP	National Nutrition Program
WHO	World Health Organization

Declaration

Acknowledgment

The authors would like to acknowledge the University of Gondar librarians.

Ethics approval and consent to participate

Not applicable

Competing of interest

The authors have declared that no any competing interest

Consent for publication

Not applicable

Funding

Not any funding received for this work

Availability of Data and materials

Not applicable since it is a protocol

Authors' contribution

WWT and YFA: Conceived the research idea, write the methodology and introduction.

WWT, ZAM, and AAM: have prepared the protocol.

WWT, AAM, and FW: Doing on the searching process

WWT, ZAM, and FW: they will appraise the quality of the studies and extract and analyze the data.

All authors have reviewed and approved the protocol for publication.

¹WWT is a Lecturer, Department of Community Health Nursing, College of Medicine and Health Sciences at the University of Gondar, Ethiopia. WW has a Bachelor of Science Degree in Nursing and Master's Degree in Public Health Human Nutrition.

²AAM is a Lecturer, Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences at the University of Gondar. AAM has Bachelor of Science Degree in Nursing, and Master's Degree in Epidemiology and Biostatistics

³ZAM is a Lecturer, Department of Health informatics, Institute of Public Health, College of Medicine and Health Sciences at Debre Markos University, FW has Bachelor of Science Degree in Nursing, MSc in Pediatrics and Child Health Nursing.

⁴YFA is a Lecturer, Department of comprehensive nursing, School of Nursing, College of Medicine and Health Sciences at the University of Gondar, Ethiopia. YFA has a Bachelor of Science Degree in Nursing and Masters in general public Health.

⁵FW is a Lecturer, Department, Department of Nursing, College of Medicine and Health Sciences at Debre Markos University, FW has Bachelor of Science Degree in Nursing, MSc in Pediatrics and Child Health Nursing.

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE: Undernutrition and its determinants among Ethiopian adolescent girls: A protocol for systematic review and meta-analysis.			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria; participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3-4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and if available, provide registration information including registration number. Prospero CRD-42018106180	6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6-7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	7
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	9
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9-10



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Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	9
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Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	9-10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	9-10
RESULTS			Not applicable (NA)
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	-
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICO, follow-up period) and provide the citations.	-
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	-
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	-
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	-
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	-
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	-
DISCUSSION			NA
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	-
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	-
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	-
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	12

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