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## Prevalence of overweight and obesity among adults in Ethiopia: A systematic review and meta-analysis

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# Prevalence of overweight and obesity among adults in Ethiopia: A systematic review and meta-analysis

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## **Abstract**

**Background:** Overweight and obesity are emerging public health problems in developing countries including Ethiopia. Despite the presence of multiple studies, primary study findings on the prevalence of overweight and obesity in Ethiopia are inconsistent. Therefore, this study aimed to estimate the pooled prevalence of overweight and obesity among adults in Ethiopia.

**Methods:** PubMed, Scopus, Cochrane Library, and Google Scholar were searched for studies that looked at overweight and obesity among adults. The Cochran's Q chi-square and the I<sup>2</sup> test statistics were used to check heterogeneity among the studies. The funnel plot and Egger's regression tests were also used to assess the presence of publication bias. A weighted inverse variance random-effects model was applied to estimate the pooled national prevalence of overweight and obesity with a 95% confidence interval across the studies. Subgroup analysis was

1 performed by residence, study setting, sample size, and year of study. Sensitivity analysis was  
2 also conducted to assess the effect of a single study on the pooled estimates. Data analysis was  
3 done using STATA™ Version 14 software.  
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8  
9 **Results:** In this systematic review and meta-analysis, a total of 16 studies with 19,527 study  
10 participants were included to estimate the pooled prevalence of overweight and obesity among  
11 adults. Among these studies, 14 were used to estimate the pooled prevalence of overweight, and  
12 all the 16 studies were used to estimate the pooled prevalence of obesity. The estimated pooled  
13 prevalence of overweight among adults in Ethiopia was 20.4%, and after adjustment for  
14 publication bias with the trim and fill analysis the estimated prevalence rate was changed to 19%.  
15 Besides, the estimated pooled prevalence of obesity was 5.4%. The prevalence rate of  
16 overweight and obesity was different from rural to urban and from time to time with an  
17 increasing fashion.  
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30 **Conclusion:** The prevalence of overweight and obesity is increasing in Ethiopia compared to  
31 previous studies. This needs large scale awareness creation campaigns and situation-based and  
32 context-specific prevention strategies.  
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37 **Keywords:** Adult; Ethiopia; Obesity; Overweight  
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## 40 **Strength and limitation of the study**

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43 ❖ **Strength:** The study has used a pre-specified protocol for search strategy and data  
44 abstraction and used internationally accepted tools for a critical appraisal system for quality  
45 assessment of individual studies.  
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- 49  
50 ❖ **Limitations:** It is difficult to determine if the results from various regions are  
51 representative of the entire country, as no data were found for all region of the country.  
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## Introduction

Overnutrition is becoming a major global health problem. It includes, overweight, obesity and diet-related non-communicable diseases (1). Overweight and obesity are used to refer an abnormal or excessive fat accumulation that can put people at greater risk and may impair their health (2). Obesity is considered an illness that necessitates immediate reversal to prevent early and untimely death among patients (3, 4).

Overweight and obesity affect all age groups of people both in developed and developing countries regardless of their socioeconomic status (1, 5). Since 1980; the prevalence of obesity has doubled in more than 70 countries and has continuously increased in most other countries (6).

In 2016, more than 1.9 billion adults were overweight worldwide. Of these, over 650 million were obese. Overweight accounted for 39% (39% of men and 40% of women), and obesity 13% (11% of men and 15% of women) in the same year (7).

The prevalence of overweight and obesity is escalating in developing countries, particularly among urban dwellers and wealthier people due to the influence of demographic, epidemiologic, and nutrition transitions (8). According to a study on the global trends of overweight and obesity, 26.9% of adults in Africa are overweight and obese (9).

Overweight and obesity in adults are associated which increased risk of diabetes, hypertension, and other chronic diseases. In addition to these chronic diseases, overweight and obesity in women increases the risk of cesarean section delivery, postpartum hemorrhage, high birth weight babies, and infant overweight and obesity (1, 10).

1  
2 Most of the world's population live in countries where overweight and obesity kills more  
3  
4 people than underweight (11). In 2015, high body mass index (BMI) had caused an estimated 4  
5  
6 million deaths globally, and nearly 40% of these deaths occurred in persons who were  
7  
8 overweight but not obese. More than two-thirds of deaths related to high BMI were due to  
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10 cardiovascular diseases (6, 12). The latest WHO reports also showed that overweight and obesity  
11  
12 are becoming the leading causes of death worldwide (1, 13).  
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16  
17 Overweight and obesity costs the world billions of dollars a year in lost opportunities for  
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19 economic growth and lost investments in human capital associated with increased preventable  
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21 morbidity and mortality rates in both children and adults (1, 14).  
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25 Ethiopia is not different. According to the 2016 EDHS report, the proportion of  
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27 overweight and obesity among women has increased from 3% in 2000 to 8% in 2016. Similarly,  
28  
29 3% of men were overweight or obese (15).  
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32  
33 Overweight and obesity are associated with many factors including excessive  
34  
35 consumption of alcohol, cigarette smoking and sedentary lifestyle habits (16). Some studies have  
36  
37 also reported that the risk of overweight and obesity is increased with education in developing  
38  
39 countries (17, 18) and wealth (15, 19, 20).  
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42  
43 As a treatment, behavioral and pharmaceutical interventions are available and helpful in  
44  
45 getting weight loss. A reduction of 5% to 7% of body weight alone is associated with a lower  
46  
47 incidence of diabetes, hypertension and other cardiovascular diseases. Larger weight loss has  
48  
49 even been linked with better improvements in controlling the level of blood glucose and lipids in  
50  
51 limited surgical outcomes data (21).  
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1  
2 Therefore, knowing the prevalence of overweight and obesity is paramount to design  
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4 preventive strategies. However, primary studies on the prevalence of overweight and obesity in  
5  
6 Ethiopia are inconclusive. Hence, this systematic review and meta-analysis aimed to determine  
7  
8 the pooled prevalence of overweight and obesity among adults in Ethiopia.  
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## 10 11 12 **Methods**

### 13 14 **Literature search strategy**

15  
16 Firstly, The Cochrane Library, Joanna Briggs Institute (JBI) and PROSPERO databases  
17  
18 were searched to check whether a systematic review and meta-analysis studies exist or for the  
19  
20 presence of ongoing projects related to overweight and obesity in Ethiopia. The necessary  
21  
22 articles were searched using PubMed, Scopus, Google scholar, and African journals online.  
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26 For this study relevant articles were identified using the following terms: “overweight”,  
27  
28 “obesity”, “nutrition”, “malnutrition”, “undernutrition”, “over nutrition”, “adults”, “elders”,  
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30 “geriatrics” “Ethiopia”. The key terms were used in combination using Boolean operators like  
31  
32 “OR” or “AND”. The searches were restricted to full texts, free articles, human studies, and  
33  
34 English language publications. This search involved articles published from January 1<sup>st</sup>, 2010 to  
35  
36 March 10<sup>th</sup>, 2020. Grey literatures like surveillance report, academic dissertations, and  
37  
38 conference abstracts were also examined and included when they deemed low risk.  
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43 Besides, the reference lists of included articles in this systematic review and meta-  
44  
45 analysis were hand-searched to identify any relevant additional articles. PubMed search strategy:  
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47 (((((((((overweight) OR obesity) OR nutrition) OR malnutrition) OR over nutrition) OR  
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49 undernutrition) AND Adults) OR Elders) OR Geriatrics) AND Ethiopia)))))))).  
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## Eligibility criteria

Studies were included in this systematic review and meta-analysis if they followed the following guidelines: (1) all observational study designs (cross-sectional, case-control, and cohort studies) which reported the prevalence of overweight and obesity or one of them; (2) published from 2010 to 2020; (3) published in English language; (4) abstract and, or full text available for this review; and (5) conducted in Ethiopia. Studies were excluded if they: (1) possessed a poor quality score as per the stated criteria; (2) failed to determine the desired outcomes (overweight and obesity); and (3) included children and adolescents.

## Outcomes of interest

The main outcomes of interest were the prevalence of overweight and obesity reported in the original papers either as a percentage or as the number of cases (n) / total number of study participants (N). These two parameters were necessary to calculate the pooled prevalence of overweight and obesity in the meta-analysis. Therefore, the prevalence rate was calculated by dividing the number of individuals who were overweight and, or obese to the total number of study participants (sample size) multiplied by 100.

The outcome variables of interest were categorized as follows based on the WHO Classification of body mass index; overweight if the BMI is 25.0-29.9kg/m<sup>2</sup> and obese if it is  $\geq 30.0$ kg/m<sup>2</sup> for the study participants of the included studies in the systematic review and meta-analysis (22).

## Data extraction

The authors developed a data extraction form on the excel sheet which includes the author name, year of publication, study setting, study design, sex of participants, sample size, and the prevalence of overweight and obesity. The data extraction sheet was piloted using 5

1 papers randomly. The extraction form was adjusted after having a piloted template. Two of the  
2 authors independently extracted all the necessary data from each study using the data extraction  
3 format. The third author checked the correctness of the data independently. Any disagreements  
4 between authors who extracted the data were resolved through discussions with the third  
5 reviewer and fourth reviewer when required. For articles that did not provide details of their  
6 study background, corresponding authors were contacted through e-mail and asked for the  
7 relevant information, such as study time, region, or others.

### 18 **Quality assessment**

20 Two independent authors assessed the methodological quality of all of the potential  
21 studies to be included in the analysis. Any disagreements between the authors were resolved  
22 through discussion or, if consensus could not be reached, consultation with a third independent  
23 author was considered. The quality of each included study was assessed using the JBI quality  
24 appraisal checklist for cross-sectional studies (23). Because the articles included in this study  
25 were all cross-sectional. Studies were considered low risk when scored 50% and above of the JBI  
26 quality assessment indicators.

### 37 **Statistical analysis**

39 To obtain the pooled prevalence of overweight and obesity, a meta-analysis using the  
40 random-effects model was performed due to the presence of heterogeneity (24). Cochran's Q  
41 chi-square statistic and the I<sup>2</sup> tests were run to assess the random variations between primary  
42 studies (25). In this study, heterogeneity was interpreted as an I<sup>2</sup> value of 0% = no heterogeneity,  
43 ≤ 25% = low, 25%-50% = moderate, and ≥ 75% = high (25). In the case of high heterogeneity,  
44 subgroup and sensitivity analyses were run to identify possible moderators for the heterogeneity.  
45 Potential publication bias was assessed by visually inspecting funnel plots and objectively using

1 the Egger's bias test (26). The trim and fill analysis was done to assess for any publication bias  
2 based on the assumption that the effect sizes of all the studies are normally distributed around the  
3 center of a funnel plot in the absence of publication bias. The meta-analysis was performed using  
4 the STATA™ Version 14 software (27). Finally, for all analysis, a p-value of less than 0.05 was  
5 considered to declare statistically significant values.  
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## 14 **Presentation and reporting of results**

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16 The results of this systematic review and meta-analysis were reported based on the  
17 Preferred Reporting Items for Systematic Review and Meta-Analysis statement (PRISMA)  
18 guideline (Supplementary file-PRISMA checklist) (28). The entire process of study screening,  
19 selection, and inclusion are shown with the support of a flow diagram. Moreover, tables and  
20 narrative summaries are used to report the risk of bias for every eligible study.  
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## 29 **Results**

### 30 **Search results**

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32 In the first step of article searches, 825 studies that were published from 2010-2020 were  
33 retrieved through database searching from five international databases. Three studies were  
34 retrieved through manual search from Grey literatures. Of these studies, 135 duplicate records  
35 were identified and after duplication removal, a total of 690 articles remained. Finally, 22 studies  
36 were screened for full-text review and, 16 articles (n = 19,527 participants) were selected to  
37 estimate the pooled prevalence of overweight and obesity among adults in Ethiopia. The detailed  
38 steps in the screening process are shown in the PRISMA flow chart of the study selection (Fig 1).  
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## Baseline characteristics of included studies

In the current meta-analysis, a total of 16 studies with 19,527 study participants were included to estimate the pooled prevalence of overweight and obesity among adults in Ethiopia. Among these studies, 14 had reported the prevalence of both overweight and obesity and 2 studies had reported the prevalence of obesity only. Concerning the study design, all of the studies included were cross-sectional. The studies included in this systematic review and meta-analysis varied substantially in sample size ranging from 68 to 6,602.

Overall information regarding the prevalence of overweight and obesity among adults was obtained from various regions in the country. Six of the studies involved participants from Amhara (23-28), four from SNNPR (29-32), one from Oromia (33), one from Somali (34), one from Tigray (35), one from Addis Ababa (36) and two studies involving participants from different regions (37, 38).

Regarding sampling, all of the studies had used the probability sampling technique. The quality score of each primary study, based on the JBI quality appraisal criteria showed no considerable risk; hence, all the studies were included in this systematic review and meta-analysis (**Supplementary Table 1**).

## The pooled prevalence of overweight among adults in Ethiopia

Fourteen studies (n=14) had reported the prevalence of overweight among adults in different regions of Ethiopia (Supplementary Table 1). The prevalence of overweight reported in the country ranges from 4.7% (33) to 40.1% (32). The random-effects model analysis from those studies revealed that in this meta-analysis, the estimated pooled prevalence of overweight among adults in Ethiopia was 20.44% (95% CI: 16.69, 24.19) with a significant level of heterogeneity among the studies ( $I^2 = 97.6\%$ ;  $p \leq 0.001$ ) (Fig 2).

