The critical role of infection prevention overlooked in Ethiopia, only one-half of health-care workers had safe practice: A Systematic Review and Meta-Analysis

Biniyam Sahiledengle1*, Yohannes Tekalegn1, Demelash Woldeyohannes1

1Department of Public Health, Madda Walabu University Goba Referral Hospital, Bale Goba, Ethiopia

*Corresponding author

ORCiD: 0000-0002-1114-4849

Email: biniyam.sahiledengle@gmail.com

NOTE: This preprint reports new research that has not been certified by peer review and should not be used to guide clinical practice.
Abstract

Background: Effective infection prevention and control measures, such as hand hygiene, the use of personal protective equipment, instrument processing, safe injection, and safe disposal of infectious wastes in the healthcare facilities maximize patient outcomes and are essential to providing effective, efficient, and quality health care services. In Ethiopia, findings regarding infection prevention practices among healthcare workers have been highly variable and uncertain. Therefore, this systematic review and meta-analysis estimate the pooled prevalence of safe infection prevention practices and summarize the associated factors among healthcare workers in Ethiopia.

Methods: PubMed, Science Direct, Google Scholar, and the Cochrane library were systematically searched. We included all observational studies reporting the prevalence of safe infection prevention practices among healthcare workers in Ethiopia. Two authors independently extracted all necessary data using a standardized data extraction format. Qualitative and quantitative analyses were employed. The Cochrane Q test statistics and I² tests were used to assess the heterogeneity of the studies. A random-effects meta-analysis model was used to estimate the pooled prevalence of safe infection prevention practice.

Results: Of the 187 articles identified through our search, 10 studies fulfilled the inclusion criteria and were included in the meta-analysis. The pooled prevalence of safe infection prevention practice in Ethiopia was 52.2% (95%CI: 40.9-63.4). The highest prevalence of safe practice was observed in Addis Ababa (capital city) 66.2% (95%CI: 60.6-71.8), followed by Amhara region 54.6% (95%CI: 51.1-58.1), and then Oromia region 48.5% (95%CI: 24.2-72.8), and the least safe practices were reported from South Nation Nationalities and People (SNNP) and Tigray regions with a pooled prevalence of 39.4% (95%CI: 13.9-64.8). In our qualitative syntheses, healthcare workers socio-demographic factors (young age, female gender), behavioral-related factors (being knowledgeable and having a positive attitude towards infection prevention), and healthcare facility-related factors (presence of running water supply, availability of infection prevention guideline, and receiving training) were important variables associated with safe infection prevention practice.

Conclusions: Only half of the healthcare workers in Ethiopia practiced safe infection prevention. Furthermore, the study found out that there were regional and professional variations in the prevalence of safe infection prevention practices. Therefore, the need to step-up efforts to intensify
the current national infection prevention and patient safety initiative as key policy direction is
strongly recommended, along with more attempts to increase healthcare worker’s adherence towards
infection prevention guidelines.

**Keywords:** Infection prevention, standard precaution, healthcare-associated infections, healthcare
workers, Ethiopia, systematic review, meta-analysis
Background

Effective infection prevention and control measures, such as proper hand hygiene, the use of personal protective equipment (PPE), environmental cleaning, instrument processing, safe injection, and safe disposal of infectious wastes in the healthcare facility maximize patient outcomes and are essential to providing effective, efficient, and quality health care services. [1-3].

Worldwide, HAIs affecting the quality of care of hundreds of millions of patients every year, contributing to increased morbidity, mortality, and substantial healthcare cost [1,2]. According to the World Health Organization (WHO), at any point in time in every hundred hospitalized patients, ten in developing countries and seven in developed countries will acquire at least one HAI [3]. Data from the European Centre for Disease Prevention and Control (ECDC) surveillance reports showed that the prevalence of patients with at least one HAI in acute care hospitals in Europe was 6.0% (country range 2.3%–10.8%)[4]. The Centre for Disease Prevention and Control (CDC) estimates 2 million patients who will suffer from HAIs every year in the United States (US), and a near hundred thousand of them die [5], which cost as much as 4.25 billion United States dollars [6].

In developing countries, the burden of HAIs is largely unknown, and in most cases, is underestimated due to the lack of proper surveillance. Studies conducted in low-income settings showed that the prevalence of HAIs varies from 5.7% to 19.1%, with a pooled prevalence of 10.1% [7]; and the cumulative incidence range is from 5.7% to 45.8% [8]. Remarkably, in many sub-Saharan African countries including Ethiopia the true prevalence of HAIs is still uncertain [8], and adherence towards infection prevention recommendations among healthcare workers (HCWs) is poor [9-12]. Known in this region of Africa, the risk of occupational injury and exposure to blood-borne infections is on the rise. A review by Auta et al showed that the estimated pooled lifetime prevalence on occupational exposure to body fluids among HCWs in 21 countries in Africa was 65.7% [13]. The only sustainable, practical, and long-term solution to reduce the problems of HAIs, and occupational exposures lie on actions to implement safe infection prevention practices in all healthcare facilities [3,9,10].

