Lowest wealth quintiles predispose under-five children to stunting in Ethiopia: Updates of systematic review and meta-analysis

Mesfin Wudu Kassaw (mesfine12a@gmail.com)
Woldia University https://orcid.org/0000-0002-6327-7723

Aschalew Afework
GAMBY College of Medical Science

Alemayehu Digssie
Debre Tabor University

Netsanet Fentahun
Bahir Dar University

Murat Açık
Ankara University

Taddesse Awoke
University of Gondar

Research

Keywords: Amhara Public Health Institute, Meta-Analysis, Stunting, Wealth index, Children

DOI: https://doi.org/10.21203/rs.3.rs-58090/v1

Abstract

Background: Malnutrition remains as a major public health problem in the world, particularly in developing countries such as Ethiopia. The prevalence of stunting in Ethiopia has been decreased considerably from 58% in 2000 to 44% in 2011 and 38% in 2016. The aim of this systematic review and meta-analysis is to assess the prevalence of stunting and its associations with wealth index among under-five children in Ethiopia.

Methodology: The databases screened were PubMed/MEDLINE, Scopus, HINARI and grey literatures. The studies' qualities were assessed by two reviewers independently, and any controversy was handled by other reviewers using the JBI critical appraisal checklist. In the statistical analysis, the funnel plot, Egger's test, and Begg's test were used to assess publication bias. The I^2 statistic, forest plot, and Cochran's Q test were used to deal with heterogeneity.

Results: The pooled prevalence of stunting was 41.5% among under-five children, despite its considerable heterogeneity (I^2=97.6%, p<0.001). However, the included studies had no publication bias in calculating the pooled prevalence (Egger's test p=0.26; Begg's test p=0.87). Children from households with a medium or low/poor wealth index had higher odds of stunting (AOR 1.33, 95% CI: 1.07, 1.65 or AOR 1.92, 95% CI: 1.46, 2.54, respectively) compared to children from households with a high/rich wealth index.

Conclusions: The pooled prevalence of stunting is great. In the subgroup analysis, the Amhara region, followed by the Oromia region and then the Tigray region had the highest prevalence of stunting

Background

Malnutrition remains a major public health problem in the world, particularly in developing countries such as Ethiopia. Children and women are the most vulnerable segment of the population for malnutrition (1). In 2016, out of 667 million children, 159 million were stunted and 50 million were wasted worldwide(2). In fact, malnutrition not only has obvious physical and developmental impacts but also harms economic growth. Worldwide, between 3 and 16 percent of the GDP is lost annually due to stunting alone. Stunting also has long-term effects on individuals and societies, including diminished cognitive and physical development, reduced productive capacity and poor health, and an increased risk of degenerative diseases (such as diabetes) (3, 4).Growth faltering happens mostly from 3 to 24 months of age (5).The prevalence of stunting reaches its peak between 12 and 24 months of age (40%–54%), continues to increase until 36 months of age (58%), and then remains fairly stable until 5 years of age (55%) (6).Globally, stunting affect approximately 162 million children under the age of 5 years(7). In Africa as a whole and in Sub-Saharan Africa, 35% and 42% of children under 5 years of age are believed to be stunted, respectively (8). According to a 2017 report by the WHO, the prevalence of stunting decreased between 2000 and 2016. Nevertheless, the absolute numbers of stunted children are increased from 50.4 million in 2000 to 58.5 million in 2016(9, 10). Ethiopia has made good progress in reducing stunting amongst young children, starting from very high levels in the 1990s (11). Although the prevalence of stunting in Ethiopia has decreased considerably from 58% in 2000 to 44% in 2011 and 38% in 2016, it remains high and is considered a major public health problem for the country (12-15). A number of variables were identified as determinants of stunting from different studies. For example, inadequate nutrition and repeated occurrence of infection during the first 1000 days of a child's life were the major determinants (7-16). In addition, birth weight, birth interval, maternal occupation, residence, food security, unsafe source of drinking water, poor dietary diversity, vitamin A supplementation, bottle feeding, duration of exclusive breastfeeding, wealth index and time of initiation of complementary feeding were important factors for stunting (17-30).In Ethiopia, the duration of breastfeeding, maternal working status, maternal education, vitamin A supplementation, family size, income, deworming status, paternal education, birth weight, ANC visits, maternal height, maternal BMI, birth order, and dietary diversity were associated with stunting (31-39).Assessing the pooled prevalence of stunting, and determining the effect of the wealth index on stunting is crucial to formulate appropriate interventions, which can help policymakers and managers to monitor the efficacy of existing strategies on stunting among under-five children. In addition, there is inconsistency between the studies and reviews regarding stunting. Therefore, this review will provide evidence on the pooled magnitude of stunting and its association with the wealth index.

Review questions

The aim of this review is to answer the following two review questions:

- What is the pooled prevalence of stunting among under-five children in Ethiopia?
- Does the wealth index have an effect on stunting prevalence among under-five children in Ethiopia?

Methods

PROSPERO registration

The protocol has been registered in PROSPERO (registration number CRD42019127005).

Searching strategies

We conducted a systematic search of literatures published between 2010 and 2019. We assumed issues that happened in the past 10 years could be used as key research gaps for the work we intended to carry out. This systematic review and meta-analysis were conducted to assess the pooled prevalence of stunting and its associations with the wealth index among children below 5 years of age in Ethiopia. A comprehensive search strategy was designed as a priori, in which the search term was developed using Boolean operators, and adapted to databases. The databases and online libraries mainly used were PubMed/MEDLINE, Scopus, HINARI, Google Scholar, and Google. In addition, the searches for unpublished studies were also done from institutional libraries and research gate. All searches were limited to the English language and publication dates between 20 January 2010 and 15 November 2019. The search grid or combination of terms used in PubMed was child OR children OR under-five children AND wealth index AND stunting OR malnutrition OR nutritional status AND Ethiopia.

Inclusion and exclusion criteria

Inclusion criteria

Observational studies (cross-sectional, analytical cross-sectional, case-control and cohort) studies with one of the following criteria were included:

- Studies that have reported a response rate > 85 percentage
- Studies done on under five years old children
- Articles published only using the English language
- Studies published between 20 January 2010 and 15 November 2019 and that reported a stunting prevalence, or wealth index as factors of stunting

Exclusion criteria

However, studies with one of the following criteria were excluded:

- Articles without full text and data that were difficult to extract the odds ratio, despite contacting the corresponding author(s)
- Studies done in healthcare facilities, as illness greatly affected the nutritional status of the study participants
- Studies with methodological limitations, such as incorrect outcome ascertainment criteria
- Studies that measured the outcome variable (stunting) other than Z-score

Measurement of the outcome variables

The primary outcome of this review was to assess the pooled prevalence of stunting and determine its associations with the wealth index among under-five children in Ethiopia. In this review, stunting was defined as having a height-for-age Z-score (HAZ) < -2 SDs for a child's age and gender. Stunting is the impaired growth and development that children experience from poor nutrition, repeated infection, and inadequate psychosocial stimulation. It is classified as a HAZ < -2SDs, a measure based on comparisons of a child's height (cm) and age (months) to WHO standards (40).The wealth index is a composite measure of a household's living standard that is separated into five quintiles. It is calculated using the ownership of a household's selected assets (rural or urban), such as televisions and bicycles, materials used for housing construction, types of water access and sanitation facilities. In this review, the wealth index was categorized into three quintiles (low/poor, medium, and high/rich) from the primary studies that reported the wealth index using five categorized quintiles: poorest, poorer, medium, richest, and richer. In this review, the poorest and poorer wealth indices were grouped into low/poor, medium wealth index into medium, and the richest and richer wealth indices into high/rich.

Study selection and data collection

The studies identified through the databases searches were combined, exported and managed using Endnote version X9.2 software (Thomson Reuters, Philadelphia, PA, USA). Duplicated studies were removed and the full texts of the articles were searched by Endnote software and manually. Three reviewers (AA, AD and MW) assessed the studies for eligibility independently. The reviewers assessed papers starting with the title, abstract and then full text. The discrepancies between these three reviewers were solved by discussion and by other reviewers (TA, MA, and NF).

Quality assessment of individual studies

A method to assess the outcome variables for the included studies was used in assessing the risk of bias. The study design, study participants, outcomes, definition of stunting, statistical methods used to identify the associations, results/data presentation, and odds ratios (ORs) with confidence intervals (CIs) were assessed. The retrieved studies were assessed using the JBI checklist for all analytic cross-sectional studies (42), case control studies (43), and cohort studies(44). With regard to the critical appraisal process, studies that got 5 out of 8 for cross-sectional, 6 out of 11 for cohort, and 5 out of 10 for case control were considered to have good quality/low risk. However, studies below the cut points in the JBI checklist were considered as poor quality/high risk.

Data extraction and management

Statistical analysis

The extracted data were exported to STATA/SE version 11.0 software for further analysis. A descriptive summary of the included studies was presented. The pooled prevalence of stunting and its associations with the wealth index were determined by the random effects model using DerSimonian-Laird weighting (45). Since the studies retrieved were heterogeneous by study area, sample size, design, population, and study period, we decided to use the random effects model. Our statement is also concurrent with evidence that heterogeneity in meta-analysis is mostly known to be inevitable due to differences in study quality, sample size, method and different outcomes measured across studies (46, 47). The statistical heterogeneity was checked by forest plot subjectively and Cochran's Q test and I^2statistic (48) objectively. In order to minimize the variance of point estimates between primary studies, a subgroup analysis was carried out by region of study and by design of study. When the heterogeneity was consistent, sensitivity analysis was used to determine the effect of each study on the pooled prevalence. The presence of publication bias (small study effect) was also checked using graphical tests (funnel plots) and the objective tests, Egger's test (49), and Begg's test. Both the Egger's and Begg's tests were statistically significant ($p<0.05$), indicating the presence of a small study effects. Whenever there was publication bias, it was handled by the non-parametric trim and fill analysis using the random effects model (50).

Results

Literature searches and selections

In the initial search, 1642 records were found from the electronic databases. The databases searched and the records found were from MEDLINE (1059), Scopus (175), Google Scholar (236), HINARI (110), and grey literatures (62). The grey literatures considered in this review were Google Search, Research Gate, Google Scholar, and institutional repository. Of the 1642 papers, only 828 papers remained for further evaluation after removing duplicates. Upon the examination and screening of the titles and abstracts, 323 records were excluded. There were 58 full text articles that were eligible for data extraction. However, 18 records were further excluded for not fulfilling the inclusion criteria. Finally, 40 articles remained for this review and meta-analysis (21, 22, 38, 51-86). Of these 40 studies, 35 of the studies were used in assessing the pooled prevalence of stunting(21, 22, 38, 51-58, 60, 61, 63-77, 79, 80, 82, 84-87), and 16 of the studies were used to estimate the effect of wealth index on stunting (51, 52, 57, 61, 66, 69, 72, 73, 75, 76, 78, 79, 81-84)(Figure1).Of the 16 papers that used to estimate the effect of wealth index on stunting, four were not used in calculating the pooled prevalence of stunting (78, 79, 81, 83).

Characteristics of the studies

The pooled magnitude of stunting was computed using 35 studies that considered 51,452 children aged birth to 5 years old. The sample size ranged from 214 to 9893 under-five children. Of the sample children for the review, 24,107 had the outcome of stunting, or and wealth index (21, 22, 38, 51-58, 60, 61, 63-77, 79, 80, 82, 84-87). Only one study was conducted at a health facility(22), whereas the remaining 34 studies were conducted in the community. All the studies considered in the pooled magnitude of stunting were studied using a cross-sectional design. Eight of the papers were published from 2010 to 2014 (56, 61-63, 69, 72, 73, 75), and the remaining 31 papers were published from 2015 to 2019. Three of the studies were conducted from EDHS data (58, 81, 87), and two of the papers were studied using secondary data(22, 56). Five of the studies considered children aged 6-24 months (51, 52, 63, 66, 78) and one study considered children aged 24 to 59 months old (54). However, all the other studies were conducted on children aged 6 to 59 months old. Nine studies were from Amhara (21, 38, 61, 72, 75, 76, 80, 82, 85) and SNNPR regions (53, 55, 57, 63, 69, 71, 74, 78, 79). Studies in other regions included from Oromia (n=7) (22, 51, 54, 62, 67, 73, 83), Tigray (n=3) (60, 65, 66), Somalia(n=2) (52, 70), Benishangul-Gumz(n=1) (84), and Afar(n=2) (64, 77), and six studies were nation-based (56, 58, 68, 81, 86, 87)(Table1).

Table 1: The summary of included studies on computing pooled magnitude of stunting and its association with wealth index in Ethiopia, 2010-2019

or	P/year	Region	Study setting	Study design	Data source	Sample size	Outcome
dan and a	2017**	Oromia	Community based	Cross sectional	Primary	584	Wasting and stunting
. et al.	2015**	Somalia	Community based	Cross sectional	Primary	210	Nutritional status
ot et al.	2018	SNNP	Community based	Cross sectional	Primary	398	Stunting
ed et al.	2015	Oromia	Community based	Cross sectional	Primary	453	Underweight and wasting
ı et al.	2017	SNNP	Community based	Cross sectional	Primary	508	Nutritional status
ı et al.	2013	NA	Community based	Cross sectional	Secondary	3422	Under nutrition
et al	2017**	SNNP	Community based	Cross sectional	Primary	3975	Stunting
ewoz et al.	2016	NA	Community based	Cross sectional	EDHS	11,872	Stunting
ıun et al.	2019	NA	Community based	Cross sectional	EDHS	8743	Stunting
ı et al.	2017	Tigray	Community based	Cross sectional	Primary	610	Malnutrition
ıawitetal.	2015	Amhara	Community based	Cross sectional	Primary	1287	Stunting
ıyeetal.	2014**	Amhara	Community based	Cross sectional	Primary	610	Under nutrition
tY. et al.	2012	Oromia	Community based	Cross sectional	Primary	791	Under nutrition
eshaetal.	2011	SNNP	Community based	Cross sectional	Primary	575	Stunting
etal.	2017	Afar	Community based	Cross sectional	Primary	840	Malnutrition
yeetal.	2019	Tigray	Community based	Cross sectional	Primary	394	Stunting
ıemariam et	2016**	Tigray	Community based	Case control	Primary	330	Stunting
eMekonen	2019	Oromia	Community based	Cross sectional	Primary	616	Chronic under nutrition
t D. et al.	2017	SNNP	Community based	Cross sectional	Primary	834	Under nutrition
ilu T. et al.	2014**	Amhara	Community based	Cross sectional	Primary	620	Malnutrition
ilu T et al.	2014**	Amhara	Community based	Cross sectional	Primary	367	Malnutrition
de et al.	2013**	Oromia	Community based	Cross sectional	Primary	820	Malnutrition
a et al.	2014**	Amhara	Community based	Cross sectional	Primary	844	Stunting
e T et al.	2017**	Amhara	Community based	Cross sectional	Primary	1295	Stunting
raw et al.	2018	Amhara	Community based	Cross sectional	Primary	410	Stunting

an et al.	2016	Afar	Community based	Cross sectional	Primary	401	Stunting
S	2019	Ethiopia	Community based	Cross sectional	Primary	4989	Stunting
et al.	2019	Ethiopia	Community based	Cross sectional	Primary	9495	Stunting
e D. et al.	2010**	SNNP	Community based	Cross sectional	Primary	2410	Stunting
bari et al.	2016	Somalia	Community based	Cross sectional	Primary	694	Stunting
ziaw et al.	2015	SNNP	Community based	Cross sectional	Primary	567	Stunting
nu et al.	2017	Oromia	Facility based	Cross sectional	Secondary	384	Malnutrition
aw G. et.al.	2018**	Amhara	Community based	Cross-sectional	Primary	593	Under nutrition
ι et al.	2019*	Ethiopia	Community based	Cross-sectional	EDHS	7452	nutritional status
e et al.	2017*	SNNP	Community based	Case control	Primary	587	Stunting, and wasting
on et al.	2019*	SNNP	Community based	Cross sectional	Primary	342	stunting
et al.	2018*	Oromia	Community based	Cohort	Primary	4468	Stunting
oAbdisa	2018**	Benishangul	Community based	Cross sectional	Primary	564	Stunting
e T. et al	2016	Amhara	Community based	Cross sectional	Primary	681	Stunting
alemMulugeta	2017	Amhara	Community based	Cross sectional	Primary	480	Under nutrition