## The pooled prevalence of obesity among adults in Ethiopia

Besides overweight, sixteen studies (n=16) had reported the prevalence of obesity among adults in different parts of the country (Supplementary Table 1). The prevalence of obesity reported in the country ranges from 1.6% (33) to 16.2% (25). In this meta-analysis, the estimated pooled prevalence of obesity among adults was 5.44% (95% CI: 4.37, 6.51) with a significant level of heterogeneity among the studies in the random-effects model analysis ( $I^2 = 93.3\%$ ,  $p \leq 0.001$ ) (Fig 3).

### Subgroup analysis

There was a significant level of heterogeneity among the primary studies included in this systematic review and meta-analysis. Thus, a subgroup analysis was conducted through stratification using study year, residence, study setting, and sample size to identify the sources of heterogeneity for the pooled prevalence of overweight and obesity among adults.

In the subgroup analysis, the prevalence of overweight was found to be 22.55% in studies published since 2015, 22.43% in studies conducted only in urban settings, 20.44% in institution-based settings and 24.39% in studies with a sample size of less than or equal to 384 participants.

Similarly, the prevalence of obesity was found to be 6.90% in studies published since 2015, 6.23% in studies conducted only in urban settings, 6.41% in institution-based settings and 9.61% in studies with a sample size of less than or equal to 384 participants (**Table 1**).

**Table 1:** Prevalence of overweight and obesity in Ethiopia after subgroup analysis by characteristics of the studies included.

Subgroup	No. of studies	Overweight (95%CI)	I <sup>2</sup> and P-value	No. of studies	Obesity (95%CI)	I <sup>2</sup> and P-value
<b>Year of study</b>						
Before 2015	6	17.49(12.17,22.81)	(96.5%, p≤0.001)	7	3.74(2.73,4.75)	(82.3%, p≤0.001)
After 2015	8	22.55(16.57,28.54)	(98.2%, p≤0.001)	9	6.90(4.89,8.92)	(95.8%, p≤0.001)
<b>Residence</b>						
Urban	12	22.43(17.76,27.10)	(97.4%, p≤0.001)	14	6.23(4.92,7.54)	(92.6%, p≤0.001)
Rural	-	-	-	-	-	-
Both	2	10.15(8.70,11.61)	(60.5%, p≥0.05)	2	1.93(1.54,2.32)	(0.0%, p≥0.05)
<b>Setting</b>						
Community based	9	19.46(15.93,23.00)	(95.8%, p≤0.001)	10	5.13(3.90,6.35)	(92.9%, p≤0.001)
Institution based	5	20.44(16.69,24.19)	(98.9%, p≤0.001)	6	6.41(3.79,9.03)	(94.8%, p≤0.001)
<b>Sample size</b>						
<384	4	24.39(6.71,42.08)	(98.7%, p≤0.001)	5	9.61(3.94,15.28)	(94.8%, p≤0.001)
>384	10	19.34(15.59,23.09)	(97.4%, p≤0.001)	11	4.55(3.54,5.55)	(92.5%, p≤0.001)

### Sensitivity analysis for the prevalence of overweight

To evaluate the effect of individual studies on the pooled prevalence of overweight among adults in Ethiopia, a sensitivity analysis was performed using the random-effects model. The results from the sensitivity analysis had revealed that a single study had not influenced the pooled estimated prevalence of overweight among adults. The pooled estimated prevalence of overweight varied between 18.92 (15.39, 22.44) (32) and 21.69 (17.89, 25.48) (33) after the deletion of a single study (Fig 4).

### Sensitivity analysis for the studies included in obesity

To check the effect of individual studies on the pooled prevalence of obesity in Ethiopia, a sensitivity analysis was performed using the random-effects model and the results had revealed that there was no influential study on the pooled estimated prevalence of obesity among adults. The pooled estimated prevalence of obesity ranged from 4.98 (3.97, 5.99) (32) and 5.83 (4.64, 7.03) (31) after the deletion of a single study (Fig 5).

## Publication bias

There was a publication bias among the included studies in both overweight and obesity as illustrated by the asymmetrical distribution of funnel plot tests (Supplementary Fig 1 and 2 ). Similarly, the results of Egger's tests for the funnel plot were statistically significant for the presence of publication bias ( $P = 0.002$  for overweight and  $p \leq 0.001$  for obesity) respectively (Fig 6 and 7).

## Trim and fill analysis for the prevalence of overweight and obesity

To reduce and adjust publication bias in the studies, trim and fill analysis was performed to estimate the number of missing studies that might exist. After adjustment for publication bias, the estimated pooled prevalence of overweight among adults in Ethiopia was 19.02 (95% CI: 15.29, 22.74) with a significant level of heterogeneity among the studies ( $I^2 = 50.29\%$ ;  $p \leq 0.001$ ) (Fig 8).

Likewise, studies included in obesity estimation among adults in Ethiopia were adjusted with trim and fill analysis. After adjustment, the estimated pooled prevalence of obesity was found to be 5.44% (95% CI: 4.37, 6.51). This finding is similar with the unadjusted prevalence rate of obesity, but with different levels of heterogeneity among the studies in the random-effects model analysis ( $I^2 = 3.71\%$ ,  $p \leq 0.001$ ) (Fig 9).

## Discussion

This systematic review and meta-analysis were conducted to estimate the pooled prevalence of overweight and obesity among adults in Ethiopia. In this study, the estimated pooled prevalence of overweight among adults was 20.4%. However, due to the presence of publication bias, after adjustment with the trim and fill analysis, the estimated prevalence rate was changed to 19%. Besides, the estimated pooled prevalence of obesity among adults in

1 Ethiopia was 5.4%. This finding is higher than the 2011 and 2016 Ethiopian demographic and  
2 health survey reports indicating an increasing trend in overweight and obesity prevalence rates  
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4 (39). The result is in line with a meta-analysis in the Asian Pacific region which has reported that  
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6 the prevalence of over nutrition was estimated at 23% (40).  
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11 A consistent finding has been also reported from a study in Ghana that the national  
12 prevalence of overweight was estimated at 25.4%. However, obesity in the Ghanaian study was  
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14 significantly higher (17.1%) than the current study (41).  
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19 Similar to the Ghanaian study, a study in Iran has shown that the prevalence of obesity in  
20 adults of Iran was 21.4% based on a meta-analysis of studies in the country (42). Another meta-  
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22 analysis in Iran among military personnel has also indicated that the pooled prevalence of  
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24 overweight and obesity was 41% and 13% respectively, a significantly higher value than our  
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26 study finding (43).  
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31 These discrepancies might be due to differences in the study population, the  
32 developmental level of these countries, and the educational level of participants. One of the  
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34 Iranian studies was conducted among military personnel and may not be representative of the  
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36 national prevalence of overweight and obesity because the high prevalence rate may be  
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38 occupation-related (43). This might be also due to their capacity of purchasing more energy-  
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40 dense foods as witnessed from studies in both developed and developing countries that high-  
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42 income households purchased foods in bulk and were more likely to over-consume these foods  
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44 (44-46).  
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51 Likewise, the prevalence of overweight and obesity in Ethiopia is significantly lower than  
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53 a study in Spain that the estimated prevalence of overweight in the Spanish adult population was  
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1 39.3% and obesity was 21.6% (47). The Spanish result is in line with the WHO global report that  
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3 39% of adults aged 18 years and over were overweight in 2016, and 13% were obese (7).  
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7 There was a significant level of heterogeneity among the primary studies included in this  
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9 systematic review and meta-analysis. Thus, a subgroup analysis was conducted through  
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11 stratification using study year, residence, study setting, and sample size in order to identify the  
12  
13 sources of heterogeneity to the pooled prevalence of overweight and obesity. The prevalence of  
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15 overweight was found to be higher in some groups; 22.55% in studies conducted since 2015,  
16  
17 22.43% in studies conducted only in urban settings, 20.44% in institution-based settings and  
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19 24.39% in studies with a sample size of less than or equal to 384 participants. This indicates that  
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21 overweight is in an increasing trend among adults in Ethiopia compared to previous studies (39).  
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26 Besides, the prevalence of obesity was found to be 6.90% in studies conducted since  
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28 2015, 6.23% in studies conducted only in urban settings, 6.41% in institution-based settings and  
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30 9.61% in studies with a sample size of less than or equal to 384 participants. This means the  
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32 prevalence of overweight and obesity is increasing from time to time especially among urban  
33  
34 residents. The finding is in line with the Ghanaian study which has reported a higher prevalence  
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36 of overweight (27.2% in urban and 16.7% in rural), and obesity (20.6% in urban and 8.0% in  
37  
38 rural settings) among urban than rural residents (41). Similar findings have been reported from  
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40 other studies (18, 39, 48).  
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45 This finding might be due to the rapid demographic, epidemiologic, and nutrition  
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47 transitions in Ethiopia because urbanization and a shift in nutritional habits are the major known  
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49 factors which predispose people to overweight and obesity (8). The other reason could be due to  
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51 differences in lifestyle of urban dwellers as compared to the rural residents. Unlike rural  
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53 residents who are usually more actively involved in a less sedentary lifestyle and more laborious  
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1 activities, the occupation of urban dwellers may result in sedentary type lifestyles among adults  
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4 (49-51).  
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## 6 7 **Conclusion**

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10 This study revealed that the prevalence of overweight and obesity is increasing in  
11 Ethiopia compared to previous studies. The prevalence rate of overweight and obesity is different  
12 from rural to urban and time to time with an increasing fashion. Hence, large scale awareness  
13 creation campaigns and situation-based and context-specific preventive strategies need to be  
14 designed to reduce the burden of overweight and obesity in the country. Moreover, this  
15 systematic review and meta-analysis may help policymakers and program managers to design  
16 strategies on the prevention methods of overweight and obesity among adults in Ethiopia.  
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## 26 27 **Abbreviations**

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29 AOR: Adjusted Odds Ratio; BMI: Body mass index; CI: Confidence Interval; JBI:  
30 Joanna Briggs Institute; SNNPR: Southern Nations, Nationalities, and Peoples Region;  
31 PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses.  
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## 36 37 **Declaration**

### 38 39 **Ethics approval and consent to participate**

40  
41 Not applicable.  
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### 43 44 **Consent for publication**

45  
46 Not applicable.  
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### 48 49 **Availability of data and materials**

50 The data used during this systematic review and meta-analysis is available within the  
51 article and the supporting file.  
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## Competing interest

The authors declare that no competing interests exist.

## Funding

Not applicable.

## Author's contribution

AM and BB developed the study protocol and were involved in the design, selection of study, data extraction, statistical analysis, and writing the initial drafts of the manuscript. MW was involved in data extraction, quality assessment, statistical analysis, and revising. AM and BB prepared and edited the final manuscript. All authors have read and approved the submission of the final version of the manuscript.

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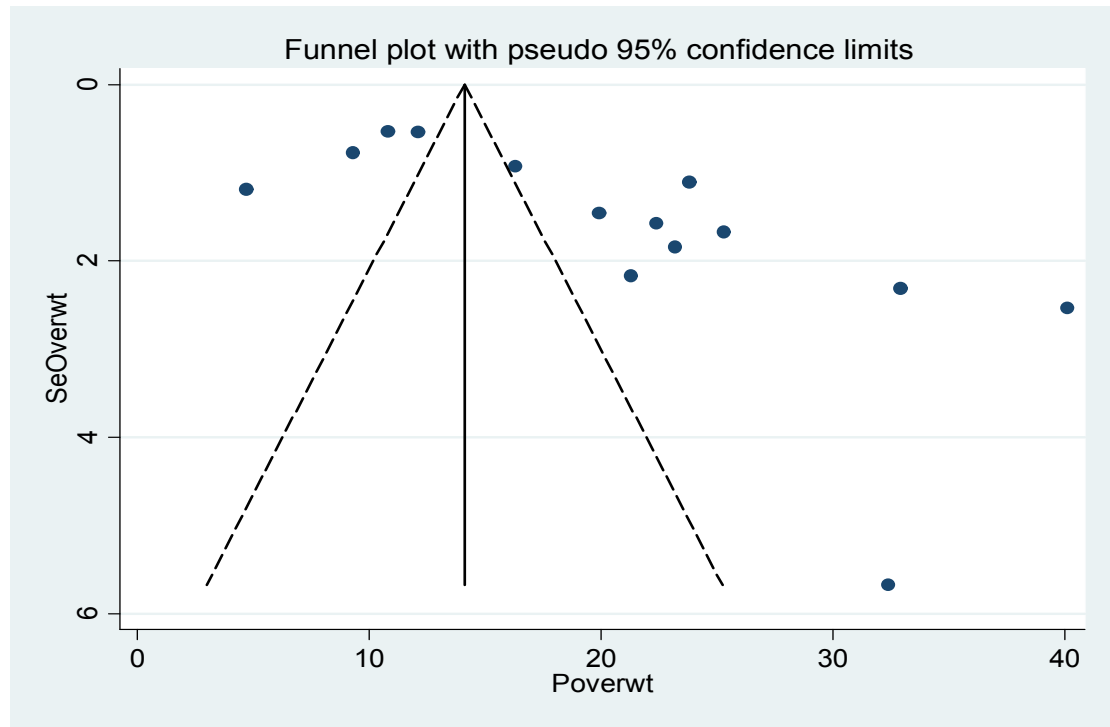


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**Supplementary Table 1:** Distribution of studies on the prevalence overweight and obesity among adults in Ethiopia, 2010-2020.

