Evaluation of hygienic food handling practices and associated factors among food handlers in the Amhara region, Ethiopia: a systematic review and meta-analysis

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Abstract

Foodborne illnesses as a result of poor food handling practices pose a significant threat to public health. The main objective of this systematic review and meta-analysis was to pool the level of hygienic food handling practices among food handlers working in public food establishments in the Amhara region, Ethiopia. An inclusive search of databases was undertaken using PubMed/MEDLINE, SCOPUS, Web of Science, and Google Scholar from the 1st of January 2014 to the 30th of December 2023. Data was collected, entered into Excel, and finally exported to Stata V.17 for analysis. Eyeball testing using forest plots, Cochrane *Q* test statistics and I^2 had been used to identify and measure heterogeneity. The pooled prevalence of hygienic food handling practices was estimated using a random effects model. The pooled prevalence of hygienic food handling practices of food handlers in the Amhara region was 48% [95% confidence interval (CI): (43%, 53%)] with significant heterogeneity (I^2=94.39%, p<0.05). Food handlers who have more than 2 years of food preparation experience [odds ratio (OR) = 3.51; 95% CI (2.64, 4.38)] and who got food preparation training [OR=2.14; 95% CI (1.06, 3.22)] were significantly associated with good food handling practice in the Amhara region. The pooled prevalence of hygienic food handling practices was low in the Amhara region, Ethiopia. This review indicated that a high level of experience and training in food preparation were the determinants of good food handling practices in the region. This finding can be used by policymakers, non-governmental organizations, and stakeholders for intervention and regulatory measures.

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Introduction

Public health is seriously threatened by foodborne infections in both developed and developing countries. Eating contaminated food exposes millions of individuals to foodborne illness and increases their risk of illness globally (Fung *et al.*, 2018). Around the world, unsafe food consumption causes 600 million foodborne deaths and 420,000 foodborne illnesses annually; children under the age of 5 account for 30% of these deaths (Pattabhiramaiah and Mallikarjunaiah, 2023). 10% of the 33 million individuals are impacted, and 420,000 of them die every month and year (Ernawati *et al.*, 2021). The use of contaminated water for washing and processing food, as well as poor manufacturing and handling practices, a lack of facilities for storing food, and inadequate or improperly applied regulations and standards in developing countries, each of these variables increases the risk of foodborne diseases (Adeyeye, 2017). The majority of foodborne illnesses are primarily caused by pathogenic bacteria, viruses, and parasites. *Salmonella*, *Campylobacter*, Enterohemorrhagic *Escherichia coli*, and *Listeria* are the most common bacteria that cause foodborne infections (Hassanain *et al.*, 2013). According to O'Shea *et al.* (2019), the two primary risks associated with viral foodborne transmission are the norovirus and the hepatitis A virus. Foodborne infections caused by intestinal parasites, such as *Entamoeba histolytica*, *Giardia lamblia*, Taenia species, *Ascaris lumbricoide,* and

Trichuris trichiura, are associated with unsanitary food handling practices (FHPs) (Desalegn *et al.*, 2022).

According to Mulugeta Habtewold and Heshmati (2023), FHPs are basic concepts that are mainly concerned with maintaining the biological safety of food during processing, preparation, storage, and cleaning of kitchenware and other surfaces that come into direct contact with food. Poor FHPs are responsible for 75% of foodborne outbreaks globally, resulting in an estimated 420,000 deaths annually from these outbreaks. Due to poor infrastructure and related FHPs, foodborne bacterial infections—especially those brought on by Shigella, *Bacillus cereus*, Salmonella species, and *Staphylococcus aureus*—occur frequently in Ethiopia (Mengistu and Kassie, 2022). It is essential to implement effective FHPs to ensure food safety and significantly reduce the occurrence of foodborne diseases. According to the Ethiopian Public Health Law, every food handler working in a food establishment must undergo a medical examination at least once every 3 months (Ayele and Fessha, 2021).