Three of the studies did not report sex of the study population, children (62, 63, 82), but all the other studies reported the sex of the children. Accordingly, boys contributed to 65.2% (33,533) (Table1) of the population. Most papers were published in internationally reputable journals, but only one study (84), and one mini EDHS report (86) fulfilled the criteria during the critical appraisal process and were included for this systematic review and meta-analysis. Regarding to the associations between wealth index and stunting, the sample size of the studies included was 22,183 children aged birth to 5 years. With regard to the effect estimation of the associations, the sample size ranged from 214 to 7452 participants. The response rate of the studies used for effect estimation in assessing the associations was 91.9%, and all the studies were conducted in the community (51, 52, 57, 61, 66, 69, 72, 73, 75, 76, 78, 79, 81-84). Considering this associations between stunting and wealth index, one of the papers studied used a cohort design(83), two of the papers studied used a case control design (66, 78), and the remaining 13 studies used cross-sectional design. Six of the studies(61, 72, 75, 76, 78, 82) were from Amhara region, three were from SNNPR region(57, 69, 79), three from Oromia region(51, 73, 83), one from Tigray region (66), one from Somalia region (52), and one from Benishangul-Gumuz region (84), while one study was a nation-based (Ethiopia) (81)(Table1, and Table2).

Table 2: The main findings, and quality assessment results of the included studies for the systematic review and meta-analysis on stunting, and wealth index associations with stunting in Ethiopia, 2010-2019

Author	P/year	Male	Age in months	Anthropometric analysis	Confounding adjusted	Main findings	Risk (JBI)
Kalkidan and Tefera	2017**	289	6-24	WHO ENA smart	Age, residence, complementary feeding initiation, breast feeding, dietary diversity, family size, food insecurity, educational status, meal frequency, wealth index, diarrhea, and farming land size	Child caring practices are independent predictors of nutritional status than wealth or economic indicators	Low
Yirgu et al.	2015**	109	6-24	WHO Anthro	Maternal education, food security, age at complementary feeding, meal frequency, bottle feeding, breast feeding in the first 24 hours, dietary diversity, and wealth index	Low dietary diversity scores, inappropriate age of complementary feeding initiation and bottle-feeding were predictors of stunting.	Low
Lamrot et al.	2018	171	6-59	WHO Anthro	Age, sex, birth order, maternal education, latrine availability, hand washing using soap, and ANC follow up	41.7% of child was stunted. Age, sex, birth order, mother education, having toilet facility, washing hand with soap, and ANC follow up were associated factors of stunting	Low
Ahmed et al.	2015	422	24-59	WHO ENA	Confounding not adjusted	In this study, 61.1% of children were stunted	High
Bealu et al.	2017	447	6-59	WHO Anthro	Food security, child sex, child age, initiation of complementary feeding, maternal education, and	Of the included children, 45.6% were stunted. Household food insecurity, child age and initiation of complementary	Low

					breastfeeding status	feeding were associated factors of stunting.	
Disha et al.	2013	1783	6-59	NAv	Food insecurity	Of the included children, 50.7% of children were stunted. Household food insecurity was associated with stunting.	High
Seifu et al	2017**	1969	6-59	WHO Anthro	Age of the child, sex of the child, morbidity, place of delivery, maternal education, ethnicity/race, household food insecurity, and household wealth index	Of the included children, 43.7% of children were stunted. Age and sex were positively associated factors of stunting. Advanced maternal education and house hold food security were protective factors of stunting	Low
Demewoz et al.	2016	6168	6-59	NAv	Child age, sex, immunization, anemia, maternal age, maternal education, birth interval, number of children, sex of household head, father's educational status, family size, wealth index, place of residency, poverty rate, region, improved latrine facility, and source of drinking water	Of the included children, 44.4 % of children were stunted. Birth interval, sex of the child, sex of household head, anemia, maternal education, father's education, poverty, and maternal nutritional status	Low
Kasahun et al.	2019	4455	6-59	NAv	Child age, birth interval, wealth index, maternal education, type	Children from undernourished mothers, not breastfeeding	Low

					of toilet, source of drinking water, mothers body mass index, and child sex	children, children from poor households, households that have no toilet facilities, male children, being in between 12 and 59 months, unable to read and write mothers, and short birth spacing were associated with stunting.	
Araya et al.	2017	326	6-59	WHO Anthro	Mothers hand washing, cleaning material used to wash hands, source of drinking water, latrine availability, and age of child,	Of the included children, 36.1% of children were stunted. Age is the only factor associated with stunting	Low
Selamawit et al.	2015	622	6-59	ENA smart	Morbidity, age of child, number of family size, marital status, father's education, and occupational status of house hold head	Of the included children, 49.4% of children were stunted. Age of the child, number of family size, and father's educational status were associated factors of stunting	Low
Wagaye et al.	2014**	399	6-59	WHO ENA smart	Child age, monthly income, ANC follow up, family size, pre lacteal feeding, and maternal age at first birth	Of the included children, 57.7% of children were stunted. Pre lacteal feeding and age at first birth were associated factors of stunting. Monthly family income was inversely associated with stunting	High

Hiwot Y. et al.	2012	NAv	6-59	WHO Anthro	Residence, number children, age of child, birth order, mothers BMI, and source of drinking water	Of the included children, 45.8% of children were stunted. Residence, number of children, age of the child, birth order, and mothers BMI were associated factors of stunting	Low
Masresha et al.	2011	NAv	6-24	WHO Anthro	Time of complementary food started, frequency of breast feeding, extra food during pregnancy and lactation, pre lacteal feeding, bottle-feeding, meal frequency, and dietary diversity.	Of the included children, 37.2 %of children were stunted. Time of complementary food started and extra food during pregnancy and lactation are associated factors of stunting.	Low
Abel et al.	2017	476	6-59	WHO Anthro	Sex of child, age of child, time of complementary food started, child immunization status, diarrheal disease in the last 2 weeks, fever in last 2 weeks, and presence of latrine in the house	Of the included children, 43.1% of children were stunted. Sex of child, age of the child, diarrhea in the last two weeks, and fever in the last two weeks were associated factors of stunting	High
Tesfaye et al.	2018	172	6-59	ENA smart	Sex of the child, marital status, mother education, mother occupation, fever last 2 weeks, extra food during lactation, and hand washing facility near to toilet	Of the included children, 49.2% of children were stunted. Sex of the child and hand washing facility near to toilet were associated factors of stunting	Low
Kidanemariam	2016**	164	6-24	NAv	Maternal	Maternal	High

et al.					education, mother height, birth weight, number of children under five, dietary diversity, mother BMI, repeated previous illness, father education, duration of exclusive breast feeding, age at complementary feeding, and household income.	education, mother height, birth weight, number of children, dietary diversity, mother BMI, and repeated previous illness were associated factors of stunting	
Jalane Mekonen	2019	306	6-59	WHO Anthro	Fever in the last 2 weeks, diarrhea in the last 2 weeks, age at complementary food started, additional foods in the past 48 hr., pre-lacteal foods/fluids, duration of exclusive breast feeding, decision making on the use of money, mother educational status, and number of children	Stunting was associated with mother educational status, number of children in the house hold, decision making on the use of money, age of complementary foods started, and presence of diarrhea in the last two weeks	Low
Hiwot D. et al.	2017	432	6-59	ENA smart	Age of mothers, colostrums feeding, exclusive BF in the first six months, cessation of breast-feeding status, frequency of complementary feeding, diarrheal morbidity in the past 12 months,	Of the included children, 39.3%, 15.8% and 6.3% of children were stunted, underweighted and wasted respectively. Male sex of the child, mothers older than 35 years, not fed on colostrums, cessation of breastfeeding	Low

					and sex of the child	before two years of age, frequency of complementary feeding per day, and diarrheal morbidity in the last 12 months were associated with stunting.	
Behailu T. et al.	2014**	330	6-59	ENA smart	Sex of Head of HH, family size, ANC visits, child sex, domestic animals, colostrums feeding, immunization status, EBF, measles sickness, latrine, protected water, deworming, birth order, knowledge about malnutrition, presence of bed, child diarrhea, and monthly income	The prevalence of stunting, underweight and wasting were 60.6%, 31.1%, 12.6% in the community-based nutrition program implementing districts, respectively	High
Behailu T et al.	2014**	192	6-59	ENA smart	Sex of Head of HH, family size, ANC visits, child sex, domestic animals, colostrums feeding, immunization status, EBF, measles sickness, latrine, protected water, deworming, birth order, knowledge about malnutrition, presence of bed, child diarrhea, and monthly income	The prevalence of stunting, underweight and wasting were 39.0%, 27.5%, 14.7% in none-community based nutrition program implementing districts, respectively.	High
Kebede et al.	2013**	410	6-59	ENA smart	Sex, age, educational status of	Of the included children, 47.6%, 30.9% and 16.7%	Low

					mothers, family monthly income, ownership of farm land, gestational age, use of family planning, Pre-lactation foods/fluids, and time to obtain drinking water	of children were stunted, underweight and wasted, respectively. The associated factors of stunting were child age, family monthly income, pre-lacteal feeding and family planning. Underweight was associated with number of children and pre-lacteal feeding. Treatment of water was the only variable associated with wasting.	
Birara et al.	2014**	435	6-59	ENA smart	Sex of child, deworming, Age of child in months, breast feeding status, and Wealth quintile	The prevalence of stunting, underweight and wasting were 47.3% 25.6%, and 8.9% (95%CI: 6.9-10.2), respectively. Age of the child 11-23 months, deworming status, sex of the child, and breastfeed status associated with stunting.	Low
Amare T et al.	2017**	656	6-59	WHO Anthro	Number of under five children, wealth status, source of family food, maternal education, maternal employment status, paternal education, health care access, source of	Of the included children, 37.7% and 26.8% were moderately andseverely stunted, respectively. Farming occupation of mother, lack of postnatal vitamin-A	Low

					drinking water, availability of latrine, maternal vitamin A supplementation, breastfeeding initiation, exclusive breastfeeding status, complementary feeding initiation, and dietary diversity score	supplementation, poorer household wealth status and accessing family food from farms were determinants of severe stunting	
Shiferaw et al.	2018	228	6-59	ENA smart	Birth order, sex of the child, educational status of mothers, birth interval, birth weight, PNC, recurrent episode of diarrhea, immunization status, diarrhea, colostrums feed, method of feeding, age of child, duration of BF, and complementary food started	Low weight at birth, female sex of the child., older age, mistimed initiation of complimentary feeding, and mothers' lack of ANC visit were associated with chronic malnutrition	Low
Misgan et al.	2016	178	6-59	WHO Anthro	Sex of household head, Sex of the child, ANC visit, minimum dietary diversity, household hunger scale, Pre-lacteal feeding, colostrum feeding, Postnatal care visit, maternal age, and Monthly household income	Of the included children, 32.2%, 23.5% and 13.8% of them were stunted, underweight and wasted, respectively.	Low
EDHS	2019	1298	6-59	NAv	Confounding not adjusted	9,150 households were selected. Of the	Low

						included children, 37% of children were stunted. The prevalence of stunting was 22% among children 6-8 months and 44% on children aged 48-59 months.	
Abay et al.	2019	3637	6-59	NAv	Age of the child, region, mother's education, mother's BMI, wealth index, sex, size of child, and number of children	Child age, maternal education, region, wealth status, religion, sex of child, number of children, child size, water access, and toilet facility were influencing factors of stunting	High
Amare D et al	2010**	974	6-59	NAv	Age of mother, sex, birth order, and family income	There is no association between malaria and undernutrition	Low
Abdibari et al.	2016	232	6-59	ENA smart	Family size, educational status of mothers, occupations of mothers, income, child sex, and availability of latrine in the house	Factors contributing to malnutrition were immunization status, family size, child sex, monthly income, maternal education, and total duration of breast-feeding.	Low
Eskeziaw et al.	2015	273	6-59	WHO Anthro	Residence, sex, age of mother, maternal education, occupational status, media exposure, place of delivery, ANC follow up, PNC follow up, and maternal illness	Stunting was significantly associated with child sex, ANC follow up, maternal illness after delivery, maternal literacy and occupation.	Low