Ethiopia, similar to other African countries, does not have a well-described report on the burden of HAIs. Few HAI studies are available that focus on the incidents and prevalence of HAIs [14-17]. A study by Endalafer et al reported the overall incidence of nosocomial infections in a tertiary hospital
in Ethiopia was 35.8/100 patients, which is enormous [14]. Moreover, a high prevalence of HAIs has reported from all corners of the country, 15.4% in north Ethiopia [15], 11.4%-19.4% in southwest Ethiopia [16,17], and 16.4% in central Ethiopia [18]. The evidence available further suggests that inadequate infection prevention practices among HCWs are frequent [19, 20].

Sufficient evidence that demonstrated the role of infection prevention on the reduction of HAIs [21-23]- for example, Sickbert et al, in their study reported was an improvement in hand hygiene compliance by 10%, which associated a significant reduction in overall HAIs [22]. It is also reported that effective infection prevention and control reduce HAIs by at least 30% [21]. Despite these facts-in many low-income settings, lack of well-trained HCWs, lack of infection prevention and control policies, and technical guidelines made the problem even worse [9,15,24-28].

To maximize the prevention of HAIs at the national level in Ethiopia, there has been a growing recognition of the need for guidance on the documents, and in 2012, the publication of the second national infection prevention and patient safety guidelines was released. From that day on, considerable progress has been made in understanding the basic principles, acceptance, and use of evidence-based infection prevention practices in Ethiopia [9]. Despite the effort underway, studies reported inconsistent findings regarding HCWs infection prevention practice in Ethiopia [19,20,27,29-33]. Although the reporting of such practices is important for the prevention and control of HAIs and improving quality of care, the previously conducted studies had many differences in the geographical regions and preceded remarkable variations in the reported practices. Due to the aforementioned reason, we conducted a systematic review and meta-analysis of observational studies to estimate the pooled prevalence of safe infection prevention practices among HCWs in Ethiopia. Also, we aim to summarize descriptively the factors that were associated with safe practice.
Materials and methods

Search strategy

This systematic review and meta-analysis analyzed the pooled prevalence of safe infection prevention practices among HCWs in Ethiopia. In addition, we qualitatively analyzed the factors that were associated with safe infection prevention practices from the included studies based on the articles published in national and international journals. The protocol for this review was registered in the International Prospective Register of Systematic Reviews (PROSPERO), the University of York Centre for Reviews and Dissemination (record ID: CRD42019129167, on the 31st May 2019).

Databases including PubMed/MEDLINE, Science Direct, Cochrane Library, and Google Scholar were systematically searched. Also, we screened at the references lists of identified articles to detect and identify additional relevant studies for this review. Furthermore, to find unpublished papers relevant to this systematic review and meta-analysis, Addis Ababa University Digital Library were searched. The search for the literatures was conducted between the 15th of April to the 31st of May, 2019. The following terms and keywords were applied for PubMed/MEDLINE search: (infection prevention OR infection control OR standard precaution OR practice) AND (healthcare workers OR health workers OR health personnel OR healthcare providers) AND (health facilities OR hospitals OR public health facilities) AND (Ethiopia) as well as all possible combinations of these terms. For the other electronic databases, we used database-specific subject headings linked with the above terms and keywords used in PubMed. This review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [34] (S1 File). The search strategy is provided in S2 File and S3 File.

S1 File. Table. PRISMA Checklist
S2 File . Search Strategy (Full searching strategies for PubMed)
S3 File. Search Strategy (Example Google scholar)
Inclusion criteria

• Study design: observational studies
• Population: only studies involving healthcare workers
• Language: articles published in the English language
• Reported condition: studies that reported the overall healthcare workers infection prevention practice
• Availability of full texts
• Study area: studies conducted in Ethiopia

Exclusion criteria

Articles with the following characteristics were excluded from this review

• Studies whose full data were not accessible even after requests from the authors
• Studies which did not report the overall prevalence of infection prevention practices
• Studies conducted on medical, interns, health science students and housekeeping staffs
• Qualitative studies, reviews, commentaries, editorials, letters, interventional studies, and other opinion papers
• Excluded published articles with unclear methods

The outcome of the study

These systematic reviews have two main outcomes. Prevalence of safe infection prevention practices in Ethiopia, as the primary outcome variable of this study, is defined as the overall correct practice of the core components of infection prevention that include hand hygiene, utilization of personal protective equipment, reusable medical equipment processing, healthcare waste management, tuberculosis infection control, and safe injection and medication practices. The prevalence was computed by dividing the number of healthcare workers reported correct/acceptable infection prevention practices by the total number of healthcare workers (sample size), and multiplied by 100. The second outcome of this study was to summarize descriptively the factors that were associated with safe infection prevention practices in Ethiopia from the included studies.
Data extraction

Two investigators (BS and YT) independently extracted the data from the studies included in our analysis as recommended by PRISMA guidelines [34]. The data were extracted using a standard data extraction forms. The following information were extracted from the selected studies: first author’s name, year of publication, the type of study design, study setting, study population, sample size, sampling methods, the magnitude of infection prevention practice, infection prevention components assessed, response rate, and region.