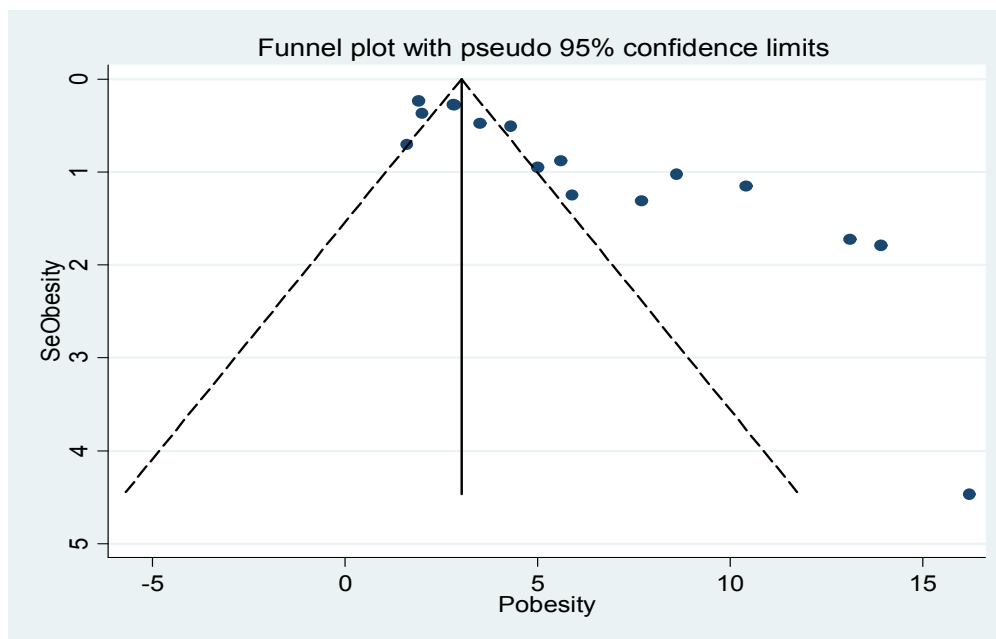
Author	Year of study	Publication year	Region	Setting	Sample Size	Prevalence of overweight	Prevalence of obesity	Quality Score
Abera D, etal	After 2015	2017	SNNPR	Urban	413	32.9	7.7	Low risk
Abrha S, etal	Before 2015	2016	Not specified	Urban	3602	12.1	2.8	Low risk
Tebekaw Y, etal	Before 2015	2014	Addis Ababa	Urban	1592	16.3	4.3	Low risk
Amare B, etal	Before 2015	2012	Amhara	Urban	356	21.3	5.9	Low risk
Awoke A, etal	Before 2015	2012	Amhara	Urban	679	25.3	5.6	Low risk
Dagne S, etal	After 2015	2019	Amhara	Urban	751	19.9	8.6	Low risk
Darebo T, etal	After 2015	2019	SNNPR	Urban	524	23.2	5	Low risk
Gutema BT, etal	After 2015	2020	SNNPR	Both	3,346	10.8	1.9	Low risk
Hundera TD, etal	Before 2015	2015	Oromia	Urban	317	4.7	1.6	Low risk
Hussein M, etal	After 2015	2016	Somali	Urban	698	22.4	10.4	Low risk
Kahsay AB, etal	After 2015	2018	Tigray	Urban	1486	23.8	3.5	Low risk
Mekonnen T, etal	After 2015	2018	Amhara	Both	1405	9.3	2	Low risk
Moges B, etal	Before 2015	2014	Amhara	Urban	68	32.4	16.2	Low risk
Yohannes M	After 2015	2019	SNNPR	Urban	374	40.1	13.9	Low risk
Janakiraman B, etal	After 2015	2020	Amhara	Urban	381		13.1	Low risk
Mekonnen W, etal	Before 2015	2017	Not specified	Urban	3535		2.84	Low risk

### Publication bias test for overweight



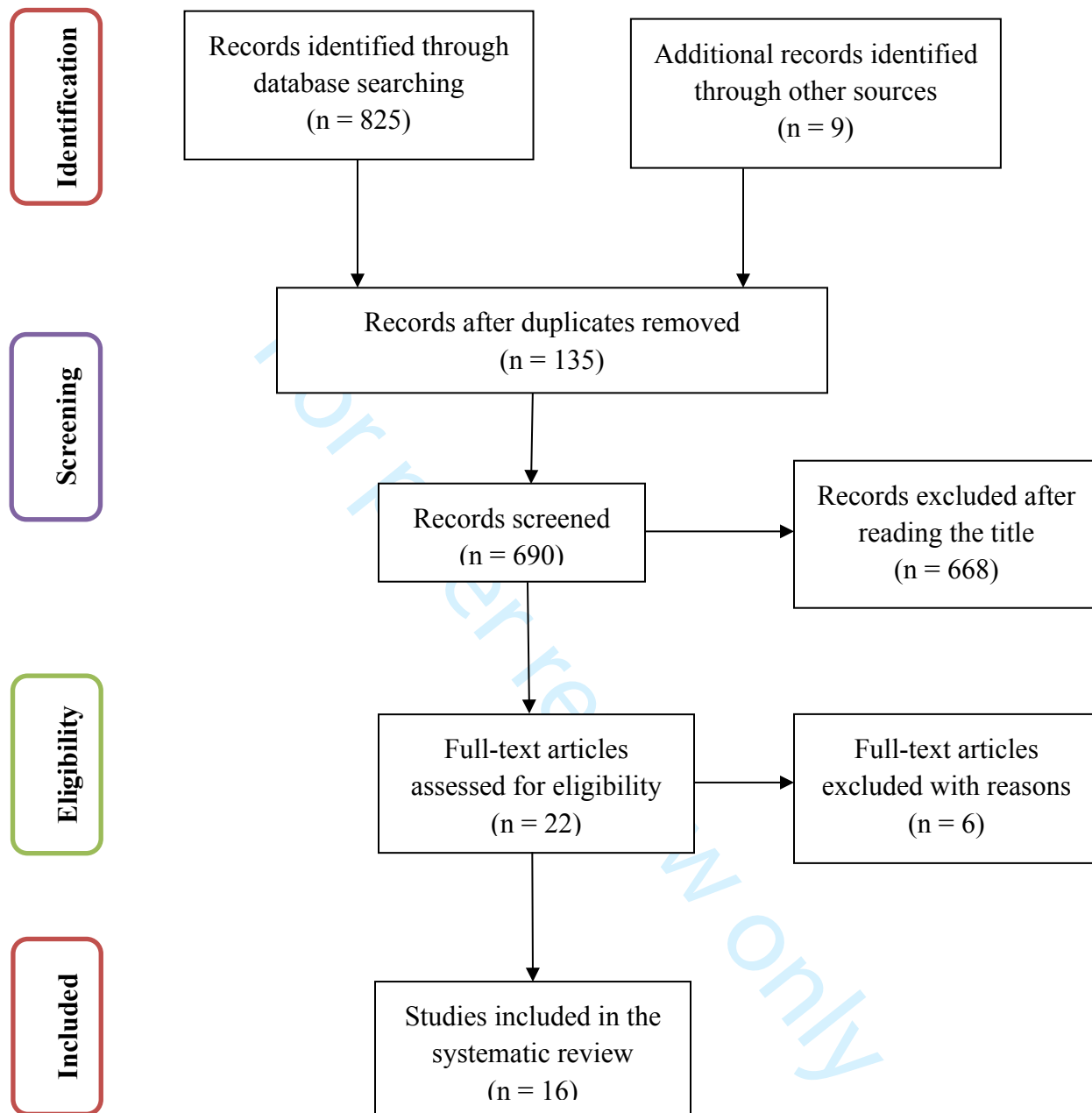
Supplementary Figure 1: Distribution of studies included in overweight analysis in the Funnel graph.

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3 **Publication bias for obesity**  
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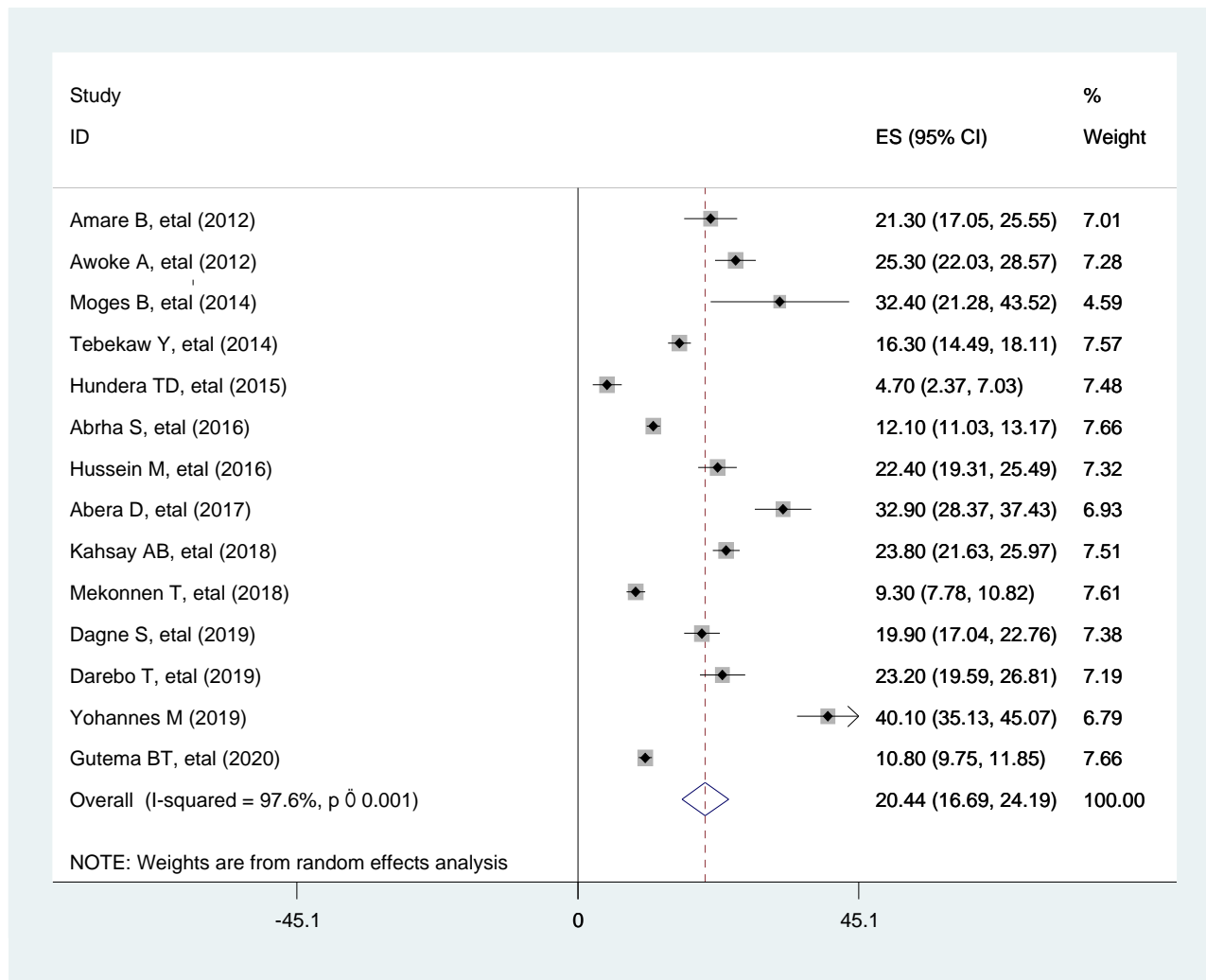


26 Supplementary Figure 2: Distribution of studies included in obesity analysis in the Funnel graph.  
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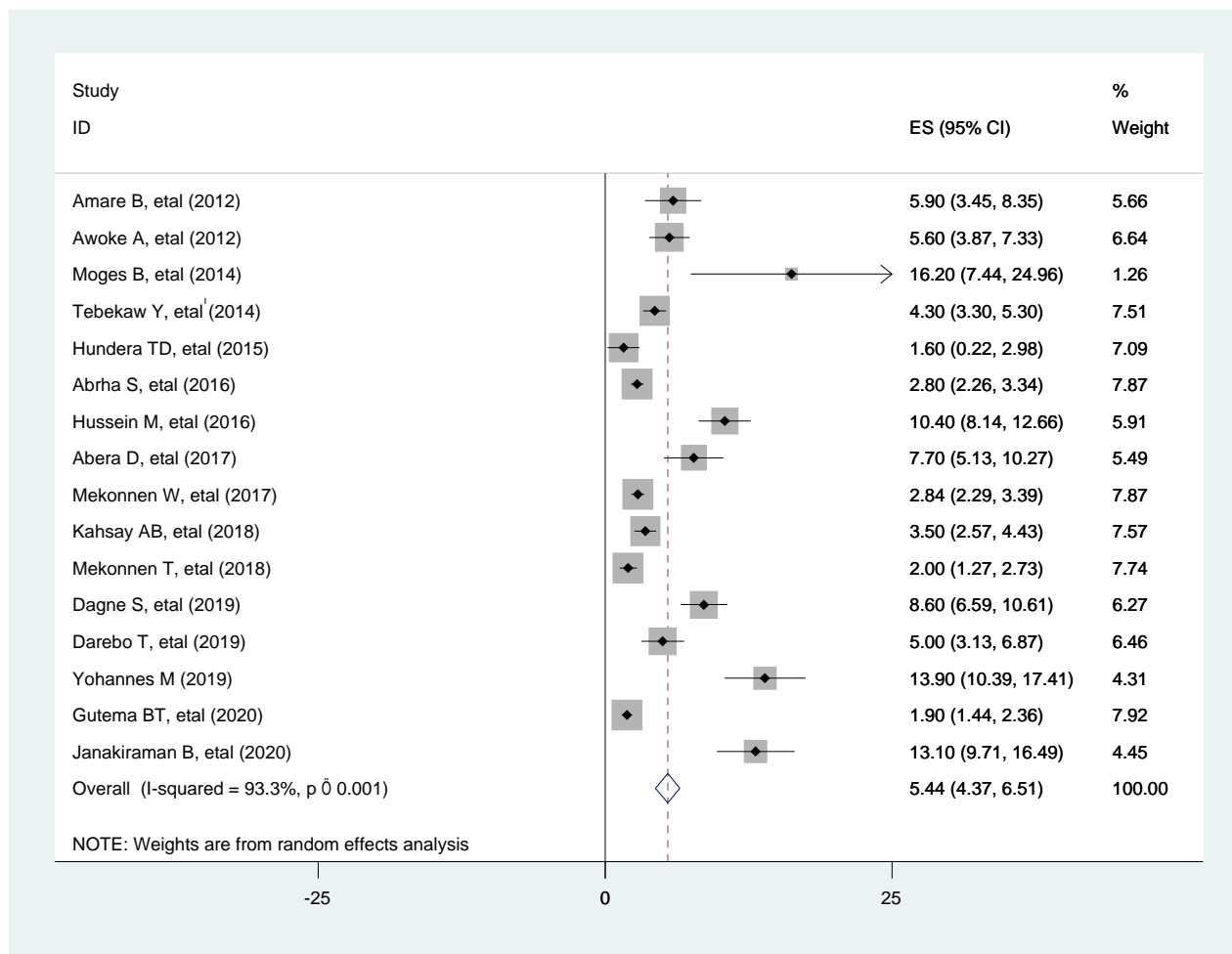
## PRISMA FLOW CHART



**Figure 1:** PRISMA flow chart of study selection for the prevalence of overweight and obesity among adults in Ethiopia.