In Ethiopia, 10-20% of foodborne illness outbreaks are attributed to food handler contamination, while around 70% of diarrheal infections are connected to ingesting contaminated food (Tegegne and Phyo, 2017). Eating and drinking in public places such as restaurants, hotels, and snack bars is normal in Ethiopia, particularly in urban areas. These dining establishments raise the possibility of contamination by handling, preparing, and serving enormous quantities of food to a large number of patrons rapidly. Food handlers seem to be a key source and technique of food contamination, according to Alemayehu *et al.* (2021). Thus, assessing and improving food handlers' knowledge of food safety and handling procedures is essential to ensuring strict adherence to food safety regulations.

Numerous cross-sectional studies on the knowledge and practices of food handlers about food safety were conducted in the Amhara region of Ethiopia. However, their results show notable variations. Furthermore, the estimated proportion of FHPs in the Amhara region is the subject of observational studies undertaken by many research groups, making it challenging to make an informed decision (Alamneh *et al.*, 2022). In the municipalities of Debre Markos and Dangila, good FHPs were found to be 54% and 52%, respectively (Lalit *et al.*, 2015; Alemayehu *et al.*, 2021). Nonetheless, it was found that 72% of residents in Dessie Town handled food properly (Adane *et al.*, 2018). Chekol *et al.* (2019) discovered that the proportion of Debark Town residents who handled food properly was 40%. Likewise, 32% of Bahir Dar town's residents reportedly handle food improperly (Bantie *et al.*, 2023).

According to the databases we checked so far, there has not been a systematic study or meta-analysis of hygienic FHPs in the Amhara region. As a result, the region's ability to readily obtain prepared documents about hygienic food handling techniques and related issues is limited. A notable gap exists in the literature because there is no regional pooled study that looks at the prevalence and contributing factors of FHPs among food handlers employed by public eating businesses in the Amhara region, Ethiopia. Therefore, the purpose of this systematic review and meta-analysis was to assess the current state of food handlers' behaviors and related variables among those employed by Amhara's public dining venues. This meta-analysis was therefore conducted to pool the proportion of FHPs among food handlers in the Amhara region to generate a single summary estimate from several independent studies by pooling the data. It increases the sample size, detects publication biases, and leads to more precise estimates of the proportion while identifying deficiencies in study design, data analyses, and interpretation of the findings. This review can provide well-organized data on available research works on FHPs in Amhara, Ethiopia. The findings of this study could help governmental institutions like the Ethiopian Public Health Institution, the Ethiopian Ministry of Health, and non-governmental organizations (NGOs) such as the Food and Agriculture Organization, the United Nations International Children's Emergency Fund, and World Health Organization to develop and implement effective strategies to improve food handler's food hygiene and safety practices.

Materials and Methods

Registration and protocol

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist was used to conduct this systematic review and meta-analysis (PRISMA, 2020). The study protocol was registered in PROSPERO (Record ID: CRD42024534430).

Search strategy

In this review, the step-by-step guide for conducting a systematic review and meta-analysis (Ahn *et al.*, 2016) was used. An inclusive search of databases was undertaken using PubMed/MEDLINE, SCOPUS, Web of Science, and Google Scholar from the publication year of 1st January 2014 to 30th December 2023 to find potentially relevant articles. All searches were limited to papers written in English, and the last search in all databases was performed on the 10th of April 2024. In addition to the electronic database search, grey literature was searched using Google Search University's Digital Library in the Amhara region, Ethiopia. Reference lists of the included articles for related studies were also searched. For the journal search strategy, the following phrases and keywords were used: ["Food OR Foods AND Hygiene OR "Hand hygiene" AND "Handling Practices" OR Practice AND "Associated Factors" OR Factor OR Determinant OR Determinants, OR "AND "Food Handling" OR "Food handlers" OR "Amhara Region" AND "Ethiopia"] as well as all possible combinations of these terms. We used database-specific subject headings linked with the above terms and keywords used in PubMed for the other electronic databases.

Eligibility criteria

Articles that met the following criteria were considered for inclusion in the review: i) study area – only studies in the Amhara region of Northern Ethiopia have been included; ii) language – only papers written in the English language were taken into consideration; iii) study population – the study involved all food handlers working in food establishments, including hotels, cafeterias, and institutions, such as universities and prisons; iv) study design – all studies conducted through cross-sectional study designs that reported the proportion of good FHPs and associated factors were considered; v) publication status – only published studies were included.