Zemenu et al	2017	80	6-59	NAv	Child age, sex, and maternal education	Of the included children, 38.3% of children were stunted. Only maternal education was associated with stunting	High
~~Atanaw G.~~ et.al.	~~2018**~~	~~NAv~~	6-59	WHO Anthro	Mothers occupation, number of under five children, decision making, age of children, and wealth index	The prevalence of stunting and wasting were 42.3% and 7.3%, respectively. Poor wealth status and age of child were independently associated with stunting. Similarly, presence of fever in the previous 2 weeks and paternal control over resources were associated factors of wasting.	Low
Zufan et al.	2019*	3816	6-59	NAv	Sex of the child, age of the child, residence, region, family size, maternal educational status, source of drinking water, type of toilet facility, wealth index, size of child at birth, birth order, maternal BMI, maternal anemia status, and place of delivery	Maternal education and maternal nutritional status were associated factors of stunting. Similarly, maternal nutritional status, place of delivery, and birth interval were associated factors of wasting	Low
Terefe et al.	2017*	569	6-24	WHO Anthro plus	Maternal education, maternal occupation, father education, wealth status, main source of	The prevalence of stunting and wasting among children aged 6–24 months were 58.1 and 17.0%, respectively.	Low

					family food, source of drinking water, availability of latrine, maternal vitamin A supplementation, dietary diversity, and child age	Poor wealth status, unavailability of latrine, child age: 12–24 months, not receiving maternal postnatal vitamin-A supplementation, and source of family food: own food production was associated with higher odds of stunting. However, only history of diarrheal morbidity was associated with wasting.	
Samson et al.	2019*	164	6-59	WHO Anthro	Child sex, child age, maternal educational status, monthly income, gestational age at birth, use of family planning, distance to obtain drinking water, diarrheal morbidity in the last 2 weeks, family size, and pre-lacteal feeding	The prevalence of stunting was 24.9% with 7.9% of severely stunted. Being female, children aged 12–23months old, mother 's who do not use family planning, children with diarrheal morbidity, income of 750–1500 ETB and>1500, and children who received pre-lacteal feeding were predictors for stunting.	Low
Taye et al.	2018*	1419	6-59	ENA for SMART	Sex of child, age of child, malaria infection, height for age, wealth status, and maternal education	The prevalence of stunting was 44.9%. The observed case was 103 with 118 episodes of malaria. In addition, there	Low

						were 684 new stunting and 239 new wasting cases. Children with malaria infection, and younger age were more likely to be stunted. Furthermore, children with malaria infection, and young age group were more likely to be wasted. But, stunting and wasting were not risk factors of malaria illness.	
Dilano Abdisa	2018**	311	6-59	WHO Anthro plus	Sex of child, duration of breastfeeding, head of household, family size, paternal education, and paternal occupation	The prevalence of stunting was 32.8%. Family size, low dietarydiversity score, duration of breast feeding, child who have no feed animal food source, and sex of children were associated with stunting	High
Amare T. et al	2016	365	6-59	ENA/SMART software	Colostrums, family size, source of household food, complementary food initiation, mothers age at first birth, child age, latrine availability, and dietary diversity	The overall prevalence of stunting was 46 %. Latrine facility, and family size were associated with stunting	Low
Yeshalem Mulugeta	2017	248	6-59	ENA for SMART	Marital status, occupation, educational status, television possession, possession of radio, child's living situation,	The prevalence of stunting, underweight, and wasting was 42%, 22.1%, and 6.4%, respectively. Illness in the	Low

					number of children, illness, decision makers, pre-lacteal feeding, and initiation of complimentary feeding	preceding two weeks, having two children under three years old, taking pre-lacteal feeding, and early or late initiation of complementary feeding were associated with stunting.	

More important descriptions for this review came from a study by Behailu et al. that used a comparative cross-sectional design and reported two prevalence values and two odds ratio (OR) values. Thus, we considered this paper as two papers in the meta-analysis section, but it was cited only once. Therefore, the data on the pooled magnitude of stunting was generated from 36 (72) studies, and the pooled estimate of the wealth index was produced using 17 studies (72), but, the number of citations were indicated as 35 and 16 for the pooled prevalence and effect estimate, respectively.

Systematic review

The prevalence of stunting varies from 18.7% to 64.5% (Figure2). The studies included representative data from seven regions of Ethiopia (33 studies) and at the country level (six studies) (56, 58, 68, 81, 86, 87). The highest number of studies was reported from the Amhara region, covering nine of the prevalence studies (21, 38, 61, 72, 75, 76, 80, 82, 85), and six of the wealth index studies(61, 72, 75, 76, 78, 82), while the lowest number of studies was from the Benishangul-Gumuz region, with only one study included in the prevalence section(84). With regard to the association between the wealth index and stunting, Tigray (66), Somalia(52), Benishangul-Gumz (84), and Ethiopia (country-wide) (81)contributed only one study each. The highest prevalence of stunting were reported from the Amhara region (64.5% (76) and 60.6% (72), followed by the Oromia region (61.1%) (54). Whereas, the lowest prevalence was from the SNNPR region (18.7%) (74), followed by the Somalia region (22.9%) (52) (Table1).The highest odds of stunting because of having a poor wealth index were reported from Tigray (AOR 6.0)(66), and Oromia (AOR 4.5 and 3.3) (51, 73). Similarly, the highest odds of stunting because of having a medium wealth index were from SNNP (AOR 2.5) (79), Tigray (AOR 2.4)(66), and Oromia (AOR 2.3)(73).

Meta-analysis

Thirty five studies were included to assess the pooled prevalence of stunting (21, 22, 38, 51-58, 60, 61, 63-77, 79, 80, 82, 84-87). On the other hand, 16 studies were used to estimate the pooled effect of wealth index on stunting (51, 52, 57, 61, 66, 69, 72, 73, 75, 76, 78, 79, 81-84).The procedure we followed while including, excluding, appraising, and extracting papers presented in Figure1 (88).

Prevalence of stunting in Ethiopia

The pooled prevalence of stunting in Ethiopia was 41.5% (95% CI: 38.65, 44.34), despite a considerable heterogeneity (I^2=97.6% and p<0.001). Cochran's Q-test and I^2 statistics, as well as forest plot and Galbraith plot, were considered to deal with this high degree of heterogeneity. The Galbraith plot indicated that more than 26 of the points or studies were outside of the 95% CI, and the CIs were not overlapping on the forest plot (Figure2).

Heterogeneity deal

The heterogeneity among studies in assessing prevalence among 35 studies by region while using subgroup analysis was very high. The I^2 statistics varied from 89.4% from Somalia region to 98.6% at the country-based studies. The prevalence of stunting (from the lowest to the highest magnitude of stunting) was 28.4% from Somalia region, 32.8% (single study prevalence) from Benishangul-Gumuz region, 36.45% from SNNPR region of Ethiopia, 37.78% from Afar region, 40.12% at the country-based study (Ethiopia), 42.55% from Tigray region, 43.53% from Oromia region, and 48.21% from Amhara region, with considerable high heterogeneity. The heterogeneity of the prevalence estimates among the subgroups of 35 studies on stunting by population of the study was also very high. The I^2statistics for children ≤ 2 years old (6 to 24 months) was 93.0%, while it was 97.6% for children less than 5 years old (6 to 59 months old). The prevalence of stunting among children ≤ 2 years old (6 to 24 months) was 28.16% (95% CI: 18.83, 37.48), while it was 42.68% (95% CI: 39.78, 45.59) among children < 5 years old.

Sensitivity: Sensitivity analysis was done on 26 studies by removing data from the meta-analytic model in order to examine the influence of studies with low quality and high bias on the pooled prevalence of stunting. After 10 prevalence studies removed due to being highly biased, the prevalence became 43.19% (95% CI: 42.62, 43.76, I^2=97.3%, and Cochran's Q=927.85). This sensitivity analysis prevalence put in within the 95%CI of the pooled magnitude of stunting, 41.5% (95% CI: 38.65, 44.34, I^2=97.6%, and Cochran's Q=1461.93). Thus, the sensitivity analysis assured that quality of studies did not significantly affect the pooled random prevalence of stunting (Supplementary figure1).

Cumulative meta-analysis: The cumulative meta-analyses indicated a stabilized trend of stunting prevalence among under-five children in the last 10 years, 2010 to 2019. The prevalence of stunting in 2010 and 2012 were lower than studies reported more recently from 2016 to 2019. Although the difference was irrelevant, there were upward and downward trends of stunting in the last 10 years. The prevalence of stunting was downward for the period 2010–2012, 2014–2015, and 2015–2016. However, the trend of stunting from late 2016 to 2019 was standing at 41% and 42% in down and up trends, with a slight difference in each year. For all years, a significant upward trend of stunting occurred in the period from 2012 to 2014 (Figure3).

Publication bias

The publication biases in this meta-analysis were examined using the subjective method, funnel plot by visual checking for asymmetry, and objectively using Egger's test and Begg's test. In the funnel plot, all studies were distributed symmetrically. Both small- and large-scale studies were distributed on the bottom and top of the graph, assuring the absence of publication bias (Supplementary figure2). The visual inspection of Begg's funnel plot did not identify substantial asymmetry, as nearly all of the studies laid within the 95% CI. Both Egger's and Begg's objective tests also confirmed the absence of publication bias. According to Egger's test, the estimated bias coefficient (intercept) was 2.4, with a standard error of 2.07 and a p-value of 0.26. Thus, the test provided evidence for the absence of small study effects. Similarly, the p-value for Begg's test was 0.87 that assured the absence of statistical evidence for publication bias.

Wealth index and stunting in Ethiopia

Sixteen studies were included to estimate the associations between the wealth index and stunting. The AOR of stunting varied from 0.83 (72) to 2.46 (66) from medium wealth index households and from 0.83(72) to 6.05 (66) from low/poor wealth index households as the primary studies indicated. The AOR assured that the wealth index of households was associated with the prevalence of stunting in under-five children in Ethiopia from studies conducted between 20 January 2010 and 15 November 2019(76, 78, 82). In this meta-analysis, the odds of stunting increased at medium wealth index households compared to high/rich wealth index households (AOR 1.33, 95% CI: 1.07, 1.65) (Figure4).

Similarly, the odds of stunting at low/poor wealth index households was greater compared with high/rich wealth index households, that was associated with stunting (AOR 1.92, 95% CI: 1.46, 2.54) (Figure5). The heterogeneity of pooled random effect size estimates among the 17 AOR reports using 16 studies on stunting and associations with low/poor or medium wealth index households was substantial (I^2=63.8% and 78.3% and p<0.001 for both low/poor and medium wealth index households, respectively) (48).In addition to Cochran's Q-test and I^2 statistic, both the forest plot and Galbraith plot were considered to deal with this substantial degree of heterogeneity for both low/poor and medium wealth index households against the high/rich wealth index households. The Galbraith plot showed three studies that were out of the 95% CI, and the CIs were not overlapping on the forest plot (Figure4). Similarly, in the low/poor wealth index households, the Galbraith plot showed five points were out of the 95% CI, and the CIs were not overlapping on the forest plot (Figure5).

Heterogeneity deal

The pooled I^2 statistic from medium wealth index households and associations with stunting indicated a substantial degree of heterogeneity (I^2=63.8%) (48) (Figure4).The heterogeneity of the pooled random effect size estimates of low/poor wealth index households and associations with stunting had a discrepancy. The pooled I^2statistic from low/poor wealth index households and associations with stunting indicated a considerable degree of heterogeneity (I^2=78.3%) (48). From the subgroup analysis of medium wealth index households and associations with stunting by design, the individual I^2 statistic ranged from 0% in the case control design to 52.5% in the cross- sectional design, which have a low and moderate degree of heterogeneity, respectively (Figure6).

The odds of stunting at medium wealth index households relative to high/rich wealth index households in case control studies were AOR 1.67 (95% CI: 1.41, 1.98) and in cross-sectional studies were AOR 1.19 (95% CI: 0.94, 1.52) (Figure6). Thus, the subgroup analysis by design in determining the associations between medium wealth index and stunting reported that cross-sectional studies were the more relevant heterogeneity moderators (I^2=52.5 and p=0.01), but the case control studies were homogeneous (I^2=0% and p=0.37). Similarly, there was no statistical associations of stunting and medium wealth index in cross-sectional studies (OR 1.19, 95% CI: 0.94, 1.52), but there was an associations between stunting and medium wealth index in case control studies (OR 1.67, 95% CI: 1.41, 1.98) (Figure6). The pooled random effect size estimates of medium wealth index and associations with stunting by region had no associations in the two regions. But, in the Oromia region, a significant association was reported. The odds of stunting from medium wealth index households in comparison with high/rich wealth index households were AOR 2.05 (95% CI: 1.17, 3.58) and I^2=0%, although the regions considered in the subgroup analysis of medium wealth index and association with stunting were only SNNPR, Amhara, and Oromia. The other regions have only a single study and a single AOR was reported in the subgroup analysis of medium wealth index and associations with stunting by region (Figure7).

The pooled random effect size estimates of low/poor wealth index and associations with stunting by region had no association in the SNNPR region, but in both Amhara and Oromia regions, a significant associations were reported with a pooled estimate (AOR 1.66 (95% CI: 1.18, 2.34) in the Amhara region and AOR 4.04 (95% CI: 2.29, 7.11) in the Oromia region) (Figure8). In the subgroup analysis of low/poor wealth index and associations with stunting by design, the individual I^2 statistics ranged from 73.3% in the case control design to 77.9% in the cross-sectional design, which had a substantial degree of heterogeneity (Figure9). The odds of stunting from low/poor wealth index households relative to high/rich wealth index households were AOR 2.69, (95% CI: 1.71, 4.23) in case control studies and AOR 1.69 (95% CI: 1.20, 2.38) in cross-sectional studies (Figure9). Thus, the subgroup analysis of low/poor wealth index and associations with stunting by design reported that both cross-sectional and case control studies were relevant heterogeneity moderators (I^2=77.9% and 73.3% and p=0.01 for both, respectively). Both the case control and cross-sectional studies had statistically considerable associations with stunting and low/poor wealth index (Figure9).

Publication bias

This review assessed the risk of publication bias using funnel plots for symmetry by visual inspection for both the medium and poor household wealth index and associations with stunting. The plot appeared symmetrical and found no publication bias, with most studies concentrated on the top of the plot. The visual inspection of Begg's funnel plot also did not identify substantial asymmetry. Egger's linear regression test revealed evidence of no publication bias (p=0.68), and Begg's rank correlation test again assured the absence of publication bias (p=0.09).

