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Food handling practice and associated factors among food handlers in public food establishments of Ethiopia: A systematic review and Meta-analysis

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Abstract

Objectives: Food handlers are getaways to ready-to-eat foods that have a high probability of contaminating food or transmitting microbes to consumers if not handled carefully and therefore maintaining good food handling practice by food handlers is very essential. The main aim of this review is to pool the level of good food handling practice among food handlers working in public food establishments in Ethiopia.

Methods: This review has been registered at PROSPERO with registration identification number **CRD42020223348**. Individual articles were searched up to the end of February 2021 from databases such as PubMed, Google Scholar, and Advanced Google Search using keywords and medical subject headings. This review included both published and unpublished original articles written in English which was conducted from 2010 to the end of February 2021 among food handlers working in public food establishments in Ethiopia.

Result: A total of 16 institutional-based (75%) and community-based (25%) research articles with cross-sectional study design (100%) were included in the review. The pooled level of good food handling practice among food handlers of public food establishments was found to be 50.72% with 95%CI (43.84, 57.6). Training [AOR=3.4, 95% CI=(2.33, 4.95)], attitude [AOR=3.62, 95% CI=(2.23, 5.85)], and medical checkup [AOR=5.12, 95% CI=(2.93, 8.95)] were identified as factors affecting good food handling practice with 95% CI at P<0.05.

Conclusion: The level of good food handling practice among food handlers working in public food establishments of Ethiopia was very low compared to literature and variables such as food handler training, attitude towards good food handling practice, and the existence of regular

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medical checkup were factors affecting good food handling practice. Provision of training that could change the attitude towards good food handling practice and regular medical checkups for food handlers has to be in place to improve good food handling practice.

Keywords: Ethiopia, Food handlers, Food handling, Public food establishment.

Limitations of the study

- The investigators of this review were doing their best to include all available shreds of evidence regarding the issue under review but still, there might be works of literature that were not published and hanged on by authors.
- Though the investigators also did their best to include articles of all study designs still the available literature was obtained only with cross-sectional design and this might still have its influence on the quality of the review.
- A little bit different operational definitions were used to define good food handling practice by authors of individual articles and therefore this might have its implication on the generalizability of the findings.

Introduction: Ethiopian Public Health Proclamation No. 200/2000 defined food as any substance whether processed, semi-processed, or raw which is intended for human consumption and includes drinks, chewing gum, and any substance which has been used in the manufacture, preparation, or treatment of food, but it does not include tobacco, cosmetics or substances used only as drugs [1].

Experts in different national and international organizations believed that food has to be promoted as part of essential components of primary health care [2]. Availing sufficient quantity with adequate nutritional content only doesn't guarantee the wellbeing of consumers. It has to be safe for consumption and not endanger the health of the consumer via contamination or intoxication as well [2]. Whenever we say the food is hygienic and safe, we are saying that the food we are going to eat has to be free of microbiological or chemical contamination that could bring ill-health [3, 4].

Many stakeholders can be involved in bringing food to the dining table including producers, harvesters, shippers, processors, distributors, handlers, and others [5]. Usually, food handlers are

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getaways to ready-to-eat foods that have a high probability of contaminating food or transmitting microbes to consumers if not handled carefully and therefore maintaining good food handling practice by food handlers is very essential [6]. A food handler is defined as anyone who handles packaged or unpackaged food directly as well as the equipment and utensils used to prepare or serve food and/or surfaces that come into contact with food [7].

Research findings abroad indicated the level of food handling practice among food handlers from very low (59.3%) to high (90%) (Indonesia, 90% [8], Saudi Arabia, 80.29% [9], Malaysia, 59.3% [10], Jordan, 89.43% [11], Nigeria, 78.2% [12]). Similarly, good food handling practice among food handlers in Ethiopia also ranged from a very low 27.4% in Addis Ababa to 72% in Dessie [13-28].

The rationale of the review: As to reviewers of view, the inconsistent effect size in different individual research articles conducted in different parts of the country would make researchers, policymakers, and other stakeholders in trouble to use the findings. Moreover, as we can see from the literature the highest effect size of individual research articles was obtained from the small sample size [28] while the smallest effect size was obtained from a relatively large sample size (13). Hence, a systematic review and meta-analysis are needed to overcome the limitations of small sample sizes and evaluate effects in different subsets of participants. Therefore, the main aim of this review is to pool the level of good food handling practice among food handlers working in public food establishments in Ethiopia.

Methods

Protocol and Registration: Usually, researchers are advised to maintain prior registration of their systematic review and meta-analysis in organizations like PROSPERO ((http://www.crd.york.ac.uk/PROSPERO/) which could make the process transparent and hence reduces duplication of efforts [29]. Therefore, this review has been registered at PROSPERO with registration identification number **CRD42020223348**.

Literature search: In this review, the step-by-step guide for conducting a systematic review and meta-analysis [30] was used. So, setting a research question was the first step, a preliminary search was done to see the existence of a similar article thereby reducing duplication of efforts. Individual articles were searched up to the end of February 2021 from databases such as

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PubMed, Google Scholar, and Advanced Google Search using keywords and medical subject headings. After having individual research articles, the title and abstract were screened, the protocol has been written and approved by each member and registered to PROSPERO.

Study Selection: Selection of studies was done through removing duplicate studies, selecting researches that meet the inclusion/exclusion criteria based on the abstracts, and then make the final selection of studies based on their full text. Each of the researchers was conducting study selection independently and brought it together for ensuring the consistency of our search. Differences between two investigators regarding a single research article have happened and the third investigator brought the issue to the table and finally, all of the investigators became on the same page after a big debate moderated by the third investigator.

Eligibility Criteria: While doing a systematic and meta-analysis, numerous strategies are usually taken to include or exclude research articles in the review such as title and abstract screening, full-text downloading and screening after setting guiding criteria's such as language, type of study participants, and type of the article. Therefore, this review included both published and unpublished original articles written in English which was conducted from 2010 to the end of February 2021 among food handlers working in public food establishments in Ethiopia. However, this review excluded articles losing originality, local or governmental reports, and conference abstracts, and articles which were very difficult to access the full text.

Patient and Public Involvement

No patient involved

Data Extraction and Study Quality Assessment

After collecting eligible individual research articles using criteria described under the heading 'eligibility criteria', variables more frequently used by individual research articles were collected as data. The collection of these data was performed independently by all reviewers and finally merged after reconciling disagreements created during data extraction.

A tool called Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI) adapted for both cross-sectional/case-control study design [31] was

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used to assess the quality of each research article (Table 1). The assessment was performed by two reviewers namely Mr. Amare Dagnew and Ms. Dehabo Alamirew. During the start of this review, disagreements created while assessing the quality of the articles were planned to be reconciled by Mr. Maru Meseret. However, the two assessors (Mr. Amare Dagnew and Ms. Dehabo Alamirew) agreed and ranked accordingly so that Mr. Maru Meseret was not involved in reconciling.

Table 1: Result of JBI Critical Appraisal Checklist for Analytical Cross Sectional Studies

Lead Author & Study year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Decision
Abdi et al., 2017 [13]	4	4	1	4	4	3	4	4	Included
Ayehu et al.,2013 [22]	4	4	1	4	4	3	4	4	Included
Chekol et al., 2018 [16]	4	4	1	4	4	3	4	4	Included
Dawit G. et al., 2019 [25]	4	4	1	4	4	3	4	4	Included
Legesse D, et al., 2015 [15]	4	4	1	4	4	3	4	4	Included
Henok D, et al., 2018 [21]	4	4	1	4	4	3	4	4	Included
Lalit et al., 2015 [23]	4	4	1	4	4	3	4	4	Included
Melese A, et al., 2017 [17]	4	4	1	4	4	3	4	4	Included
Mulugeta A, et al., 2018 [27]	4	4	1	4	4	3	4	4	Included
Zemichael G, et al., 2014 [14]	4	4	1	4	4	3	4	4	Included
Asrat M, et al., 2014 [19]	4	4	1	4	4	3	4	4	Included
Metadel A, et al., 2014 [28]	4	4	1	4	4	3	4	4	Included
Daniel N and Kumie, 2011 [24]	4	4	1	4	4	3	4	4	Included
Derso et al., 2013 [26]	4	4	1	4	4	3	4	4	Included
Lema et al., 2019 [18]	4	4	1	4	4	3	4	4	Included
Azanaw et al., 2018 [20]	4	4	1	4	4	3	4	4	Included

Hint: 4=Yes, 3=No, 2=Not clear and 1=Not applicable

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Data synthesis and statistical analysis

Data were collected and entered into excel and finally exported to Stata v14 (StataCorp, College Station, Texas, USA) for analysis. Eyeball test using forest plot, Chi-squared (χ^2) test, and I-squared (I^2) were used to identify and measure heterogeneity. Moreover, subgroup analysis and meta-regression were also employed to explore the existence of heterogeneity between research articles. I^2 reflects the percentage of total variation across studies that were attributable to heterogeneity rather than chance. Heterogeneity was quantified as low, moderate, and high, with upper limits of 25%, 50%, and 75% for I2, respectively [32]. Moreover, Subgroup analysis is usually defined as the process of comparing a treatment effect for two or more variants of an intervention [33].

In this review, publication bias was determined by statistical methods such as drawing funnel plots, and statistical testing (Eggers regression test). Eggers test with a P value of less than 0.1indicats the presence of publication bias [34].

Individual research articles were collected from all regions in the country which were conducted from 2010 to the end of February 2021 in the country. Investigators of this review believed that the true estimate of food handling practice could vary from region to region due to differences in access to education and medical checkup. Moreover, the true estimate could also vary due to the size of the study participants enrolled in each study. Therefore, the random-effects model which could address this issue [35] was used during analysis, and odds ratios with their 95% CI were used to present the pooled effect sizes. Meta-regression was also done to examine the effect of characteristics of studies against the effect size that is good food handling practice with a 95% confidence interval at $P<0.05$.

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Result

Search Results

The investigators of this review tried to search for databases such as PubMed, Advanced Google search, and Google scholar. The research articles were filtered by country, year of study, and type of study. Finally, articles fulfilling the eligibility criteria were included in the review (Figure 1).

Characteristics of studies

A total of 16 institutional-based (75%) and community-based (25%) research articles with cross-sectional study design (100%) were included in the review. All of the research articles were conducted from 2011-2019 and published [15/16] from 2012-2020. Regarding the distribution of the included articles, 10 (62.5%) of them were conducted in the Amhara region followed by Addis Ababa and Tigray contributed 2 (12.5%) each while the rest 2(12.5%) were contributed by SNNPR and Benshangul Gumez regions. The mean value (343) of the study participants included in the review was calculated and more than half (62.5%) of the articles included >343 study participants. Study participants were sampled by simple random sampling by 66.67 %(10/16) articles, Systematic simple random sampling by 20% (3/16) articles, and Census by 13.33% (2/16) articles (Table2).

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Table 2: Characteristic of included studies in systematic review and meta-analysis

Ser.No	First author and study year	Region	Study design	Sampling technique	Study population	Sample size	Response Rate	Prevalence (%)
1	Abdi et al., 2017 [13]	Addis Ababa	CS	SRS	FH	394	95.2	27.4
2	Ayehu et al.,2013 [22]	Amhara	CS	Census	FH	406	94.4	52.5
3	Chekol et al., 2018 [16]	Amhara	CS	SRS	FH	416	98.6	40.1
4	Dawit G. et al., 2019 [25]	Amhara	CS	SyRS	FH	214	95.5	66.4
5	Legesse D, et al., 2015 [15]	SNNPRS	CS	SRS	FH	383	99	32.6
6	Henok D, et al., 2018 [21]	Amhara	CS	SRS	FH	423	100	49.6
7	Lalit et al., 2015 [23]	Tigray	CS	SRS	FH	369	96.9	53.1
8	Melese A, et al., 2017 [17]	Amhara	CS	SRS	FH	288	100	46.5
9	Mulugeta A, et al., 2018 [27]	Benshangul Gumuz	CS	SRS	FH	355	100	67.8
10	Zemichael G, et al., 2014 [14]	Amhara	CS	SyRS	FH	403	100	30.3
11	Asrat M, et al., 2014 [19]	Addis Ababa	CS	Census	FH	302	100	47.7
12	Metadel A, et al., 2014 [28]	Amhara	CS	SyRS	FH	416	85.9	72
13	Daniel N and Kumie, 2011 [24]	Tigray	CS	SRS	FH	377	97.5	63.9
14	Derso et al., 2013 [26]	Amhara	CS	SRS	FH	417	98.8	67.6
15	Lema et al., 2019 [18]	Amhara	CS	SRS	FH	394	97.8	46.7
16	Azanaw et al., 2018 [20]	Amhara	CS	SRS	FH	338	88	49

CS=cross-sectional, SRS= Simple Random Sampling, SyRS=Systematic SRS

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Pooled Level of good food handling practice

This review used a total of 5495 study participants obtained from 16 research articles to pool the level of good food handling practice among food handlers of public food establishments. In a systematic and meta-analysis, two models are usually used for the analysis based on the assumptions behind. Hence, the fixed-effect model was used to pool the level of good food handling practice but showed a very high level of heterogeneity. Therefore, this review employed a random effect model for analysis and the pooled level of good food handling practice among food handlers of public food establishments was found to be 50.72% with 95%CI (43.84, 57.6) (Figure 2). By observing the forest plot and considering I-squared (I^2=96.6%), a high level of heterogeneity between studies was observed (Figure 2).

Sub-group analysis: The test for sub-group analysis suggests that there is a statistically significant sub-group effect (P<0.0001). The pooled level of good food handling practice is higher among articles conducted before 2016 [52.34% with 95% CI (41.62, 63.05)] compared to articles conducted after 2016 [49.12% with 95% CI (39.75, 58.5)]. However, there is substantial unexplained heterogeneity between the articles within each of these subgroups (conducted before 2016: I^2 = 97.1%; conducted after 2016: I^2= 96.4%) (Figure 3).

Similarly, there is a statistically significant sub-group effect (P<0.0001). The pooled level of good food handling practice is higher among articles having a sample size of ≤ 343 [57.36% with 95% CI (48.98, 65.73)] compared to articles having a sample size of <343 [46.76% with 95% CI (37.65, 55.86)]. However, there is substantial unexplained heterogeneity between the articles within each of these subgroups (sample size of ≤ 343: I^2 = 91.4%; a sample size of ≤ 343: I^2= 97.3%). Therefore, the validity of the good food handling practice estimate for each subgroup is uncertain, as individual article results are inconsistent (Figure 4).

Publication Bias: A funnel plot was drawn and evaluated subjectively by investigators and evidence of publication bias was not observed. Publication bias can be suspected if the plot shows an asymmetric shape, with no points on one side of the graph (Figure 5). Moreover, the Eggers test for small-study effects was also performed but unable to show evidence of the existence of publication bias at p =0.949.

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Meta-regression: Potential effect modifiers such as study year and size of participants involved in each article were regressed against good food handling practice and none of the effect modifiers showed the existence of association against good food handling practice (Table 3).

Table 3: Meta-regression output for assessing causes of heterogeneity among studies included

Variable	Category	Coef	P>|t|	[95% Conf. Interval]
Year of study	After 2016	Ref.	Ref.	Ref.
	Before 2016	3.184339	0.663	(-12.14331, 18.51198)
Size of study participants	≤343	Ref.	Ref.	Ref.
	>343	-10.69023	0.143	(-25.47183, 4.091367)

Determinants of good food handling practice

At the individual level of analysis, 43.8% (7/16) of the articles identified training as a factor that could determine good food handling practice among food handlers working in public food establishments. Consequently, the pooled estimate indicated that the odds of having good food handling practice was 3.4 times higher among trained food handlers compared to non-trained food handlers [AOR=3.4, 95% CI=(2.33, 4.95)] (Figure 6).

Out of the total research articles, 25% (4/16) of the included individual research articles indicated that the attitude of food handlers was associated with good food handling practice. Similarly, the pooled estimate indicated that those food handlers having favorable attitudes were 3.62 times more likely to have good food handling practice compared to those who had unfavorable attitudes [AOR=3.62, 95% CI=(2.23, 5.85)] (Figure 7).

Regarding medical checkup, 18.8% (3/16) of the included individual research articles indicated that regular medical checkup of food handlers was associated with good food handling practice. The pooled estimate also indicated that food handlers who had regular medical checkups were 5.12 times more likely to have good food handling practice compared to those food handlers who didn't have regular medical checkups [AOR=5.12, 95% CI=(2.93, 8.95)] (Figure 8).

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Discussion

In individual studies, the level of good food handling practice among food handlers working in public food establishments ranges from 27.4% in Addis Ababa to 72% in Dessie [13-28]. However, the pooled level of good food handling practice among food handlers working in public food establishments was 50.72%. This finding is lower than the findings from Indonesia, 90% [8], Saudi Arabia, 80.29% [9], Malaysia, 59.3% [10], Jordan, 89.43% [11], Nigeria, 78.2% [12]. The possible explanation for the finding could be related to the availability of training and medical checkup regularly. In Ethiopia, most establishments are opened without having trained food handlers and even without establishing a mechanism for having a regular medical checkup.

The odds of having good food handling practice was 3.4 times higher among trained food handlers working in public food establishments compared to non-trained food handlers. This finding was supported by findings from different parts of the world suggesting that the provision of training positively influences the food handling practices of food handlers [36-38]. This could happen because trained food handlers could develop a positive attitude and a positive attitude could lead to a good handling practice as evidenced by this review.

Likewise, the pooled estimate also indicated that food handlers having favorable attitudes were 3.62 times more likely to have good food handling practice compared to those who had unfavorable attitudes. Evidence also suggested that attitude was playing a significant role in promoting good food handling practice [39-40]. This review has also uncovered that training has a significant positive association with good food handling practice and this might, in turn, improve attitude towards good food handling practice.

The pooled estimate also indicated that food handlers who had regular medical checkups were 5.12 times more likely to have good food handling practice compared to those food handlers who didn't have a regular medical checkup. The probable explanation for the finding could be during regular medical checkup healthcare professionals might counsel regarding safe handling of food, consequences of contaminated food, and other related issues which could trigger positive attitude towards good food handling practice.

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Conclusion

The level of good food handling practice among food handlers working in public food establishments of Ethiopia was very low compared to literature used above [8-12] and variables such as food handler training, attitude towards good food handling practice, and the existence of regular medical checkup were factors affecting good food handling practice among food handlers working in public food establishments of Ethiopia. Provision of training that could change the attitude towards good food handling practice and regular medical checkups for food handlers has to be in place to improve good food handling practice among food handlers working in public food establishments of Ethiopia.