Quality assessment

The assessment of methodological quality was carried out independently by two reviewers using the Newcastle-Ottawa scale (NOS) [35]. This scale has three sections: 1st selection (maximum 5 stars), (2) comparability between groups (maximum 2 stars), and (3) outcome assessment (maximum 3 stars). In summary, the maximum possible score was 10 stars, which represented the highest methodological quality. The two authors (BS and YT) independently assessed the quality of each original study using the quality assessment tool. Any disagreements during the data extraction were resolved through discussion and consensus. Finally, any article with a scale of greater than or equal to ≥ 7 out of 10 was included in this Systematic Review and Meta-analysis. A detailed scoring result was described in the supplementary file (S4 File).

S14 File. Table: Methodology quality assessment of included and excluded studies

Data analysis and synthesis

Data extractions were done using Microsoft Excel spreadsheet, then analyses were done using STATA version 14 statistical software. The descriptive data were presented using a table to describe the characteristics of each primary study. The standard errors for each original study were calculated using the binomial distribution formula. The presence of heterogeneity among the reported prevalence was assessed by computing p-values for the Cochran Q test and I² test. Cochran’s Q test was used to test the null hypothesis of no significant heterogeneity across the studies [36]. Although there can be no absolute rule for when heterogeneity becomes important, Higgins et al. tentatively suggested low for I² values between 25%–50%, moderate for 50%–75%, and high for ≥75% [36].
Subgroup analysis was done by the region where primary studies were conducted, publication year, sample size, sampling method, and type of healthcare facility.

Publication bias was assessed using a funnel plot. In the absence of publication bias, the plot resembles a symmetrical large inverted funnel. Egger's weighted regression and Begg's rank correlation tests were used in checking the publication bias (P < 0.05), considered statistically significant [37]. We also conducted a leave-one-out sensitivity analysis to appraise the main studies that exerted an important impact on between-study heterogeneity.
Results

Identification of studies

For this review, one hundred and eighty-seven studies were identified in the initial search. Of these, 118 were excluded during the evaluation of the title and abstract. And based on the inclusion and exclusion criteria, a total of 10 studies were included in the final systematic review and meta-analysis (Fig 1).

Fig 1: PRISMA flow chart of review search.