Discussion

This systematic review and meta-analysis is considered an updated version, because there were two reviews that were carried out previously. One was conducted by Ahmed et al. (89) who reported the pooled prevalence of stunting, wasting, and underweight, as well as the determinants of stunting, wasting, and underweight. The other review was done by Kalkidan and Tefera (90) who reported the determinate factors of stunting, wasting, and underweight. Although the present review had considerable differences compared with these previous two reviews, we were persuaded to consider this work as an updated version. Despite the presence of these two reviews with certain limitations, there was inflicting force to conduct this review, the stability of stunting irrespective of economic growth in Ethiopia. In this review and meta-analysis, the pooled prevalence of stunting in Ethiopia was 41.5% (95% CI: 38.65, 44.34). The 2018 UNICEF, WHO and World Bank joint report indicated that the prevalence of stunting in the world was 22.2%, 9.6% in Latin American and Caribbean countries, 35% in south Asia, and 33.9% in Sub-Saharan Africa (91). This report confirmed that prevalence of stunting in Ethiopia was higher compared to the world, Latin American and Caribbean countries, south Asia, and Sub-Saharan Africa. The consistently high prevalence of stunting in Ethiopia after 2010 might be due to the drought that occurred from 2010 to 2014 and the political instability that occurred after 2016. Both the drought and the political instability caused immigration, which may have affected children disproportionately. The prevalence of stunting in our review was greater than another study that reported stunting as 22% globally, 24% in developing countries, and 6% in developed countries (92). This indicates that stunting in Ethiopia was uniquely high and did not have significant improvements. The UNICEF, WHO and World Bank joint estimation reported that the international trend in the prevalence of stunting decreased from 39.6% to 23.8% between 1990 and 2014 (93).But, the prevalence of stunting in Ethiopia is still unchanged from the previous review (89). The current review shows a decrease of only 0.5% from the previous review, which considers papers from 1997 to 2015, and revealed a 42% prevalence of stunting(89). This consistently high prevalence of stunting forced us to hypothesizing that achieving the global targets of reducing stunting among children younger than 5 years by 40% in 2030 would be impossible for Ethiopia (94). This hypothesis agreed with the fourth Ethiopian Health Sector Development Plan. The plan aimed to reduce under-nutrition among under-five children by 30% in 2015, but it failed(95). Beyond this, the current stunting reduction rate in Ethiopia is 2.8%, which is far lower than the expected annual reduction rate of 6% to achieve the WHO's targets of stunting reduction (94).Therefore, Ethiopia will not reach the United Nations sustainable developmental goals of ending child malnutrition by 2030 or the national commitment to the Seqota Declaration(96) at the current rate of reduction and type of programmes being implemented. On the other hand, this review agreed with the report of the WHO, UNICEF and World Bank that indicated the number of stunted children in Africa is expected to increase from 56 million in 2010 to 61 million by the year 2025 (97).The match might be because of analogous geographic location, data and methodological quality both in the current review and the joint report. Unlike the previous review (89), in this meta-analysis, the prevalence of stunting did not have one directional track, yet the peak prevalence of stunting appeared in the year 2014, with the years 2013–2015 having the highest relative prevalence of stunting of all years. The prevalence of stunting in the years 2016–2019 was higher than the prevalence in the years 2010–2012.This makes stunting a tragic puzzle for Ethiopia, because the years 2015–2019 had relatively good economic improvements, despite the political instability across the country in the years 2016-2019. In considering this review and meta-analysis, the authors recommend a qualitative research, mainly a focused ethnographic study to explore the culture of both rural and urban villages on caring and handling children, preparing the meals of children, health-seeking behaviour of mothers during illness, and perception of the community towards nutrition from preconception to the end of adolescence. The stunting scenario in Ethiopia contradicts with the literature that children throughout the world can attain full growth potential if they are nurtured in healthy environments and their caregivers strictly stick to the recommended health, nutrition and health care practices (98). However, in Ethiopia, the prevalence of stunting was not decreased, while both the economic status of the community and the health care services provided were improved. Although the economic changes brought to Ethiopia were not paramount in decreasing stunting per the WHO 2030 plan (2), and HSTP 2015(95), a relative reduction must occur. We are also considering the drought from 2010 to 2014 and immigration from 2016 to 2019, which might reverse the trends of reduction in stunting. Nonetheless, the prevalence of stunting from late 2010 to 2019 should not be 41.5%. Because, unlike most of the Sub-Saharan Africa countries, Ethiopia had the highest and continuous reduction in the prevalence of stunting between 2000 and 2011, where stunting decreased from 57.7% in 2000 to 50.8% in 2005 to 44.3% in 2011(99). With regard to the sensitivity analysis of this review, a 43.19% (95% CI: 42.62, 43.76) prevalence of stunting was computed, while 10 papers with low scores were removed. But, the sensitivity analysis from the previous review reported a 40% (95% CI; 32, 48) prevalence of stunting(89). Thus, the current review has a higher prevalence of stunting (by 3.19 %.) The reason for such a difference in prevalence might be the studies included in our review reported a higher prevalence of stunting, particularly studies conducted from late 2016 to 2019. However, the important question is why stunting became higher than the previous review. Although the interval prevalence of the previous review and the current review are similar, there was a figurative difference. The reason might be because of the researchers concern to address the most vulnerable communities that may have not been addressed before the year 2010 and could not consider in the previous review. On the contrary, those papers might have a high prevalence of stunting and were included in our review. The other causes for such a high prevalence of stunting in these years might be the drought in Ethiopia from 2010 to 2014 caused by La Niña(100, 101).

Currently, the number of people targeted for relief food and cash support remains largely unchanged due to the significant spike in internal displacement since April 2018 (102). The pooled prevalence of stunting by subgroup analysis showed marked differences with regard to the prevalence of stunting among regions. According to the WHO’s 2010 classification, the prevalence of stunting was considered “very high” (above 40) in the Amhara, Oromia, Tigray, and country-based studies; high (30–39%) in the SNNPR and Afar; and “medium” (20–29%) in Somalia. Of the studies included in this review, there was no region that had a prevalence of stunting that was considered “low” (< 20%) (40).This high prevalence of stunting in the Amhara and Oromia regions might be due to the high numbers of children and population in both regions, which might contribute to insufficient food production at the household level. The 2016 EDHS report (103)revealed the prevalence of stunting was 46% in the Amhara region, 43% in the Benishangul-Gumuz region, 41% in the Afar region, 39% in the Tigray region, 39% in the SNNPR region, 27% in the Somalia region, and 37% in the Oromia region. The subgroup meta-analysis reported the prevalence of stunting was 48.21% in the Amhara region, 37.78% in the Afar region, 42.55% in the Tigray region, 36.45% in the SNNPR region, 43.53% in the Oromia region, and 28.4% in the Somalia region. The 2016 EDHS report and this subgroup meta-analysis have results that agree in some regions and some results that are contradicted in other regions. For example, the subgroup analysis of this review and the 2016 EDHS report have close prevalence in the Amhara, SNNPR, and Somalia regions. Regarding the associations between stunting and the wealth index, this review and meta-analysis identifies that low wealth quintiles are associated with stunting. This meta-analysis indicated that the pooled odds of stunting due to having a low/poor wealth index was 1.92 (95% CI: 1.46, 2.54) and due to having a medium wealth index was 1.33 (95% CI: 1.07, 1.65) compared to households that had a high/rich wealth index. This associations of stunting and the wealth index was supported by a report that stunting is greatly influenced by three important factors: food, health, and quality of care provided for children(104). In relation to this, other evidence has reported that combating stunting among children depends on accessing diversified and nutrient-rich foods, providing appropriate care for mothers and children, creating appropriate health care services and a healthy environment, including safe water, good hygiene, and sanitation (105). Food, health and health care services are affected by social, economic and political factors. To afford the above important conditions, the socioeconomic status of a given household is an invaluable condition (106). Although the determinant factors of stunting are diverse, socioeconomic status plays a great role in the occurrence of stunting. When socioeconomic status improves and poverty is reduced, child stunting will be improved by getting greater access to food, improved maternal and child care, and better public health care services (107-109). This meta-analysis agreed with the study done by Krishna et al. that was conducted in four low- and middle-income countries (Ethiopia, India, Peru and Vietnam) (110). A further analysis of the demographic and health surveys of Rwanda (2014–2015) and Uganda (1995, 2001, 2006, and 2011) showed the same result(111) to this review. The associations between stunting and wealth index was also reported by other studies conducted from south Asia (Afghanistan, Bangladesh, India, Nepal and Pakistan) (112, 113).Thus, socioeconomic status greatly influences the living standard, which is explained by the wealth index and in turn caused stunting. This implies that improving the living standard of the community will decrease the occurrence of stunting. The finding of this review contradicts the previous meta-analysis(51), where the wealth index was not a factor for stunting. This disagreement might be because of differences in the sample size, search date, and number of studies included. In addition, the review by Kalkidan had considerable heterogeneity (I^2=92%), but the heterogeneity in our review was lower (I^2=63.8%). Thus, the lower degree of heterogeneity in our review migtt indicates the robustness of its scientific quality. In contrast to the previous review, we performed subgroup analyses by region and by study design. The subgroup analysis by design indicated that cross-sectional studies had moderate heterogeneity (I^2=52.5%), but the case control studies were homogeneous (I^2=0%). This means that the review might be more relevant than the previous one because of its homogeneity. Additionally, the review by Kalkidan Hassen categorized the wealth index into two quintiles: low and high. But, we classified the wealth index into three quintiles: low/poor, medium, and high/rich. This might be the other reason for the contradictory pooled estimation. In contrary to the review by Kalkidan and Tefera, our review agreed with the study done by Fenske et al., where the wealth index had the largest effect on stunting (114). The similarity might be that wealth is a universal factor for stunting irrespective of cultural, educational, and sociodemographic data, because children from low/poor wealth index households are less likely to have adequate food. This review agreed with a review that was conducted in urban setting and reported low household income was identified as a risk factor for stunting (115, 116). This similarity might support that the wealth index is a known underlying cause of stunting. Particularly, in urban settings, the dependence on cash flow might emphasize that household income is a real cause of stunting. The findings of the current review agree with the reports of Headey and Biadgilign who reported that the wealth index and stunting have an associations (117, 118). The similarity might be due to the fact that the study populations are similar. Both of the studies were nation-based study on under-five children. This review agreed with a study that reported the presence of an associations between stunting and wealth index, with a substantial wealth gap in stunting, even after controlling for wealth-related differences (119). This study indicated that Ethiopian children in the top 60% of the wealth distribution are 3.9 percentage points less likely to be stunted compared with an equivalent child that is among the poorest 40% (119).The review agreed with a nation-based study conducted in Ghana that showed the wealth index was significantly associated with stunting. The study showed that children residing in the lowest wealth quintile households had significantly increased probabilities of being stunted in comparison to children residing in the highest wealth quintile households (AOR 2.36, 95% CI: 1.29, 4.30) (120). From this literature and our review, we recognize a reduction of stunting by 40% per the WHO's 2030 plan might be achieved through improving the economic status of the community in collaboration with the agriculture sectors. Some authors have agreed and recommended that strengthening the existing micronutrient interventions and community-based management of severe acute malnutrition programmes (121) have public health importance in reducing the prevalence of stunting. This review is supported by another study that reported a stunted child was more likely to have been born into a low-income household; hence, intergenerational transmission of poverty and of childhood stunting is a possibility and may become a vicious cycle (122).This again agreed with a nation-based study in Ethiopia that reported under the recent situational Analysis of the Nutrition Sector (SITAN), which indicated an associations between poverty and stunting. The nation-based study indicated children from lowest wealth quintile were found to be stunted (123).This review agreed with the previous studies that reported children born to severely and moderately food insecure households were more likely to be stunted than children born to food secure households (56, 124).This review agreed with a study that stunting disproportionately affects children in poorer countries and from poorer households (97, 108).The review also agreed with studies that reported poorer households experience a higher prevalence of anthropometric failure (125-129).

Conclusion

Despite the great deal of heterogeneity, the present review revealed useful updates on the pooled prevalence of stunting and its associations with the wealth index, which could be used for monitoring the burden of stunting in Ethiopia. This review revealed that stunting is still stable and ominously high in the country. Moreover, stunting is associated with the economic class in which children from low/poor wealth index households become stunted compared with high/rich wealth index households. Thus, the implementation of policies to reverse stunting should get the concern of the government. In particular, the health and agriculture sectors need to act together to improve the socioeconomic status of the community. The implication of this review is that there is a need for qualitative research, particularly focused ethnographic studies to comprehend and figure out the culture of mothers, families, and communities in caring and handling children, preparing meals, and health-seeking behaviour during illness in Ethiopia. Although we did not address these measurements in our meta-analysis, the review indicated this type of study is needed.

Limitation of the review

The limitation of this review was the high heterogeneity in the samples of the retrieved studies, which might be because of differences in the locations and populations of the studies.

Abbreviations

AOR- adjusted odds ratio, CI – confidence interval, EDHS-Ethiopian Demography and Health Survey, UNICEF-, WHO-World Health Organization, WB-World Bank, SNNPR-South nation's nationalities and peoples of representatives, PRISMA- Preferred Reporting Items for Systematic Reviews and Meta-Analyses, GDP- Gross Domestic Product, ANC- Antenatal Care, BMI- Body Mass Index, JBI-Joanna Briggs Institute

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The raw materials that support the conclusions of this review incorporated to the manuscript and presented in tables or figures in the result section and as supplementary file.

Competing interests

The authors declare that they have not conflict of interests

Funding

This review sponsored by Amhara public health institute, and Amhara regional health bureau. The funders had no any contribution in searching, appraising, analyzing, and writing the review except the financial expenses.

Authors' contributions

Conceived the title and designed the review; AA, AD, NF, MA, TA, and MW; developing the searching terms; MW, NF, TA, MA, AA, and AD; developing the data extraction sheet; TA, NF, MW, AA, MA and AD; critically revising the review; AA, MA, NF, TA, AD, and MW; analyzing the data; AA, and MW; writing the final review; MW, TA, MA, NF, AA, and AD. All the authors had read and approved the final version of this manuscript. The authors agreed to be accountable for all aspects of this work.

Acknowledgements

We would like to express our gratitude and appreciation to Amhara public health institute, and Amhara regional health Bureau for providing 5 phases of consecutive systematic review and meta-analysis training for one-year, financial expenses, and assigning mentors for the actual works of this systematic review. We would also acknowledge University of Gonder, GAMBY Medical college, Woldia University, Bahir Dar University, and Debre Tabore University for their willingness and permission of training and working days for the authors of this review. We are also extending our gratitude to Mr. Daniel Mekonen for searching the Scopus database using Bahir Dar university IP address. Lastly, we recognize that this review is the result of former studies, and want to acknowledge the authors of those primary studies.

References

1. EPHI. Ethiopia National Food Consumption Survey in 2013 by Ethiopian Public Health Institute. 2013
2. IFP. RII. Global Nutrition Report in 2016 From Promise to Impact, Ending Malnutrition by 2030 Summary. 2016.
3. WHO. Nutrition in the WHO african region. WHO African region. 2017.
4. Nations FaAOotU. Regional Overview of Food Security and Nutrition, the Food Security and nutrition-conflict nexus Building Resilience for Food Security, Nutrition and Peace Africa. A. 2017
5. Victora CG dOM, Hallal PC, Blössner M, Shrimpton R. Worldwide timing of growth faltering: revisiting implications for interventions. Pediatrics. 2010;; 125(3):473-80.
6. Bhutta Z DJ, Rizvi A, Gaffey MF, Walker N, Horton S, et al. . Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet 2013;382 (9890):452-77.
7. You T YR, Lyles MF, Gong D, Nicklas BJ, Wells JCK, et al. WHA Global Nutrition Target 2025: Stunting Policy Brief. Eur J Clin Nutr. 2010;92.