Exclusion criteria were as follows: i) articles with unclear statistical methodologies, full-text papers not fully available, and articles that did not indicate the overall proportion of good FHPs were all excluded; ii) articles conducted outside the Amhara region in Ethiopia were also excluded.

Outcome of interest

The outcome variable was hygienic FHP, which was characterized as having a good practice based on the operational definition of included studies. FHPs of food handlers were assessed at key points by asking practical questions like whether they always washed their hands with water and soap. Good hand hygiene was defined as a score above or equal to the mean value on the hand hygiene questions, while poor hand hygiene was defined as a score below the mean value. A determinant of food handlers' hand hygiene practices was the study's second finding. It was based on data calculated using the odds ratio (OR) and binary outcomes from the primary studies included.

Study selection

Both reviewers established the studies using the principles of inclusion and exclusion criteria. The studies were chosen first based on the importance of their titles and abstracts. After that, full-text articles were collected and checked to ensure that they were eligible. Any inconsistencies were resolved during discussions among authors for agreement. Divergences have been resolved or determined by the authors' consensus. The PRISMA flow diagram was used to summarize the data collection methods (Hoy *et al.*, 2012).

Data extraction

Through a pretested data extraction format, both investigators extracted all of the review data such as the name of the first author or research group, year of publication, zone/study setting, sampling method, study design and sample size, and status of FHP. Reviewers independently collected data on factors associated with food handlers' hand hygiene practices. Data were extracted in a 2×2 table format for the second outcome (factors associated with FHPs), and the OR for each factor was calculated based on the findings of the original studies.

Quality assessment

The Joanna Briggs Institute quality assessment tool for prevalence studies was used to assess the quality of included studies and to assess the risks of biases. The quality of the included studies was independently appraised by two reviewers (LF and KT). The tool included: i) was the sample frame appropriate to address the target population?; ii) were study participants sampled in an appropriate way?; iii) was the sample size adequate?; iv) were the study subjects and the setting described in detail?; v) was the data analysis conducted with sufficient coverage of the identified sample?; vi) were valid methods used for the identification of the condition?; vii) was the condition measured in a standard, reliable way for all participants?; viii) was the response rate adequate, and if not, was the low response rate managed appropriately?; ix) was there appropriate statistical analysis?. Each item was classified as having a low or high bias risk. Articles having unclear assessment tools for data collection were labeled as having a high risk of bias. Finally, the overall bias risk score was graded based on the number of studies with high bias risk: low (2), moderate (3-4), and high (5).

Data analysis

Data was collected and entered into Excel (Microsoft, Redmond, WA, USA) and finally exported to Stata V.17 (StataCorp, College Station, Texas, USA) for analysis. Eyeball testing using forest plots, χ^2 test, and I^2 had been 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 was attributable to heterogeneity rather than chance. Heterogeneity was quantified as low, moderate, and high, with upper limits of 25%, 50%, and 75% for I^2, respectively. Moreover, subgroup analysis is usually defined as the process of comparing a treatment effect for two or more variants of an intervention. In this systematic review, publication bias was determined by statistical methods such as drawing funnel plots and statistical testing (Egger's regression test). Egger's test with a p-value of less than 0.05 indicates the presence of publication bias. The effect size in this study is calculated using the mean pooled prevalence of FHPs in the Amhara region.

Table 1. Summary of studies in the systematic review and meta-analysis of food handling practice in the Amhara region, Ethiopia.