Characteristics of included studies

A total of 10 articles [19,20,27,31,33,38-42] were included in meta-analysis. The study sample included 3,510 samples with a mean of 351 samples in each study. The maximum and minimum sample sizes were found in studies conducted by Geberemariyam BS., et al (648 samples) in the Oromia region [20] and Abreha N., et al. (108 samples) in Addis Ababa (the capital city of Ethiopia) [41]. Selected studies were conducted between 2014 and 2019. All the included studies were cross-sectional by design. With regards to regional distribution, about (30%) of the studies were conducted in Addis Ababa [27,40,41]. The prevalence of safe infection prevention practices ranged between 15% [33], and 72.5% [41] in South Nation Nationalities and People (SNNPs) Region and Addis Ababa, respectively. Concerning the quality score, all included studies were of a reputable methodological quality score of 7 from a total of 10-point (Table 1).
| Primary author, (year) (reference number) | Region location | Study design | Setting | Study population | Sampling | Infection prevention component assessed | Response rate (%) | Sample size | Prevalence with 95 %CI | Quality score |
|------------------------------------------|-----------------|--------------|---------|------------------|----------|--------------------------------------|------------------|------------|------------------------|--------------|
| Sahiledengle B., et al (2018) [27]        | Addis Ababa     | CS           | Hospital & health centers | Nurses, Midwives, Health officers, Physicians, Laboratory technicians, Anesthesiologist, Dentist, Ophthalmologist | Systematic random sampling | Hand hygiene, use of personal protective equipment (PPE), instrument processing, waste management, post-exposure prophylaxis (PEP), TB-infection control, safe injection, and medication practice | 96.2% | 605 | 66.1(64.1-68.0) | 7            |
| Geberemariyam BS., et al (2018) [20]     | Oromiya         | CS           | Hospital & health centers | Physicians, health officers, nurses, midwives, anesthetist, laboratory technicians, pharmacists, environmental health officers, radiographer | Random sampling (Lottery methods) | Hand hygiene, PPE utilization, instrument processing, healthcare waste handling, safe injection | 95.3% | 648 | 36.3(34.4-38.1) | 7            |
| Hussen SH., et al (2017) [38]             | SNNP            | CS           | Referral hospital          | Physicians, nurses, laboratory technicians, pharmacist, radiographer | Census | | 96.7% | 271 | 60.5(57.5-63.4) | 7            |
| Bekele I., et al (2018) [39]              | Oromiya         | CS           | University hospital        | Nurses | Systematic sampling | | | | | |
| Study                                                                 | Region  | Facility Type | Physicians, Staff          | Sampling Technique                  | Hygiene Practices                                                                 | Compliance Rate | Sample Size | CI             | Study Duration |
|----------------------------------------------------------------------|---------|---------------|---------------------------|-------------------------------------|-----------------------------------------------------------------------------------|----------------|-------------|----------------|----------------|
| Yohannes T., et al. (2019) [33]                                       | SNNP    | General & district hospital | Physicians, nurses, midwives, laboratory technicians, anesthetists, health officers, emergency medical surgeons, specialists, radiographer | Simple random sampling technique   | Hand hygiene, use of PPE, instrument processing, waste management                  | 98.2%          | 274         | 15.0(12.8-17.1) | 7              |
| Yallew WW., et al. (2015) [42]                                       | Amhara  | Teaching hospital | Physicians, nurse, health officers, health assistants | Systematic random sampling          | PPE, blood-borne disease practice, urinary catheter and surgical wound and intravenous catheters | 97.8%          | 413         | 55.0(52.5-57.4) | 7              |
| Gebresilassie., et al (2014) [19]                                    | Tigray  | Hospital & health centers | Physicians, nurses, midwives, laboratory technicians | Simple random sampling              | PPE, hand washing, injection safety                                                | 95.6%          | 483         | 42.9(40.6-45.1) | 7              |
| Gulilat K., et al (2014) [31]                                        | Amhara  | Hospital, health centers, and private clinic | Physicians, nurses, midwives, laboratory technicians, health officers, sanitarian | Simple random sampling              | Hand hygiene, use of PPE, Injection safety                                          | 97.8%          | 354         | 54.2(51.5-56.8) | 7              |
| Asmr Y., et al (2019) [40]                                           | Addis   | Specialized and referral hospital | Physicians, nurses | Simple random sampling              | Hand washing, PPE, instrument decontamination,                                    | 96.1%          | 123         | 60.0(55.5-64.4) | 7              |
| Abreha N., et al.                                                     | Addis   | Specialized hospital | Nurses | Census                              | Hand washing, PPE,                  | 90.7%          | 108         | 72.5(68.2-76.8) | 7              |
| Year | Authors | Study Type | Institutional Setting | Key Findings |
|------|---------|------------|-----------------------|--------------|
| 2018 [41] | Ababa | Cross-Sectional study | Hospital | Instrument decontamination, waste segregation, PEP |
Meta-Analysis

Prevalence of safe infection prevention practices

A total of ten studies were included in the meta-analysis. From these studies, the pooled prevalence of safe infection prevention practices in Ethiopia was 52.2% (95%CI: 40.9-63.4). A significant higher heterogeneity among the ten included studies was found ($I^2=98.0\%; Q=453.55$, Variance Tau-squared = 319.63, $p<0.001$). Due to the existence of significant heterogeneity, we used a random-effect meta-analysis model to estimate pooled prevalence (Fig 2). According to the sensitivity analysis, there was no single influential study that significantly accounted for it (Table 2).

Fig 2: Forest plot of the pooled prevalence of safe infection prevention practice in Ethiopia, 2014-2019

Table 2. Sensitivity analysis of prevalence for each study being removed at a time: Prevalence and 95% confidence interval of infection prevention practice in Ethiopia, 2014-2019.

| Study excluded                   | Prevalence | 95% CI  | $I^2$ (%) | Q      | p-value |
|---------------------------------|------------|---------|-----------|--------|---------|
| Sahiledengle B., et al (2018) [27] | 50.6       | 39.1-62.1 | 97.7      | 348.0  | $p<0.001$ |
| Geberemariyam BS., et al (2018) [20] | 54.0       | 41.6-66.4 | 98.0      | 405.8  | $p<0.001$ |
| Hussen SH., et al (2017) [38]    | 51.3       | 39.1-63.4 | 98.2      | 434.9  | $p<0.001$ |
| Bekele I., et al (2018) [39]     | 51.2       | 39.1-63.3 | 98.2      | 436.2  | $p<0.001$ |
| Yohannes T., et al (2019) [33]   | 56.2       | 48.1-64.4 | 95.6      | 181.3  | $p<0.001$ |
| Yallew WW., et al (2015) [42]    | 51.9       | 39.4-64.4 | 98.2      | 444.8  | $p<0.001$ |
| Gebresillassie., et al (2014) [19] | 53.2       | 40.5-65.9 | 98.2      | 447.3  | $p<0.001$ |
| Gulilat K., et al (2014) [31]    | 52.0       | 39.5-64.4 | 98.2      | 447.8  | $p<0.001$ |
| Asmr Y., et al (2019) [40]       | 51.3       | 39.4-63.3 | 98.2      | 446.1  | $p<0.001$ |
| Abreha N., et al (2018) [41]     | 50.0       | 38.3-61.6 | 98.1      | 420.3  | $p<0.001$ |
Subgroup Analyses