Data Availability

The Excel data is available from the corresponding author upon request.

Competing interests

The authors declare that we have no competing interests.

Funding Statement

No organization or individual funded this research.

Authors' contributions

Maru Meseret designed the study, prepared the protocol, supervised data collection, analyzed and interpreted the data.

Maru Meseret, Amare Dagnew, and Dehabo Alamirew coached the research from protocol development to data interpretation. Maru Meseret drafted and prepared the manuscript. All authors read and approved the final manuscript.

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Figures

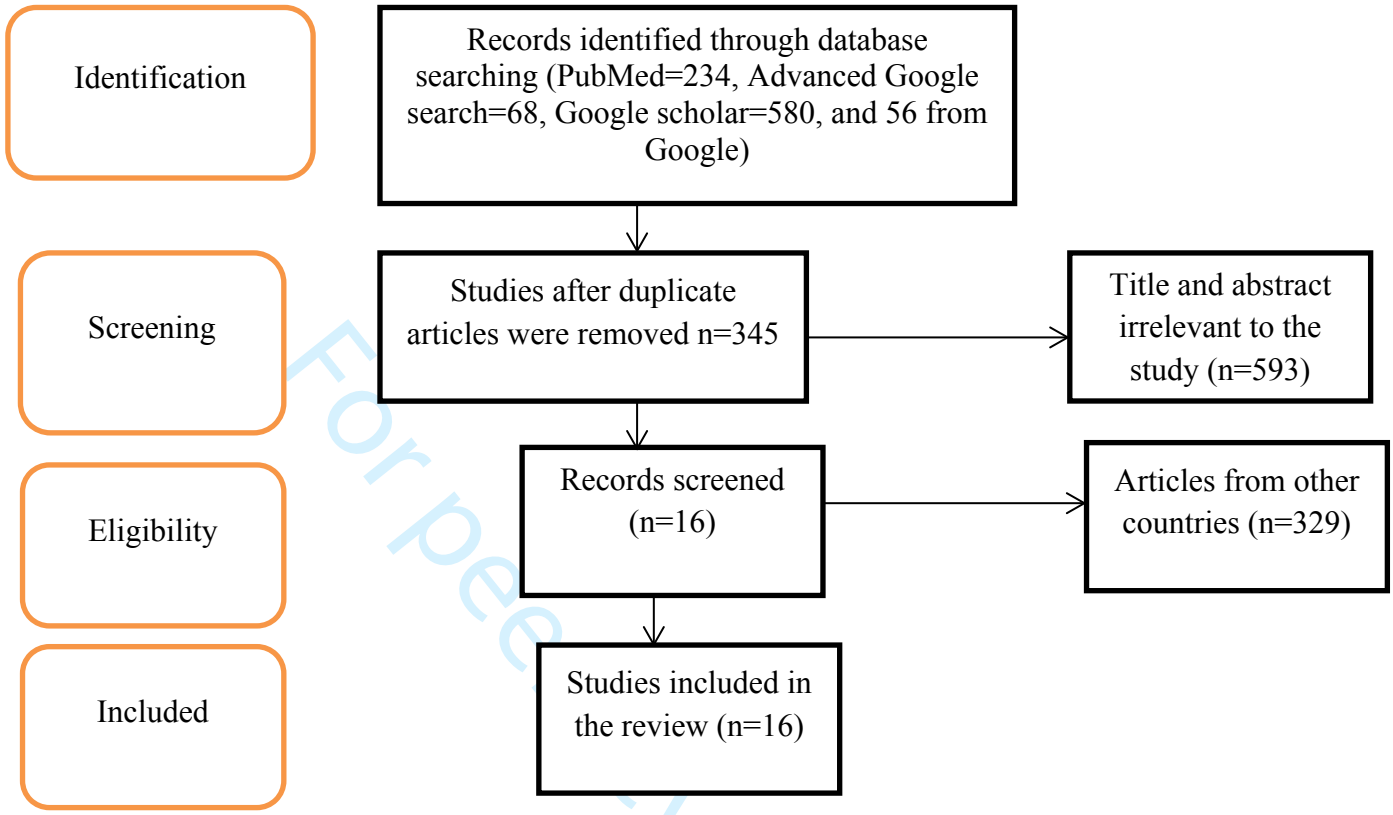

Figure 1: PRISMA flow-chart diagram describing the selection of studies.

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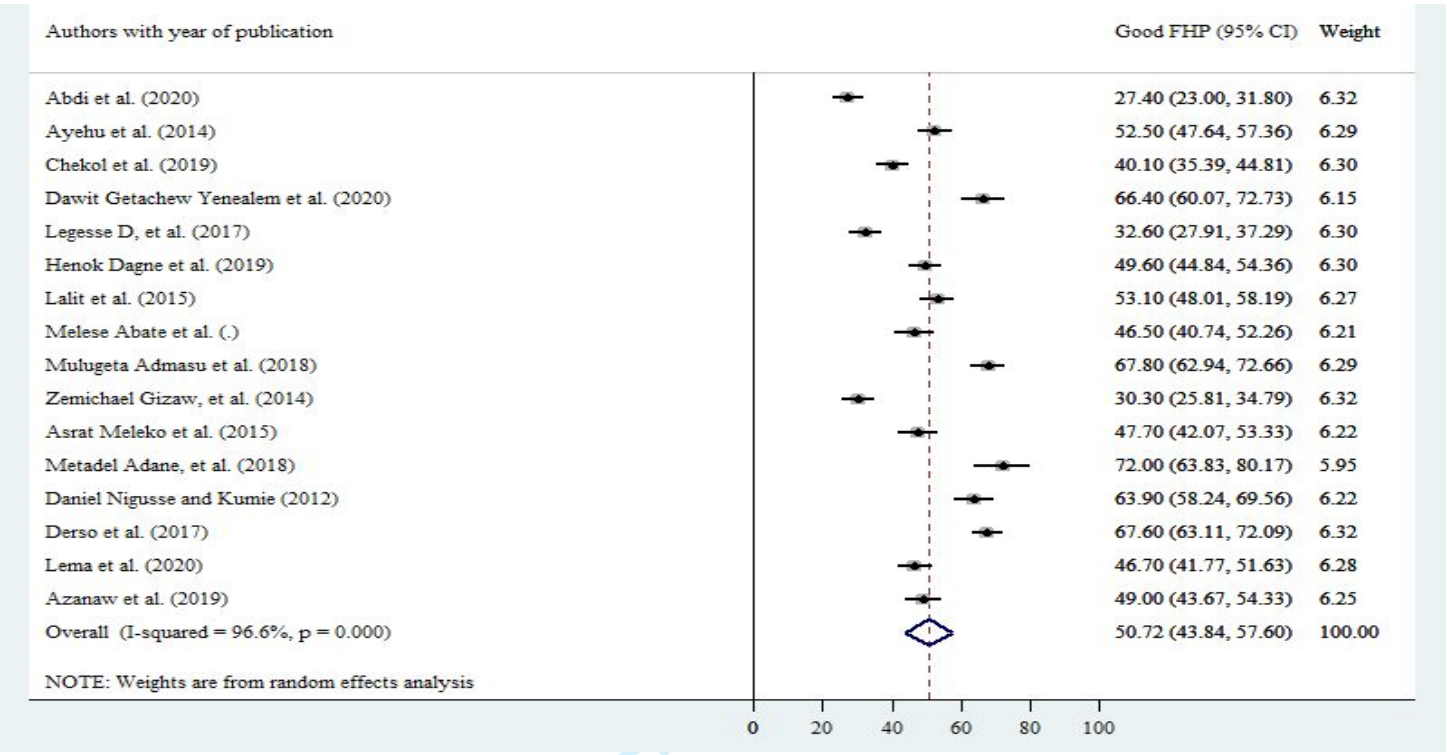

Figure 2: Forest plot showing the pooled level of good food handling practice among food handlers working public food establishments of Ethiopia, 2021.

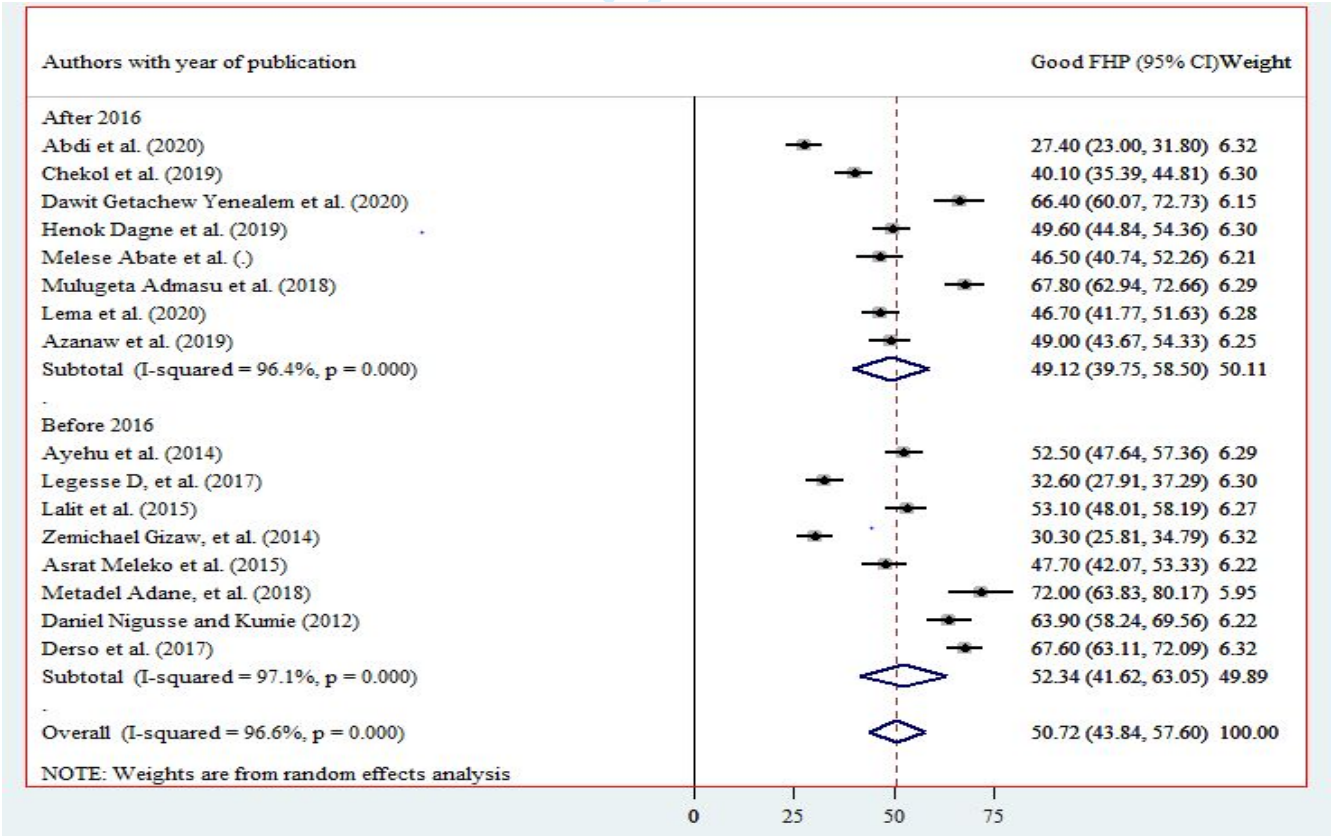

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Figure 3: Sub-group analysis of good food handling practice by year of study

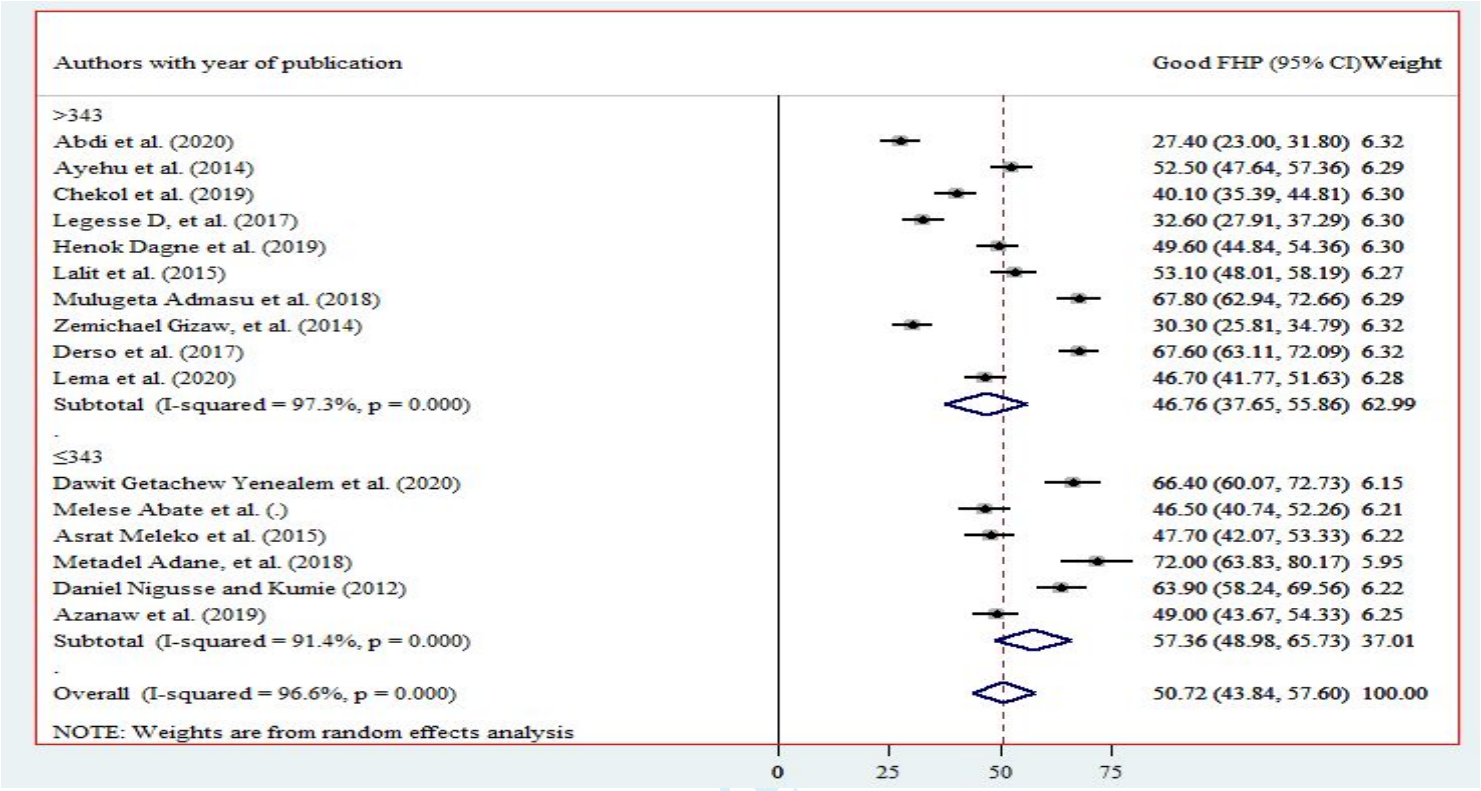

Figure 4: Sub-group analysis of good food handling practice by size of study participants

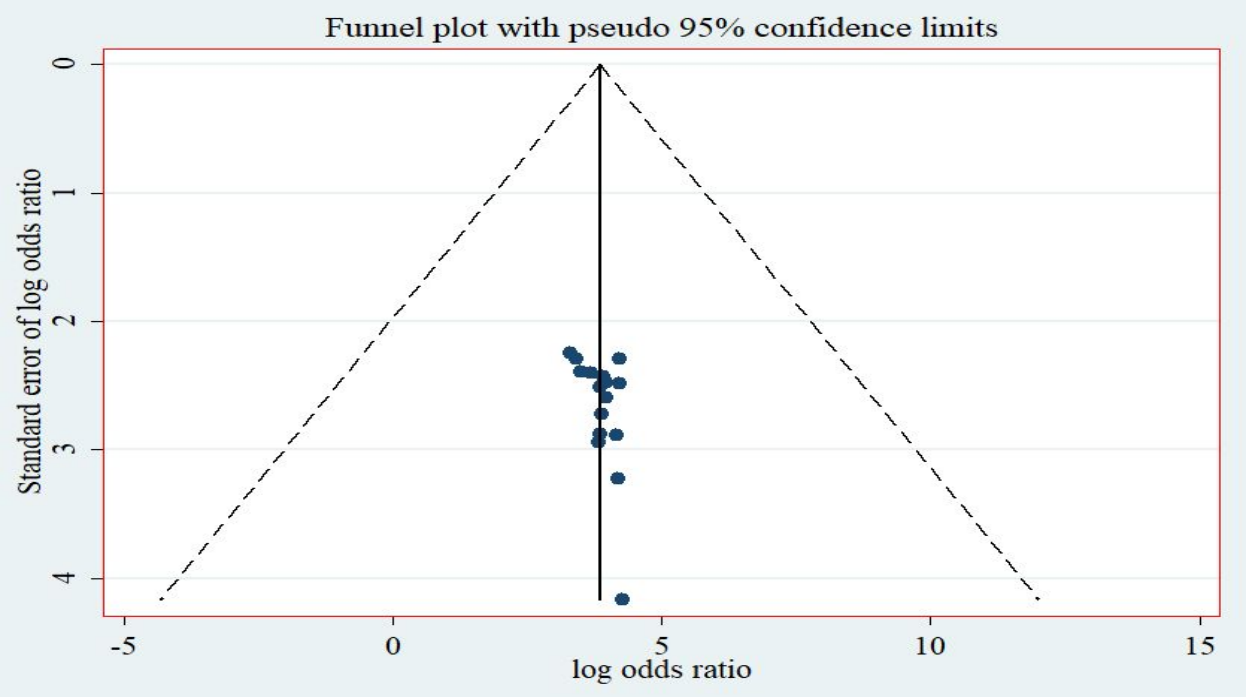

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Figure 5: Funnel plot, in which the vertical line indicates the effect size whereas the diagonal line indicates the precision of individual studies with 95% confidence limit.