Name of author and publication year	Study area	Study design	Sampling method	Sample size	Proportion of good food handling practice (%)	RB
Tessema *et al.*, 2014	Dangila	CS	Census	406	52.50	Low
Azanaw *et al.*, 2021	Gonder	CS	SRRS	430	30.70	Low
Alamneh *et al.*, 2022	East and West Gojam	CS	SYRS	836	48.80	Low
Alemu *et al.*, 2023	Bahirdar	CS	SRS	422	47.60	Low
Adane *et al.*,, 2018	Desie	CS	SYRS	135	69.60	Low
Alemayehu *et al.*, 2021	Debre Markos	CS	SRS	408	53.70	Low
Zeleke *et al.*, 2022	Debark	CS	SRS	423	44.90	Low
Azanaw *et al.*, 2022	Gonder	CS	SRS	395	49.10	Low
Engdaw *et al.*,, 2023	Gonder	CS	SYRS	417	37.60	Low
Bantie *et al.*, 2023	Bahir Dar	CS	SYRS	421	36.10	Low
Chekol *et al.*,, 2019	Debark	CS	SRS	416	40.10	Low
Dagne *et al.*, 2019	Debark	CS	SRS	423	49.60	Low
Derso *et al.*, 2017	Bahir Dar	CS	SRS	417	67.60	Moderate
Silamlak, 2022	Woldia	CS	SRS	291	49.40	Low
Reta *et al.*, 2021	Woldia	CS	SRS	288	46.50	Moderate

CS, cross-sectional; SRS, simple random sampling; SRRS, stratified random sampling; SYRS, systematic random sampling; RB, risk of bias.

Results

Description of included studies

By using a database and Google engine searching, a total of 64 and 3 articles were found. Due to the study area, 39 articles were removed, 4 were irrelevant reports, and 7 duplicated articles were removed. Here, 17 full-text articles were screened, with two rejected as one was unpublished and the other lacked the information required by our eligibility criteria. Finally, 15 articles were included in this study (*Supplementary Figure 1*).

The screened studies were cross-sectional by study design and were published between 2014 and 2023. A total of 6128 study participants were included in this meta-analysis to estimate the pooled proportion of good FHPs of food handlers in the Amhara region, Ethiopia. In positions of area specification of included studies in the region, three studies were from Bahir Dar (Derso *et al.*, 2017; Alemu *et al.*, 2023; Bantie *et al.*, 2023), three from Debark (Chekol *et al.*, 2019; Dagne *et al.*, 2021; Zeleke *et al.*, 2022), three from Gonder (Azanaw *et al.*, 2022; Engdaw *et al.*, 2023), two from Woldia (Reta *et al.*, 2021; Abegaz, 2022), one from Dangila (Tessema *et al.*, 2014), one from East and West Gojam (Alamneh *et al.*, 2022), one from Desie (Adane *et al.*, 2018), and one from Debre Markos (Alemayehu *et al.*, 2021) (Table 1).

Meta-analysis of pooled good food handling practices

In this meta-analysis, the pooled prevalence of good hygiene FHPs of food handlers in Amhara was 48%; 95% confidence interval (CI): (43%, 53%). The pooled prevalence estimate varied across studies with significant heterogeneity (I^2=94.39%, p<0.05). As a result, a random effects model was used to estimate the pooled proportion of hygienic FHPs in the region. The highest proportion of good FHPs was 69.6% (CI) reported by Adane *et al.* (2018) in Desie town whereas, the lowest proportion was 30.7% (CI) reported by Azanaw *et al.* (2022) in Gonder (*Supplementary Figure 2*).

Subgroup analysis

This meta-analysis performed subgroup analysis based on the year of publication, size of study participants, study site of the region, and sampling method applied in the respective study. The subgroup analysis suggests that there is a statistically significant subgroup effect of good FHP against the study period (p<0.0001) in the Amhara region. The pooled level of good FHP is higher among articles conducted before 2020 [56% with 95% CI (45%, 67%)] compared with articles conducted after 2020 [44% with 95% CI (40% to 49%)]. However, there is substantial unexplained heterogeneity between the articles within each of these subgroups (conducted before 2020: I^2=95.62%; conducted after 2020: I^2=89.33%) (*Supplementary Figure 3*). This could be due to urbanization and the migration of new food handlers from rural areas to towns, and the expansion of vended food services in the streets of

The subgroup analysis in the meta-analysis suggests that there is a significant subgroup effect of good FHP against study size (p<0.0001) in the region. The pooled level of good hygienic FHP is higher among articles having a sample size of ≤400 [53% with 95% CI (43% to 64%)] as compared with articles conducted with a study size ≥401 [46% with 95% CI (40%, 52%)]. However, there is still a substantial unexpected heterogeneity between articles within each of these subgroups (sample size ≤400 I^2=91.44%, sample size of ≥401 I^2=94.887%) (*Supplementary Figure 4*). This could be due to the ease of collecting data from a small sample size as compared to a large sample size.