8. Mamabolo RL, Alberts M, Steyn NP, Delemarre-van de Waal HA, Levitt NS. Prevalence and determinants of stunting and overweight in 3-year-old black South African children residing in the Central Region of Limpopo Province, South Africa. Public health nutrition. 2005;8(5):501-8.
9. UNICEF W. World Bank Group, Levels and trends in child malnutrition, 2016. 2018.
10. WHO WUU-. The World Bank joint Child Malnutrition. New York United Nations Child Fund; Geneva World Heal Organ. 2013:2-4.
11. Commission E. Country Profile on Nutrition: Bangladesh. . 2016.
12. CSA. Ethiopia Demographic and health survey. 2000.
13. International. CEaI. FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA ETHIOPIA Demographic and Health Survey 2016 Key Indicators Report. Ethiopians Water Sector Development Program. 2016.
14. ORC. CaM. Ethiopia Demographic and Health Survey 2005. Addis Ababa, Ethiopia and Maryland, USA: Central Statistical Agency(CSA) [Ethiopia] and ORC Macro. . 2006.
15. M G. Ethiopia Demographic and Health Survey, 2011 . Central Statistics Agency, Ethiopia. 2012. . 2012.
16. WHO. Childhood Stunting: Context, Causes and Consequences. . Matern Child Nutr 2013;9.
17. Desalegn E, Fikre K, Bosha T. Stunting and its associated factors in under five years old children: the case of Hawassa University Technology villages, Southern Ethiopia. Journal of Environmental Science, Toxicology and Food Technology. 2016;10(11):25-31.
18. Mantovani SAS, Ramalho AA, Pereira TM, Branco FLCC, Oliart-Guzmán H, Delfino BM, et al. Stunting in children under five years old is still a health problem in the Western Brazilian Amazon: a population-based study in Assis Brasil, Acre, Brazil. Ciencia & saude coletiva. 2016;21:2257-66.
19. Bogale TY, Bala ET, Tadesse M, Asamoah BO. Prevalence and associated factors for stunting among 6–12 years old school age children from rural community of Humbo district, Southern Ethiopia. BMC public health. 2018;18(1):653.
20. Batiro B, Demissie T, Halala Y, Anjulo AA. Determinants of stunting among children aged 6-59 months at Kindo Didaye woreda, Wolaita Zone, Southern Ethiopia: Unmatched case control study. PloS one. 2017;12(12):e0189106.
21. Geberselassie SB, Abebe SM, Melsew YA, Mutuku SM, Wassie MM. Prevalence of stunting and its associated factors among children 6-59 months of age in Libo-Kemekem district, Northwest Ethiopia; A community based cross sectional study. PloS one. 2018;13(5):e0195361.
22. Kassa ZY, Behailu T, Mekonnen A, Teshome M, Yeshitila S. Malnutrition and associated factors among under five children (6-59 Months) at Shashemene Referral Hospital, West Arsi Zone, Oromia, Ethiopia. Current Pediatric Research. 2017.
23. Y. M. Assessment of Stunting, Wasting Rate and Associated Factors among Children 0-59 Months at Jigjiga Town in Somali Regional State, Ethiopia. J Food, Nutr Popul Heal. 2018;02:1-4.
24. Dewana Z, Fikadu T, Facha W, Mekonnen N. Prevalence and Predictors of Stunting among Children of Age between 24 to 59 Months in Butajira Town and Surrounding District, Gurage Zone, Southern

Ethiopia. Health Sci J. 2017;11(4):518.

25. Fernandes ECB, CASTRO TGd, Sartorelli DS. Associated factors of malnutrition among African children under five years old, Bom Jesus, Angola. Revista de Nutrição. 2017;30(1):33-44.
26. Senbanjo IO, Oshikoya KA, Odusanya OO, Njokanma OF. Prevalence of and risk factors for stunting among school children and adolescents in Abeokuta, southwest Nigeria. Journal of health, population, and nutrition. 2011;29(4):364.
27. Tariq J, Sajjad A, Zakar R, Zakar M, Fischer F. Factors associated with undernutrition in children under the age of two years: secondary data analysis based on the Pakistan demographic and health survey 2012–2013. Nutrients. 2018;10(6):676.
28. Asfaw M, Wondaferash M, Taha M, Dube L. Prevalence of undernutrition and associated factors among children aged between six to fifty nine months in Bule Hora district, South Ethiopia. BMC Public health. 2015;15(1):41.
29. Haile A, Amboma T. Children's nutritional status and its determinants in small towns, Sebeta Hawas district, Oromia, Ethiopia. J Food Sci Nutr 2018; 1 (1): 33-47 J Food Sci Nutr 2018 Volume 1 Issue. 2018;1(66.6):2-4.
30. Tesfamariam K, Yilma D. Prevalence of stunting and its associated factors among children under 5 age in Holeta town, West Shoa zone, Oromia region, Ethiopia, 2017. EC Nutrition. 2017;12(2):90-8.
31. Teshome B, Kogi-Makau W, Getahun Z, Taye G. Magnitude and determinants of stunting in children underfive years of age in food surplus region of Ethiopia: the case of west gojam zone. Ethiopian Journal of Health Development. 2009;23(2).
32. Mesfin F, Berhane Y, Worku A. Prevalence and associated factors of stunting among primary school children in Eastern Ethiopia. Nutr Diet Suppl. 2015;7:61-8.
33. Herrador Z, Sordo L, Gadisa E, Moreno J, Nieto J, Benito A, et al. Cross-sectional study of malnutrition and associated factors among school aged children in rural and urban settings of Fogera and Libo Kemkem districts, Ethiopia. PLoS One. 2014;9(9):e105880.
34. Gultie T, Sisay E, Sebsibie G. Nutritional status and associated factors among orphan children below the age of five years in Gondar City, Ethiopia. Journal of Food and Nutrition Sciences. 2014;2(4):179-84.
35. Yalew BM. Prevalence of malnutrition and associated factors among children age 6-59 months at lalibela town administration, North WolloZone, Anrs, Northern Ethiopia. J Nutr Disorders Ther. 2014;4(132):2161-0509.
36. Amare D, Negesse A, Tsegaye B, Assefa B, Ayenie B. Prevalence of undernutrition and its associated factors among children below five years of age in Bure Town, West Gojjam Zone, Amhara National Regional State, Northwest Ethiopia. Advances in Public Health. 2016;2016.
37. Yonatan Menber D, AbayWoday, Hailemeske Cherieand Selamawit Kebede. Prevalence of Stunting and Associated Factors among School Age Children in Primary Schools of Haik Town, South Wollo Zone, North-Eastern Ethiopia. 2017.

38. Abeway S, Gebremichael B, Murugan R, Assefa M, Adinew YM. Stunting and its determinants among children aged 6–59 months in northern Ethiopia: a cross-sectional study. Journal of nutrition and metabolism. 2018;2018.
39. USAID. Agency for International Development (USAID) ENGINE project under Agreement No. AID-663-A-11-00017. The contents are the responsibility of Tufts University and Save the Children and do not necessarily reflect the views of USAID or the United States.
40. WHO. Nutrition Landscape Information System (NLIS): Country Profile 274 Indicators - Interpretation Guide. (ed W.H. Organization). World Health 275 Organization, Geneva, Switzerland. 2010.
41. von Elm E AD, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. . The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for reporting observational studies. Prev Med (Baltim). 2007;45(4):247-51.
42. Moola S MZ, Tufanaru C, Aromataris E, Sears K, Sfetcu R, et al. . Critical appraisal checklist for analytical cross-sectional studies. Joanna Briggs Inst Rev Man 2017.
43. Institute JB. The Joanna Briggs Institute critical appraisal tools for use in JBI systematic reviews checklist for case control studies
44. Institute JB. The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews Checklist for Cohort Studies. .
45. DerSimonian R, Laird N. Meta-analysis in clinical trials. Controlled clinical trials. 1986;7(3):177-88.
46. Huedo-Medina TB, Sánchez-Meca J, Marín-Martínez F, Botella J. Assessing heterogeneity in meta-analysis: Q statistic or I^2 index? Psychological methods. 2006;11(2):193.
47. Thompson SG, Smith TC, Sharp SJ. Investigating underlying risk as a source of heterogeneity in meta-analysis. Statistics in medicine. 1997;16(23):2741-58.
48. Higgins JP, Green S. Cochrane handbook for systematic reviews of interventions: Cochrane book series. 2008.
49. Egger M SG, Schneider M, Minder C. . Bias in meta-analysis detected by a simple, graphical test. . Br Med J. 1997;315(7109):629-34.
50. Duval S, Tweedie R. A nonparametric “trim and fill” method of accounting for publication bias in meta-analysis. Journal of the American Statistical Association. 2000;95(449):89-98.
51. Abate KH, Belachew T. Care and not wealth is a predictor of wasting and stunting of ‘The Coffee Kids’ of Jimma Zone, southwest Ethiopia. Nutrition and health. 2017;23(3):193-202.
52. Fekadu Y, Mesfin A, Haile D, Stoecker BJ. Factors associated with nutritional status of infants and young children in Somali Region, Ethiopia: a cross-sectional study. BMC Public health. 2015;15(1):846.
53. Abera L, Dejene T, Laelago T. Magnitude of stunting and its determinants in children aged 6–59 months among rural residents of Damot Gale district; southern Ethiopia. BMC research notes. 2018;11(1):557.

54. Abdurahman AA, Mirzaei K, Dorosty AR, Rahimiforoushani A, Kedir H. Household Food Insecurity May Predict Underweightand Wasting among Children Aged 24–59 Months. Ecology of food and nutrition. 2016;55(5):456-72.
55. Betebo B, Ejajo T, Alemseged F, Massa D. Household food insecurity and its association with nutritional status of children 6–59 months of age in east Badawacho District, south Ethiopia. Journal of environmental and public health. 2017;2017.
56. Ali D, Saha KK, Nguyen PH, Diressie MT, Ruel MT, Menon P, et al. Household food insecurity is associated with higher child undernutrition in Bangladesh, Ethiopia, and Vietnam, but the effect is not mediated by child dietary diversity. The Journal of nutrition. 2013;143(12):2015-21.
57. Hagos S HD, WoldeHanna T, LindtjørnB. Spatial heterogeneity and risk factors for stunting among children under age five in Ethiopia: A Bayesian geo-statistical model. PLoS ONE 2017;12(2).
58. Haile D, Azage M, Mola T, Rainey R. Exploring spatial variations and factors associated with childhood stunting in Ethiopia: spatial and multilevel analysis. BMC pediatrics. 2016;16(1):49.
59. Takele K, Zewotir T, Ndanguza D. Risk factors of morbidity among children under age five in Ethiopia. BMC public health. 2019;19(1):942-9.
60. Wasihun AG, Dejene TA, Teferi M, Marugán J, Negash L, Yemane D, et al. Risk factors for diarrhoea and malnutrition among children under the age of 5 years in the Tigray Region of Northern Ethiopia. PloS one. 2018;13(11):e0207743.
61. Fentahun W, Wubshet M, Tariku A. Undernutrition and associated factors among children aged 6-59 months in East Belesa District, northwest Ethiopia: a community based cross-sectional study. BMC public health. 2016;16(1):506.
62. Yisak H, Gobena T, Mesfin F. Prevalence and risk factors for under nutrition among children under five at Haramaya district, Eastern Ethiopia. BMC pediatrics. 2015;15(1):212.
63. Tessema M, Belachew T, Ersino G. Feeding patterns and stunting during early childhood in rural communities of Sidama, South Ethiopia. Pan African Medical Journal. 2013;14(1).
64. Abel Gebre PSR, Afework Mulugeta, YayoSedik, and MollaKahssay. Prevalence of Malnutrition and Associated Factors among Under-Five Children in Pastoral Communities of Afar Regional State, Northeast Ethiopia: A Community-Based Cross-Sectional Study. Hindawi, Journal of Nutrition and Metabolism. 2019;Volume 2019.
65. Gebru TT, Tesfamichael YA, Bitow MT, Assefa NE, Abady GG, Mengesha MB, et al. Stunting and associated factors among under-five children in Wukro town, Tigray region, Ethiopia: a cross sectional study. BMC research notes. 2019;12(1):504.
66. Berhe K, Seid O, Gebremariam Y, Berhe A, Etsay N. Risk factors of stunting (chronic undernutrition) of children aged 6 to 24 months in Mekelle City, Tigray Region, North Ethiopia: An unmatched case-control study. PloS one. 2019;14(6):e0217736.
67. Mekonen J, Addisu S, Mekonnen H. Prevalence and associated factors of chronic undernutrition among under five children in Adama town, Central Ethiopia: a cross-sectional study design. BMC research notes. 2019;12(1):532.

68. Tekile AK, Woya AA, Basha GW. Prevalence of malnutrition and associated factors among under-five children in Ethiopia: evidence from the 2016 Ethiopia Demographic and Health Survey. BMC research notes. 2019;12(1):391.
69. Deribew A, Alemseged F, Tessema F, Sena L, Birhanu Z, Zeynudin A, et al. Malaria and under-nutrition: a community based study among under-five children at risk of malaria, south-west Ethiopia. PLos one. 2010;5(5):e10775.
70. AbdibariMa'alin DB, Samuel Melaku, Daniel Tolossa, Yusuf Mohammed and KirosGebremicheal. Magnitude and factors associated with malnutrition in children 6-59 months of age in Shinille Woreda, Ethiopian Somali regional state: a cross-sectional study. BMC nutrition,. 2016.
71. Darsene H, Geleto A, Gebeyehu A, Meseret S. Magnitude and predictors of undernutrition among children aged six to fifty nine months in Ethiopia: a cross sectional study. Archives of Public Health. 2017;75(1):29.
72. Tariku B, Mulugeta A, Tsadik M, Azene G. Prevalence and risk factors of child malnutrition in community based nutrition program implementing and Nonimplementing districts from south East Amhara, Ethiopia. Open Access Library Journal. 2014;1(03):1.
73. Mengistu K, Alemu K, Destaw B. Prevalence of malnutrition and associated factors among children aged 6-59 months at Hidabu Abote District, North Shewa, Oromia Regional State. J nutr disorders ther. 2013;1:1-15.
74. Agedew E, Chane T. Prevalence of stunting among children aged 6–23 months in Kemba Woreda, Southern Ethiopia: a community based cross-sectional study. Advances in Public Health. 2015;2015.
75. Yalew B, Amsalu F, Bikes D. Prevalence and factors associated with stunting, underweight and wasting: A community based cross sectional study among children age 6-59 months at Lalibela Town, Northern Ethiopia. J Nutr Disorders Ther. 2014;4(147):2161-0509.1000147.
76. Tariku A, Biks GA, Derso T, Wassie MM, Abebe SM. Stunting and its determinant factors among children aged 6–59 months in Ethiopia. Italian journal of pediatrics. 2017;43(1):112.
77. Liben ML, Abuhay T, Haile Y. Determinants of child malnutrition among agro pastorals in northeastern Ethiopia: a cross-sectional study. Health Science Journal. 2016;10(4):1.
78. Derso T, Tariku A, Biks GA, Wassie MM. Stunting, wasting and associated factors among children aged 6–24 months in Dabat health and demographic surveillance system site: A community based cross-sectional study in Ethiopia. BMC pediatrics. 2017;17(1):96.
79. Dake SK, Solomon FB, Bobe TM, Tekle HA, Tufa EG. Predictors of stunting among children 6–59 months of age in Sodo Zuria District, South Ethiopia: a community based cross-sectional study. BMC Nutrition. 2019;5(1):23.
80. Tariku A, Woldie H, Fekadu A, Adane AA, Ferede AT, Yitayew S. Nearly half of preschool children are stunted in Dembia district, Northwest Ethiopia: a community based cross-sectional study. Archives of Public Health. 2016;74(1):13.
81. Zufan Bitew Dessie M, Zegeye Abebe, Tadesse Awoke Ayele, and KindieFentahunMuchie. Maternal characteristics and nutritional status among 6–59months of children in Ethiopia: further analysis of

demographic and health survey. BMC pediatrics. 2019.