The subgroup analyses of infection prevention practice prevalence

The results of the subgroup analysis showed that the pooled prevalence of safe infection prevention practices were highest in Addis Ababa (capital city) 66.2% (95%CI: 60.6-71.8) \([I^2 = 51.4\%,\ p=0.128]\), and 54.6% (95%CI: 51.1-58.1) \([I^2 = 0.0\%,\ p=0.825]\) in Amhara Region; 48.5% (95%CI: 24.2-72.8) in Oromia Regional State; and the least safe practices were reported from other regions (SNNP and Tigray regions) with pooled prevalence of 39.4% (95%CI:13.9-64.8). A considerable heterogeneity was also found \([I^2 = 97.7\%;\ p<0.001]\); and \([I^2 = 98.8\%;\ p<0.001]\) for the Oromia Regional State, and other regions (SNNP and Tigray), respectively. The prevalence of infection prevention practices was analyzed separately for either nurses or all other healthcare workers. The present findings show the prevalence of safe infection prevention practices more in studies conducted exclusively on nurses than in other health care workers (66.4% vs. 48.6%). We also conducted a subgroup analysis based on the study setting. The pooled prevalence of safe infection prevention practice showed more in studies conducted exclusively in hospitals than in those that include health centers (53.5% vs. 49.8%). More details on the prevalence of safe infection prevention practices for subgroups are presented in Table 3.
Table 3: The subgroup prevalence of safe infection prevention practice in Ethiopia, 2014-2019.

| Variables                  | Subgroup                        | Number of studies included | Sample size | Prevalence (95% CI)         | Heterogeneity across the studies | Heterogeneity between group (p-value) |
|----------------------------|---------------------------------|---------------------------|-------------|-----------------------------|---------------------------------|--------------------------------------|
|                            |                                 |                           |             |                             | $I^2$ (%)                       | P-value                              |
| Region                     | Addis Ababa                     | 3                         | 836         | 66.2(60.6-71.8)             | 51.4                            | 0.128                                | 0.260                                |
|                            | Oromia                          | 2                         | 879         | 48.5(24.2-72.8)             | 97.7                            | p<0.001                              |                                      |
|                            | Amhara                          | 2                         | 767         | 54.6(51.1-58.1)             | 0.0                             | 0.825                                |                                      |
|                            | Others (SNNP & Tigray)          | 3                         | 1,028       | 39.4(13.9-64.8)             | 98.8                            | p<0.001                              |                                      |
| Type of healthcare facility| Hospital & health centers      | 4                         | 2090        | 49.8(35.7-63.9)             | 97.8                            | p<0.001                              | 0.741                                |
|                            | Hospital only                   | 6                         | 1420        | 53.9(34.7-73.0)             | 98.4                            | p<0.001                              |                                      |
| Sample size                | ≤ 300                           | 5                         | 1007        | 53.7(29.5-77.8)             | 98.0                            | p<0.001                              | 0.820                                |
|                            | >300                            | 5                         | 2503        | 50.8(39.5-62.1)             | 97.1                            | p<0.001                              |                                      |
| Profession                 | Nurses only                     | 2                         | 339         | 66.4(55.2-77.5)             | 98.0                            | p<0.001                              | 0.196                                |
|                            | All type of healthcare workers  | 8                         | 3171        | 48.6(36.1-61.2)             | 98.3                            | p<0.001                              |                                      |
| Sampling method            | Random                          | 8                         | 3131        | 48.7(36.1-61.3)             | 98.2                            | p<0.001                              | 0.206                                |
|                            | Census                          | 2                         | 379         | 66.1(54.3-77.8)             | 81.0                            | 0.022                                |                                      |
| Number of healthcare       | >10                             | 3                         | 1607        | 52.1(33.3-71.0)             | 98.4                            | p<0.001                              | 0.998                                |
| facilities assessed        | ≤ 10                            | 7                         | 1903        | 52.2(36.9-67.3)             | 98.1                            | p<0.001                              |                                      |
| Publication year           | ≤ 2015                          | 3                         | 1250        | 50.6(42.6-58.6)             | 88.0                            | p<0.001                              | 0.864                                |
|    | >2015 | 7 | 2260 | 52.9(36.3-69.5) | 94.7 | p<0.001 |

SNNP = South Nation Nationalities and Peoples
Publication Bias

In the present study, Begg’s and Egger's tests were utilized to detect the presence of publication bias. However, none of the tests revealed significant publication bias (p-values of 0.210 and 0.246, respectively) for the prevalence of safe infection prevention practice in Ethiopia (Fig 3).