A subgroup analysis of good FHPs against the study site was conducted, and a significant subgroup effect was found in Bahir Dar, Debark, and Gonder (p<0.0001) sites of the region. The pooled level of good FHP is higher among articles conducted in Bahir Dar [50% with 95% CI (43% to 52%)] followed by studies conducted in Debark [45% with 95% CI (40%, 50%] and Gonder [39% with 95% CI (29%, 50%)]. However, there is still a substantial unexpected heterogeneity between articles within each of these subgroups (study site in Bahir Dar I^2=97.83%, Debark I^2=74.11%, and Gonder I^2=93.50%) (*Supplementary Figure 5*).

A subgroup analysis of good FHPs against the sampling methods applied was also conducted, and a significant subgroup effect in articles conducted by systematic random sampling (SYRS) and simple random sampling (SRS) (p<0.0001) was found. The pooled level of good FHP is higher among articles conducted by using SRS [50% with 95% CI (45% to 55%)], followed by articles conducted through SYRS [48% with 95% CI (33%, 63%]. However, there is still a substantial unexpected heterogeneity between articles within each of these subgroups (study site in SYRS I^2=97.47% and SRS I^2=89.46%) (*Supplementary Figure 6*). Therefore, the validity of the good FHP evaluation for each subgroup is indeterminate, as individual article results are inconsistent.

Publication bias

The existence of publication bias was determined within the included studies. A funnel plot and Egger's tests were used to assess publication bias. The funnel plot revealed that the distribution of articles was asymmetrical (*Supplementary Figure 7*), whereas Egger's tests revealed that estimating the prevalence of hygienic FHPs among food handlers was not statistically significant. From this result, the regression-based test uses the declared random-effects model with REML estimation to account for residual heterogeneity. The estimated slope in Eager's test, (is 10.49, standard error of 5.386, test statistic of z=1.95 and p=0.0516) and Beggs test (Kendall's score is 35.00, standard error of score = 20.207, z=1.68 and Prob>|z|=0.0925) for small-study effects was unable to show evidence of the existence of publication bias for estimating the prevalence of FHPs in Amhara region, Ethiopia.

Meta-regression

A meta-regression analysis was done employing variables such

Table 2. Meta-regression of pooled food handling practice in the Amhara region, Ethiopia.

Variables	Coefficient	SE	Z	p	95% CI	
Constant	0.696	0.086	8.12	0.000	0.528	0.864
Publication year	-0.121	0.045	-2.43	0.015	-0.219	-0.023
Sample size	-0.077	0.053	-1.44	0.149	-0.182	0.028
Sampling method	-0.031	0.029	-1.05	0.294	-0.089	0.027
Study site	-0.004	0.009	-0.39	0.699	-0.022	0.015

SE, standard error; CI, confidence interval.

as study year, size of participants involved, sampling method employed, and study sites where the investigation in each article was regressed against good FHPs to identify potential sources of heterogeneity. Among the included variables, the year of publication was found to be a significant source of heterogeneity on good FHPs at a 5% level of significance in the Amhara region (Table 2).