**Figure 2:** Forest plot for the prevalence of overweight among adults in Ethiopia.



**Figure 3:** Forest plot for the prevalence of obesity among adults in Ethiopia.

Study omitted	Coef.	[95% Conf. Interval]
Abera D, etal	19.458002	15.773933 23.142069
Abrha S, etal	21.24802	16.798456 25.697584
Tebekaw Y, etal	20.829943	16.721661 24.938225
Amare B, etal	20.375648	16.482386 24.268913
Awoke A, etal	20.031092	16.230967 23.831217
Dagne S, etal	20.491842	16.559935 24.42375
Darebo T, etal	20.217529	16.353727 24.081333
Gutema BT, etal	21.33058	17.008682 25.652477
Hundera TD, etal	21.686108	17.891603 25.480614
Hussein M, etal	20.278517	16.404625 24.152409
Kahsay AB, etal	20.123743	16.369978 23.87751
Mekonnen T, etal	21.394331	17.333912 25.45475
Moges B, etal	19.859375	16.047747 23.671003
Yohannes M	18.918518	15.393227 22.443808
Combined	20.439183	16.689844 24.188523

**Figure 4:** Result of sensitivity analysis of the 14 studies in the meta-analysis of overweight.

Study omitted	Coef.	[95% Conf. Interval]
Abera D, etal	5. 2844915	4. 2053108 6. 3636723
Abrha S, etal	5. 8013558	4. 5596724 7. 0430388
Tebekaw Y, etal	5. 5626507	4. 425869 6. 6994324
Amare B, etal	5. 4089479	4. 3111115 6. 5067844
Awoke A, etal	5. 4232454	4. 3210888 6. 5254025
Dagne S, etal	5. 156126	4. 1098514 6. 2024007
Darebo T, etal	5. 4749699	4. 3657789 6. 5841608
Gutema BT, etal	5. 832715	4. 6363239 7. 0291057
Hundera TD, etal	5. 748404	4. 6261935 6. 8706145
Hussein M, etal	5. 0217872	4. 0067286 6. 0368457
Kahsay AB, etal	5. 6494417	4. 4939957 6. 8048878
Mekonnen T, etal	5. 787991	4. 6217656 6. 9542165
Moges B, etal	5. 2873678	4. 2271786 6. 3475571
Yohannes M	4. 9776611	3. 9654725 5. 98985
Ahmed KY, etal	5. 4408903	4. 3709903 6. 5107903
Daka DW, etal	5. 4408903	4. 3709903 6. 5107903
Combi ned	5. 4408902	4. 3709902 6. 5107903

**Figure 5:** Result of sensitivity analysis of the 16 studies in the meta-analysis of obesity.

#### Egger's test

Std_Eff	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
slope	6. 137967	2. 411285	2. 55	0. 026	. 8842288 11. 39171
bias	9. 04124	2. 353041	3. 84	0. 002	3. 914404 14. 16808

**Figure 6:** Egger's test for the detection of publication bias for studies included in overweight.

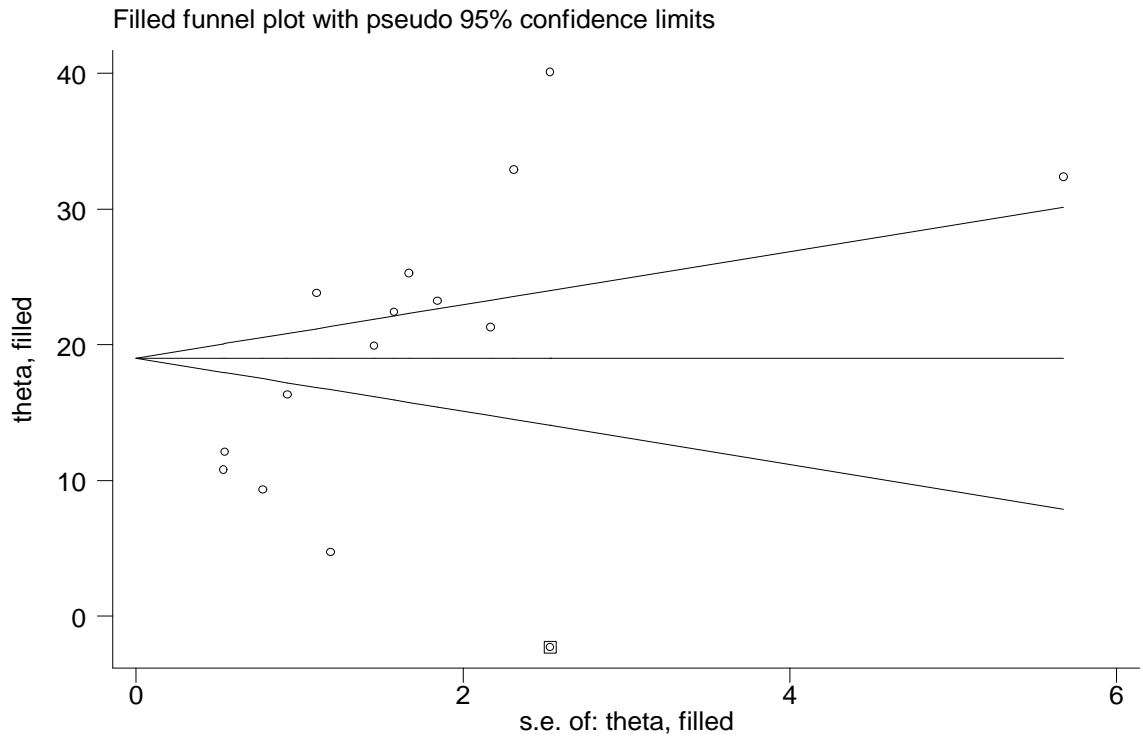
#### Egger's test

Std_Eff	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
slope	. 8714913	. 4245854	2. 05	0. 059	-. 0391538 1. 782136
bias	5. 452998	. 8718187	6. 25	0. 000	3. 583133 7. 322863

**Figure 7:** Egger's test for the detection of publication bias for studies included in obesity.



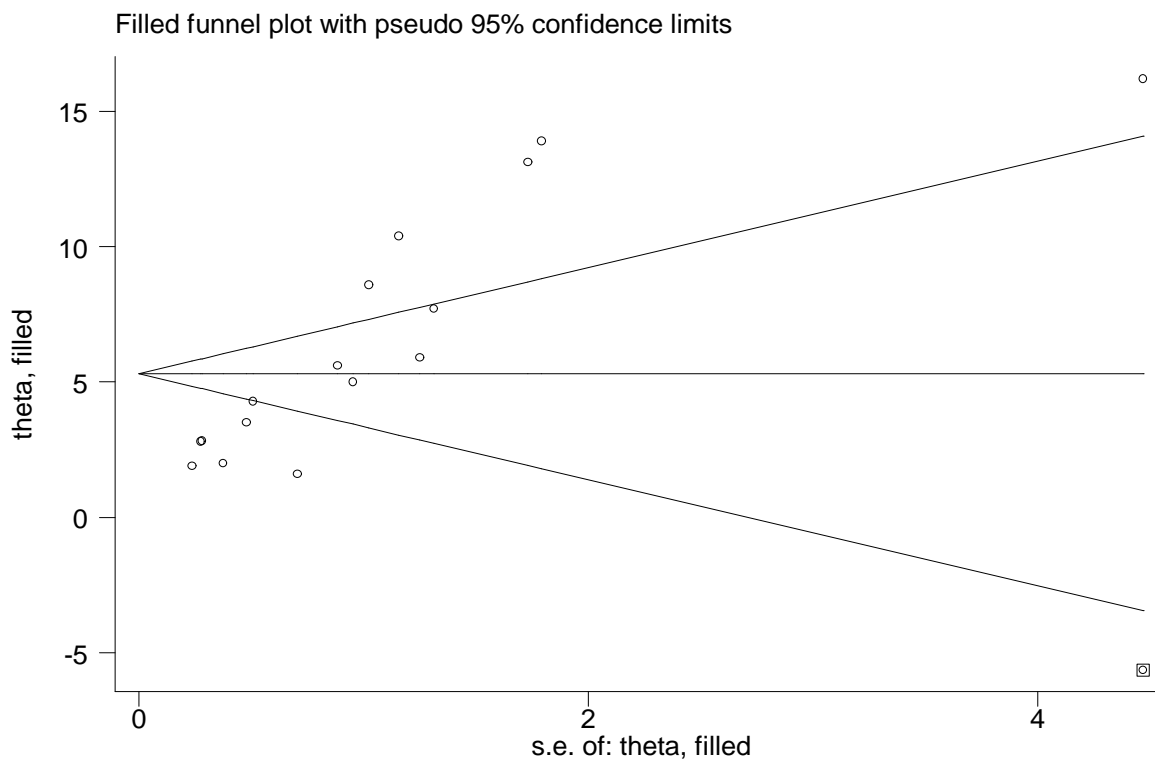
### Trim and fill analysis for the pooled prevalence of overweight