82. Gelu A, Edris M, Derso T, Abebe Z. Undernutrition and associated factors among children aged 6–59 months living in slum areas of gondar city, northwest ethiopia: a cross-sectional study. Pediatric health, medicine and therapeutics. 2018;9:81.
83. Gari T LE, Deressa W, SolomonT, LindtjørnB. Malaria increasedthe risk of stunting and wasting among youngchildren in Ethiopia: Results of a cohort study. . PLoS ONE 2018;13(1).
84. Abdissa. D. Prevalence of stunting and associated factors among children age between 6-59 months in Dibate district, Metakal zone, Benishangul-Gumuz region, western Ethiopia, MPH Thesis. Haramay University, . 2018.
85. Demilew YM, Abie DD. Undernutrition and associated factors among 24–36-month-old children in slum areas of Bahir Dar city, Ethiopia. International journal of general medicine. 2017;10:79.
86. CSA. Mini Ethiopian Demography and Health Survey. 2019.
87. 2019. Understanding correlates of child stunting in Ethiopia using generalized linear mixed models BMC public health,. KasahunTakele, TemesgenZewotir, and Denis Ndanguz.
88. Moher D LA, Tetzlaff J, Altman DG. . The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. . PLoS Med. 2009,;6(7).
89. Ahmed Abdulahi SR, Kourosh Djafarian, Sakineh Shabbidar. Nutritional Status of Under Five Children in Ethiopia: A Systematic Review and Meta-Analysis Ethiop J Health Sci 2017;27(1): 175.
90. Kalkidan Hassen Abate aTB. Chronic Malnutrition Among Under-Five Children of Ethiopia May Not Be Economic. A Systematic Review and Meta-Analysis Ethiop J Health Sci. 2018;29(2):265.
91. Bank. UWW. Levels and trends in child malnutrition: UNICEF/WHO/World Bank Group Joint Malnutrition Estimates. 2018;96.
92. De Onis M BM, Borghi E. Prevalence and trends of stunting among pre-school children, 1990–2020. Public health nutrition. 2012;15(1):142-48.
93. U-W-TWBJCME. U-W-W. Levels and Trends in Child Malnutrition. UNICEF, WHO, World Bank Group joint malnutrition estimates. 2015.
94. WHO. Proposed global targets for maternal, infant and young child nutrition _globaltargets_backgroundpaper. 2012.
95. IV FH. Health Sector Strategic Plan 2010/11-2014/15. In: Federal Ministry of Health AA, editor. 2010.
96. FDRE. “SEQOTA” Declaration: Implementation Plan (2016-2030), WHO. (2016). WORLD HEALTH STATISTICS MONITORING HEALTH FOR THE SDGs. WHO.int. 2016.
97. Black RE, Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., De Onis, M., … Uauy, R. Maternal and child undernutrition and overweight in low-income and middle-income countries. The Lancet. 2013; 382(9890):427-51.
98. M O. Assessment of differences in linear growth among populations in the WHO Multicentre Growth Reference Study. Acta Paediatrica. 2006;95 (S450):56-65.

99. Wirth J. Determinants of stunting in East Africa. Université Montpellier, English. . Human health and pathology. 2018.;2018MONTG007.
100. Abdi A VA, Yengoh GT, Anyamba A, Seaquist J, Ummenhofer CC, et al. . The El Niño–La Niña cycle and recent trends in supply and demand of net primary productivity in African drylands. Climatic Change. 2016;138(1-2):111-25.
101. Simane B BH, Deressa W, Kumie A, Berhane K, Samet J. Review of Climate Change and Health in Ethiopia: Status and Gap Analysis. The Ethiopian Journal of Health Development (EJHD). 2016.
102. OCHA. United Nations' Office for the Coordination of Humanitarian Affairs: Ethiopia, (65/October 2015), 1–3. Weekly Humanitarian Bulletin: . 2018.
103. CSA. Demography and health survey EPHI. 2016.
104. Blössner M OMD. Malnutrition: quantifying the health impact at national and local levels. Environ Burd Dis Ser. 2005;12(12):43.
105. KY SA. Malnutrition: Causes and Strategies. J Food Process Technol. 2015;06(04).
106. Unicef. THE STATE OF THE WORLD'S CHILDREN. Children. In: Press OU, editor. 1998
107. C B. Conceptual Models of Child Malnutrition the Acf Approach in Mental Health and Care Practices 2012 15-50.
108. UNICEF. The state of the world's children 2014 in numbers: every child counts. New York: UNICEF. 3. 2014.
109. UNICEF. Improving child nutrition, The achievable imperative for global progress NCSL legisbrief. 2013;18:1-2.
110. Krishna A OJ, Lee J, Lee H-Y, Perkins JM, Heo J, et al. Short-term and long-term associations between household wealth and physical growth: a cross-comparative analysis of children from four low- and middle-income countries. Glob Health Action. 2015;8(26523).
111. Habimana S BE. Risk Factors Of Stunting Among Children Under 5 Years Of Age In The Eastern And Western Provinces Of Rwanda: Analysis Of Rwanda Demographic And Health Survey 2014/2015 Pediatr Heal Med Ther. 2019;10(115-30).
112. Kim R M-GI, Corsi DJ, Aguayo VM, Subramanian S V. Relative importance of 13 correlates of child stunting in South Asia: Insights from nationally representative data from Afghanistan, Bangladesh, India, Nepal, and Pakistan. Soc Sci Med. 2017;187:144-54.
113. Angdembe MR DB, Bhattarai K, Karn S. Trends and predictors of inequality in childhood stunting in Nepal from 1996 to 2016. Int J Equity Health. 2019;18(1):1-17.
114. Fenske N BJ, Hothorn T, Rehfuess EA. . Understanding child stunting in India: a comprehensive analysis of socio-economic, nutritional and environmental determinants using additive quantile regression. PloS One. 2013;8(11).
115. Mian RM AM, Ferroni PA, Underwood P. The nutritional status of school-aged children in an urban squatter settlement in Pakistan. Pakistan Journal of Nutrition. 2002;1(3):121-3.

116. Veiga GR FH, Sawaya AL, Calado J, Florêncio TM. Dyslipidaemia and undernutrition in children from impoverished areas of Maceió, state of Alagoas, Brazil. International Journal of Environmental Research and Public Health. 2010;7(12):4139-51.
117. D. H. An analysis of trends and determinants of child under nutrition in Ethiopia, 2000–2011. . International Food Policy Research Institute (IFPRI). 2014.
118. Biadgilign S SA, Yesigat H. Does Economic Growth Reduce Childhood Under nutrition in Ethiopia. Plos One. 2016.
119. Leander R. Buismana∗ EVdP, Owen O'Donnellb, Eddy K.A. van Doorslae. What explains the fall in child stunting in Sub-Saharan Africa? . Population Health.
120. Mahama Saaka aSZG. Relationships between Wasting and Stunting and their concurrent occurrence in Ghanaian Preschool Children. . Hindawi Publishing Corporation Journal of Nutrition and Metabolism Volume 2016.
121. UNICEF. communication UDo. Tracking progress on child and maternal nutrition: a survival and development priority 2009.
122. Martorell R, & Zongrone, A. Intergenerational influences on child growth and undernutrition Paediatric and Perinatal Epidemiology, . 2012:302-14.
123. FMoH. Situation Analysis of the Nutrition Sector in Ethiopia 2000-2015. In: Ethiopian Federal Ministry of Health U, and European Commission Delegation, Addis Ababa, Ethiopia, editor. 2016b.
124. al Ge. Is the adapted Household Food Insecurity Access Scale (HFIAS) developed internationally to measure food insecurity valid in urban and rural households of Ethiopia? . BMC Nutrition. 2015;1(1):2.
125. Outes I PC. Catching up from early nutritional deficits? Evidence from rural Ethiopia. Econ Hum Biol. 2013;11(14863).
126. Behrman J HJ. An evaluation of the impact of PROGRESA on child height. Washington, DC. International Food Policy Research Institute. 2001;21.
127. P. G. Do conditional cash transfers improve child health? Evidence from PROGRESA's control randomized experiment. Am Econ Rev. 2004; 94(33641):22.
128. Hoddinott J BJ, Maluccio JA, Melgar P, Quisumbing AR, Ramirez-Zea M, et al. Adult consequences of growth failure in early childhood. Am J Clin Nutr 2013;98(11708):23.
129. Hoddinott J SE. The impact of PROGRESA on food consumption. . Econ Dev Cult Change 2004; 53(3761).

Figures

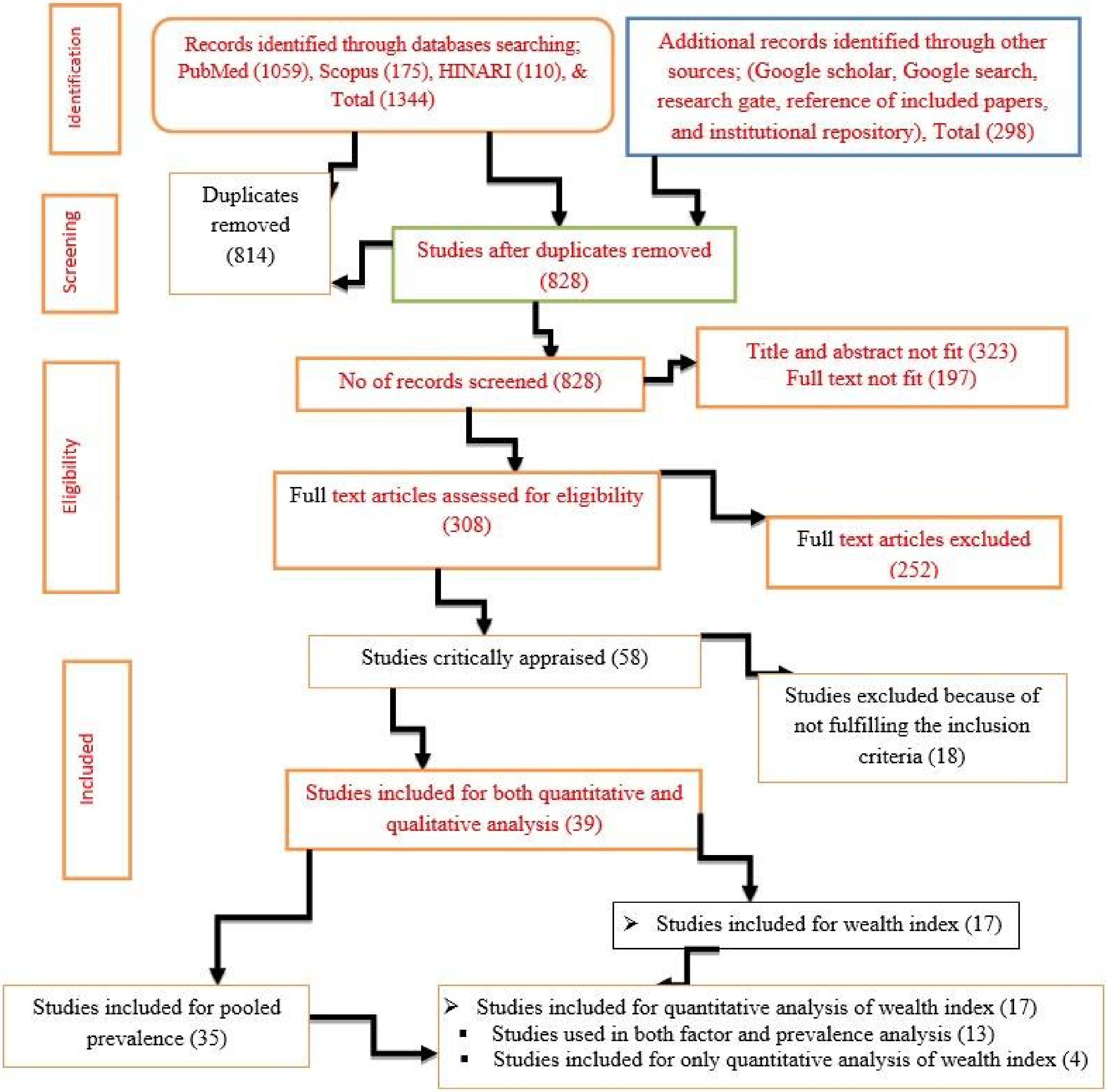

Figure 1

The PRISMA flowchart that indicates the study selection and appraisal process in reviewing wealth quintiles and stunting associations in Ethiopia"