Fig 3: Funnel plot showing publication bias on prevalence studies among healthcare workers in Ethiopian, a systematic review and meta-analysis, Ethiopia

Sensitivity Analysis

Table 2 shows the sensitivity analysis of prevalence for each study being removed at a time. To identify the potential source of heterogeneity in the analysis, a leave-one-out sensitivity analysis on the prevalence of infection prevention practice in Ethiopia was employed. The results of this sensitivity analysis showed that the findings were robust and not dependent on a single study. The pooled estimated prevalence of infection prevention practice varied between 56.2 (95%CI: 48.1-64.4) and 50.0 (95%CI: 38.3-61.6) after removing a single study.

Moreover, to identify the possible sources of variations across studies, the meta-regression model was performed by considering the geographical region, publication year, and sample size as covariates. The geographical region (p-value= 0.260), publication year (p-value= 0.864), and sample size (p-value= 0.820) were not statistically significant source of heterogeneity (Table 3).

Narrative Review

From the ten studies, we summarized descriptively the factors that were associated with safe infection prevention practices in Ethiopia. Factors were categorized into the following three domains: socio-demographic factors (four factors), behavior-related factors (three factors), and healthcare facility-related factors (five factors). The overview of these factors including the strength of association and corresponding articles was presented in Table 4.

Socio-demographic Factors

Four socio-demographic factors were significantly associated with safe infection prevention practices. Healthcare workers age [19,41], gender [33,38], profession [19,20,27,42], and higher service year [31] were identified as underlying factors associated with safe infection prevention practice. The odds of safe infection prevention practices were higher among the age groups between 20-29 [19], 30-39 [19], and 31-40 [41] than HCWs of greater age. The odds of safe infection
prevention practices were also higher in female HCWs than males [33,38]. Lastly, significantly lower odds on safe infection prevention practices were observed among all professionals such as midwives [20], laboratory technicians [27], health officers and health assistants [42], and physicians and nurses [19] (Table 4).

Behavioral related factors

Having good knowledge of infection prevention measures was identified as a factor associated with safe infection prevention practices [27]. In the same way, having a positive attitude towards infection prevention measures, and awareness on infection prevention guideline were the most commonly identified factors associated with the aforementioned practice [27,33] (Table 4).

Healthcare facility related factors

As illustrated in Table 4, four healthcare facility-related factors were positively and significantly associated with safe infection prevention practices in Ethiopia. Healthcare workers who worked in facilities with continuous water supply have higher odds on safe infection prevention practice [27]. Similarly, healthcare workers who worked in facilities with access to infection prevention guidelines in the working department have higher odds on the prevention practice [19,20,27]. Lastly, factors such as the type of healthcare facility, current working department, and completion of formal infection prevention training, were the most important factors associated with this prevention practice [20,27,33,38,42].
Table 4: Summary of factors associated with healthcare workers safe infection prevention practice of studies included in Ethiopia, systematic review, 2014-2019.