**Figure 8:** Trim and fill analysis for the prevalence of overweight among adults in Ethiopia.

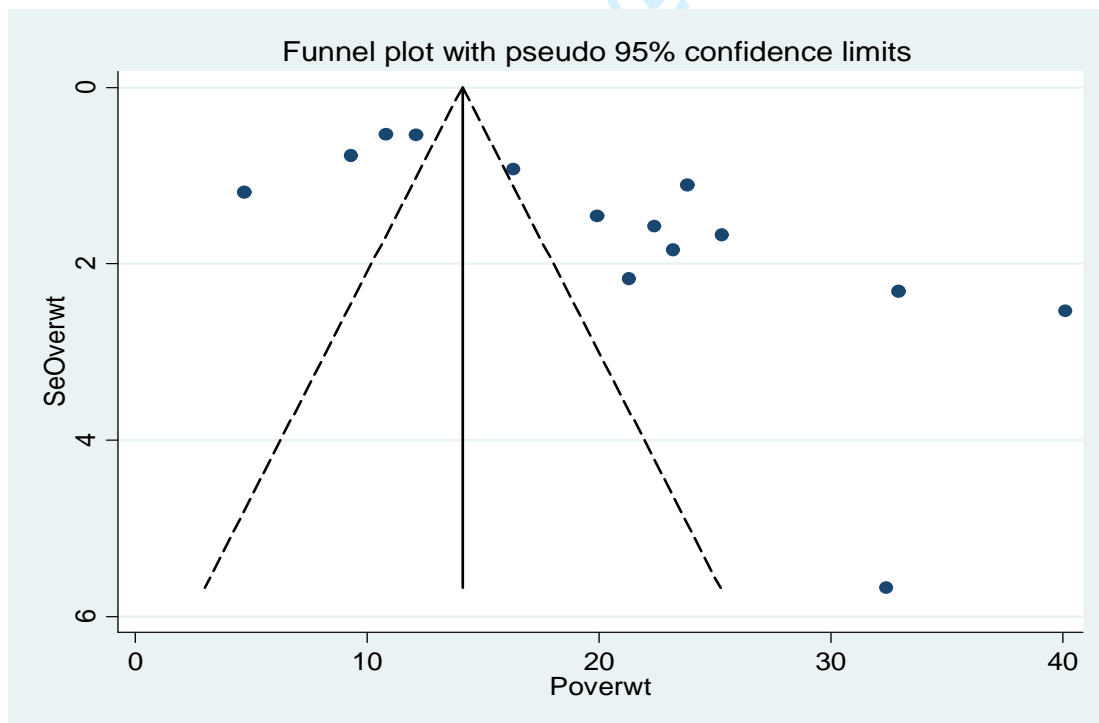
review only

**Trim and fill analysis for the pooled prevalence of obesity**



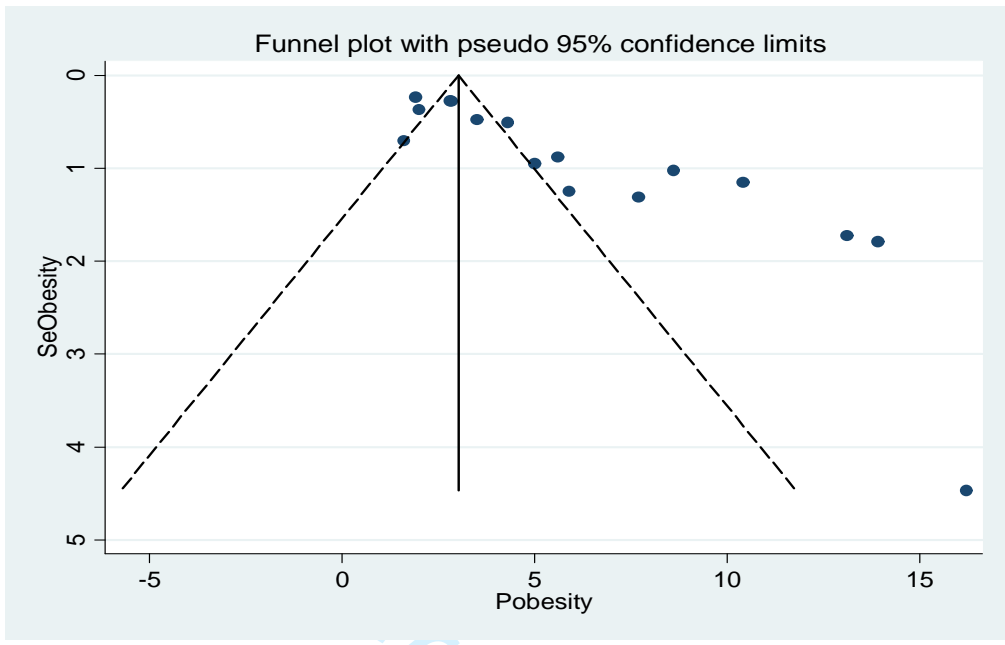
**Figure 9:** Trim and fill analysis for the prevalence of obesity among adults in Ethiopia.

**Publication bias test for overweight**



Supplementary Figure 10: Distribution of studies included in overweight analysis in the Funnel graph.

Publication bias for obesity



Supplementary Figure 11: Distribution of studies included in obesity analysis in the Funnel graph.



# PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3-4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
<b>METHODS</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4-5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	3-6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4-5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5-7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	3-6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ ) for each meta-analysis.	8-10



# PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	12
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	10-12
<b>RESULTS</b>			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	10-12
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	9-11
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	9-12
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	12
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	10-12
<b>DISCUSSION</b>			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	14-15
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	14-16
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16
<b>FUNDING</b>			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	16

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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## Prevalence of overweight/obesity among the adult population in Ethiopia: A systematic review and meta-analysis

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# Prevalence of overweight/obesity among the adult population in Ethiopia: A systematic review and meta-analysis

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## **Abstract**

**Background:** Overweight and obesity are emerging public health problems in Ethiopia. However, primary study findings on the prevalence of overweight and obesity in Ethiopia are inconsistent. Therefore, this study aimed to estimate the pooled prevalence of overweight and obesity among adults in Ethiopia.

**Methods:** Studies that looked at overweight and obesity among adults were searched from four international databases. The search involved articles published from January 1<sup>st</sup>, 2010 to March 10<sup>th</sup>, 2020. The Cochran's Q chi-square and the I<sup>2</sup> test statistics were used to check heterogeneity among the studies. The funnel plot and Egger's regression tests were also used to assess the presence of publication bias. Subgroup analysis was performed by residence, study setting, sample size, and year of study. Sensitivity analysis was also done to assess the effect of a single study on the pooled estimates. Data analysis was done using STATA<sup>TM</sup> Version 14 software program.

**Results:** A total of 16 studies with 19,527 study participants were included in this systematic review and meta-analysis. The estimated pooled prevalence of overweight among adults in Ethiopia was 20.4%, and after adjustment for publication bias with the trim and fill analysis, the estimated prevalence rate was changed to 19%. Besides, the estimated pooled prevalence of obesity was 5.4%. The prevalence of overweight was higher, 22.6% in studies published since 2015, 22.4% in studies conducted only in urban settings, and 24.4% in studies with small sample



1 size ( $\leq 384$  participants). Similarly, the prevalence of obesity was 6.9% in studies published  
2 since 2015, 6.2% in studies conducted only in urban settings, 6.4% in institution-based settings,  
3 and 9.6% in studies with small sample size.  
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6

7 **Conclusion:** The prevalence of overweight and obesity is high in Ethiopia compared to previous  
8 studies. This needs large scale awareness creation campaigns and situation-based and context-  
9 specific prevention strategies.  
10  
11  
12

13 **Keywords:** Adult; Ethiopia; Obesity; Overweight  
14  
15

## 16 **Strength and limitation of the study**

17

### 18 **Strength**

19

- 20 ❖ The study has used a pre-specified protocol for search strategy and data abstraction and  
21 used internationally accepted tools for a critical appraisal system for quality assessment of  
22 individual studies.  
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### 27 **Limitations**

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- 29 ❖ It is difficult to determine if the results from various regions are representative of the entire  
30 country, as no data were found for all regions of the country.  
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32
- 33 ❖ Furthermore, the majority of the studies were conducted in urban settings and only two  
34 studies were obtained involving participants from both rural and urban settings. Hence, the  
35 results may not truly reflect the rural population of Ethiopia.  
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37

## 38 **Introduction**

39

40  
41 Overnutrition is becoming a major public health problem globally. Overweight, obesity,  
42 and diet-related non-communicable diseases are included under problems of overnutrition (1).  
43 Overweight and obesity are used to refer an abnormal or excessive fat accumulation that can put  
44 people at greater risk and may impair their health (2).  
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48  
49 Obesity is considered an illness that necessitates immediate reversal to prevent early and  
50 untimely death among patients. Because people with obesity are more likely to have other  
51 diseases including type 2 diabetes, high blood pressure, sleep apnea, and many more (3, 4).  
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1  
2 Overweight and obesity affect all age groups of people both in developed and developing  
3 countries regardless of their socioeconomic status (1, 5). Since 1980; the prevalence of obesity  
4 has doubled in more than 70 countries and has continuously increased in most other countries  
5 (6).  
6  
7

8  
9 In 2016, more than 1.9 billion adults were overweight worldwide. Of these, over 650  
10 million were obese. Overweight accounted for 39% (39% of men and 40% of women), and  
11 obesity 13% (11% of men and 15% of women) in the same year (7).  
12  
13

14  
15 The prevalence of overweight and obesity is escalating in developing countries,  
16 particularly among urban dwellers and wealthier people due to the influence of demographic,  
17 epidemiologic, and nutrition transitions (8). According to a study conducted in 2013 on the  
18 global trends of overweight and obesity, 26.9% of adults in Africa are overweight and obese (9).  
19  
20  
21

22  
23 Overweight and obesity in adults are associated with increased risk of diabetes,  
24 hypertension, and other chronic diseases. In addition to these chronic diseases, overweight and  
25 obesity in women increases the risk of cesarean section delivery, postpartum hemorrhage, high  
26 birth weight babies, and infant overweight and obesity (1, 10).  
27  
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29

30  
31 The latest WHO reports showed that overweight and obesity are becoming the leading  
32 causes of death worldwide (1, 11). In 2015, high body mass index (BMI) has caused an  
33 estimated 4 million deaths globally, and nearly 40% of these deaths occurred in persons who  
34 were overweight but not obese. More than two-thirds of the deaths related to high BMI were due  
35 to cardiovascular diseases (6, 12).  
36  
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39  
40 Overweight and obesity costs the world billions of dollars a year in lost opportunities for  
41 economic growth and lost investments in human capital associated with the increased  
42 preventable morbidity and mortality rates in both children and adults (1, 13).  
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46  
47 Like other countries, the burden of overweight and obesity is becoming a major problem  
48 in Ethiopia. According to the 2016 Ethiopian demographic and health survey report, the  
49 proportion of overweight and obesity among women has increased from 3% in 2000 to 8% in  
50 2016. Similarly, 3% of men were overweight or obese in 2016 (14).  
51  
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53

54  
55 Overweight and obesity are associated with many factors including excessive  
56 consumption of alcohol, cigarette smoking, and sedentary lifestyle habits (15). Some studies  
57

1 have also reported that the risk of overweight and obesity is increased with education (16, 17)  
2 and wealth in developing countries (18-20).  
3  
4

5  
6 As a treatment, behavioral and pharmaceutical interventions are available and helpful in  
7 getting weight loss. A reduction of 5% to 7% of body weight alone is associated with a lower  
8 incidence of diabetes, hypertension, and other cardiovascular diseases. Larger weight loss has  
9 even been linked with better improvements in controlling the level of blood glucose and lipids in  
10 limited surgical outcomes data (21).  
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14  
15 Therefore, knowing the prevalence of overweight and obesity is paramount to design  
16 preventive strategies. However, there is no national study on the prevalence of overweight and  
17 obesity in the general adult population of Ethiopia. Furthermore, findings from small studies are  
18 inconsistent with the combined prevalence of overweight and obesity reported ranging from  
19 4.5% (22) to 21.4% (23) in the country. Hence, this systematic review and meta-analysis aimed  
20 to determine the pooled prevalence of overweight and obesity among adults in Ethiopia.  
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## 25 26 **Methods**

### 27 28 **Literature search strategy**

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30 Firstly, The Cochrane Library, Joanna Briggs Institute (JBI), and PROSPERO databases  
31 were searched to check whether a systematic review and meta-analysis studies exist or for the  
32 presence of ongoing projects related to overweight and obesity in Ethiopia. The necessary  
33 articles were searched using PubMed, Scopus, Google scholar, and African journals online.  
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39 For this study relevant articles were identified using the following terms: “overweight”,  
40 “obesity”, “nutrition”, “malnutrition”, “undernutrition”, “over nutrition”, “adults”, “elders”,  
41 “geriatrics” and “Ethiopia”. The key terms were used in combination using Boolean operators  
42 like “OR” or “AND”. The searches were restricted to full texts, free articles, human studies, and  
43 English language publications. This search involved articles published from January 1<sup>st</sup>, 2010 to  
44 March 10<sup>th</sup>, 2020.  
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50 Grey literatures like surveillance reports, academic dissertations, and conference abstracts  
51 were also examined and included when they deemed low risk. Besides, the reference lists of  
52 included articles in this systematic review and meta-analysis were hand-searched to identify any  
53 relevant additional articles.  
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1 **PubMed search strategy:** (((((((((((overweight)) OR (obesity)) OR (nutrition)) OR  
2 (malnutrition)) OR (overnutrition)) OR (undernutrition)) AND (Adults)) OR (Elders)) OR  
3 (Geriatrics)) AND (Ethiopia)) AND (("2010/01/01"[Date - Entry]: "2020/10/03"[Date - Entry])).  
4  
5 Filters applied: Free full text, in the last 10 years.  
6  
7

## 8 **Eligibility criteria**

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11 Studies were included in this systematic review and meta-analysis if they followed the  
12 following guidelines: (1) all observational study designs (cross-sectional, case-control, and  
13 cohort studies) which reported the prevalence of overweight and obesity or one of them; (2)  
14 published from 2010 to 2020; (3) published in the English language; (4) abstract and, or full text  
15 available for this review; and (5) conducted in Ethiopia. Studies were excluded if they: (1)  
16 possessed a poor quality score as per the stated criteria; (2) failed to determine the desired  
17 outcomes (overweight and obesity); and (3) included children and adolescents. It was considered  
18 that the exclusion of articles published in other languages due to translation issues might create  
19 language bias. However, no articles published in other languages including the Amharic  
20 language were obtained during the search period.  
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## 29 **Outcomes of interest**

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32 The main outcomes of interest were the prevalence of overweight and obesity reported in  
33 the original papers either as a percentage or as the number of cases (n) / total number of study  
34 participants (N). These two parameters were necessary to calculate the pooled prevalence of  
35 overweight and obesity in the meta-analysis. Therefore, the prevalence rate was calculated by  
36 dividing the number of individuals who were overweight and, or obese to the total number of  
37 study participants (sample size) multiplied by 100.  
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43 The outcome variables of interest were categorized as follows based on the WHO  
44 Classification of body mass index; overweight if the BMI is 25.0-29.9kg/m<sup>2</sup> and obese if it  
45 is  $\geq 30.0$ kg/m<sup>2</sup> for the study participants of the included studies in the systematic review and meta-  
46 analysis (24).  
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## 51 **Data extraction**

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53 The authors developed a data extraction form on the excel sheet which includes the  
54 author name, year of publication, study setting, study design, sex of participants, sample size,  
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1 and the prevalence of overweight and obesity. The data extraction sheet was piloted using 5  
2 papers randomly. The extraction form was adjusted after having a piloted template.  
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5  
6 Two of the authors independently extracted all the necessary data from each study using  
7 the data extraction format. The third author checked the correctness of the data independently.  
8 Any disagreements between authors who extracted the data were resolved through discussions  
9 with the third reviewer and fourth reviewer when required. For articles that did not provide  
10 details of their study background, corresponding authors were contacted through e-mail and  
11 asked for the relevant information, such as study time, region, or others.  
12  
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### 16 17 **Quality assessment**

18  
19 Two independent authors assessed the methodological quality of all of the potential  
20 studies to be included in the analysis. Any disagreements between the authors were resolved  
21 through discussion or, if consensus could not be reached, consultation with a third independent  
22 author was considered. The quality of each included study was assessed using the JBI quality  
23 appraisal checklist for cross-sectional studies (25). Because the articles included in this study  
24 were all cross-sectional. Studies were considered low risk when scored 50% and above of the JBI  
25 quality assessment indicators.  
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### 32 **Patient and public involvement**

33  
34 No patient involved.  
35

### 36 **Statistical analysis**

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38 To obtain the pooled prevalence of overweight and obesity, a meta-analysis using the  
39 random-effects model was performed due to the presence of heterogeneity (26). Cochran's Q  
40 chi-square statistic and the  $I^2$  tests were run to assess the random variations between primary  
41 studies. The  $I^2$  test is used to indicate the percentage of variance in a meta-analysis that is  
42 attributable to heterogeneity among the studies (27). In this study, heterogeneity was interpreted  
43 as an  $I^2$  value of 0% = no heterogeneity,  $\leq 25\%$  = low, 25%-50% = moderate, 50-75= substantial  
44 and  $\geq 75\%$  = high level heterogeneity (27). In the case of high heterogeneity, subgroup and  
45 sensitivity analyses were run to identify possible moderators for the heterogeneity.  
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## Publication bias

Methods of avoiding publication bias like identifying and including unpublished studies, meeting abstracts, and dissertations were considered. Furthermore, potential publication bias was assessed by visually inspecting the funnel plots and objectively using the Egger's bias test during analysis (28). The trim and fill analysis was also done to assess for and adjust any publication bias based on the assumption that the effect sizes of all the studies are normally distributed around the center of a funnel plot in the absence of publication bias.