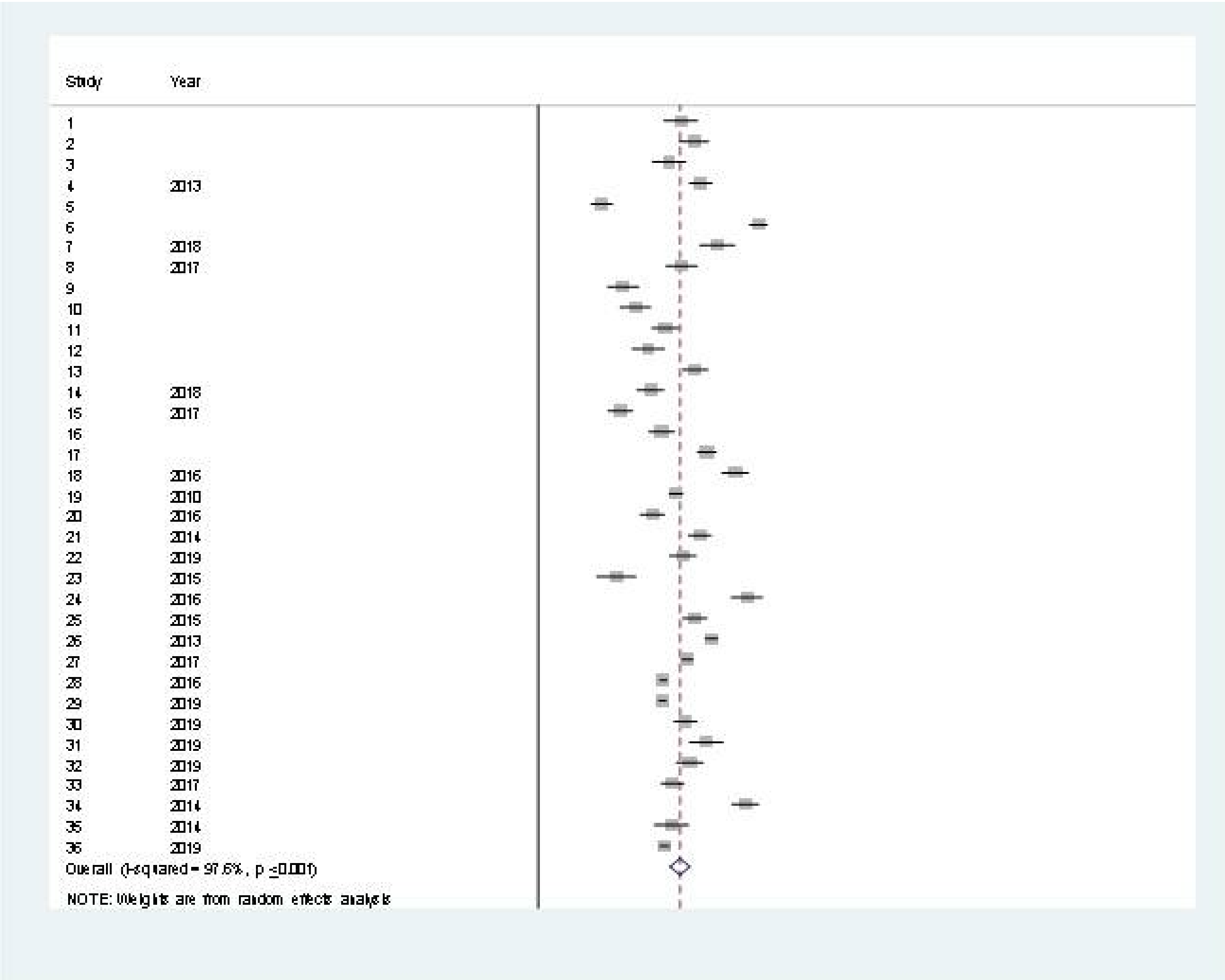

Figure 2

The Pooled magnitude of stunting from 36 studies conducted in Ethiopia between 2010 and 2019 using random effect model

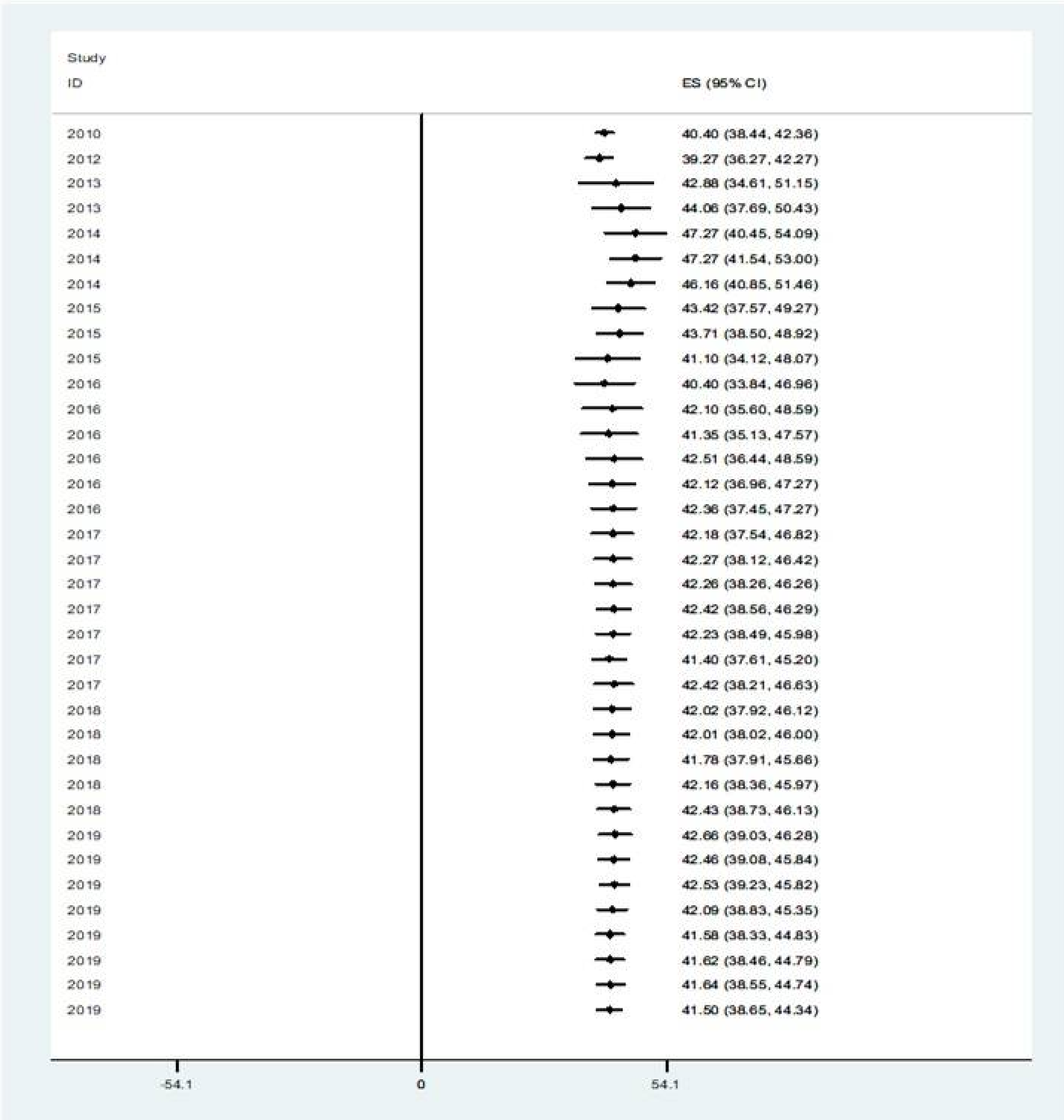

Figure 3

The trends of stunting prevalence in Ethiopia from 2010 to 2019 using cumulative meta-analysis

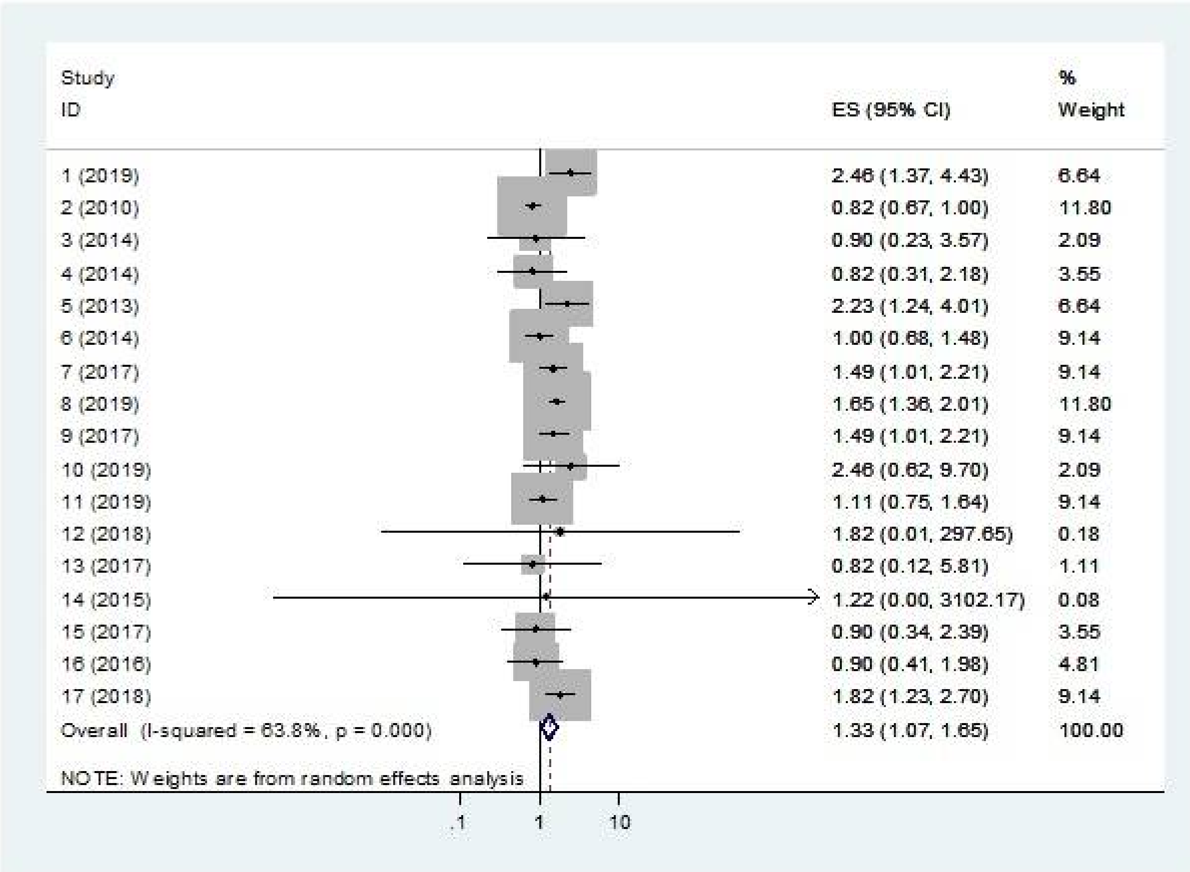

Figure 4

The pooled association of stunting and medium household wealth index in Ethiopia using studies from 2010 to 2019

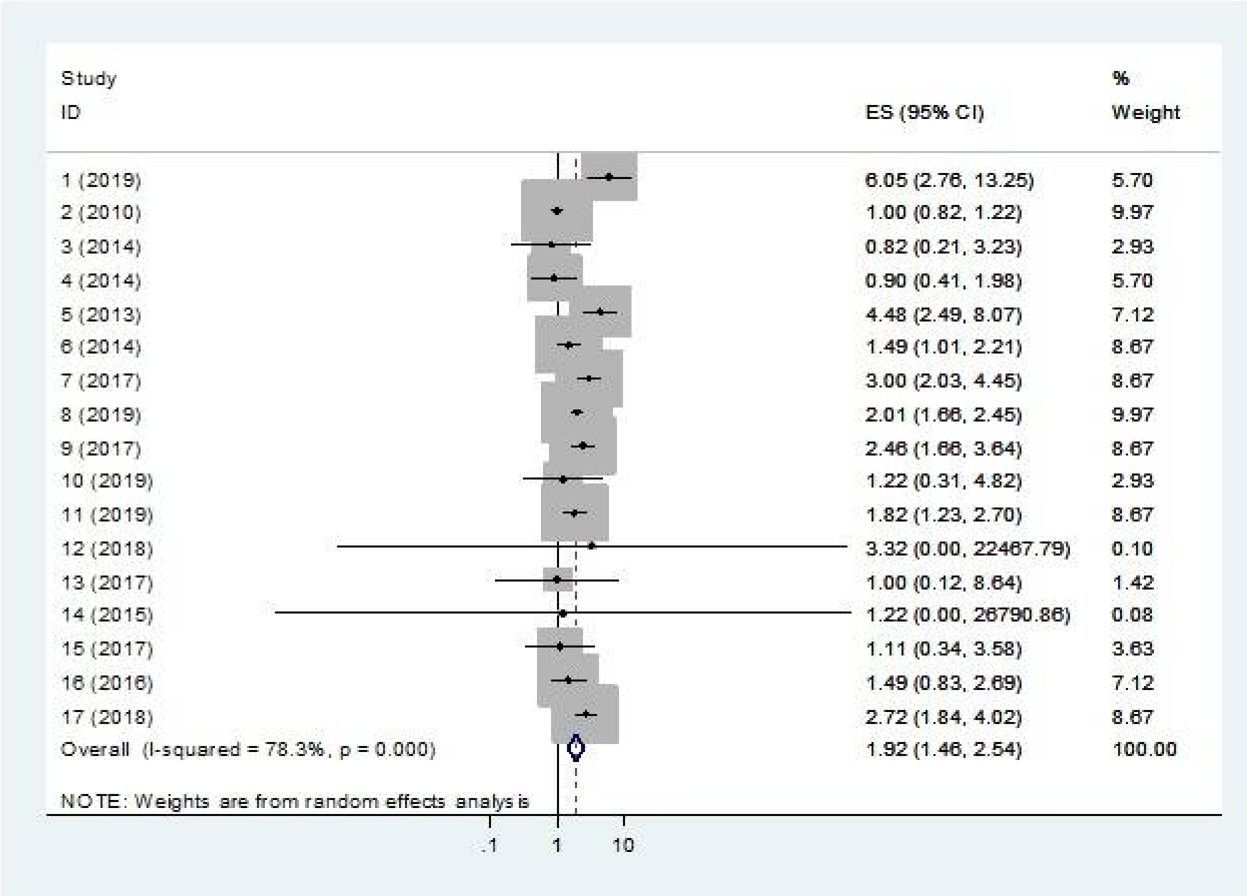

Figure 5

The pooled association of stunting and poor household wealth index in Ethiopia using studies from 2010 to 2019