| Author, year | Prevalence of safe infection prevention practice | Variables associated with the univariate analysis | Multivariate analysis factors | Adjusted Odds ratio (AOR) | 95% Confidence interval (CI) | Strength of association |
|--------------|-----------------------------------------------|-----------------------------------------------|-------------------------------|--------------------------|-----------------------------|-------------------------|
| Sahiledengle B., et al (2018) [27] | 66.1% | Current working department: Gynecology, Obstetric, Delivery, OR and Minor-OR Profession: Laboratory technicians and others (Anesthesiologist, Dentist, and Ophthalmologist) Awareness of infection prevention guideline availability | Profession: Laboratory technicians and others (Anesthesiologist, Dentist, and Ophthalmologist) Awareness of infection prevention guideline availability Presence of continuous water supply Good knowledge of infection prevention measures Positive attitude towards infection prevention measures | 0.18 | 0.07-0.46 | Strong, negative |
| | | | | 1.97 | 1.34-2.93 | Moderate, positive |
| | | | | 1.68 | 1.11-2.56 | Moderate, positive |
| | | | | 1.53 | 1.05-2.22 | Moderate, positive |
| | | | | 2.03 | 1.26-3.26 | Moderate, positive |
| Study                                    | Gender | Profession | Year of service | Availability of water in the working department | Presence of infection prevention committee | Availability of infection prevention guidelines in the working department | Ever taken infection prevention training | p-value | OR (95% CI)            | Strength       |
|------------------------------------------|--------|------------|-----------------|-------------------------------------------------|-------------------------------------------|------------------------------------------------------------------------|----------------------------------------|---------|------------------------|----------------|
| Geberemariyam BS., et al (2018) [20]     | 36.3%  | midwives   | 10-14 years     | Strong, negative                                | Strong, positive                          | Strong, positive                                                       | Strong, positive                       | **0.28** | 0.12-0.69              | Strong, negative |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        |         |                        |                 |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        | **3.34** | 1.65-6.76              | Strong, positive |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        |         |                        |                 |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        | **5.31** | 2.42-11.63             | Strong, positive |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        |         |                        |                 |
| Hussen SH., et al (2017) [38]            | 60.5%  | Surgical   | Surgical, Obstetrics and gynecology, pediatrics | Strong, negative                           | Strong, negative                          | Strong, negative                                                       | Strong, positive                       | **0.37** | 0.19-0.74              | Strong, negative |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        |         |                        |                 |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        | **0.07** | 0.02-0.20              | Strong, negative |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        |         |                        |                 |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        | **0.17** | 0.06-0.48              | Strong, negative |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        |         |                        |                 |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        | **9.68** | 1.49-81.6              | Strong, positive |
|                                          |        |            |                 |                                                 |                                           |                                                                        |                                        |         |                        |                 |
| Study                                         | Percentage | Age of healthcare workers (in years) | Gender | Experience |
|----------------------------------------------|------------|--------------------------------------|--------|------------|
| Bekele I., et al (2018) [39]                 | 61.1%      |                                      |        |            |
| Yohannes T., et al (2019) [33]               | 15.0%      | Gender                              | Gender: Female | 2.96 | 1.34-6.53 | Moderate, positive |
|                                              |            | Marital status                       |        |            |
|                                              |            | Work experience                      |        |            |
|                                              |            | The attitude of the respondents      |        |            |
|                                              |            | towards infection prevention         |        |            |
|                                              |            | Guidelines                           |        |            |
|                                              |            | Availability of personal protective  |        |            |
|                                              |            | equipment                           |        |            |
|                                              |            | Accessibility of personal            |        |            |
|                                              |            | protective equipment                 |        |            |
|                                              |            | Management support for safety        |        |            |
|                                              |            | Training on infection prevention     |        |            |
|                                              |            | guidelines                           |        |            |
| Yallew WW., et al (2015) [42]                | 55.0%      | Profession: Nurses, Health officer,  | Profession: Nurses | 2.09 | 1.27-3.43 | Moderate, positive |
|                                              |            | health assistance                     |        |            |
|                                              |            | Profession: Health officer and health |        |            |
|                                              |            | assistance                           |        |            |
| Study                        | Percentage | Variables                                                                 |
|------------------------------|------------|---------------------------------------------------------------------------|
| Gebresilassie, et al (2014)  | 42.9%      | Age of healthcare workers (in years): 20-29, 30-39                        |
|                              |            | Service year of healthcare workers: 1-10                                 |
|                              |            | Gender: Male                                                              |
|                              |            | Profession: Doctor, Nurse                                                 |
|                              |            | Presence of written material                                              |
|                              |            | Training                                                                  |
|                              |            | Age of healthcare workers (in years): 20-29                               |
|                              |            | Age of healthcare workers (in years): 30-39                               |
|                              |            | Gender: Male                                                              |
|                              |            | Gender: Female                                                            |
|                              |            | Profession: Doctor                                                        |
|                              |            | Profession: Nurses                                                       |
|                              |            | Presence of written material                                              |
|                              |            | Training                                                                  |
| Gulilat K., et al (2014)     | 54.2%      | Level of health institution: general and private hospital                 |
|                              |            | Availability of personal protective equipment                             |
|                              |            | Levels of a profession: Physician                                         |
|                              |            | Service year                                                              |
|                              |            | Availability of safety box                                               |
|                              |            | Level of health institution: general hospital                            |
|                              |            | Level of health institution: private hospital                            |
|                              |            | Availability of personal protective equipment                            |
|                              |            | Service year: < 10 years                                                 |
| Asmr Y., et al (2019)        | 60.0%      | Training                                                                  |
|                              |            | Profession                                                                |
|                              |            | Infection control guideline in                                            |
|                              |            | Annual income in 2014                                                     |