The trim and fill method is used to first trim the studies that cause asymmetry in the funnel's plot so that the overall effect estimate produced by the remaining studies can be considered minimally affected by publication bias, and then to fill imputed missing studies in the funnel plot based on the bias-corrected overall estimate (29). The meta-analysis was performed using the STATA™ Version 14 software program (30). Finally, for all analysis, a p-value of less than 0.05 was considered to declare statistically significant values.

## Presentation and reporting of results

The results of this systematic review and meta-analysis were reported based on the Preferred Reporting Items for Systematic Review and Meta-Analysis statement (PRISMA) guideline (31). The entire process of study screening, selection, and inclusion are shown with the support of a flow diagram. Moreover, tables and narrative summaries are used to report the risk of bias for every eligible study.

## Results

### Search results

A total of 834 articles were retrieved from international databases and gray literatures. In the first step of article searches, 825 studies that were published from 2010-2020 were retrieved through database searching from four international databases. On the other hand, the remaining 9 studies have been obtained from other sources including gray literatures.

Of these studies, 135 duplicate records were identified and after duplication removal, a total of 699 articles remained. Then, 677 articles were excluded after reading the title and or the abstract because either they were not conducted in Ethiopia or they were not in line with the objective of this systematic review and meta-analysis.

1  
2 Finally, 22 studies were screened for full-text review and, 16 articles (n = 19,527  
3 participants) were selected to estimate the pooled prevalence of overweight and obesity among  
4 adults in Ethiopia. The remaining 6 studies were excluded because they failed to report the  
5 prevalence of overweight and obesity separately (they only reported a combined prevalence of  
6 overweight and obesity). The detailed steps in the screening process are shown in the PRISMA  
7 flow chart of the study selection (Fig 1).  
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### 12 **Baseline characteristics of included studies**

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15 In the current meta-analysis, a total of 16 studies with 19,527 study participants were  
16 included to estimate the pooled prevalence of overweight and obesity among adults in Ethiopia.  
17 Among these studies, 14 had reported the prevalence of both overweight and obesity, and 2  
18 studies had reported the prevalence of obesity only. Concerning the study design, all of the  
19 studies included were cross-sectional. The studies included in this systematic review and meta-  
20 analysis varied significantly in sample size ranging from 68 (the small) to 6,602 (the large).  
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27 Overall information regarding the prevalence of overweight and obesity among adults  
28 was obtained from various regions in the country. Six of the studies involved participants from  
29 Amhara (32-37), four from SNNPR (38-41), one from Oromia (42), one from Somali (43), one  
30 from Tigray (44), one from Addis Ababa (45) and two studies involving participants from  
31 different regions (46, 47).  
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37 Regarding sampling, all of the studies had used the probability sampling technique. The  
38 quality score of each primary study as evaluated based on the JBI quality appraisal criteria  
39 showed no considerable risk; hence, all the studies were included in this systematic review and  
40 meta-analysis (Additional file 1).  
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### 44 **The pooled prevalence of overweight among adults in Ethiopia**

45  
46 Fourteen studies (n=14) had reported the prevalence of overweight among adults in  
47 different regions of Ethiopia (Additional file 1). The prevalence of overweight reported in the  
48 country ranges from 4.7% (42) to 40.1% (41). The random-effects model analysis from those  
49 studies revealed that in this meta-analysis, the estimated pooled prevalence of overweight among  
50 adults in Ethiopia was 20.44% (95% CI: 16.69, 24.19) with a significant level of heterogeneity  
51 among the studies ( $I^2 = 97.6\%$ ;  $p \leq 0.001$ ) (Fig 2).  
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## The pooled prevalence of obesity among adults in Ethiopia

Besides overweight, sixteen studies (n=16) had reported the prevalence of obesity among adults in different parts of the country (Additional file 1). The prevalence of obesity reported in the country ranges from 1.6% (42) to 16.2% (34). In this meta-analysis, the estimated pooled prevalence of obesity among adults was 5.44% (95% CI: 4.37, 6.51) but with a significant level of heterogeneity among the studies in the random-effects model analysis ( $I^2 = 93.3\%$ ,  $p \leq 0.001$ ) (Fig 3).

### Subgroup analysis

There was a significant level of heterogeneity among the primary studies included in this systematic review and meta-analysis. Thus, a subgroup analysis was conducted through stratification using study year, residence, study setting, and sample size to identify the sources of heterogeneity for the pooled prevalence of overweight and obesity among adults.

In the subgroup analysis, the prevalence of overweight was found to be 22.55% in studies published since 2015, 22.43% in studies conducted only in urban settings, 20.44% in institution-based settings and 24.39% in studies with a sample size of less than or equal to 384 participants. Similarly, the prevalence of obesity was found to be 6.90% in studies published since 2015, 6.23% in studies conducted only in urban settings, 6.41% in institution-based settings and 9.61% in studies with a sample size of less than or equal to 384 participants (Table 1).

**Table 1:** Prevalence of overweight and obesity in Ethiopia after subgroup analysis by characteristics of the studies included.

Subgroup	No. of studies	Overweight (95%CI)	$I^2$ and P-value	No. of studies	Obesity (95%CI)	$I^2$ and P-value
<b>Year of study</b>						
Before 2015	6	17.49(12.17,22.81)	(96.5%, $p \leq 0.001$ )	7	3.74(2.73,4.75)	(82.3%, $p \leq 0.001$ )
After 2015	8	22.55(16.57,28.54)	(98.2%, $p \leq 0.001$ )	9	6.90(4.89,8.92)	(95.8%, $p \leq 0.001$ )
<b>Residence</b>						
Urban	12	22.43(17.76,27.10)	(97.4%, $p \leq 0.001$ )	14	6.23(4.92,7.54)	(92.6%, $p \leq 0.001$ )
Rural	-	-	-	-	-	-
Both	2	10.15(8.70,11.61)	(60.5%, $p \geq 0.05$ )	2	1.93(1.54,2.32)	(0.0%, $p \geq 0.05$ )
<b>Setting</b>						
Community based	9	19.46(15.93,23.00)	(95.8%, $p \leq 0.001$ )	10	5.13(3.90,6.35)	(92.9%, $p \leq 0.001$ )
Institution based	5	20.44(16.69,24.19)	(98.9%, $p \leq 0.001$ )	6	6.41(3.79,9.03)	(94.8%, $p \leq 0.001$ )
<b>Sample size</b>						
<384	4	24.39(6.71,42.08)	(98.7%, $p \leq 0.001$ )	5	9.61(3.94,15.28)	(94.8%, $p \leq 0.001$ )
>384	10	19.34(15.59,23.09)	(97.4%, $p \leq 0.001$ )	11	4.55(3.54,5.55)	(92.5%, $p \leq 0.001$ )



### **Sensitivity analysis for the prevalence of overweight**

To evaluate the effect of individual studies on the pooled prevalence of overweight among adults in Ethiopia, a sensitivity analysis was performed using the random-effects model. The results from the sensitivity analysis had revealed that a single study had not influenced the pooled estimated prevalence of overweight among adults. The pooled estimated prevalence of overweight varied between 18.92 (15.39, 22.44) (41) and 21.69 (17.89, 25.48) (42) after the deletion of a single study (Fig 4).

### **Sensitivity analysis for the studies included in obesity**

To check the effect of individual studies on the pooled prevalence of obesity in Ethiopia, a sensitivity analysis was performed using the random-effects model and the results had revealed that there was no influential study on the pooled estimated prevalence of obesity among adults. The pooled estimated prevalence of obesity ranged from 4.98 (3.97, 5.99) (41) to 5.83 (4.64, 7.03) (40) after the deletion of a single study (Fig 5).

### **Publication bias**

There was a publication bias among the included studies in both overweight and obesity as illustrated by the asymmetrical distribution of funnel plot tests (Fig 6 and 7). Similarly, the results of Egger's tests for the funnel plot were statistically significant for the presence of publication bias ( $P = 0.002$  for overweight and  $p \leq 0.001$  for obesity) respectively (Fig 8 and 9).

### **Trim and fill analysis for the prevalence of overweight and obesity**

To reduce and adjust the publication bias in the studies, the trim and fill analysis was performed for estimation of the number of missing studies that might exist. During analysis, only one study was imputed for missing studies and after adjustment for publication bias, the estimated pooled prevalence of overweight among adults in Ethiopia appeared to be 19.02 (95% CI: 15.29, 22.74) but with a significant level of heterogeneity among the studies ( $I^2 = 50.29\%$ ;  $p \leq 0.001$ ) (Fig 10).

Likewise, studies included in obesity estimation among adults in Ethiopia were adjusted with trim and fill analysis and only one study was imputed for missing studies. However, after adjustment, the estimated pooled prevalence of obesity was found to be 5.44% (95% CI: 4.37, 6.51). This finding is similar with the unadjusted prevalence rate of obesity, but with different

1  
2 levels of heterogeneity among the studies in the random-effects model analysis ( $I^2 = 3.71\%$ ,  $p \leq$   
3 0.001) (Fig 11).  
4