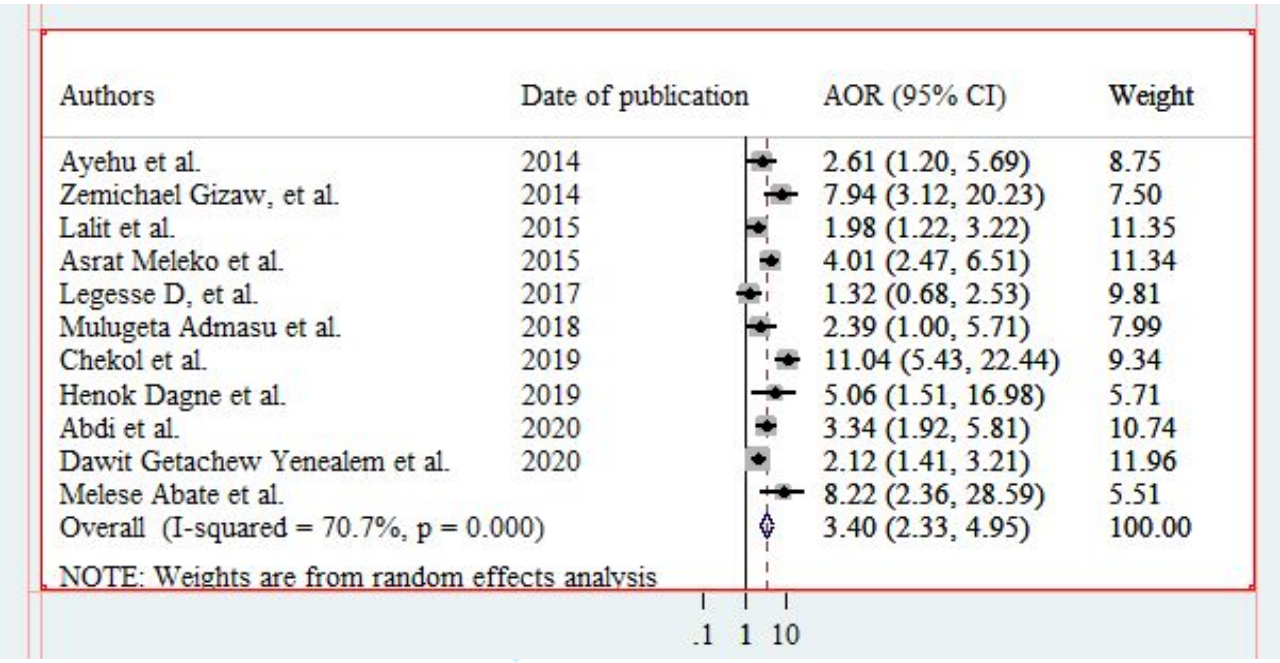

Figure 6: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of training against good food handling practice.

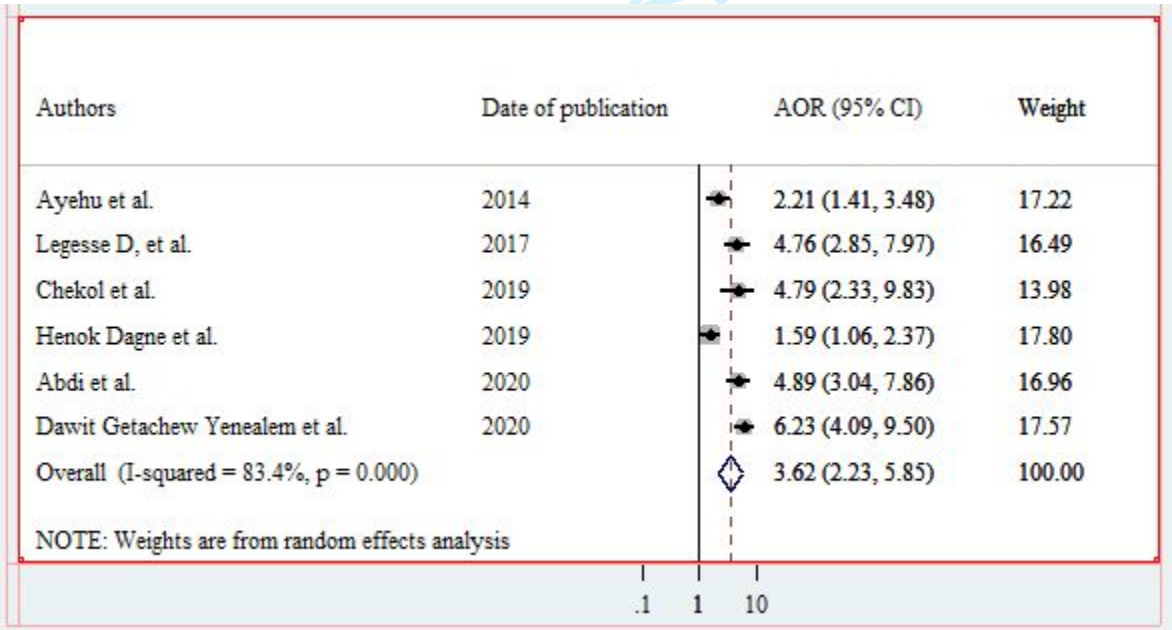

Figure 7: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of attitude against good food handling practice.

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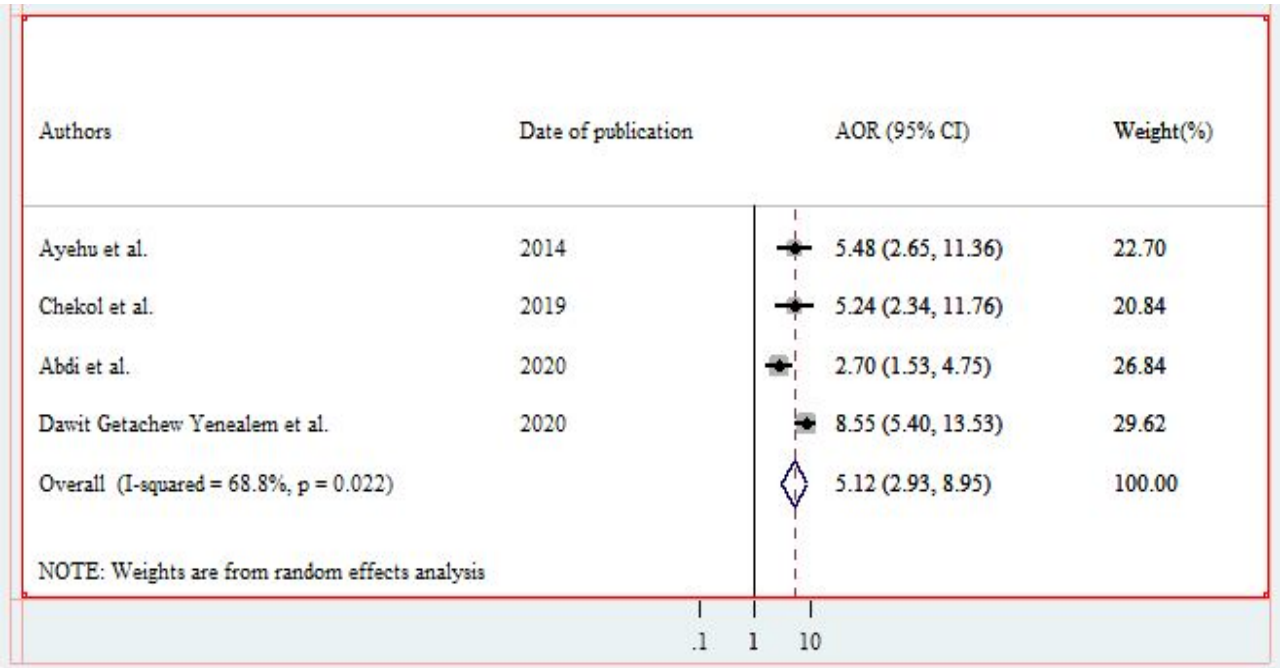

Figure 8: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of medical checkup against good food handling practice.

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1-2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
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
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.	3-4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	3-4
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).	4
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.	4-5

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Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	7-8
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.	9-10
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	10
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	9
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	9-10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	9-10
RESULTS			
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.	7
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).	9
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
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	10
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	9-10
DISCUSSION			
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).	12

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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).	2
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	12
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	12

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

Available at : **www.prisma-statement.org**.

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Food handling practice and associated factors among food handlers in public food establishments of Ethiopia: A systematic review and Meta-analysis

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Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Evidence based practice, Health informatics, Health policy, Infectious diseases
Keywords:	PUBLIC HEALTH, Infection control < INFECTIOUS DISEASES, Risk management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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Food handling practice and associated factors among food handlers in public food establishments of Ethiopia: A systematic review and Meta-analysis

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Abstract

Objectives: Food handlers are individuals who are involved in food preparation, storage, or service of food in a food facility. Unless they keep their personal hygiene, they are highly responsible for contaminating food or transmitting microbes to consumers and. The main aim of this review was to pool the level of good food handling practice among food handlers working in public food establishments in Ethiopia.

Design: A systematic and meta-analysis using the Joanna Briggs Institute (JBI) Critical Appraisal tool.

Data Sources: PubMed, Google Scholar, and Advanced Google were searched up to the end of February 2021.

Eligibility criteria for selecting studies; Publication status, publication language, type of study participants, and the type of the article were used to screen the article.

Data Extraction and Study Quality Assessment: All reviewers collected data independently and merged it together. A tool called the Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument was used to assess the quality of each research article. The assessment was performed by two reviewers.

Result: A total of 16 research articles were included in the review. The pooled level of good food handling practice was 50.72% with 95%CI (43.84, 57.6). Training [AOR=3.4, 95% CI= (2.33, 4.95)], attitude [AOR=3.62, 95% CI= (2.23, 5.85)], and medical checkup [AOR=5.12,

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95% CI= (2.93, 8.95)] were identified as factors affecting good food handling practice with 95% CI at P<0.05.

Conclusion: The level of good food handling practice among food handlers working in public food establishments of Ethiopia was very low compared to literature and variables such as food handler training, attitude towards good food handling practice, and the existence of regular medical checkups were factors affecting good food handling practice. Provision of training that could change the attitude and regular medical checkups for food handlers has to be in place.

Keywords: Ethiopia, Food handlers, Food handling, Public food establishment.

Introduction: Ethiopian Public Health Proclamation No. 200/2000 defined food as any substance whether processed, semi-processed, or raw which is intended for human consumption and includes drinks, chewing gum, and any substance which has been used in the manufacture, preparation, or treatment of food, but it does not include tobacco, cosmetics or substances used only as drugs [1].

Experts in different national and international organizations believed that food has to be promoted as part of essential components of primary health care [2]. The food that we eat should be safe for consumption and should not endanger the health of the consumer via contamination or intoxication. Moreover, it should be available in sufficient quantity with adequate nutritional content. [2].Whenever we say the food is wholesome and safe, we are saying that the food we are going to eat has to be free of microbiological or chemical contamination that could bring ill-health [3, 4].

Many stakeholders can be involved in bringing food to the dining table including producers, harvesters, shippers, processors, distributors, handlers, and others [5]. Usually, food handlers are individuals who are involved in food preparation, storage, or service of food in a food facility. Unless they keep their personal hygiene, they are highly responsible for contaminating food there by exposing to foodborne diseases. Foodborne disease (also referred to as foodborne illness or food poisoning) is any illness that results from the consumption of contaminated food, contaminated with pathogenic bacteria, viruses, or parasites, and therefore maintaining good food handling practice by food handlers is very essential[6]. A food handler is defined as anyone

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who handles packaged or unpackaged food directly as well as the equipment and utensils used to prepare or serve food and/or surfaces that come into contact with food [7].

Research findings abroad indicated the level of food handling practice among food handlers from very low (59.3%) to high (90%) (Indonesia, 90% [8], Saudi Arabia, 80.29% [9], Malaysia, 59.3% [10], Jordan, 89.43% [11], Nigeria, 78.2% [12]). Similarly, good food handling practice among food handlers in Ethiopia also ranged from a very low 27.4% in Addis Ababa to 72% in Dessie [13-28].

Researchers, policymakers, and other stakeholders need research evidence for making decisions. However, the shreds of evidence available are inconsistent ranging from 27.4% (13) in Addis Ababa to 72% in Dessie (28) which would challenge the users of the evidence to make the best choice from the available evidence. Moreover, in the research articles included in the review (13-28), the highest magnitude of good food handling practice was obtained from the small sample size [28] while the smallest effect size was obtained from a relatively large sample size (13). Hence, a systematic review and meta-analysis are needed to overcome the limitations of small sample sizes and evaluate effects in different subsets of participants. Therefore, the main aim of this review is to pool the level of good food handling practice among food handlers working in public food establishments in Ethiopia.

Methods

Protocol and Registration: Usually, researchers are advised to maintain prior registration of their systematic review and meta-analysis in organizations like PROSPERO ((http://www.crd.york.ac.uk/PROSPERO/) which could make the process transparent and hence reduces duplication of efforts [29]. Therefore, this review has been registered at PROSPERO with registration identification number CRD42020223348.

Literature search: In this review, the step-by-step guide for conducting a systematic review and meta-analysis [30] was used. So, the first step starts with designing a research question, a preliminary search was done to see the existence of a similar article thereby reducing duplication of efforts. Individual articles were searched up to the end of February 2021 from databases such

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as PubMed, Google Scholar, and Advanced Google Search using keywords and medical subject headings (‘‘Food,’’ ‘‘Handling,’’ ‘‘Practice,’’ ‘‘Handlers,’’ and ‘‘Ethiopia’’). After having individual research articles, the title and abstract were screened, the protocol has been written and approved by each member and registered to PROSPERO.

Study Selection: Selection of studies was done through removing duplicate studies, selecting researches that meet the inclusion/exclusion criteria based on the abstracts, and then making the final selection of studies based on their full text. The eligible articles for the review were selected independently by each reviewer and brought together for ensuring the consistency of our search. Differences between two investigators (AD and DA) regarding a single research article have happened and the third investigator (MM) brought the issue to the table and finally, all of the reviewers became on the same page after a big debate moderated by the third investigator.

Eligibility Criteria: Publication status, publication language, type of study participants, and the type of the article were used to screen the article. Moreover, title and, full-text downloading were also used to screen the eligible article as well. Therefore, this review included both published and unpublished original articles written in English which were conducted from 2010 to the end of February 2021 among food handlers working in public food establishments in Ethiopia. However, this review excluded articles (n=329) losing originality (Articles written and done by the same researcher), local or governmental reports, and conference abstracts, and articles that were very difficult to access the full text.

Definition of terms: Almost all of the articles included in this review thought that good food handling practice is the practice of maintaining a high degree of personal cleanliness, wearing clean outer garments and effective hair restraints, and refraining from smoking, eating, and drinking in the food preparation and service areas. While, a favorable attitude is the positive feeling that food handlers want to practice during food preparation, storage, and transportation (13-28).

Patient and Public Involvement

No patient involved

Data Extraction and Study Quality Assessment

After collecting eligible individual research articles using criteria described under the heading 'eligibility criteria', variables (Study region, study setting, study year, publication status,

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publication year, sample size, study design, and sampling technique) more frequently used by individual research articles were collected as data. The collection of these data was performed independently by all reviewers and finally merged after reconciling disagreements created during data extraction.

A tool called Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI) adapted for both cross-sectional/case-control study designs [31] was used to assess the quality of each research article (Table 1). The assessment was performed by two reviewers namely AD and DA. The two assessors (AD and DA) agreed and ranked accordingly. JBI Critical Appraisal Checklist for Analytical Cross-Sectional studies used as criteria to include articles. Answers: 1=Not applicable, 2=Not clear, 3=No and 4=Yes

1. Were the criteria for inclusion in the sample clearly defined?
2. Were the study subjects and the setting described in detail?
3. Was the exposure measured in a valid and reliable way?
4. Were objective, standard criteria used for measurement of the condition?
5. Were confounding factors identified?
6. Were strategies to deal with confounding factors stated?
7. Were the outcomes measured in a valid and reliable way?
8. Was appropriate statistical analysis used?

Table 1: Result of JBI Critical Appraisal Checklist for Analytical Cross Sectional Studies using eligibility criteria listed above.

Lead Author & Study year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Decision
Abdi et al., 2017 [13]	4	4	1	4	4	3	4	4	Included
Ayehu et al.,2013 [22]	4	4	1	4	4	3	4	4	Included
Chekol et al., 2018 [16]	4	4	1	4	4	3	4	4	Included
Dawit G. et al., 2019 [25]	4	4	1	4	4	3	4	4	Included
Legesse D, et al., 2015 [15]	4	4	1	4	4	3	4	4	Included
Henok D, et al., 2018 [21]	4	4	1	4	4	3	4	4	Included
Lalit et al., 2015 [23]	4	4	1	4	4	3	4	4	Included
Melese A, et al., 2017 [17]	4	4	1	4	4	3	4	4	Included
Mulugeta A, et al., 2018 [27]	4	4	1	4	4	3	4	4	Included

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Zemichael G, et al., 2014 [14]	4	4	1	4	4	3	4	4	Included
Asrat M, et al., 2014 [19]	4	4	1	4	4	3	4	4	Included
Metadel A, et al., 2014 [28]	4	4	1	4	4	3	4	4	Included
Daniel N and Kumie, 2011 [24]	4	4	1	4	4	3	4	4	Included
Derso et al., 2013 [26]	4	4	1	4	4	3	4	4	Included
Lema et al., 2019 [18]	4	4	1	4	4	3	4	4	Included
Azanaw et al., 2018 [20]	4	4	1	4	4	3	4	4	Included

Data synthesis and statistical analysis

Data were collected and entered into excel and finally exported to Stata v14 (StataCorp, College Station, Texas, USA) for analysis. Eyeball testing using forest plots, Chi-squared (χ^2) test, and I-squared (I^2) were used to identify and measure heterogeneity. Moreover, subgroup analysis and meta-regression were also employed to explore the existence of heterogeneity between research articles. I^2 reflects the percentage of total variation across studies that were attributable to heterogeneity rather than chance. Heterogeneity was quantified as low, moderate, and high, with upper limits of 25%, 50%, and 75% for I2, respectively [32]. Moreover, Subgroup analysis is usually defined as the process of comparing a treatment effect for two or more variants of an intervention [33].

In this review, publication bias was determined by statistical methods such as drawing funnel plots, and statistical testing (Eggers regression test). Eggers test with a P value of less than 0.1indicats the presence of publication bias [34].