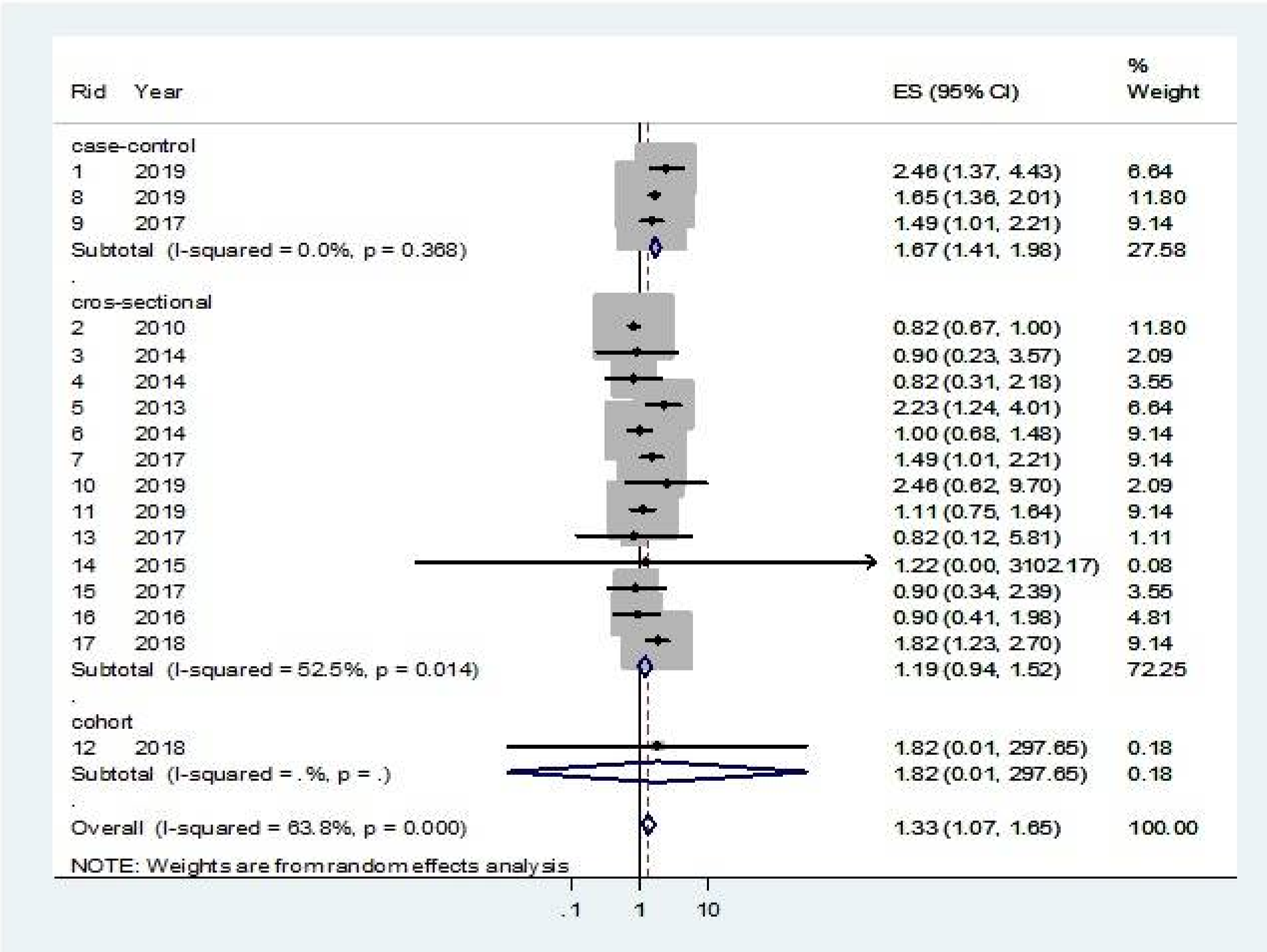

Figure 6

A subgroup analysis of the pooled random effect size estimates of medium wealth index and stunting associations by design of study subjects in Ethiopia between 2010 and 2019

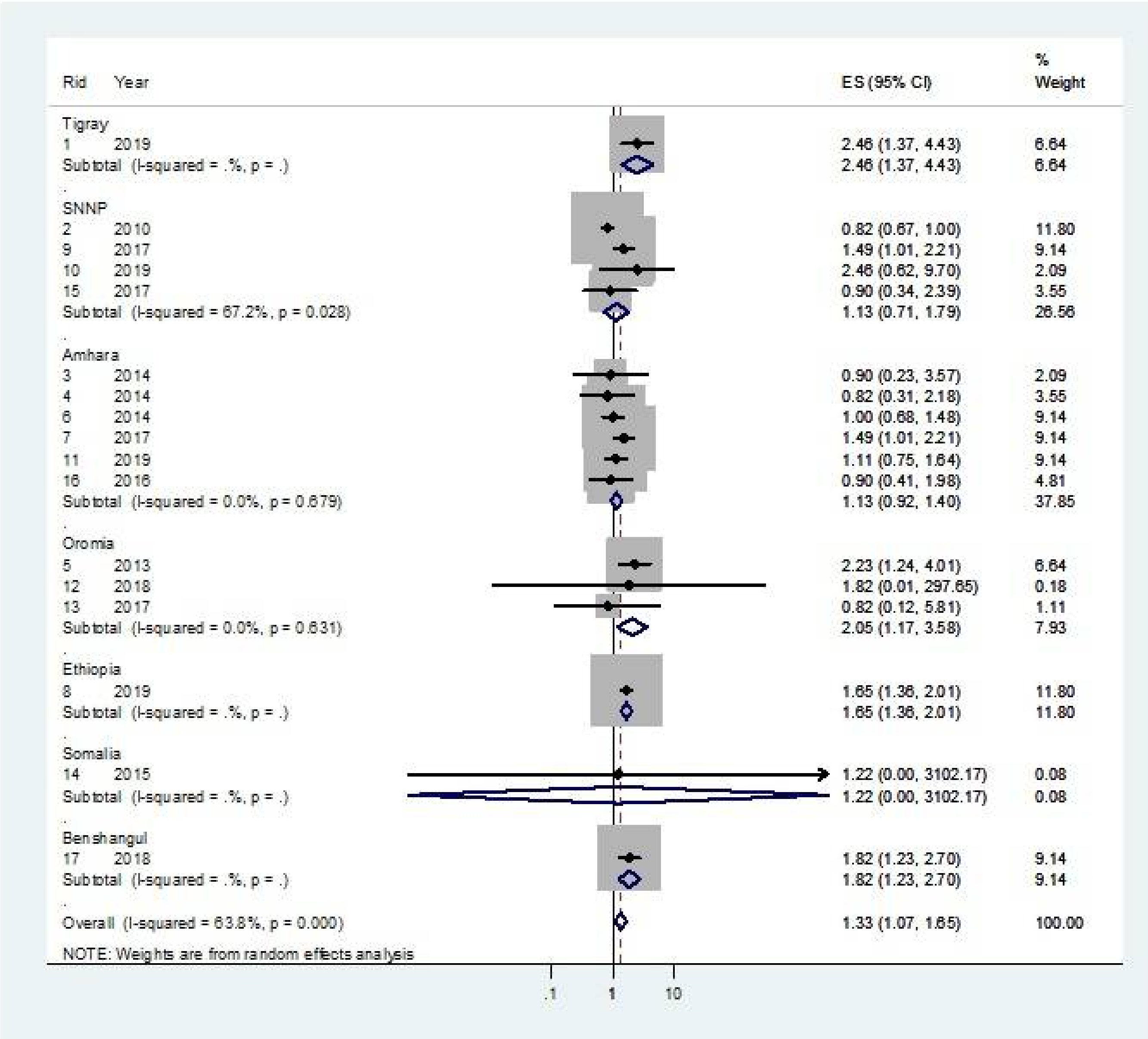

Figure 7

A subgroup analysis of the pooled random effect size estimates of medium wealth index and stunting association by regions of study subjects in Ethiopia between 2010 and 2019

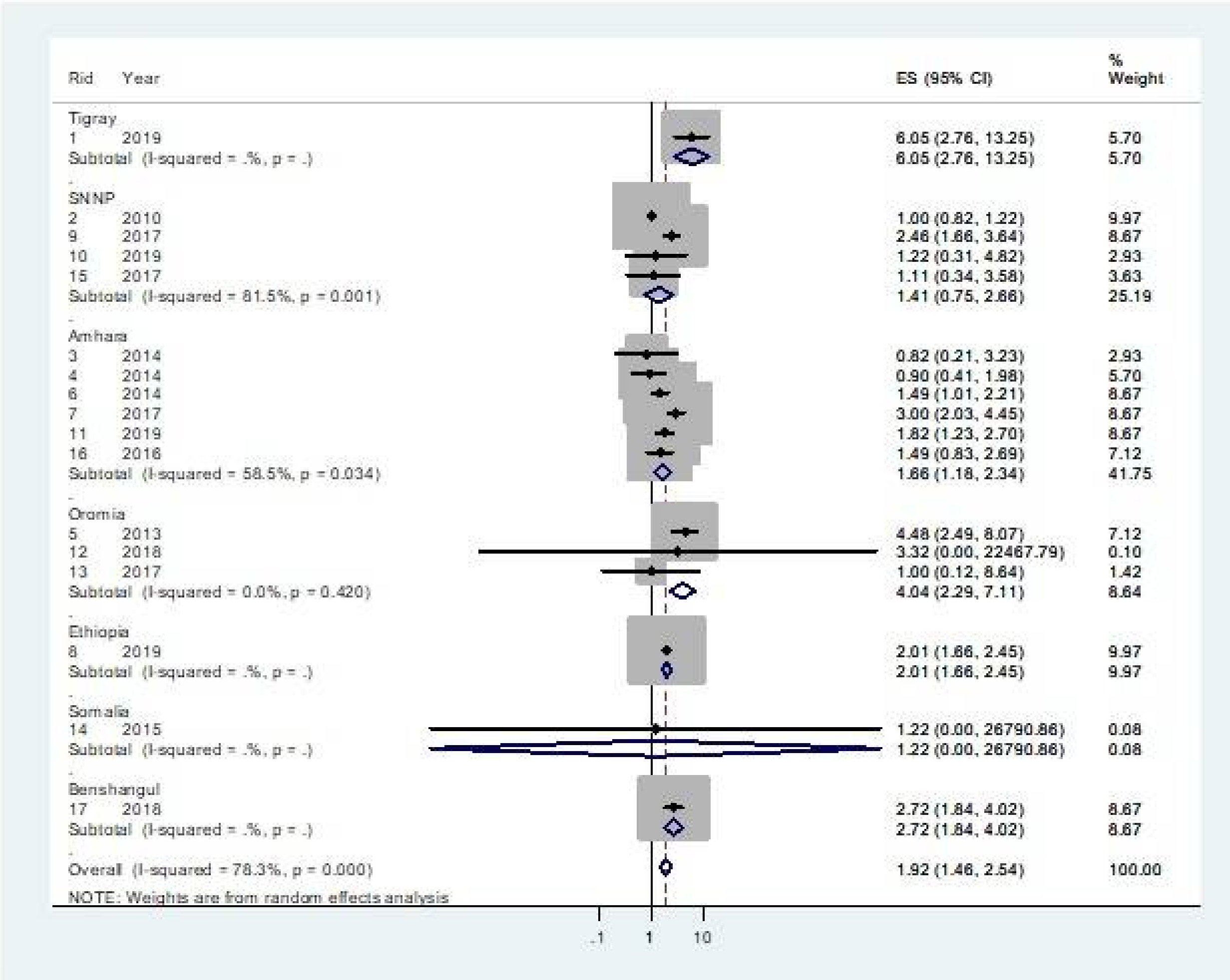

Figure 8

A subgroup analysis of the pooled random effect size estimates of poor household wealth index and stunting association by regions of study subjects in Ethiopia between 2010 and 2019

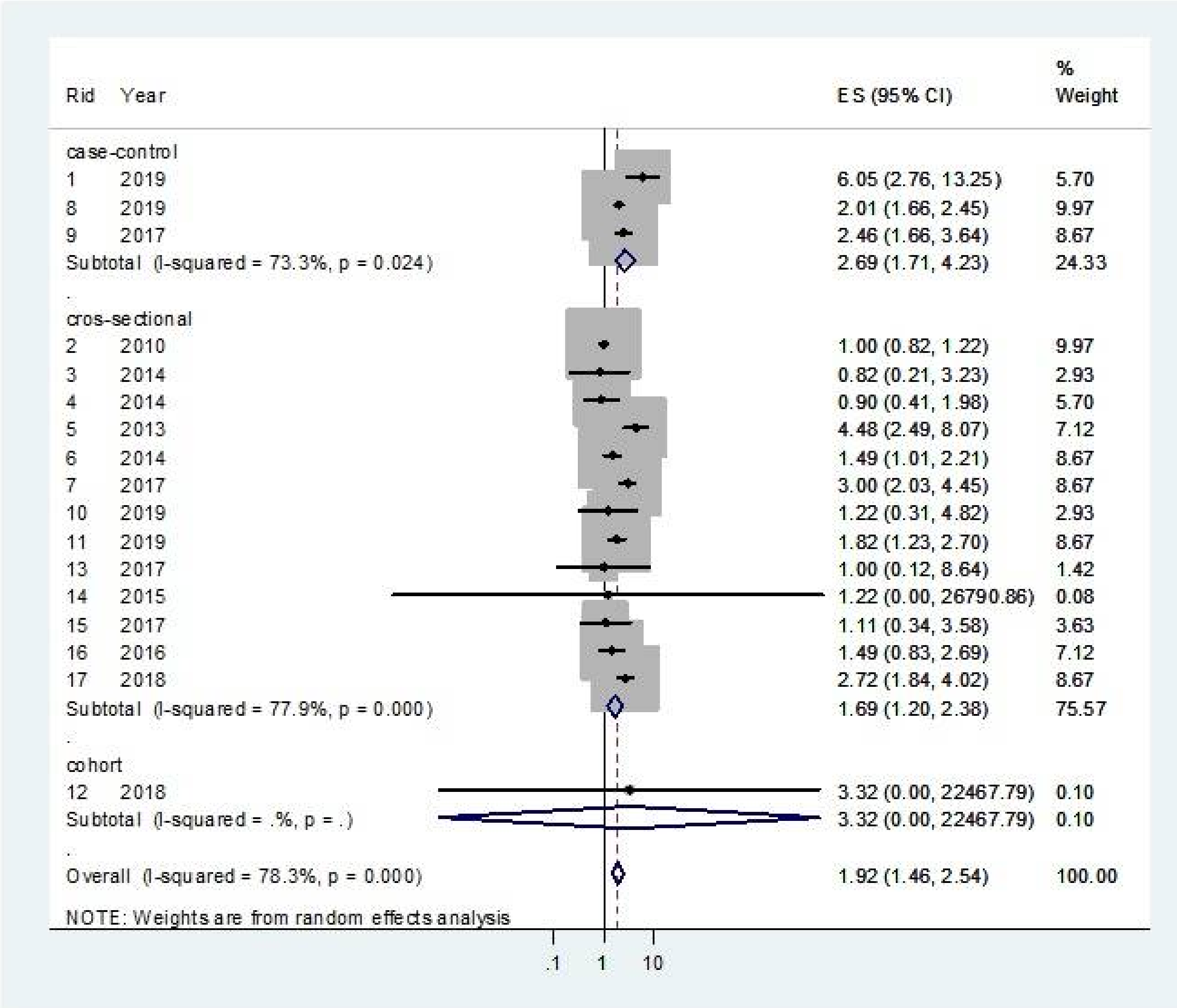

Figure 9

A subgroup analysis of the pooled random effect size estimates of poor household wealth index and stunting association by designs of study subjects in Ethiopia between 2010 and 2019

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CoverLetter.doc
- Supplementaryfigure2.docx
- Supplementaryfigure1.docx