## 5 6 **Discussion**

7  
8 This systematic review and meta-analysis were conducted to estimate the pooled  
9 prevalence of overweight and obesity among adults in Ethiopia. The prevalence of overweight  
10 reported in the country ranges from 4.7% (42) to 40.1% (41). This difference could be due to  
11 differences in the study population because unlike the first study which was conducted on the  
12 nutritional status of lactating mothers, the second study was conducted among office-based urban  
13 civil servants. Office-based civil servants are one of the highest groups for overweight and  
14 obesity due to their occupational exposure to sedentary type lifestyles (48, 49).  
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21 Besides, the prevalence of obesity reported in the country ranges from 1.6% (42) to  
22 16.2% (34). This discrepancy might be due to differences in the study population. The first  
23 finding that is 1.6% were reported from the study in lactating mothers and the later, 16.2% was  
24 reported from a study conducted among the general adult population and only in the urban  
25 setting, a well-known risk factor for overweight and obesity because people living in urban  
26 settings are at increased risk of sedentary type lifestyles and consumption of more energy-dense  
27 foods (50, 51). On the other hand, lactating mothers have increased nutritional demand and are at  
28 greater risk of undernutrition if the nutritional requirements are not properly fulfilled (52, 53).  
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36 In this study, the estimated pooled prevalence of overweight among adults was 20.4%.  
37 However, due to the presence of publication bias, after adjustment with the trim and fill analysis,  
38 the estimated prevalence rate was changed to 19%. Besides, the estimated pooled prevalence of  
39 obesity among adults in Ethiopia was 5.4%. These findings are higher than the 2011 and 2016  
40 Ethiopian demographic and health survey reports indicating an increasing trend in the prevalence  
41 rates of overweight and obesity in Ethiopia (14). The results are in line with a meta-analysis in  
42 the Asian Pacific region which has reported that the prevalence of overnutrition was estimated at  
43 23% (54).  
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50 A consistent finding has been also reported from a study in Ghana that the national  
51 prevalence of overweight was estimated at 25.4%. However, obesity in the Ghanaian study was  
52 significantly higher (17.1%) than the current study (55). In addition to the Ghanaian study, a  
53 study in Iran has shown that the prevalence of obesity in adults of Iran was 21.4% based on a  
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1 meta-analysis of studies in the country (56). Another meta-analysis in Iran among military  
2 personnel has also indicated that the pooled prevalence of overweight and obesity was 41% and  
3 13% respectively, significantly higher values than our study findings (57).  
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8 These discrepancies might be due to differences in the study population, the  
9 developmental level of these countries, and the educational level of participants. One of the  
10 Iranian studies was conducted among military personnel and may not be representative of the  
11 national prevalence of overweight and obesity because the high prevalence rate might be  
12 occupation-related (57). This might be also due to their capacity of purchasing more energy-  
13 dense foods as witnessed from studies in both developed and developing countries that high-  
14 income households purchased foods in bulk and were more likely to over-consume these foods  
15 (58-60).  
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22 Likewise, the prevalence of overweight and obesity in Ethiopia is significantly lower than  
23 a study in Spain that the estimated prevalence of overweight in the Spanish adult population was  
24 39.3% and obesity was 21.6% (61). The Spanish result is in line with the WHO global report that  
25 39% of adults aged 18 years and over were overweight in 2016, and 13% were obese (7).  
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30 There was a significant level of heterogeneity among the primary studies included in this  
31 systematic review and meta-analysis. Thus, a subgroup analysis was conducted through  
32 stratification using study year, residence, study setting, and sample size in order to identify the  
33 sources of heterogeneity to the pooled prevalence of overweight and obesity. The prevalence of  
34 overweight was found to be higher in some groups; 22.6% in studies conducted since 2015,  
35 22.4% in studies conducted only in urban settings, 20.4% in institution-based settings and 24.4%  
36 in studies with a sample size of less than or equal to 384 participants compared to their  
37 counterparts. This indicates that overweight has increased among adults in Ethiopia compared to  
38 previous studies (14).  
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46 Besides, the prevalence of obesity was found to be 6.9% in studies conducted since 2015,  
47 6.2% in studies conducted only in urban settings, 6.4% in institution-based settings, and 9.6% in  
48 studies with a sample size of less than or equal to 384 participants. This means the prevalence of  
49 overweight and obesity is increasing from time to time especially among urban residents.  
50 However, no study was found involving rural participants only. The majority of the studies were  
51 conducted in urban areas and only two studies were conducted involving participants from both  
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1 urban and rural settings. If sufficient studies were found in rural areas the results might not have  
2 been like this (Table 1).  
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6 This is due to the fact that the prevalence rate of overweight and obesity is significantly  
7 different in rural and urban settings across low and middle-income countries with the highest  
8 rates occurring in urban settings. For example, the Ghanaian study has reported a higher  
9 prevalence of overweight (27.2% in urban and 16.7% in rural), and obesity (20.6% in urban and  
10 8.0% in rural settings) among urban than rural residents (55). Similar findings have been  
11 reported from the Ethiopian demographic and health survey 2016 report and from other African  
12 countries that the prevalence rate of overweight and obesity is higher among urban residents  
13 compared to the rural residents (14, 17, 62).  
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21 This finding might be due to the rapid demographic, epidemiologic, and nutrition  
22 transitions in Ethiopia because urbanization and a shift in nutritional habits are the major known  
23 factors which predispose people to overweight and obesity (8). The other reason could be due to  
24 differences in lifestyle of urban dwellers as compared to the rural residents. Unlike rural  
25 residents who are usually more actively involved in a less sedentary lifestyle and more laborious  
26 activities, the occupation of urban dwellers might result in sedentary type lifestyles among the  
27 adult population (63-65).  
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### 33 **Conclusion**

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36 The prevalence rate of overweight and obesity is high in Ethiopia compared with the  
37 previous studies. The prevalence of overweight and obesity was higher in studies conducted only  
38 in urban settings compared with studies conducted in both urban and rural settings. Furthermore,  
39 the rates were also higher in studies conducted since 2015 and in small sample size studies.  
40 Hence, large scale awareness creation campaigns and situation-based and context-specific  
41 preventive strategies need to be designed to reduce the burden of overweight and obesity in the  
42 country.  
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### 49 **Abbreviations**

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51 AOR: Adjusted Odds Ratio; BMI: Body mass index; CI: Confidence Interval; JBI:  
52 Joanna Briggs Institute; SNNPR: Southern Nations, Nationalities, and Peoples Region;  
53 PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses.  
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**Declaration****Ethics approval and consent to participate**

Not applicable.

**Consent for publication**

Not applicable.

**Availability of data and materials**

The data used during this systematic review and meta-analysis is available within the article and the supporting file.

**Competing interest**

The authors declare that no competing interests exist.

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**Author's contribution**

AMK and BBA developed the study protocol and were involved in the design, selection of study, data extraction, statistical analysis, and writing the initial drafts of the manuscript. MWK was involved in data extraction, quality assessment, statistical analysis, and revising. AMK and BBA prepared and edited the final manuscript. All authors have read and approved the submission of the final version of the manuscript.

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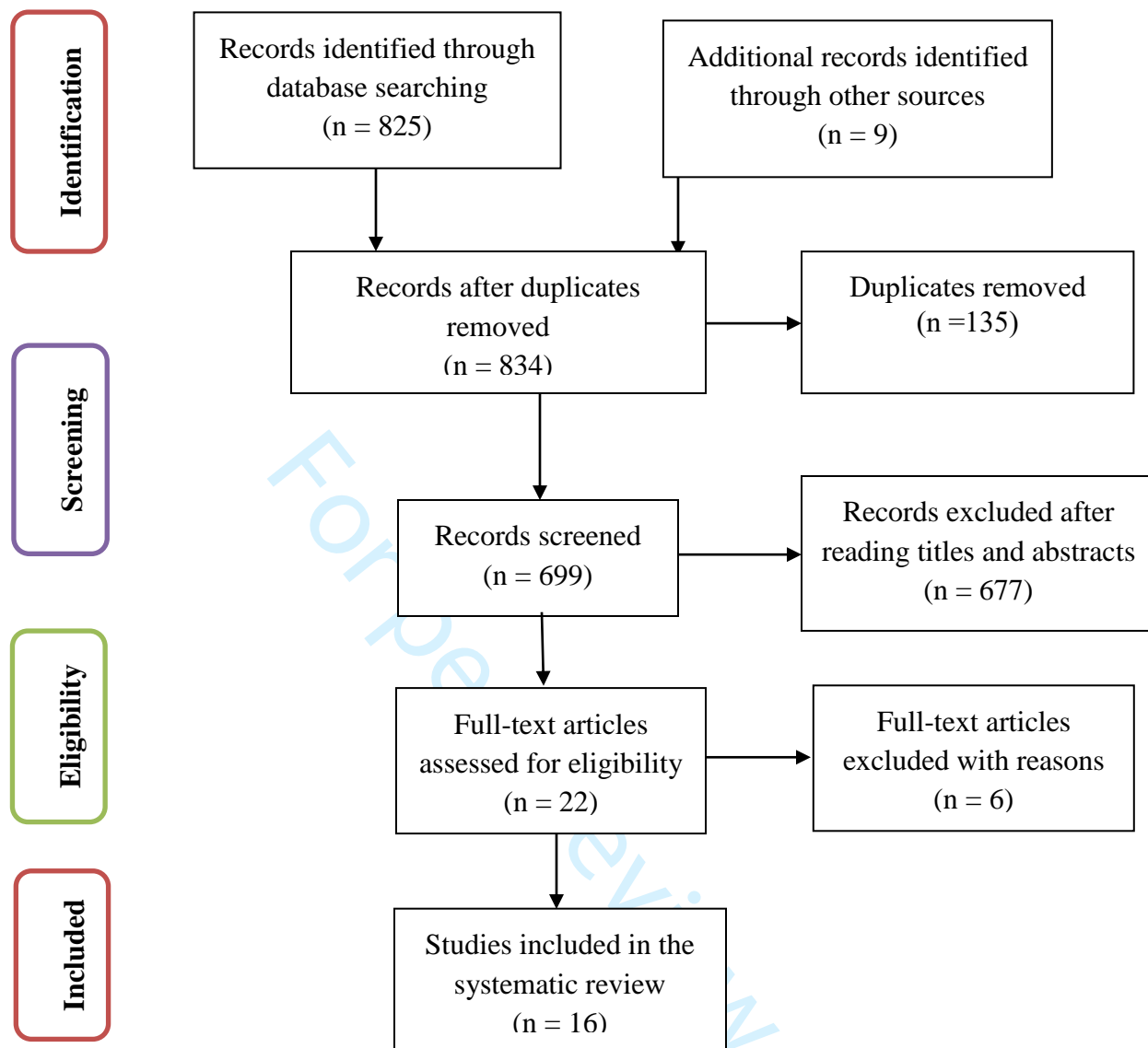


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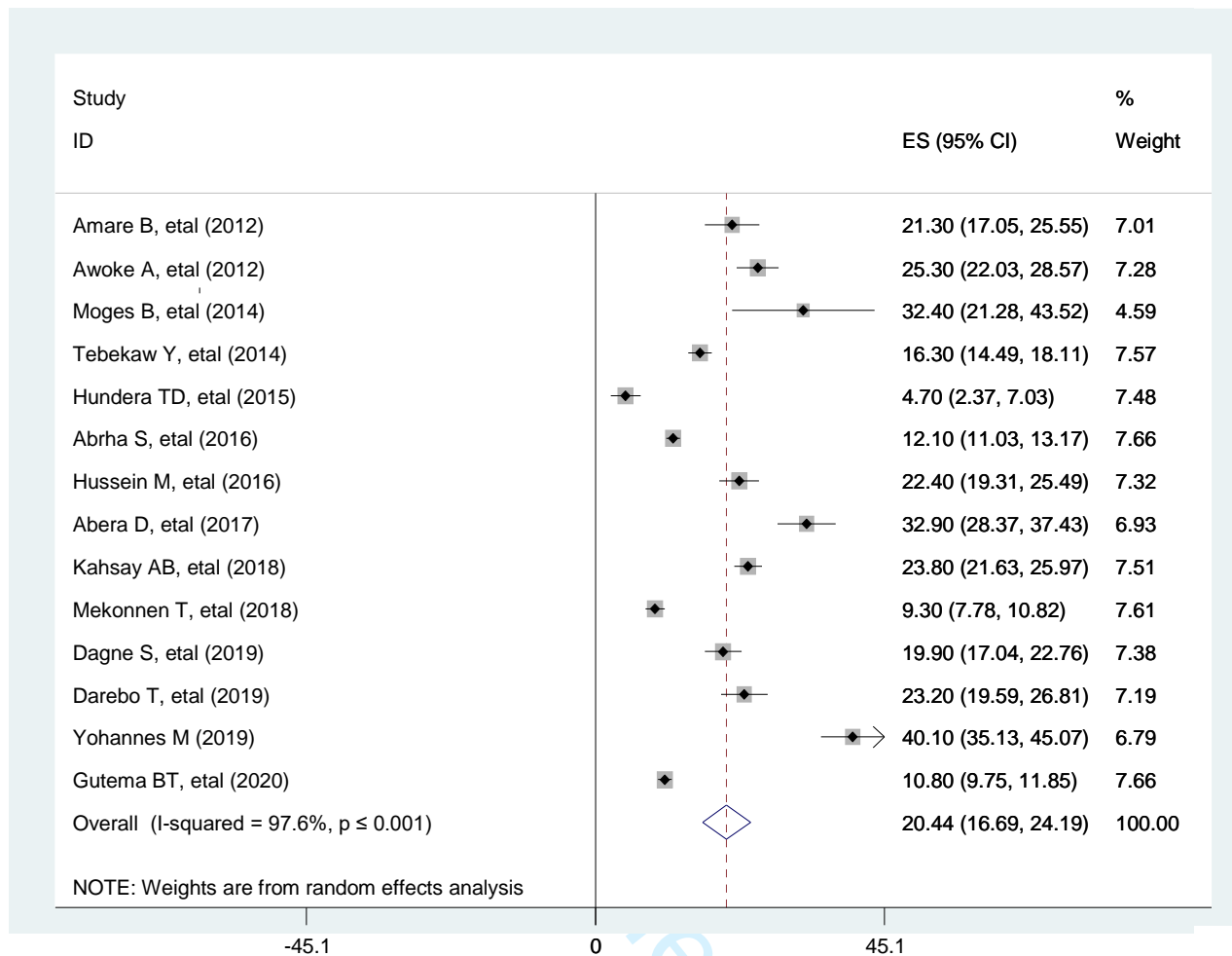


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**Figure 1:** PRISMA flow chart of study selection for the prevalence of overweight and obesity among adults in Ethiopia.