Individual research articles were collected from all regions in the country which were conducted from 2010 to the end of February 2021 in the country. Investigators of this review believed that the true estimate of food handling practice could vary from region to region due to differences in access to education and medical checkup (Ethiopian public health law proclaims every food handler working in a food establishment should have a medical checkup at least once in every three months). Moreover, the true estimate could also vary due to the size of the study participants enrolled in each study. Therefore, the random-effects model which could address

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this issue [35] was used during analysis, and odds ratios with their 95% CI were used to present the pooled effect sizes. Meta-regression was also done to examine the effect of characteristics of studies against the effect size that is good food handling practice with a 95% confidence interval at P<0.05.

Result

Search Results

The investigators of this review tried to search for databases such as PubMed, Advanced Google search, and Google scholar. The research articles were filtered using key terms described above and articles fulfilling the eligibility criteria were included in the review (Figure 1).

Characteristics of studies

A total of 16 institutional-based (75%) and community-based (25%) research articles with cross-sectional study design (100%) were included in the review. All of the research articles were conducted from 2011-2019 and published [15/16] from 2012-2020. Regarding the distribution of the included articles, 10 (62.5%) of them were conducted in the Amhara region followed by Addis Ababa and Tigray contributed 2 (12.5%) each while the rest 2(12.5%) were contributed by SNNPR and Benshangul Gumez regions. The mean value (343) of the study participants included in the review was calculated and more than half (62.5%) of the articles included >343 study participants. Study participants were sampled by simple random sampling by 66.67 %(10/16) articles, Systematic simple random sampling by 20% (3/16) articles, and Census by 13.33% (2/16) articles (Table2).

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Table 2: Characteristic of included studies in systematic review and meta-analysis

Ser. No	First author and study year	Region	Study design	Sampling technique	Sample size	Response Rate	Good food handling practice (%)
1	Abdi et al., 2017 [13]	Addis Ababa	CS	SRS	394	95.2	27.4
2	Ayehu et al.,2013 [22]	Amhara	CS	Census	406	94.4	52.5
3	Chekol et al., 2018 [16]	Amhara	CS	SRS	416	98.6	40.1
4	Dawit G. et al., 2019 [25]	Amhara	CS	SyRS	214	95.5	66.4
5	Legesse D, et al., 2015 [15]	SNNPRS	CS	SRS	383	99	32.6
6	Henok D, et al., 2018 [21]	Amhara	CS	SRS	423	100	49.6
7	Lalit et al., 2015 [23]	Tigray	CS	SRS	369	96.9	53.1
8	Melese A, et al., 2017 [17]	Amhara	CS	SRS	288	100	46.5
9	Mulugeta A, et al., 2018 [27]	Benshangul Gumuz	CS	SRS	355	100	67.8
10	Zemichael G, et al., 2014 [14]	Amhara	CS	SyRS	403	100	30.3
11	Asrat M, et al., 2014 [19]	Addis Ababa	CS	Census	302	100	47.7
12	Metadel A, et al., 2014 [28]	Amhara	CS	SyRS	116	95.9	72
13	Daniel N and Kumie, 2011 [24]	Tigray	CS	SRS	277	97.5	63.9
14	Derso et al., 2013 [26]	Amhara	CS	SRS	417	98.8	67.6
15	Lema et al., 2019 [18]	Amhara	CS	SRS	394	97.8	46.7
16	Azanaw et al., 2018 [20]	Amhara	CS	SRS	338	88	49

CS=cross-sectional, SRS= Simple Random Sampling, SyRS=Systematic SRS

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Pooled Level of good food handling practice

The fixed-effect model was used to pool the level of good food handling practice but showed a very high level of heterogeneity. Therefore, this review employed a random effect model for analysis and the pooled level of good food handling practice among food handlers of public food establishments was found to be 50.72% with 95%CI (43.84, 57.6) (Figure 2). By observing the forest plot and considering I-squared (I^2=96.6%), a high level of heterogeneity between studies was observed (Figure 2).

Sub-group analysis: The test for sub-group analysis suggests that there is a statistically significant sub-group effect (P<0.0001). The pooled level of good food handling practice is higher among articles conducted before 2016 [52.34% with 95% CI (41.62, 63.05)] compared to articles conducted after 2016 [49.12% with 95% CI (39.75, 58.5)]. However, there is substantial unexplained heterogeneity between the articles within each of these subgroups (conducted before 2016: I^2 = 97.1%; conducted after 2016: I^2= 96.4%) (Figure 3).

Similarly, there is a statistically significant sub-group effect (P<0.0001). The pooled level of good food handling practice is higher among articles having a sample size of ≤ 343 [57.36% with 95% CI (48.98, 65.73)] compared to articles having a sample size of <343 [46.76% with 95% CI (37.65, 55.86)]. However, there is substantial unexplained heterogeneity between the articles within each of these subgroups (sample size of ≤ 343: I^2 = 91.4%; a sample size of ≤ 343: I^2= 97.3%). Therefore, the validity of the good food handling practice estimate for each subgroup is uncertain, as individual article results are inconsistent (Figure 4).

Publication Bias: A funnel plot was drawn and evaluated subjectively by investigators and evidence of publication bias was not observed. Publication bias can be suspected if the plot shows an asymmetric shape, with no points on one side of the graph (Figure 5). Moreover, the Eggers test for small-study effects was also performed but unable to show evidence of the existence of publication bias at p =0.949.

Meta-regression: Potential effect modifiers such as study year and size of participants involved in each article were regressed against good food handling practice and none of the effect modifiers showed the existence of association against good food handling practice (Table 3).

Table 3: Meta-regression output for assessing causes of heterogeneity among studies included

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Variable	Category	Coef	P>|t|	[95% Conf. Interval]
Year of study	After 2016	Ref.	Ref.	Ref.
	Before 2016	3.184339	0.663	(-12.14331, 18.51198)
Size of study participants	≤343	Ref.	Ref.	Ref.
	>343	-10.69023	0.143	(-25.47183, 4.091367)

Determinants of good food handling practice

At the individual level of analysis, 43.8% (7/16) of the articles identified training as a factor that could determine good food handling practice among food handlers working in public food establishments. Consequently, the pooled estimate indicated that the odds of having good food handling practice was 3.4 times higher among trained food handlers compared to non-trained food handlers [AOR=3.4, 95% CI=(2.33, 4.95)] (Figure 6).

Twenty five percent (4/16) of the research articles included in the review identified that there was a significant association between food handlers' attitude and good food handling practice. Similarly, the pooled estimate indicated that those food handlers having favorable attitudes were 3.62 times more likely to have good food handling practice compared to those who had unfavorable attitudes [AOR=3.62, 95% CI=(2.23, 5.85)] (Figure 7).

Regarding medical checkup, 18.8% (3/16) of the included individual research articles indicated that regular medical checkup of food handlers was associated with good food handling practice. The pooled estimate also indicated that food handlers who had regular medical checkups were 5.12 times more likely to have good food handling practice compared to those food handlers who didn't have regular medical checkups [AOR=5.12, 95% CI=(2.93, 8.95)] (Figure 8).

Discussion

In individual studies, the level of good food handling practice among food handlers working in public food establishments ranges from 27.4% in Addis Ababa to 72% in Dessie [13-28]. However, the pooled level of good food handling practice among food handlers working in public food establishments was 50.72%. This finding is lower than the findings from Indonesia, 90% [8], Saudi Arabia, 80.29% [9], Malaysia, 59.3% [10], Jordan, 89.43% [11], Nigeria, 78.2% [12]. The possible explanation for the finding could be related to the availability of training and

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medical checkup regularly. In Ethiopia, most establishments are opened without having trained food handlers and even without establishing a mechanism for having a regular medical checkup.

The odds of having good food handling practice was 3.4 times higher among trained food handlers working in public food establishments compared to non-trained food handlers. This finding was supported by findings from different parts of the world suggesting that the provision of training positively influences the food handling practices of food handlers [36-38].Likewise, the pooled estimate also indicated that food handlers having favorable attitudes were 3.62 times more likely to have good food handling practice compared to those who had unfavorable attitudes. Evidence also suggested that attitude was playing a significant role in promoting good food handling practice [39-41]. Usually, training is given to food handlers seeking for two major changes. One is to add knowledge, skill and the second is to help the employees develop a positive attitude towards their job. Hence, a trained employee can know more about the job and develop a positive attitude which could help him/her to have good food handling practice.

The pooled estimate also indicated that food handlers who had regular medical checkups were 5.12 times more likely to have good food handling practice compared to those food handlers who didn't have a regular medical checkup. The probable explanation for the finding could be during regular medical checkup healthcare professionals might counsel regarding safe handling of food, consequences of contaminated food, and other related issues which could trigger positive attitude towards good food handling practice.

Limitations of the study

- The investigators of this review were doing their best to include all available shreds of evidence regarding the issue under review but still, there might be works of literature that were not published and hung on by authors.
- Though the investigators also did their best to include articles of all study designs still the available literature was obtained only with cross-sectional design and this might still have its influence on the quality of the review.

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- A little bit different operational definitions were used to define good food handling practice by authors of individual articles and therefore this might have its implication on the generalizability of the findings.

Conclusion

The level of good food handling practice among food handlers working in public food establishments of Ethiopia was very low and variables such as food handler training, attitude towards good food handling practice, and the existence of regular medical checkup were factors affecting good food handling practice among food handlers working in public food establishments of Ethiopia. Provision of training that could change the attitude towards good food handling practice and regular medical checkups for food handlers has to be in place to improve good food handling practice among food handlers working in public food establishments of Ethiopia.

Data Availability

The Excel data is available from the corresponding author upon request.

Competing interests

The authors declare that we have no competing interests.

Funding Statement

No organization or individual funded this research.

Authors' contributions

Maru Meseret designed the study, prepared the protocol, supervised data collection, analyzed and interpreted the data.

Maru Meseret, Amare Dagnew, and Dehabo Alamirew coached the research from protocol development to data interpretation. Maru Meseret drafted and prepared the manuscript. All authors read and approved the final manuscript.

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Figure Caption

Figure 1: PRISMA flow-chart diagram describing the selection of studies.

Figure 2: Forest plot showing the pooled level of good food handling practice among food handlers working public food establishments of Ethiopia, 2021.

Figure 3: Sub-group analysis of good food handling practice by year of study

Figure 4: Sub-group analysis of good food handling practice by size of study participants

Figure 5: Funnel plot, in which the vertical line indicates the effect size whereas the diagonal line indicates the precision of individual studies with 95% confidence limit.

Figure 6: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of training against good food handling practice.

Figure 7: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of attitude against good food handling practice.

Figure 8: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of medical checkup against good food handling practice.

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41. Foong Ming Moy et al: Determinants of self-reported food safety practices among youths: A cross-sectional online study in Kuala Lumpur, Malaysia: *British Food Journal*: 2018: 120(4), pp.891-900, https://doi.org/10.1108/ BFJ-04-2017-0224.

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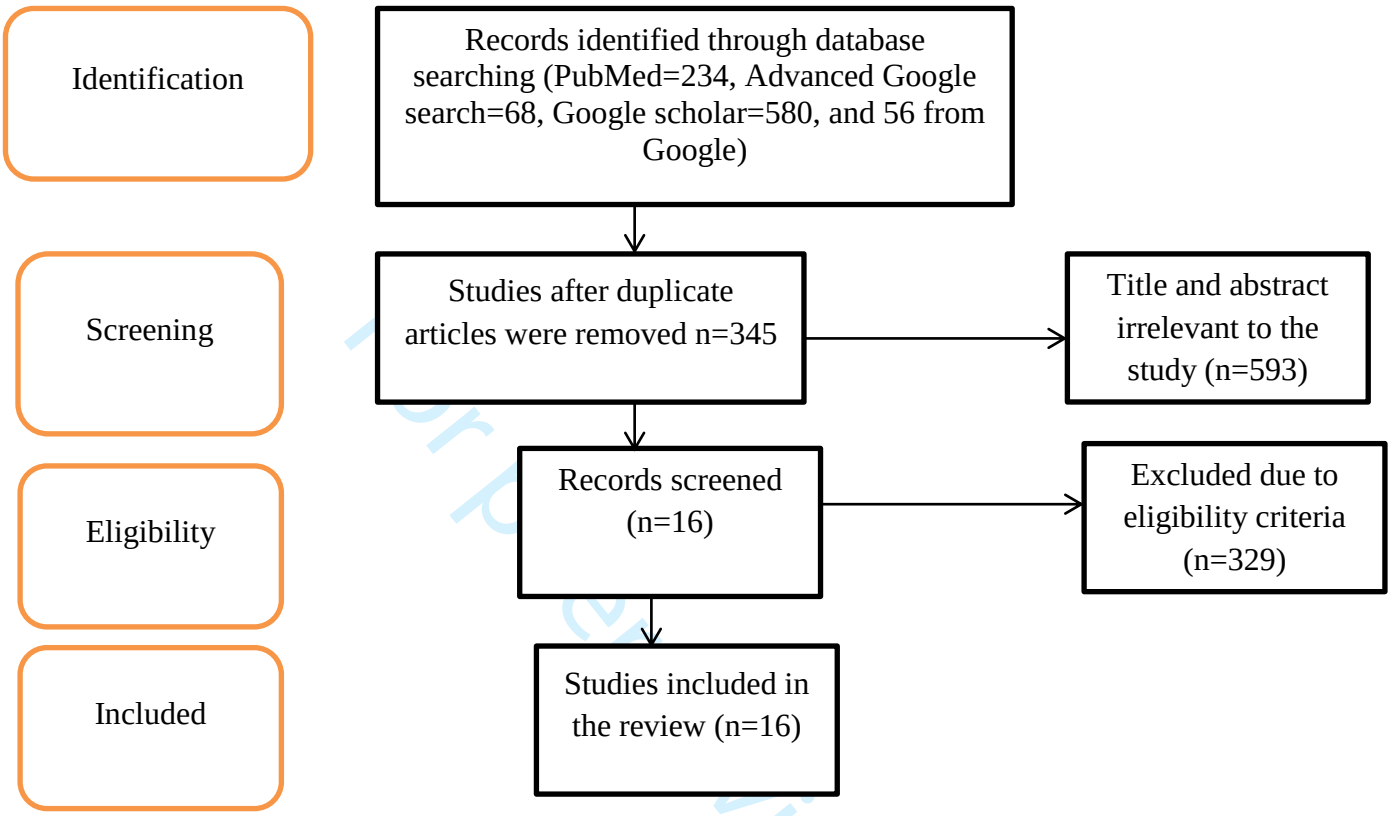

Figure 1: PRISMA flow-chart diagram describing the selection of studies.

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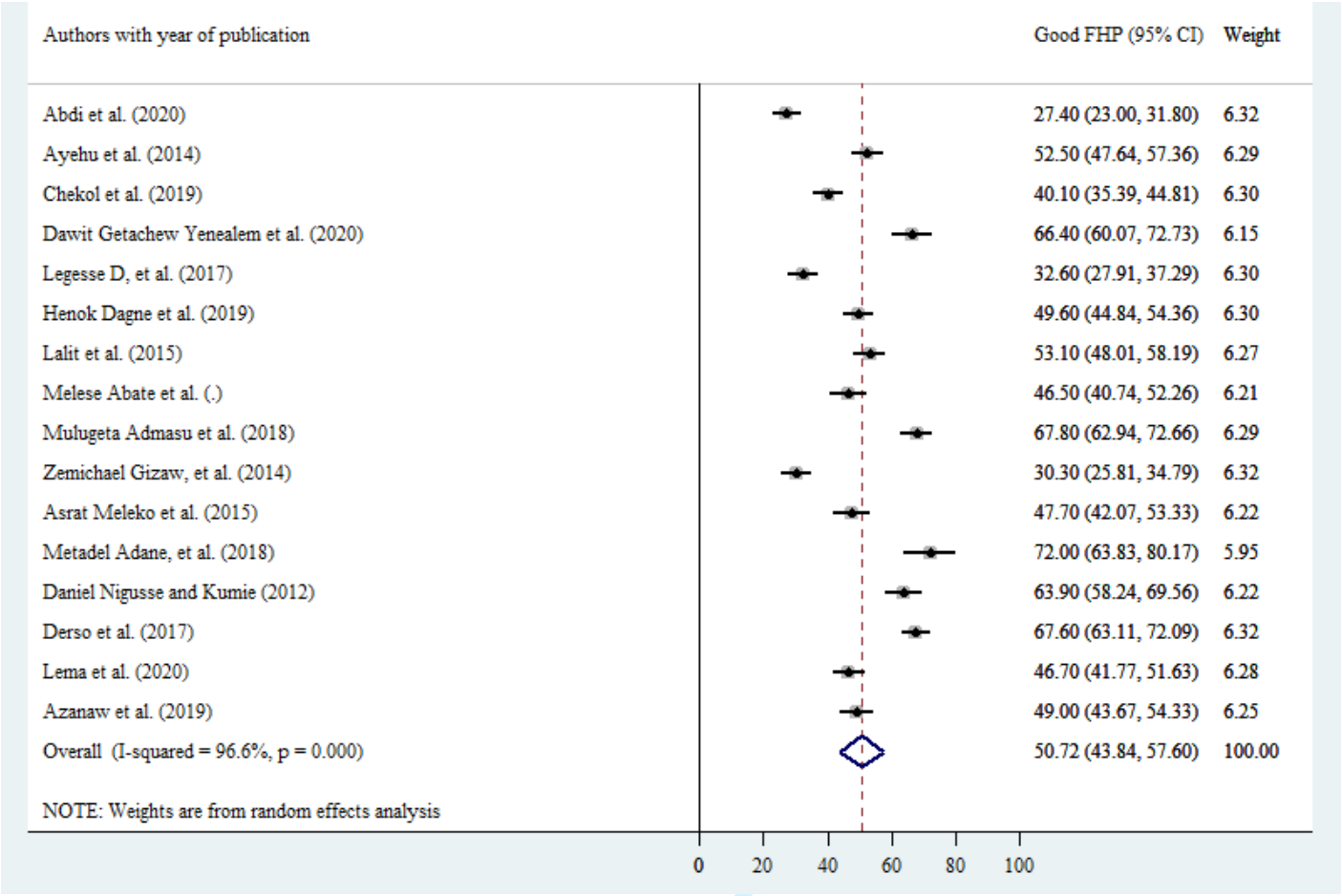

Figure 1: Forest plot showing the pooled level of good food handling practice among food handlers working public food establishments of Ethiopia, 2021.