Predictors of good food handling practice

In this systematic review and meta-analysis, being male, having a formal education, having food preparation experience, getting food preparation training, having good knowledge, and having a positive attitude were tested for significant determinants of good FHP. Hence, food preparation experience and food preparation training were found to be significant determinants for the pooled prevalence of good FHP at a 5% level of significance in the Amhara region, Ethiopia. At the individual level of analysis, 13.33% (2 of 15) of critical studies (Derso *et al.*, 2017; Bantie *et al.*, 2023) identified food preparation experience as a significant factor of good FHPs in this meta-analysis. Food handlers who have more than 2 years of food preparation experience were 3.51 [pooled OR=3.51; 95% CI (2.64, 4.38); I^2=7.37%] times more likely to have a good FHP than those who have below 2 years of experience in food preparation in the region. The test statistics exposed low heterogeneity among the included studies (I^2=7.37% and p=0.03). Thus, the association was determined using a random effect model (*Supplementary* Figure 8). In this meta-analysis, 60% (9 of 15) critical studies identified food preparation training as a factor of good FHPs (Derso *et al.*, 2017; Adane *et al.*, 2018; Chekol *et al.*, 2019; Alemayehu *et al.*, 2021; Dagne *et al.*, 2021; Reta *et al.*, 2021; Azanaw *et al.*, 2022; Zeleke *et al.*, 2022; Alemu *et al.*, 2023) (Table 1). Food handlers who have food preparation training were 2.14 [pooled OR=2.14; 95% CI (1.06, 3.22); I^2=96.76%] times more likely to have good FHP than those who do not receive food preparation training in the Amhara region, Ethiopia. The test statistics revealed high heterogeneity among the included studies (I^2=96.76% and p=0.000). As a result, the association was determined using a random effect model (*Supplementary Figure 9*).

Discussion

The main aim of this systematic review and meta-analysis was to evaluate the prevalence of good FHP and identify factors associated with hygienic FHPs among food handlers in the Amhara region, Ethiopia. In individual studies, the level of good FHPs among food handlers working in public food establishments ranges from 39% in Gonder to 70% in Desie. However, the pooled prevalence of FHPs among food handlers in public food establishments was 48%. This finding is nearly in agreement with a study conducted in Ethiopia, which reported a value of 48.36% (Negassa *et al.*, 2022). However, in the findings of Tadele *et al.* (2022) and Zenbaba *et al.* (2022) in Ethiopia in the same year, the pooled result was higher than the current pooled finding conducted in the Amhara region in the year 2022 (Tadele *et al.*, 2022; Zenbaba *et al.*, 2022).In the Amhara region, it was observed that the chances of having good FHPs were higher among trained food handlers working in public food establishments compared with 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 FHPs of food handlers (Ncube *et al.*, 2020; Alemayehu *et al.*, 2021; Tadele *et al.*, 2022; Makhunga *et al.*, 2023;). Training is given to food handlers to develop their knowledge and skills. In this review, experience in food handling was found to be a factor for good FHP. The pooled estimate also indicated that food handlers who had more than 2 years of experience were more likely to have good FHPs compared with those food handlers who had food handling experience below 2 years. The probable explanation for the finding could be that food handlers develop confidence and also get exposure to food handling from their senior food handlers. In this review, it was confirmed that variations existed between the pooled findings of the Amhara region and the pooled findings of the country from which the findings are considered from the whole regions, from which Amhara is the one. So, to get consistent pooled results at a country level, further confirmatory pooled studies should be conducted.

Conclusions

The pooled prevalence of good FHPs was low in the Amhara region, Ethiopia. Having high experience in food preparation and getting training in food preparation were the determinants of good FHPs in the region. A high level of FHP among the general population is essential to achieve commendable health in the community. The provision of training that could improve the knowledge and attitude towards good FHPs has to be provided in residence to increase good FHPs among food handlers working in public food establishments in the region. Consequently, policymakers, NGOs, and stakeholders should target on provision of food handling training which improves hygienic FHPs and in turn helps to preserve foodborne diseases in Amhara region, Ethiopia.

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Online supplementary material:

Supplementary Figure 1. Flow diagram for the selection of studies.

Supplementary Figure 2. Forest plot showing the pooled level of good food handling practice among food handlers in the Amhara region, 2024.

Supplementary Figure 3. Subgroup analysis of good food handling practice by year of study.

Supplementary Figure 4. Subgroup analysis of good food handling practice by size of study participants.

Supplementary Figure 5. Subgroup analysis of good food handling practice by study site.

Supplementary Figure 6. Forest plot of good food handling practice (FHP) by sampling method applied.

Supplementary Figure 7. Funnel plot of food handling practice in the Amhara region, Ethiopia.

Supplementary Figure 8. Forest plot of the association of food preparation experience against good food handling practice.

Supplementary Figure 9. Forest plot of the association of food preparation training against good food handling practice.