**Figure 2:** Forest plot for the prevalence of overweight among adults in Ethiopia.



Study omitted	Coef.	[95% Conf.	Interval]
Abera D, etal	19.458002	15.773933	23.142069
Abrha S, etal	21.24802	16.798456	25.697584
Tebekaw Y, etal	20.829943	16.721661	24.938225
Amare B, etal	20.375648	16.482386	24.268913
Awoke A, etal	20.031092	16.230967	23.831217
Dagne S, etal	20.491842	16.559935	24.42375
Darebo T, etal	20.217529	16.353727	24.081333
Gutema BT, etal	21.33058	17.008682	25.652477
Hundera TD, etal	21.686108	17.891603	25.480614
Hussein M, etal	20.278517	16.404625	24.152409
Kahsay AB, etal	20.123743	16.369978	23.87751
Mekonnen T, etal	21.394331	17.333912	25.45475
Moges B, etal	19.859375	16.047747	23.671003
Yohannes M	18.918518	15.393227	22.443808
Combined	20.439183	16.689844	24.188523

**Figure 4:** Result of sensitivity analysis of the 14 studies in the meta-analysis of overweight.

Study omitted	Coef.	[95% Conf.	Interval]
Abera D, etal	5.2844915	4.2053108	6.3636723
Abrha S, etal	5.8013558	4.5596724	7.0430388
Tebekaw Y, etal	5.5626507	4.425869	6.6994324
Amare B, etal	5.4089479	4.3111115	6.5067844
Awoke A, etal	5.4232454	4.3210888	6.5254025
Dagne S, etal	5.156126	4.1098514	6.2024007
Darebo T, etal	5.4749699	4.3657789	6.5841608
Gutema BT, etal	5.832715	4.6363239	7.0291057
Hundera TD, etal	5.748404	4.6261935	6.8706145
Hussein M, etal	5.0217872	4.0067286	6.0368457
Kahsay AB, etal	5.6494417	4.4939957	6.8048878
Mekonnen T, etal	5.787991	4.6217656	6.9542165
Moges B, etal	5.2873678	4.2271786	6.3475571
Yohannes M	4.9776611	3.9654725	5.98985
Ahmed KY, etal	5.4408903	4.3709903	6.5107903
Daka DW, etal	5.4408903	4.3709903	6.5107903
Combined	5.4408902	4.3709902	6.5107903

**Figure 5:** Result of sensitivity analysis of the 16 studies in the meta-analysis of obesity.

Publication bias for overweight

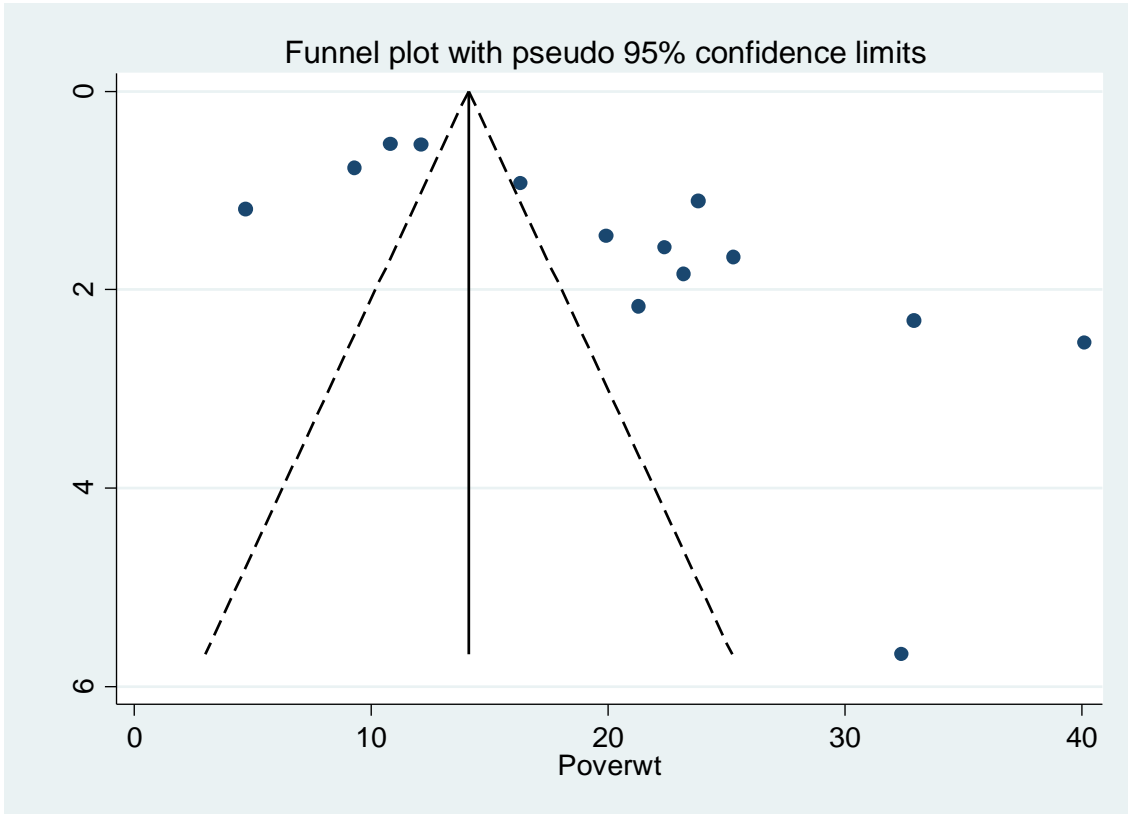


Figure 6: Distribution of studies included in overweight analysis in the Funnel graph.

Publication bias test for obesity

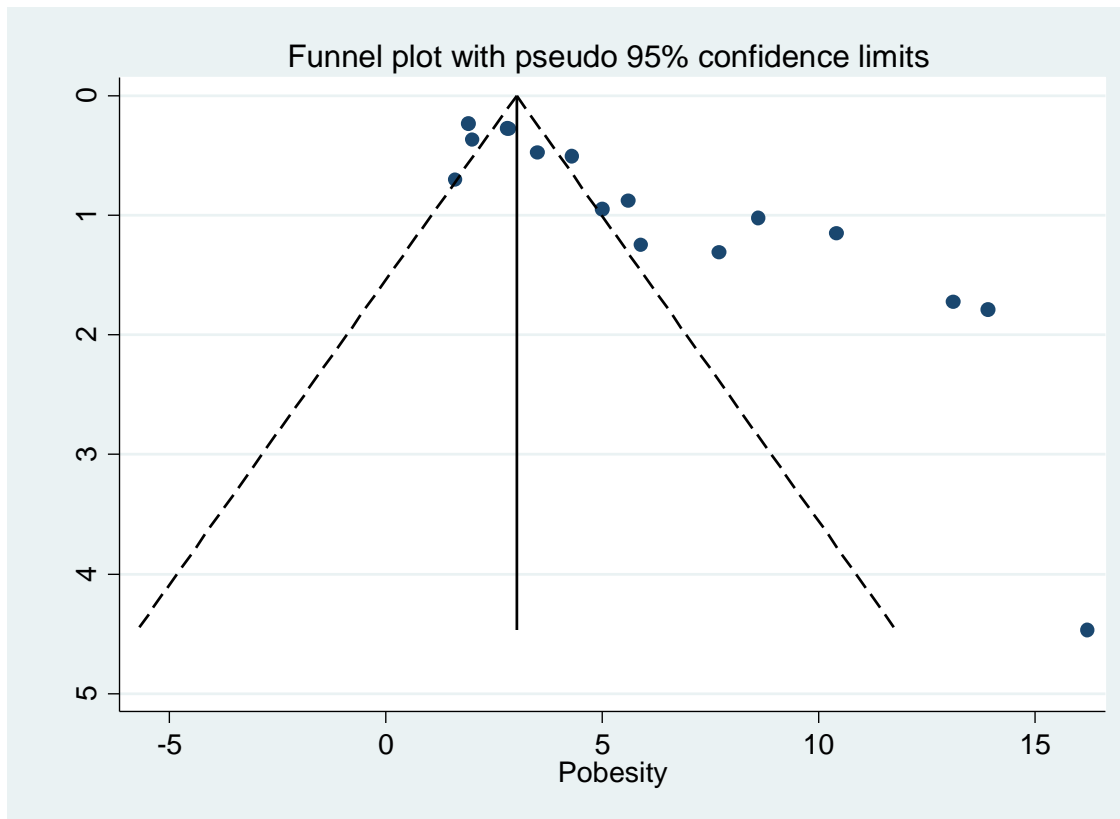


Figure 7: Distribution of studies included in obesity analysis in the Funnel graph.



## Egger's test

Std_Eff	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
slope	6.137967	2.411285	2.55	0.026	.8842288 11.39171
bias	9.04124	2.353041	3.84	0.002	3.914404 14.16808

**Figure 8:** Egger's test for detection of publication bias for studies included in overweight.

For peer review only

## Egger's test

Std_Eff	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
slope	.8714913	.4245854	2.05	0.059	-.0391538	1.782136
bias	5.452998	.8718187	6.25	0.000	3.583133	7.322863

**Figure 9:** Egger's test for detection of publication bias for studies included in obesity.

For peer review only

### Trim and fill analysis for the pooled prevalence of overweight

#### Meta-analysis

Method	Pooled Est	95% CI		Asymptotic		No. of studies
		Lower	Upper	z_value	p_value	
Fixed	14.105	13.568	14.641	51.500	0.000	14
Random	20.439	16.690	24.189	10.685	0.000	

Test for heterogeneity:  $Q = 540.744$  on 13 degrees of freedom ( $p = 0.000$ )  
 Moment-based estimate of between studies variance = 47.477

Trimming estimator: Linear  
 Meta-analysis type: Random-effects model

iteration	estimate	Tn	# to trim	diff
1	20.439	58	1	105
2	18.919	62	1	8
3	18.919	62	1	0

#### Filled Meta-analysis

Method	Pooled Est	95% CI		Asymptotic		No. of studies
		Lower	Upper	z_value	p_value	
Fixed	13.916	13.382	14.449	51.106	0.000	15
Random	19.016	15.289	22.743	10.000	0.000	

Test for heterogeneity:  $Q = 581.975$  on 14 degrees of freedom ( $p = 0.000$ )  
 Moment-based estimate of between studies variance = 50.285

**Figure 10:** Trim and fill analysis for the prevalence of overweight among adults in Ethiopia.

### Trim and fill analysis for the pooled prevalence of obesity

#### Meta-analysis

Method	Pooled Est	95% CI Lower	95% CI Upper	Asymptotic z_value	Asymptotic p_value	No. of studies
Fixed	3.019	2.780	3.258	24.795	0.000	16
Random	5.441	4.371	6.511	9.967	0.000	

Test for heterogeneity:  $Q = 223.610$  on 15 degrees of freedom ( $p = 0.000$ )  
 Moment-based estimate of between studies variance = 3.709

Trimming estimator: Linear  
 Meta-analysis type: Random-effects model

iteration	estimate	Tn	# to trim	diff
1	5.441	77	1	136
2	5.287	79	1	4
3	5.287	79	1	0

#### Filled Meta-analysis

Method	Pooled Est	95% CI Lower	95% CI Upper	Asymptotic z_value	Asymptotic p_value	No. of studies
Fixed	3.013	2.774	3.251	24.752	0.000	17
Random	5.309	4.240	6.377	9.737	0.000	

Test for heterogeneity:  $Q = 227.350$  on 16 degrees of freedom ( $p = 0.000$ )  
 Moment-based estimate of between studies variance = 3.754

**Figure 11:** Trim and fill analysis for the prevalence of obesity among adults in Ethiopia.

Additional file 1: Characteristics of included studies in the systematic review and meta-analysis of overweight and obesity among adults in Ethiopia.

Study	Author	Year of study	Publication year	Region	Residence	Setting	Design	Sex	Sampling Technique	Sample Size	Class of sample size	Poverwt	Pobesity
1	Abera D. et al	After 2015	2017	SNNPR	Urban	Institution-based	Cross-sectional	Both male and female	Simple random sampling	413	>384	32.9	7.7
2	Abriha S. et al	Before 2015	2016	Not specified	Urban	Community-based	Cross-sectional	Only female	Stratified cluster sampling	3602	>384	12.1	2.8
3	Tebekaw Y. et al	Before 2015	2014	Addis Ababa	Urban	Community-based	Cross-sectional	Only female	Stratified cluster sampling	1592	>384	16.3	4.3
4	Amare B. et al	Before 2015	2012	Amhara	Urban	Community-based	Cross-sectional	Both male and female	Simple random sampling	356	<384	21.3	5.9
5	Awake A. et al	Before 2015	2012	Amhara	Urban	Community-based	Cross-sectional	Both male and female	Systematic random sampling	679	>384	25.3	5.6
6	Dagne S. et al	After 2015	2019	Amhara	Urban	Community-based	Cross-sectional	Both male and female	Multi-stage probability sampling	751	>384	19.9	8.6
7	Darebo T. et al	After 2015	2019	SNNPR	Urban	Community-based	Cross-sectional	Both male and female	Multistage cluster sampling	524	>384	23.2	5
8	Gutema BT. et al	After 2015	2020	SNNPR	Both	Community-based	Cross-sectional	Both male and female	Simple random sampling	3,346	>384	10.8	1.9
9	Hundera TD. et al	Before 2015	2015	Oromia	Urban	Institution-based	Cross-sectional	Only female	Probability sampling	317	<384	4.7	1.6
10	Hussein M. et al	After 2015	2016	Somali	Urban	Community-based	Cross-sectional	Only female	Multistage random sampling	698	>384	22.4	10.4
11	Kahsav AB. et al	After 2015	2018	Tigray	Urban	Institution-based	Cross-sectional	Both male and female	Stratified random sampling	1486	>384	23.8	3.5
12	Mekonnen T. et al	After 2015	2018	Amhara	Both	Institution-based	Cross-sectional	Only female	Systematic random sampling	1405	>384	9.3	2
13	Moges B. et al	Before 2015	2014	Amhara	Urban	Community-based	Cross-sectional	Both male and female	Simple random sampling	68	<384	32.4	16.2
14	Yohannes M	After 2015	2019	SNNPR	Urban	Institution-based	Cross-sectional	Both male and female	stratified cluster sampling	374	<384	40.1	13.9
15	Janakiraman B. et al	After 2015	2020	Amhara	Urban	Institution-based	Cross-sectional	Both male and female	Simple random sampling	381	<384		13.1
16	Mekonnen W. et al	Before 2015	2017	Not specified	Urban	Community-based	Cross-sectional	Only female	Stratified cluster sampling	3535	>384		2.84



# PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3-4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
<b>METHODS</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4-5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	3-6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4-5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5-7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	3-6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I <sup>2</sup> ) for each meta-analysis.	8-10



# PRISMA 2009 Checklist

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Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	12
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	10-12
<b>RESULTS</b>			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	10-12
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	9-11
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	9-12
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	12
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	10-12
<b>DISCUSSION</b>			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	14-15
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	14-16
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16
<b>FUNDING</b>			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	16

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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