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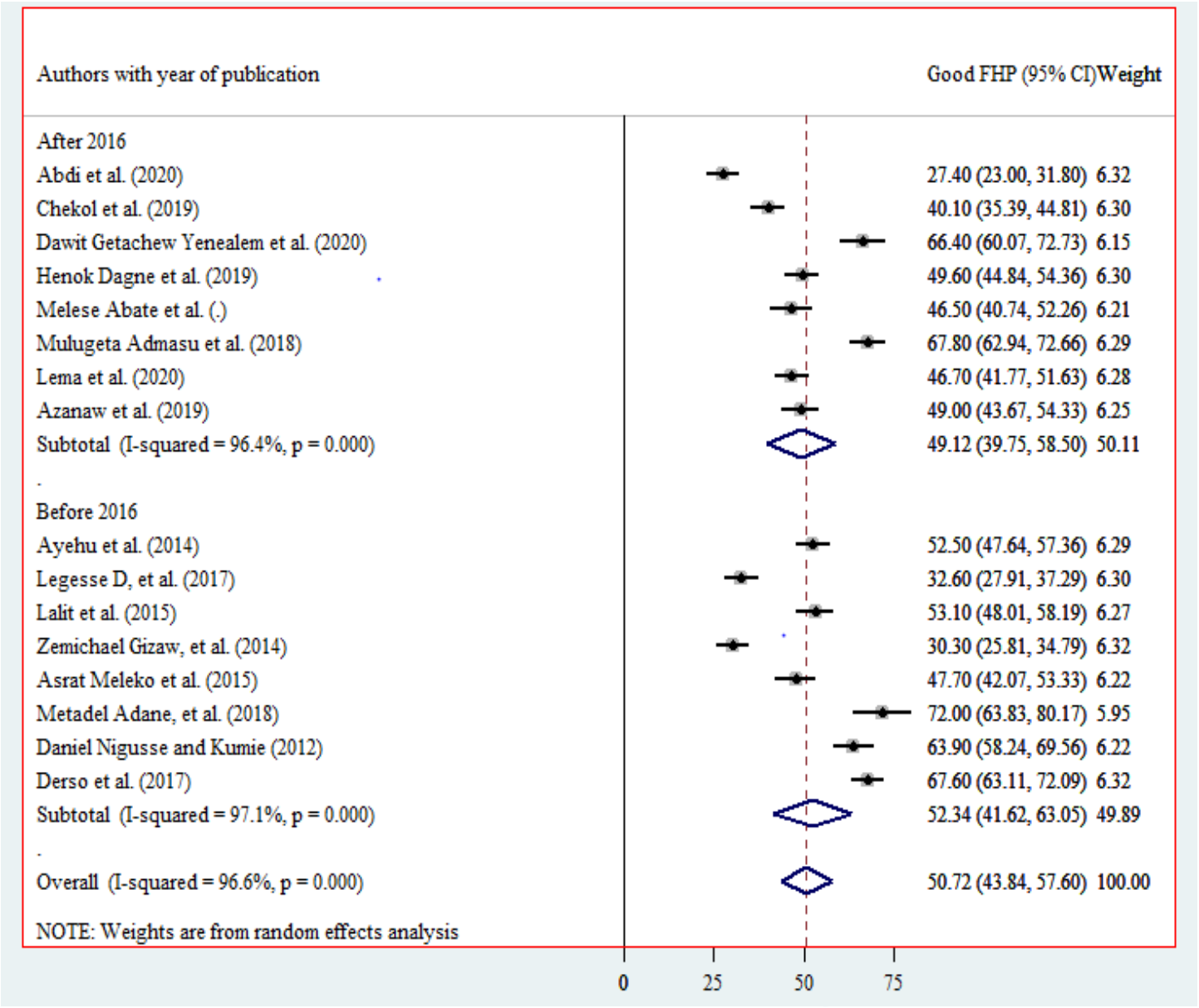

Figure 3: Sub-group analysis of good food handling practice by year of study

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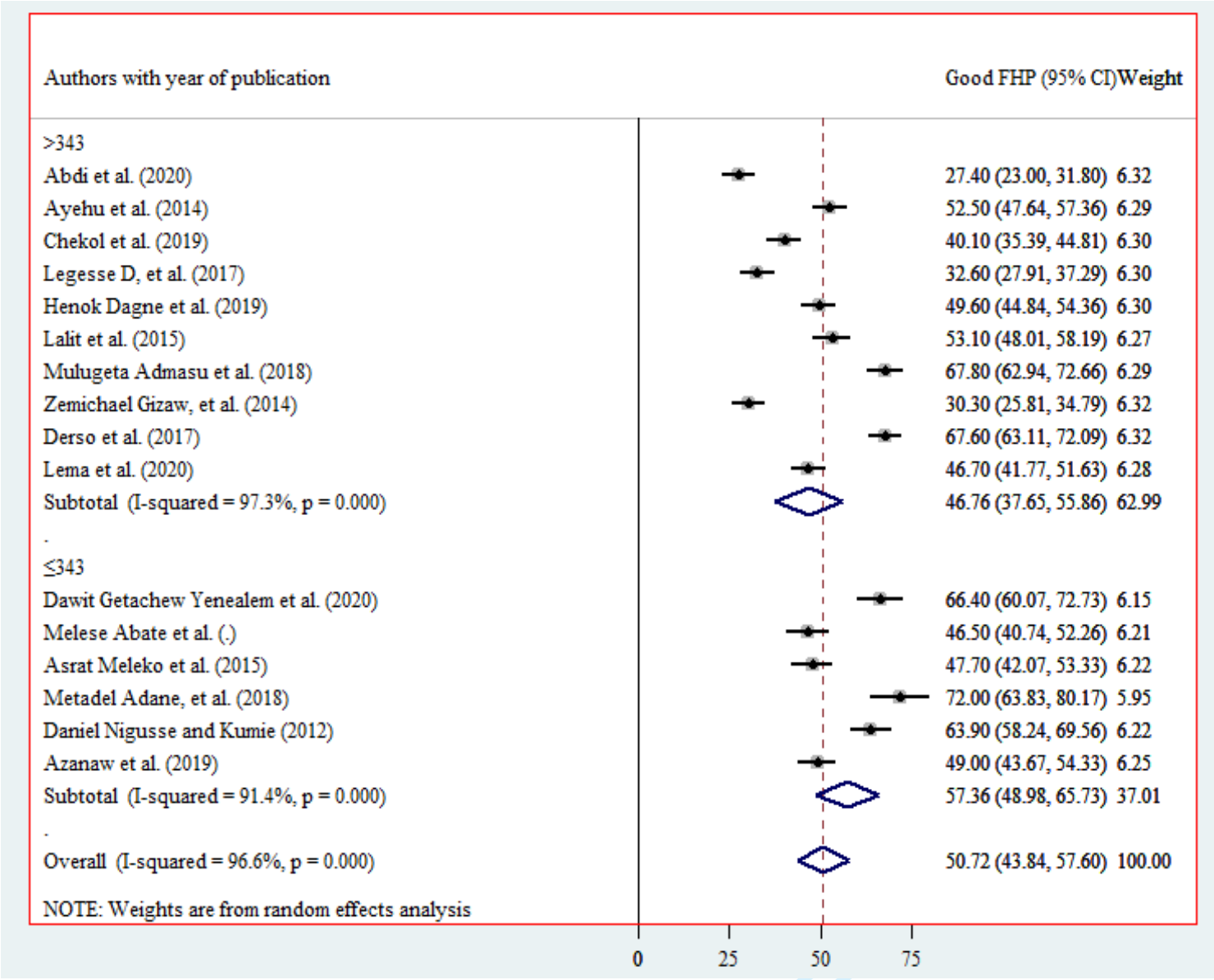

Figure 4: Sub-group analysis of good food handling practice by size of study participants

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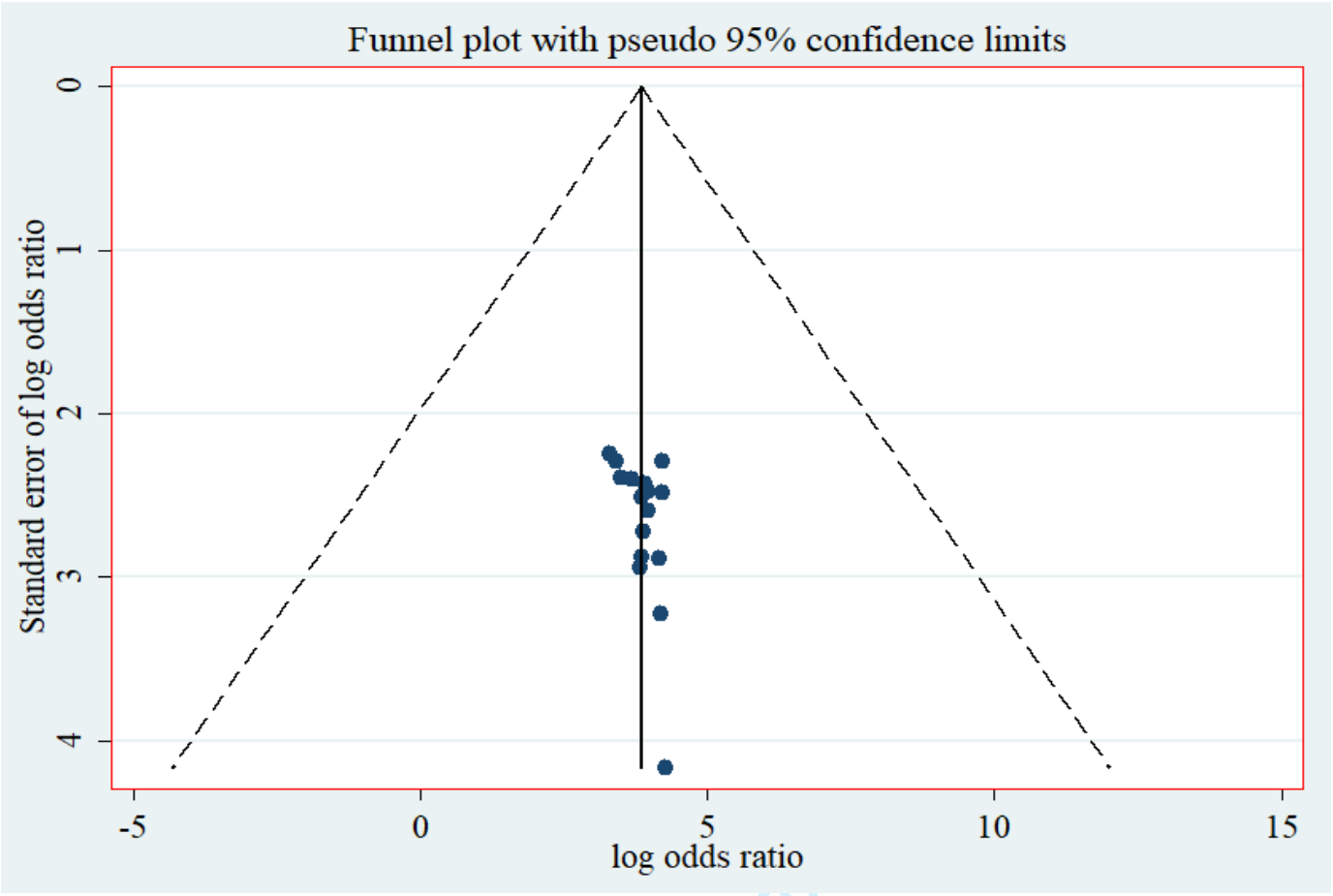

Figure 5: Funnel plot, in which the vertical line indicates the effect size whereas the diagonal line indicates the precision of individual studies with 95% confidence limit.

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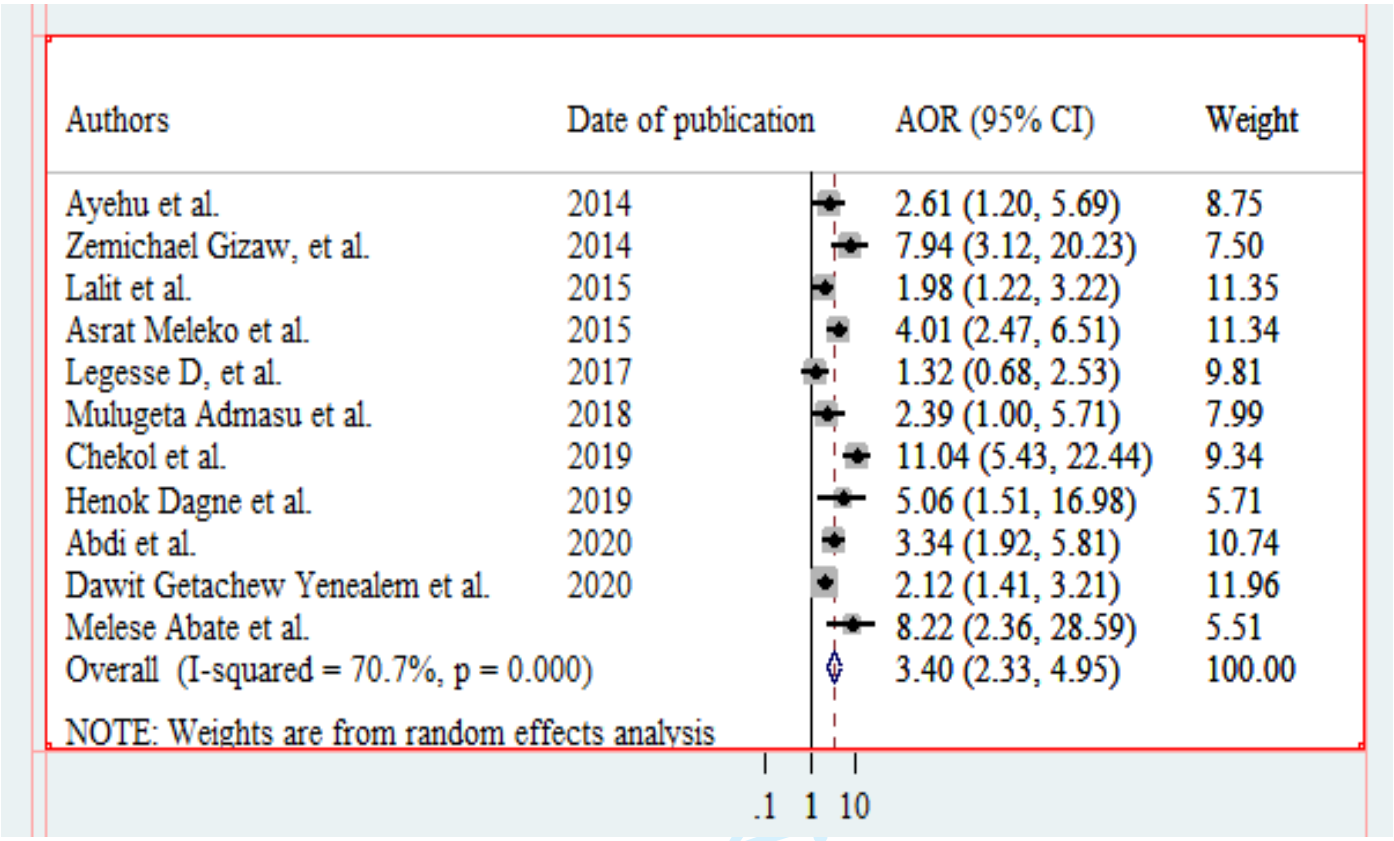

Figure 6: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of training against good food handling practice.

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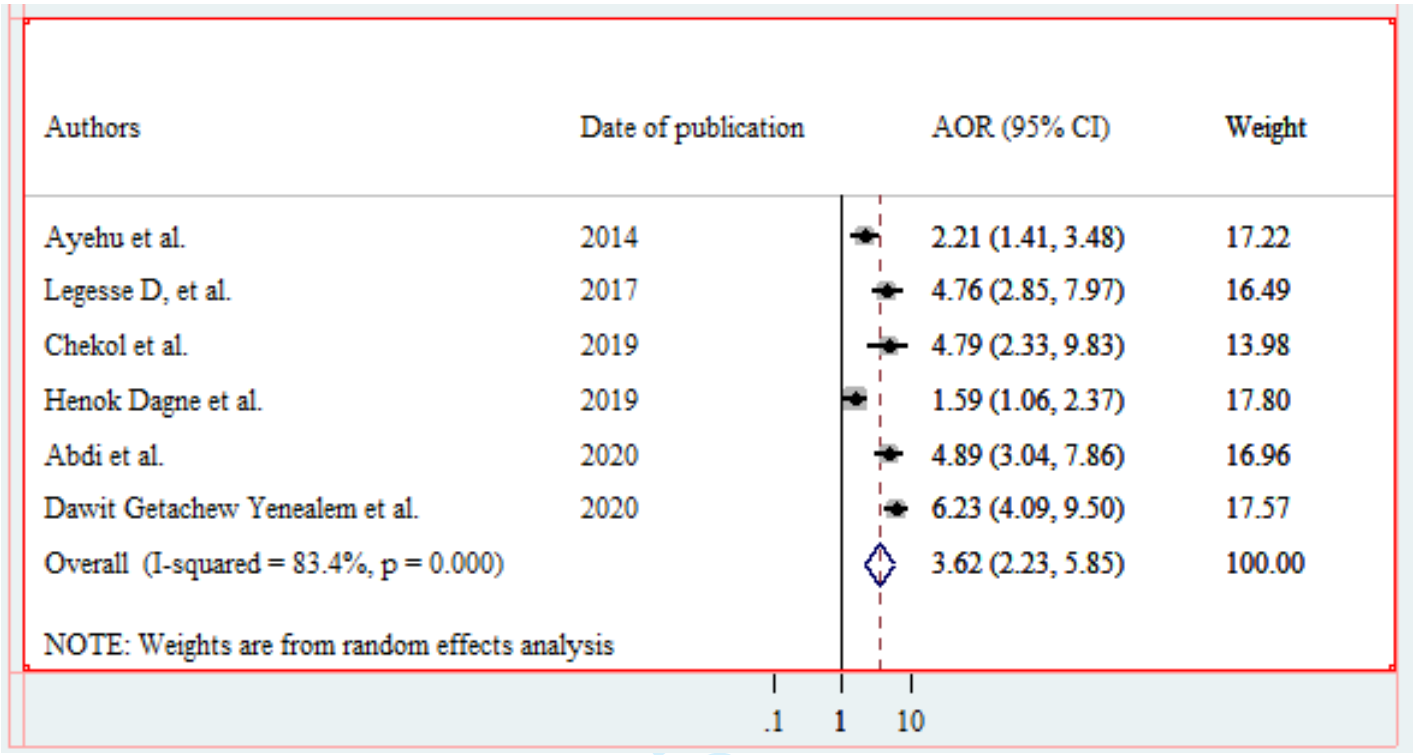

Figure 7: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of attitude against good food handling practice.

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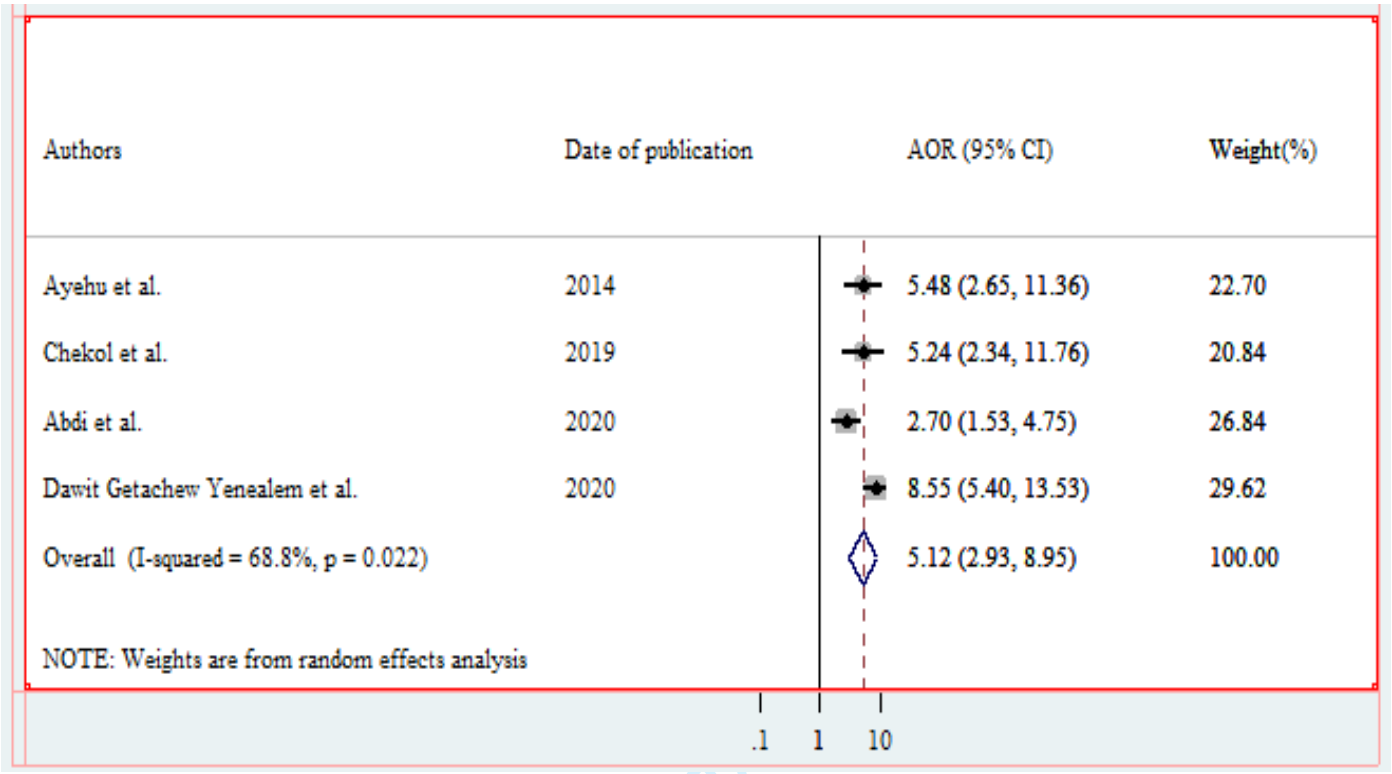

Figure 8: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of medical checkup against good food handling practice.

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1-2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
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
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.	3-4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	3-4
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).	4
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.	4-5

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Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	7-8
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.	9-10
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	10
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	9
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	9-10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	9-10
RESULTS			
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.	7
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).	9
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
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	10
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	9-10
DISCUSSION			
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).	12

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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).	2
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	12
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	12

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

Available at : **www.prisma-statement.org**.

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Food handling practice and associated factors among food handlers in public food establishments of Ethiopia: A systematic review and Meta-analysis

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Secondary Subject Heading:	Epidemiology, Evidence based practice, Health informatics, Health policy, Infectious diseases
Keywords:	PUBLIC HEALTH, Infection control < INFECTIOUS DISEASES, Risk management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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Food handling practice and associated factors among food handlers in public food establishments of Ethiopia: A systematic review and Meta-analysis

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Abstract

Objectives: Food handlers are individuals who are involved in food preparation, storage, or service of food in a food facility. Unless they keep their personal hygiene, they are highly responsible for contaminating food or transmitting microbes to consumers and. The main aim of this review was to pool the level of good food handling practice among food handlers working in public food establishments in Ethiopia.

Design: A systematic and meta-analysis using the Joanna Briggs Institute (JBI) Critical Appraisal tool.

Data Sources: PubMed, Google Scholar, and Advanced Google were searched up to the end of February 2021.

Eligibility criteria for selecting studies; Publication status, publication language, type of study participants, and the type of the article were used to screen the article.

Data Extraction and Study Quality Assessment: All reviewers collected data independently and merged it together. A tool called the Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument was used to assess the quality of each research article. The assessment was performed by two reviewers.

Result: A total of 16 research articles were included in the review. The pooled level of good food handling practice was 50.72% with 95%CI (43.84, 57.6). Training [AOR=3.4, 95% CI= (2.33, 4.95)], attitude [AOR=3.62, 95% CI= (2.23, 5.85)], and medical checkup [AOR=5.12,

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95% CI= (2.93, 8.95)] were identified as factors affecting good food handling practice with 95% CI at P<0.05.

Conclusion: The level of good food handling practice among food handlers working in public food establishments of Ethiopia was very low compared to literature and variables such as food handler training, attitude towards good food handling practice, and the existence of regular medical checkups were factors affecting good food handling practice. Provision of training that could change the attitude and regular medical checkups for food handlers has to be in place.

Keywords: Ethiopia, Food handlers, Food handling, Public food establishment.

Limitations of the study

- The investigators of this review were doing their best to include all available shreds of evidence regarding the issue under review but still, there might be works of literature that were not published and hung on by authors.
- Though the investigators also did their best to include articles of all study designs still the available literature was obtained only with cross-sectional design and this might still have its influence on the quality of the review.
- A little bit different operational definitions were used to define good food handling practice by authors of individual articles and therefore this might have its implication on the generalizability of the findings.

Introduction: Ethiopian Public Health Proclamation No. 200/2000 defined food as any substance whether processed, semi-processed, or raw which is intended for human consumption and includes drinks, chewing gum, and any substance which has been used in the manufacture, preparation, or treatment of food, but it does not include tobacco, cosmetics or substances used only as drugs [1].

Experts in different national and international organizations believed that food has to be promoted as part of essential components of primary health care [2]. The food that we eat should be safe for consumption and should not endanger the health of the consumer via contamination or intoxication. Moreover, it should be available in sufficient quantity with adequate nutritional

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content. [2]. The food is wholesome and safe for consumption implies that the food we are going to eat has to be free of microbiological or chemical contamination that could bring ill-health [3, 4].

Many stakeholders can be involved in bringing food to the dining table including producers, harvesters, shippers, processors, distributors, handlers, and others [5]. Usually, food handlers are individuals who are involved in food preparation, storage, or service of food in a food facility. Unless they keep their personal hygiene, they are highly responsible for contaminating food there by exposing to foodborne diseases. Foodborne disease (also referred to as foodborne illness or food poisoning) is any illness that results from the consumption of contaminated food, contaminated with pathogenic bacteria, viruses, or parasites, and therefore maintaining good food handling practice by food handlers is very essential[6]. A food handler is defined as anyone who handles packaged or unpackaged food directly as well as the equipment and utensils used to prepare or serve food and/or surfaces that come into contact with food [7]. According to Ethiopian public health law proclamation, every food handler working in a food establishment should have a medical checkup at least once in every three months (1).

Research findings abroad indicated the level of food handling practice among food handlers from very low (59.3%) to high (90%) (Indonesia, 90% [8], Saudi Arabia, 80.29% [9], Malaysia, 59.3% [10], Jordan, 89.43% [11], Nigeria, 78.2% [12]). Similarly, good food handling practice among food handlers in Ethiopia also ranged from a very low 27.4% in Addis Ababa to 72% in Dessie [13-28].

Researchers, policymakers, and other stakeholders need research evidence for making decisions. However, the shreds of evidence available are inconsistent ranging from 27.4% (13) in Addis Ababa to 72% in Dessie (28) which would challenge the users of the evidence to make the best choice from the available evidence. Moreover, in the research articles included in the review (13-28), the highest magnitude of good food handling practice was obtained from the small sample size [28] while the smallest effect size was obtained from a relatively large sample size (13). Hence, a systematic review and meta-analysis are needed to overcome the limitations of small sample sizes and evaluate effects in different subsets of participants. Therefore, the main aim of

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this review is to pool the level of good food handling practice among food handlers working in public food establishments in Ethiopia.

Methods

Protocol and Registration: Usually, researchers are advised to maintain prior registration of their systematic review and meta-analysis in organizations like PROSPERO ((http://www.crd.york.ac.uk/PROSPERO/) which could make the process transparent and hence reduces duplication of efforts [29]. Therefore, this review has been registered at PROSPERO with registration identification number CRD42020223348.

Literature search: In this review, the step-by-step guide for conducting a systematic review and meta-analysis [30] was used. A preliminary search was done to see the existence of a similar article thereby reducing duplication of efforts. Individual articles were searched up to the end of February 2021 from databases such as PubMed, Google Scholar, and Advanced Google Search using keywords and medical subject headings (‘‘Food,’’ ‘‘Handling,’’ ‘‘Practice,’’ ‘‘Handlers,’’ and ‘‘Ethiopia’’). After having individual research articles, the title and abstract were screened, the protocol has been written and approved by each member and registered to PROSPERO.

Study Selection: Selection of studies was done through removing duplicate studies, selecting researches that meet the inclusion/exclusion criteria based on the abstracts, and then making the final selection of studies based on their full text. The eligible articles for the review were selected independently by each reviewer and brought together for ensuring the consistency of our search. Differences between two investigators (AD and DA) regarding a single research article have happened and the third investigator (MM) brought the issue for discussion and finally, all of the reviewers agreed to include after a big debate moderated by the third investigator.

Eligibility Criteria: Publication status, publication language, type of study participants, and the type of the article were used to screen the article. Moreover, title and, full-text downloading were also used to screen the eligible article as well. Therefore, this review included both published and unpublished original articles written in English which were conducted from 2010 to the end of February 2021 among food handlers working in public food establishments in Ethiopia. However, this review excluded articles (n=329 out of 345) losing originality (An article is

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considered original research if it is the report of a study written by the researchers who actually did the study), local or governmental reports, and conference abstracts, and articles that were very difficult to access the full text.

Definition of terms: All of the articles included in this review thought that good food handling practice is the practice of maintaining a high degree of personal cleanliness, wearing clean outer garments and effective hair restraints, and refraining from smoking, eating, and drinking in the food preparation and service areas. While, a favorable attitude is the positive feeling that food handlers want to practice during food preparation, storage, and transportation (13-28).

Patient and Public Involvement

No patient involved

Data Extraction and Study Quality Assessment

After collecting eligible individual research articles using criteria described under the heading 'eligibility criteria', variables (Study region, study setting, study year, publication status, publication year, sample size, study design, and sampling technique) more frequently used by individual research articles were collected as data. The collection of these data was performed independently by all reviewers and finally merged after reconciling disagreements created during data extraction.

A tool called Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI) adapted for both cross-sectional/case-control study designs [31] was used to assess the quality of each research article (Table 1). The assessment was performed by two reviewers namely AD and DA. The two assessors (AD and DA) agreed and ranked accordingly. JBI Critical Appraisal Checklist for Analytical Cross-Sectional studies used as criteria to include articles. Answers: 1=Not applicable, 2=Not clear, 3=No and 4=Yes

1. Were the criteria for inclusion in the sample clearly defined?
2. Were the study subjects and the setting described in detail?
3. Was the exposure measured in a valid and reliable way?
4. Were objective, standard criteria used for measurement of the condition?
5. Were confounding factors identified?
6. Were strategies to deal with confounding factors stated?
7. Were the outcomes measured in a valid and reliable way?
8. Was appropriate statistical analysis used?

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Table 1: Result of JBI Critical Appraisal Checklist for Analytical Cross Sectional Studies using eligibility criteria listed above.

Lead Author & Study year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Decision
Abdi et al., 2017 [13]	4	4	1	4	4	3	4	4	Included
Ayehu et al.,2013 [22]	4	4	1	4	4	3	4	4	Included
Chekol et al., 2018 [16]	4	4	1	4	4	3	4	4	Included
Dawit G. et al., 2019 [25]	4	4	1	4	4	3	4	4	Included
Legesse D, et al., 2015 [15]	4	4	1	4	4	3	4	4	Included
Henok D, et al., 2018 [21]	4	4	1	4	4	3	4	4	Included
Lalit et al., 2015 [23]	4	4	1	4	4	3	4	4	Included
Melese A, et al., 2017 [17]	4	4	1	4	4	3	4	4	Included
Mulugeta A, et al., 2018 [27]	4	4	1	4	4	3	4	4	Included
Zemichael G, et al., 2014 [14]	4	4	1	4	4	3	4	4	Included
Asrat M, et al., 2014 [19]	4	4	1	4	4	3	4	4	Included
Metadel A, et al., 2014 [28]	4	4	1	4	4	3	4	4	Included
Daniel N and Kumie, 2011 [24]	4	4	1	4	4	3	4	4	Included
Derso et al., 2013 [26]	4	4	1	4	4	3	4	4	Included
Lema et al., 2019 [18]	4	4	1	4	4	3	4	4	Included
Azanaw et al., 2018 [20]	4	4	1	4	4	3	4	4	Included

Data synthesis and statistical analysis

Data were collected and entered into excel and finally exported to Stata v14 (StataCorp, College Station, Texas, USA) for analysis. Eyeball testing using forest plots, Chi-squared (χ^2) test, and I-squared (I^2) were used to identify and measure heterogeneity. Moreover, subgroup analysis and meta-regression were also employed to explore the existence of heterogeneity between research articles. I^2 reflects the percentage of total variation across studies that were attributable to heterogeneity rather than chance. Heterogeneity was quantified as low, moderate, and high, with upper limits of 25%, 50%, and 75% for I2, respectively [32]. Moreover, Subgroup analysis is usually defined as the process of comparing a treatment effect for two or more variants of an intervention [33].

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In this review, publication bias was determined by statistical methods such as drawing funnel plots, and statistical testing (Eggers regression test). Eggers test with a P value of less than 0.1indicats the presence of publication bias [34].

Individual research articles were collected from all regions in the country which were conducted from 2010 to the end of February 2021 in the country. Investigators of this review believed that the true estimate of food handling practice could vary from region to region due to differences in access to education and medical checkup (Ethiopian public health law proclaims every food handler working in a food establishment should have a medical checkup at least once in every three months). Moreover, the true estimate could also vary due to the size of the study participants enrolled in each study. Therefore, the random-effects model which could address this issue [35] was used during analysis, and odds ratios with their 95% CI were used to present the pooled effect sizes. Meta-regression was also done to examine the effect of characteristics of studies against the effect size that is good food handling practice with a 95% confidence interval at $P<0.05$.

Ethical Approval: This research was conducted as part of the routine educational program and was not presented to the review board

Result

Search Results

The investigators of this review tried to search for databases such as PubMed, Advanced Google search, and Google scholar. The research articles were filtered using key terms described above and articles fulfilling the eligibility criteria were included in the review (Figure 1).

Characteristics of studies

A total of 16 articles were included in the review. Out of which 12 (75%) of these articles collected data from food handlers at work within their institutions while 4 (25%) of the articles collected data from food handlers off their work. All of the research articles reviewed was cross-sectional in study design. All of the research articles were conducted from 2011-2019 and

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published [15/16] from 2012-2020. Regarding the distribution of the included articles, 10 (62.5%) of them were conducted in the Amhara region followed by Addis Ababa and Tigray contributed 2 (12.5%) each while the rest 2(12.5%) were contributed by SNNPR and Benshangul Gumez regions. The mean value (343) of the study participants included in the review was calculated and more than half (62.5%) of the articles included >343 study participants. Study participants were sampled by simple random sampling by 66.67 %(10/16) articles, Systematic simple random sampling by 20% (3/16) articles, and Census by 13.33% (2/16) articles (Table2).

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Table 2: Characteristic of included studies in systematic review and meta-analysis

Ser. No	First author and study year	Region	Study design	Sampling technique	Sample size	Response Rate	Good food handling practice (%)
1	Abdi et al., 2017 [13]	Addis Ababa	CS	SRS	394	95.2	27.4
2	Ayehu et al.,2013 [22]	Amhara	CS	Census	406	94.4	52.5
3	Chekol et al., 2018 [16]	Amhara	CS	SRS	416	98.6	40.1
4	Dawit G. et al., 2019 [25]	Amhara	CS	SyRS	214	95.5	66.4
5	Legesse D, et al., 2015 [15]	SNNPRS	CS	SRS	383	99	32.6
6	Henok D, et al., 2018 [21]	Amhara	CS	SRS	423	100	49.6
7	Lalit et al., 2015 [23]	Tigray	CS	SRS	369	96.9	53.1
8	Melese A, et al., 2017 [17]	Amhara	CS	SRS	288	100	46.5
9	Mulugeta A, et al., 2018 [27]	Benshangul Gumuz	CS	SRS	355	100	67.8
10	Zemichael G, et al., 2014 [14]	Amhara	CS	SyRS	403	100	30.3
11	Asrat M, et al., 2014 [19]	Addis Ababa	CS	Census	302	100	47.7
12	Metadel A, et al., 2014 [28]	Amhara	CS	SyRS	116	95.9	72
13	Daniel N and Kumie, 2011 [24]	Tigray	CS	SRS	277	97.5	63.9
14	Derso et al., 2013 [26]	Amhara	CS	SRS	417	98.8	67.6
15	Lema et al., 2019 [18]	Amhara	CS	SRS	394	97.8	46.7
16	Azanaw et al., 2018 [20]	Amhara	CS	SRS	338	88	49

CS=cross-sectional, SRS= Simple Random Sampling, SyRS=Systematic SRS

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Pooled Level of good food handling practice

The fixed-effect model was used to pool the level of good food handling practice but showed a very high level of heterogeneity. Therefore, this review employed a random effect model for analysis and the pooled level of good food handling practice among food handlers of public food establishments was found to be 50.72% with 95%CI (43.84, 57.6) (Figure 2). By observing the forest plot and considering I-squared (I^2=96.6%), a high level of heterogeneity between studies was observed (Figure 2).

Sub-group analysis: The test for sub-group analysis suggests that there is a statistically significant sub-group effect (P<0.0001). The pooled level of good food handling practice is higher among articles conducted before 2016 [52.34% with 95% CI (41.62, 63.05)] compared to articles conducted after 2016 [49.12% with 95% CI (39.75, 58.5)]. However, there is substantial unexplained heterogeneity between the articles within each of these subgroups (conducted before 2016: I^2 = 97.1%; conducted after 2016: I^2= 96.4%) (Figure 3).

Similarly, there is a statistically significant sub-group effect (P<0.0001). The pooled level of good food handling practice is higher among articles having a sample size of ≤ 343 [57.36% with 95% CI (48.98, 65.73)] compared to articles having a sample size of <343 [46.76% with 95% CI (37.65, 55.86)]. However, there is substantial unexplained heterogeneity between the articles within each of these subgroups (sample size of ≤ 343: I^2 = 91.4%; a sample size of ≤ 343: I^2= 97.3%). Therefore, the validity of the good food handling practice estimate for each subgroup is uncertain, as individual article results are inconsistent (Figure 4).

Publication Bias: A funnel plot was drawn and evaluated subjectively by investigators and evidence of publication bias was not observed. Publication bias can be suspected if the plot shows an asymmetric shape, with no points on one side of the graph (Figure 5). Moreover, the Eggers test for small-study effects was also performed but unable to show evidence of the existence of publication bias at p =0.949.

Meta-regression: Potential effect modifiers such as study year and size of participants involved in each article were regressed against good food handling practice and none of the effect modifiers showed the existence of association against good food handling practice (Table 3).

Table 3: Meta-regression output for assessing causes of heterogeneity among studies included

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Variable	Category	Coef	P>|t|	[95% Conf. Interval]
Year of study	After 2016	Ref.	Ref.	Ref.
	Before 2016	3.184339	0.663	(-12.14331, 18.51198)
Size of study participants	≤343	Ref.	Ref.	Ref.
	>343	-10.69023	0.143	(-25.47183, 4.091367)

Determinants of good food handling practice

At the individual level of analysis, 43.8% (7/16) of the articles identified training as a factor that could determine good food handling practice among food handlers working in public food establishments. Consequently, the pooled estimate indicated that the odds of having good food handling practice was 3.4 times higher among trained food handlers compared to non-trained food handlers [AOR=3.4, 95% CI=(2.33, 4.95)] (Figure 6).

Twenty five percent (4/16) of the research articles included in the review identified that there was a significant association between food handlers' attitude and good food handling practice. Similarly, the pooled estimate indicated that those food handlers having favorable attitudes were 3.62 times more likely to have good food handling practice compared to those who had unfavorable attitudes [AOR=3.62, 95% CI=(2.23, 5.85)] (Figure 7).

Regarding medical checkup, 18.8% (3/16) of the included individual research articles indicated that regular medical checkup of food handlers was associated with good food handling practice. The pooled estimate also indicated that food handlers who had regular medical checkups were 5.12 times more likely to have good food handling practice compared to those food handlers who didn't have regular medical checkups [AOR=5.12, 95% CI=(2.93, 8.95)] (Figure 8).

Discussion

In individual studies, the level of good food handling practice among food handlers working in public food establishments ranges from 27.4% in Addis Ababa to 72% in Dessie [13-28]. However, the pooled level of good food handling practice among food handlers working in public food establishments was 50.72%. This finding is lower than the findings from Indonesia, 90% [8], Saudi Arabia, 80.29% [9], Malaysia, 59.3% [10], Jordan, 89.43% [11], Nigeria, 78.2% [12]. The possible explanation for the finding could be related to the availability of training and

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medical checkup regularly. In Ethiopia, most establishments are opened without having trained food handlers and even without establishing a mechanism for having a regular medical checkup.

The odds of having good food handling practice was 3.4 times higher among trained food handlers working in public food establishments compared to non-trained food handlers. This finding was supported by findings from different parts of the world suggesting that the provision of training positively influences the food handling practices of food handlers [36-38].Likewise, the pooled estimate also indicated that food handlers having favorable attitudes were 3.62 times more likely to have good food handling practice compared to those who had unfavorable attitudes. Evidence also suggested that attitude was playing a significant role in promoting good food handling practice [39-41]. Usually, training is given to food handlers seeking for two major changes. One is to add knowledge, skill and the second is to help the employees develop a positive attitude towards their job. Hence, a trained employee can know more about the job and develop a positive attitude which could help him/her to have good food handling practice.

The pooled estimate also indicated that food handlers who had regular medical checkups were 5.12 times more likely to have good food handling practice compared to those food handlers who didn't have a regular medical checkup. The probable explanation for the finding could be during regular medical checkup healthcare professionals might counsel regarding safe handling of food, consequences of contaminated food, and other related issues which could trigger positive attitude towards good food handling practice.

Conclusion

The level of good food handling practice among food handlers working in public food establishments of Ethiopia was very low and variables such as food handler training, attitude towards good food handling practice, and the existence of regular medical checkup were factors affecting good food handling practice among food handlers working in public food establishments of Ethiopia. Provision of training that could change the attitude towards good food handling practice and regular medical checkups for food handlers has to be in place to improve good food handling practice among food handlers working in public food establishments of Ethiopia.

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Data Availability

The Excel data is available from the corresponding author upon request.

Competing interests

The authors declare that we have no competing interests.

Funding Statement

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Authors' contributions

Maru Meseret designed the study, prepared the protocol, supervised data collection, analyzed and interpreted the data.

Maru Meseret, Amare Dagnew, and Dehabo Alamirew coached the research from protocol development to data interpretation. Maru Meseret drafted and prepared the manuscript. All authors read and approved the final manuscript.

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Figure Caption

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Figure 1: PRISMA flow-chart diagram describing the selection of studies.

Figure 2: Forest plot showing the pooled level of good food handling practice among food handlers working public food establishments of Ethiopia, 2021.

Figure 3: Sub-group analysis of good food handling practice by year of study

Figure 4: Sub-group analysis of good food handling practice by size of study participants

Figure 5: Funnel plot, in which the vertical line indicates the effect size whereas the diagonal line indicates the precision of individual studies with 95% confidence limit.

Figure 6: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of training against good food handling practice.

Figure 7: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of attitude against good food handling practice.

Figure 8: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of medical checkup against good food handling practice.

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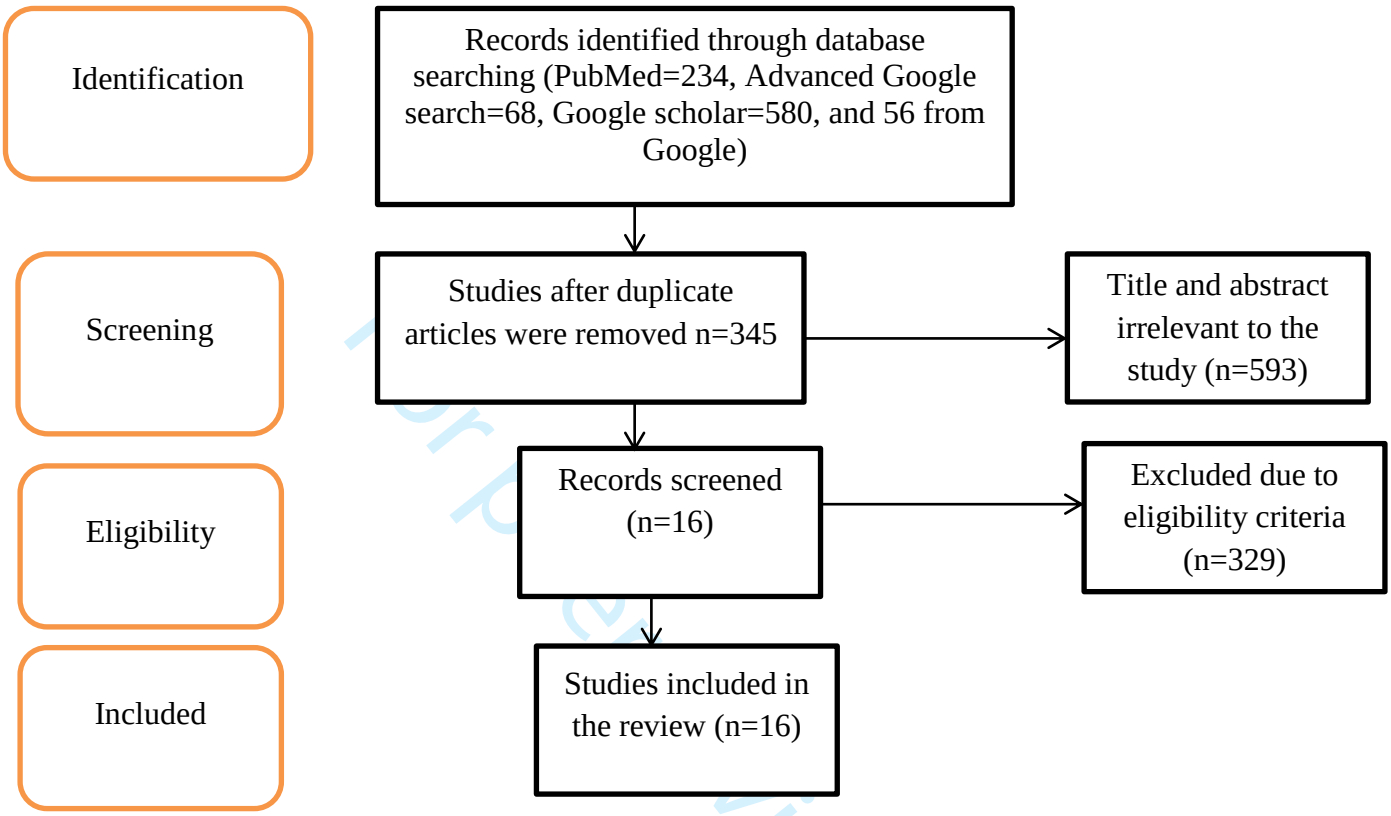

Figure 1: PRISMA flow-chart diagram describing the selection of studies.

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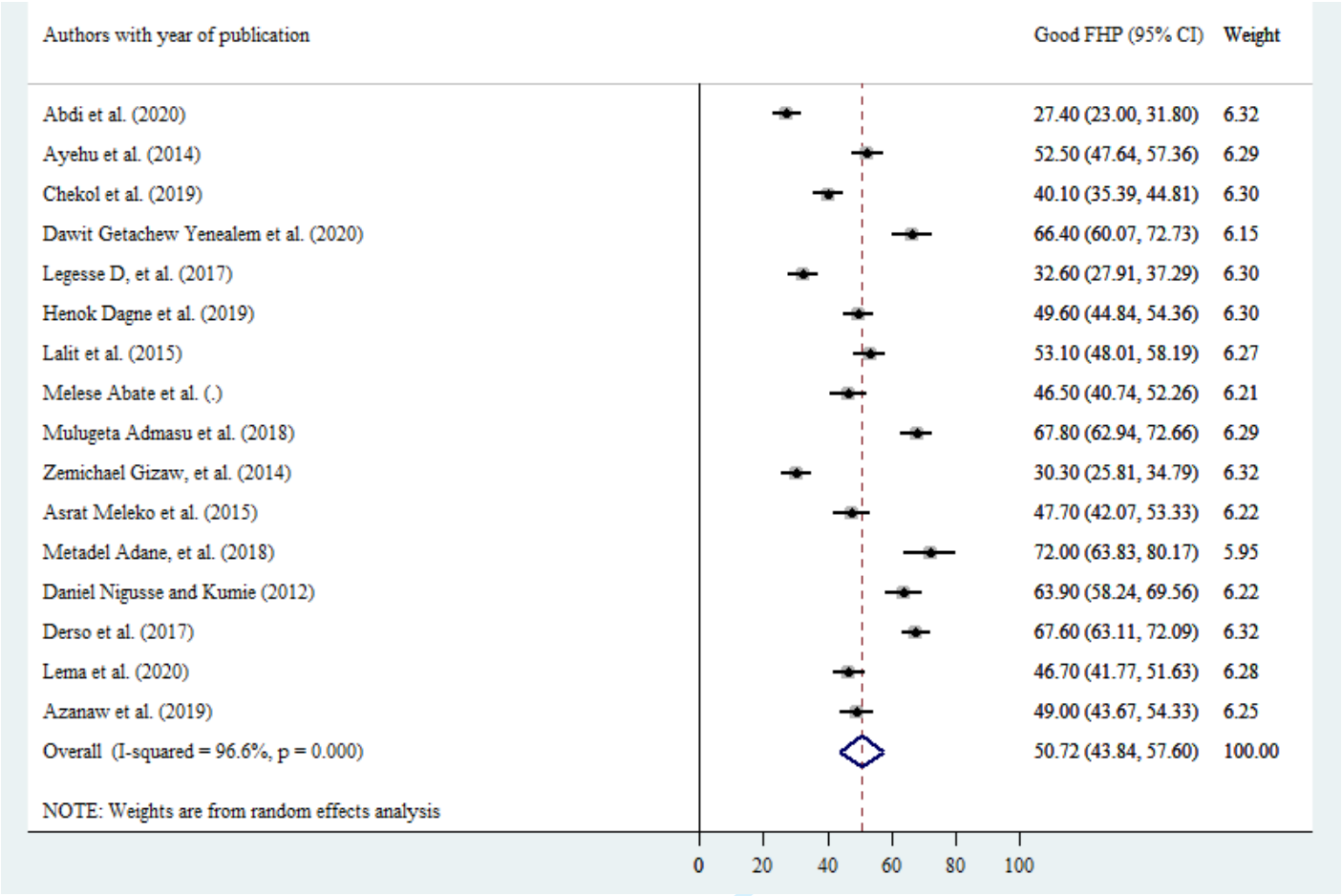

Figure 1: Forest plot showing the pooled level of good food handling practice among food handlers working public food establishments of Ethiopia, 2021.

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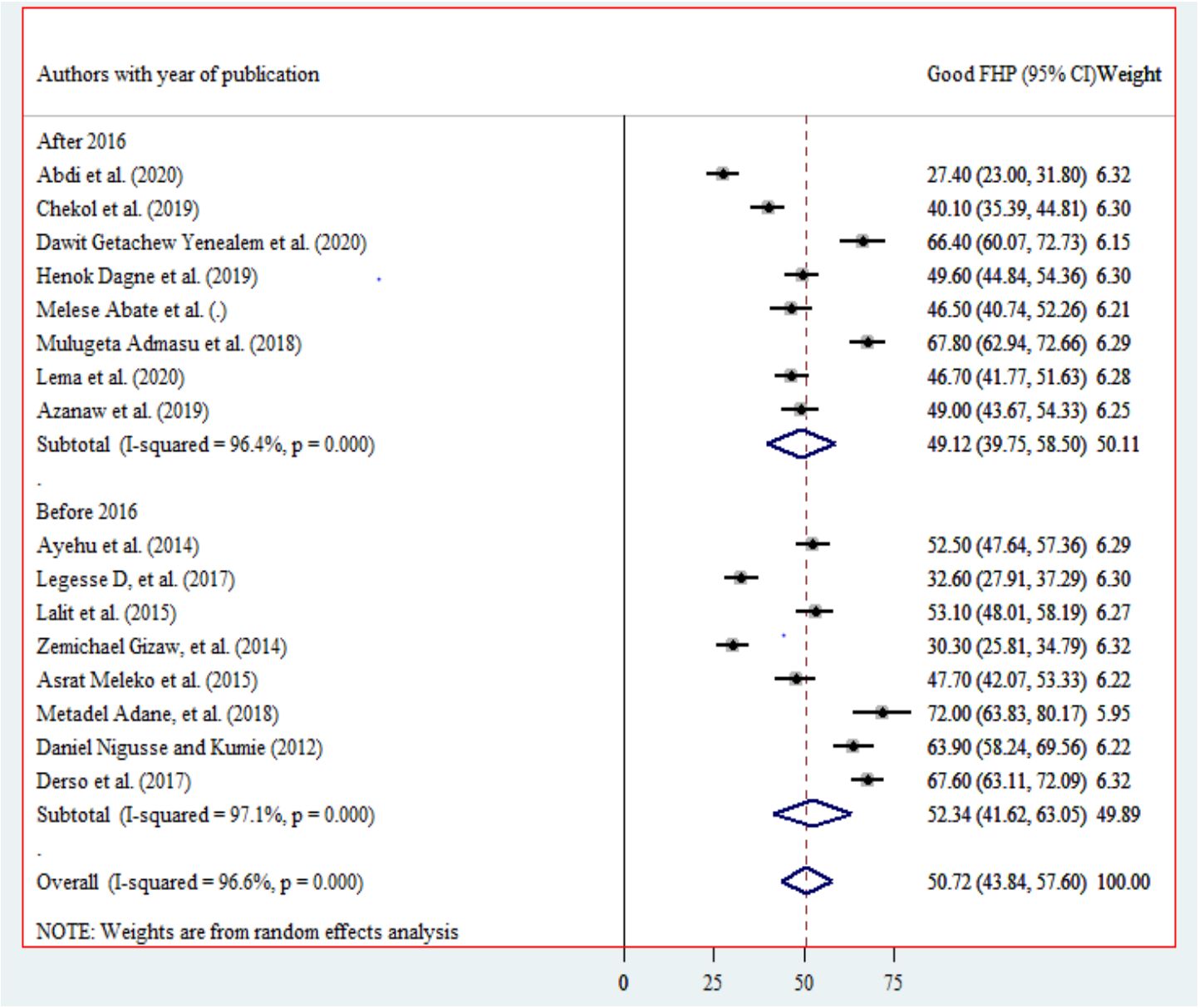

Figure 3: Sub-group analysis of good food handling practice by year of study

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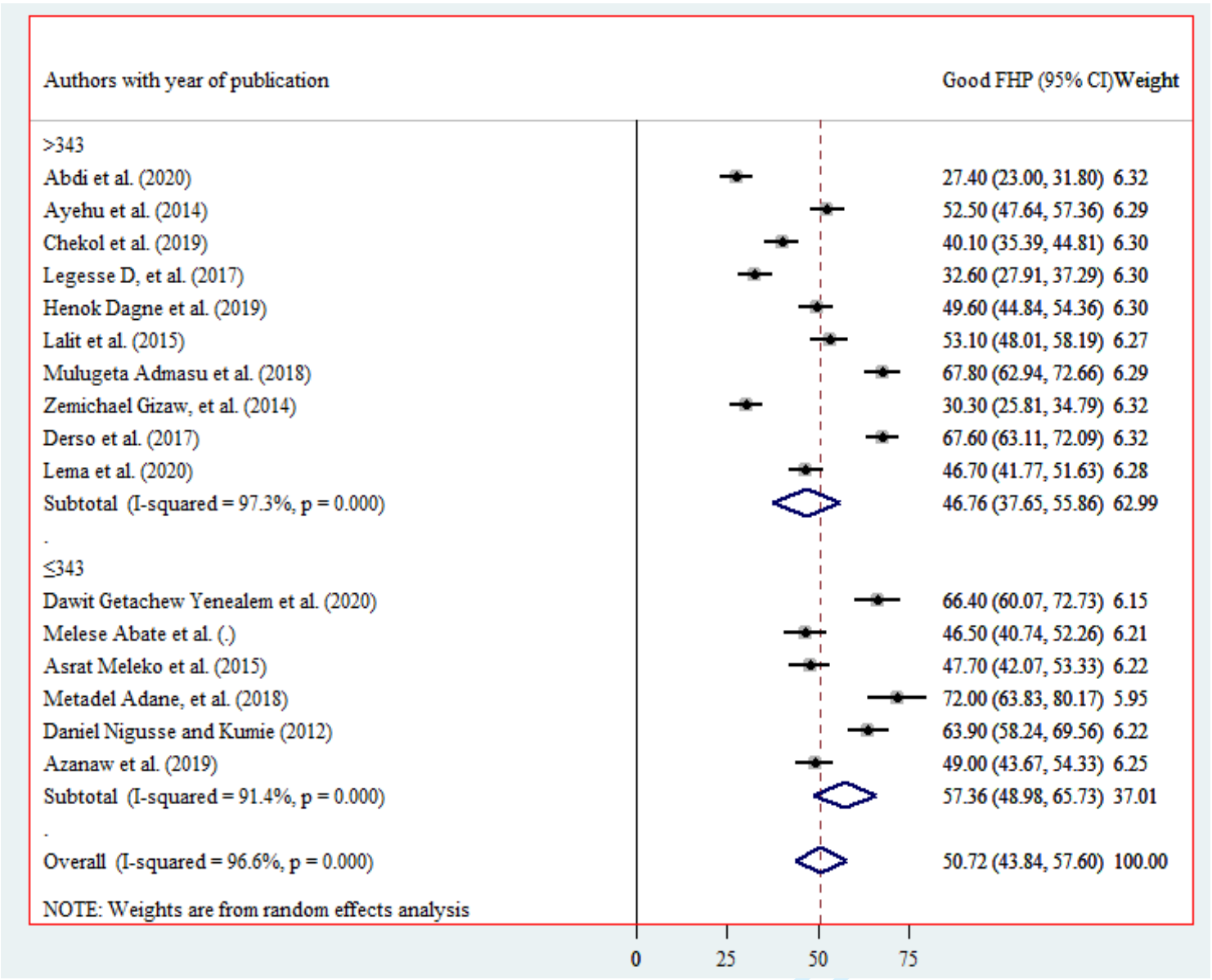

Figure 4: Sub-group analysis of good food handling practice by size of study participants

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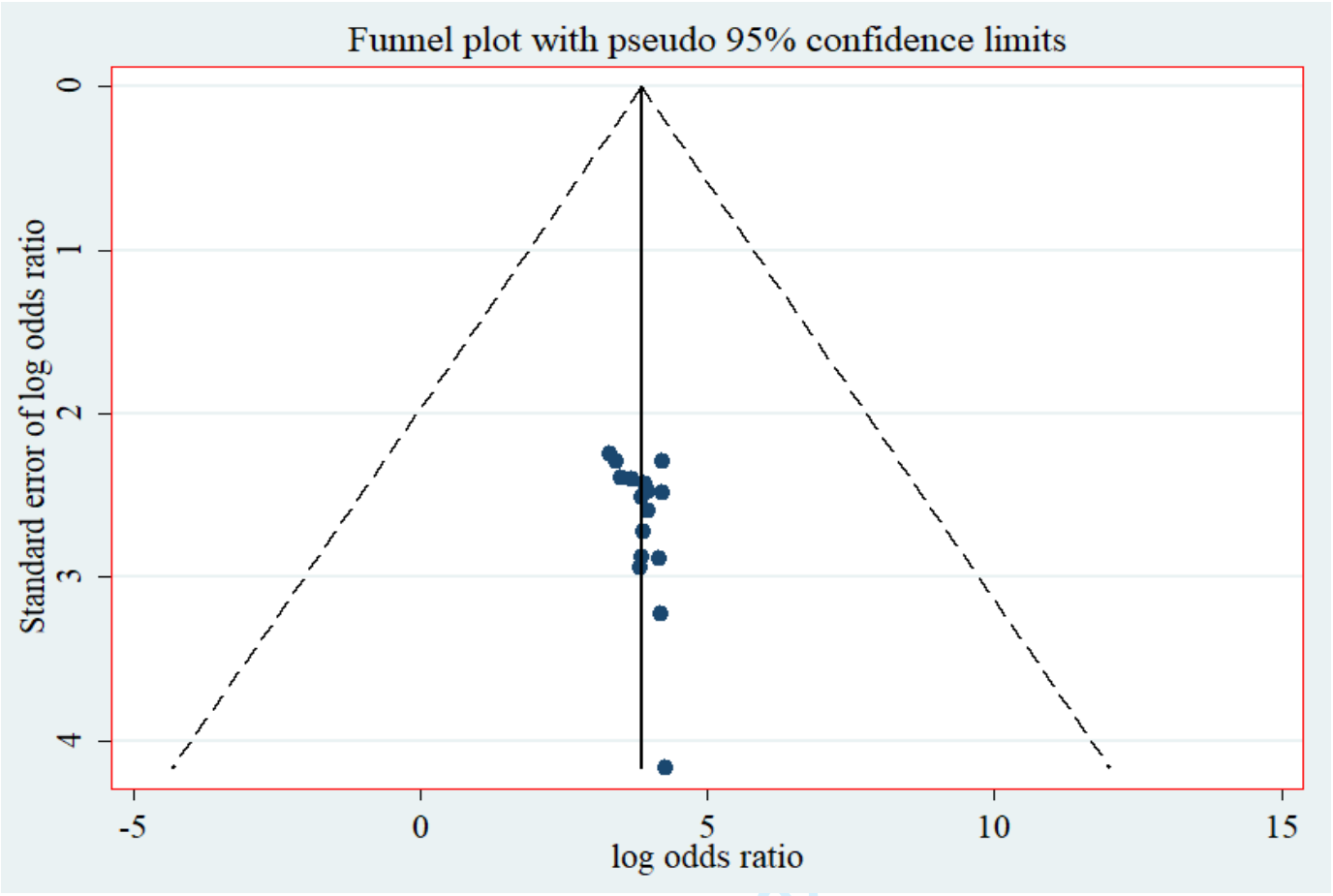

Figure 5: Funnel plot, in which the vertical line indicates the effect size whereas the diagonal line indicates the precision of individual studies with 95% confidence limit.

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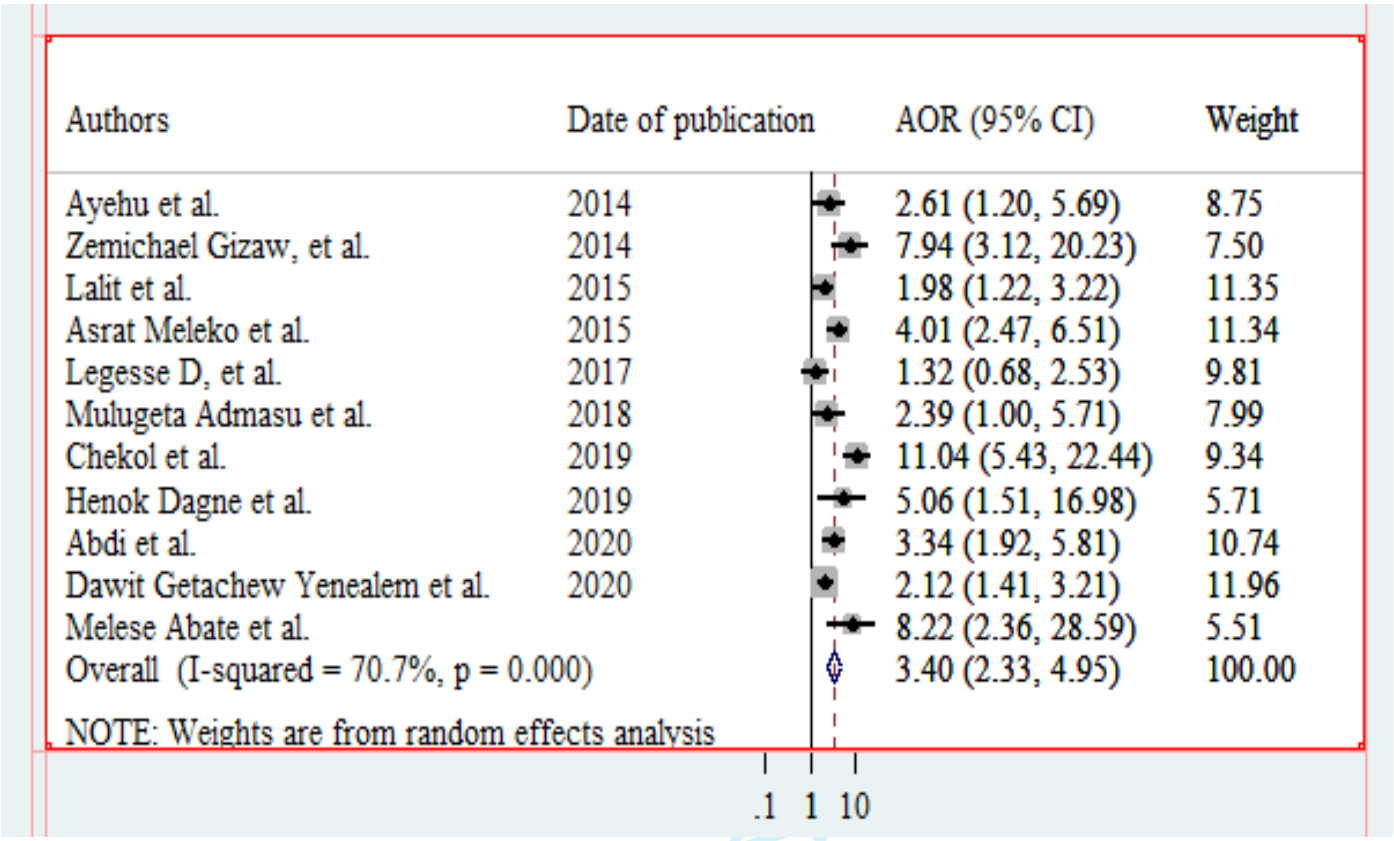

Figure 6: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of training against good food handling practice.

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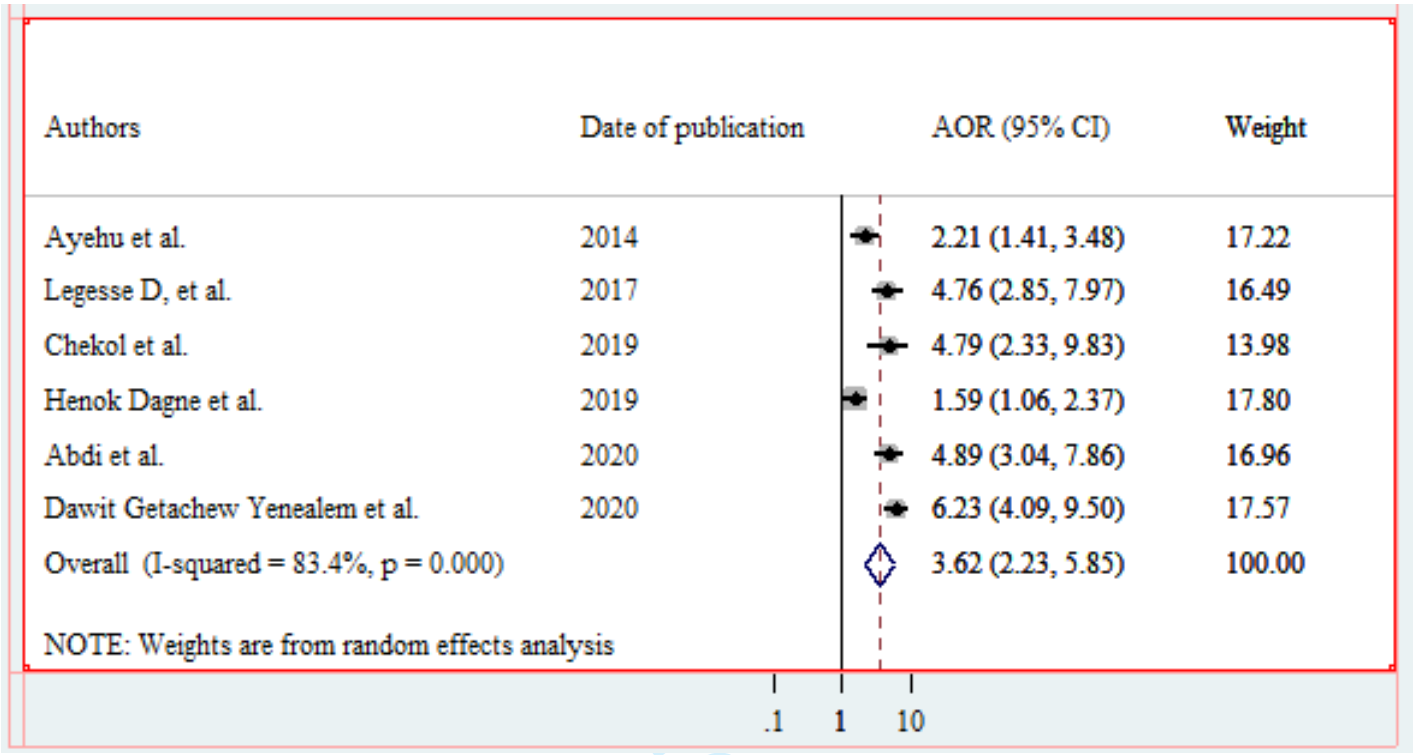

Figure 7: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of attitude against good food handling practice.

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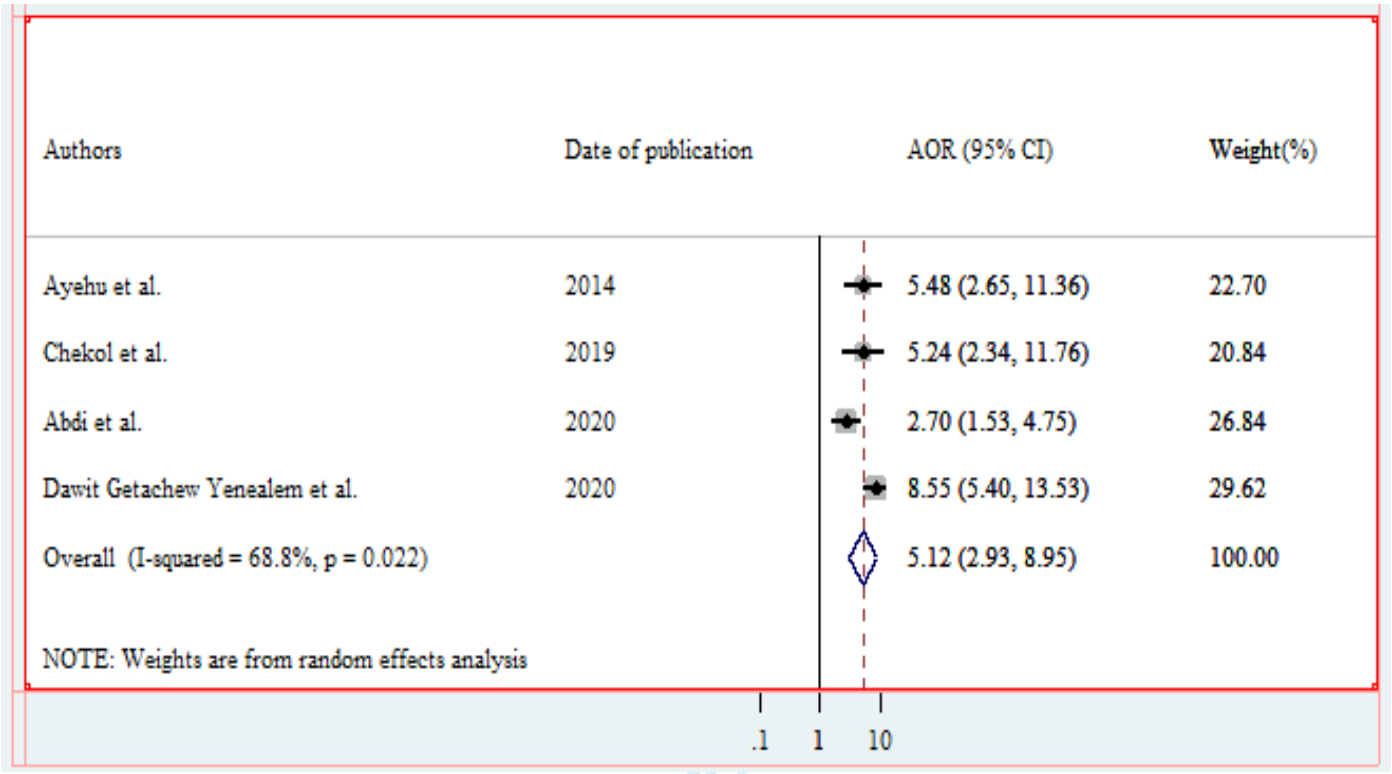

Figure 8: Forest plot of the adjusted odds ratios (AOR) with corresponding 95% CIs of studies on the association of medical checkup against good food handling practice.

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1-2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
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
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.	3-4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	3-4
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).	4
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.	4-5

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Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	7-8
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.	9-10
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	10
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	9
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	9-10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	9-10
RESULTS			
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.	7
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).	9
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
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	10
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	9-10
DISCUSSION			
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).	12

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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).	2
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	12
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	12

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

Available at : **www.prisma-statement.org**.

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