| Study                        | Percentage | Variables                                                                 |
|------------------------------|------------|---------------------------------------------------------------------------|
|                              |            | Moderate, positive                                                        |
|                              |            | Large, positive                                                           |
|                              |            | Strong, negative                                                          |
|                              |            | Strong, negative                                                          |
|                              |            | Strong, negative                                                          |
|                              |            | Strong, negative                                                          |
|                              |            | Strong, negative                                                          |
|                              |            | Strong, negative                                                          |
|                              |            | Strong, negative                                                          |
|                              |            | Strong, negative                                                          |
|       | Age of healthcare workers (in years): 31-40 | Age of healthcare workers (in years): 40 | Age of healthcare workers (in years): 31-40 |
|-------|---------------------------------------------|-------------------------------------------|---------------------------------------------|
|       | Knowing about infection prevention committee | Training on infection prevention committee | Knowing about infection prevention committee |
|       | 2.69                                        | 2.50                                       | 1.66                                       |
|       | 1.06-7.37                                   | 1.18-10.95                                 | 1.35-7.25                                  |
|       | Strong, positive                            | Moderate, positive                         | Strong, positive                            |
|       |                                             |                                            |                                            |
|       | Wash hands before touching the patients     | Have you ever had Nosocomial infections    |                                            |
|       | Wash hands before touching the patients     | Have you ever had Nosocomial infections    |                                            |
|       | Wearing personal protective equipment before touching the patients | Reused needle or syringe | standard precaution guideline |
|       | Standard precaution guideline                |                                            |                                            |
|       | Discarded used material as per standard precaution guideline |                                            |                                            |
|       | Abreha N., et al (2018)                      |                                            |                                            |
|       | 72.5%                                       |                                            |                                            |
Discussion

Infection prevention is a fundamental measure for the control of HAIs. However, sustained compliance from the recommended infection prevention principles among HCWs in developing countries is poor. In Ethiopia, findings regarding the prevalence of safe infection prevention practices have been highly variable. We conducted this systematic review and meta-analysis to estimate the pooled prevalence of safe infection prevention practices among HCWs in Ethiopia. Based on the meta-analysis result, only one-half of the HCWs in Ethiopia had safe infection prevention practices. In our qualitative syntheses, healthcare workers’ socio-demographic, behavioral and healthcare facility-related factors were important variables associated with infection prevention practice.

The result of the 10 included studies noted that the pooled prevalence of safe infection prevention practice in Ethiopia was 52.2% (95%CI: 40.9-63.4). This finding brought important information, and these signified that unsafe practices in healthcare facilities are a major public health concern in Ethiopia. As the burdens of HAIs are increasing [14-18], the current suboptimal infection prevention practices have serious implications to both the HCWs and patients.

On one hand, contracting an infection while in the healthcare facility due to poor infection prevention practice violates the basic idea that healthcare is meant to make people well. In fact, the risk of contracting HAIs is variable and multifaceted: prevalently, it depends on a patient's immune status, the local prevalence of various pathogens, and the HCWs infection prevention practices. Hence, the need for having strong infection prevention programs nationally; and at the healthcare facility levels have been therefore important [29,30,32,43,44]. Un sustained compliance with infection prevention possibly places HCWs at equal, if not at higher risk of contracting bacterial and viral infections such as HIV, HBV, HCV, and MRSA in healthcare facilities [9]. In light of this, studies conducted in Ethiopia even showed a positive correlation between poor standard precaution practices and high prevalence of blood and body fluid exposure [20,27,45,46]. For this reason, the Federal Ministry of Health infection control professionals, healthcare facility administrators, and hospital epidemiologists must pay considerable attention to curve the current poor suboptimal infection prevention practices [47, 48].

In the subgroup analysis, a variation in HCWs infection prevention practices across geographical regions was found. Safe infection prevention practices were consistently more frequent in central
Ethiopia (Addis Ababa) and less in Tigray and SNNP regions—the reason for these regional
differences may be explained by studies conducted in central Ethiopia included mainly in tertiary
and referral hospitals which and commonly staffed are with skilled and experienced healthcare
professionals as compared to those in other regions. Another possible explanation for this variation
might be due to the difference in environmental infrastructures and behavioral characteristics of
HCWs. Our findings may, therefore, indicate the need not only to promote infection prevention and
patient safety protocols for the existing HCWs in Ethiopia, moreover to address regional variations
through systematic intervention measures.

Our meta-analysis also found that the prevalence of safe infection prevention practices differed
between professions—nurses [65.4%, 95%CI (54.5-76.2)] and other healthcare workers [48.4%,
95%CI (35.7-61.0)]. The possible explanation for this observed discrepancy may be due to the
training and job description of healthcare workers; the nurses were engaged in inpatient care, and
they may have better understanding regarding infection prevention. Still, this prevalence is
suboptimal and great concern, therefore, is necessary to strive for a better quality of healthcare.

In this review, the descriptive narration of the included studies on factors associated with safe
infection prevention practice was done. Notably, three main domains of determinant factors were
identified—socio-demographic, behavioral, and healthcare facility-related factors. From the result,
HCWs working in facilities with access to infection prevention guidelines and those receiving
formal infection prevention training have higher odds on safe practice. This may, as HCWs infection
prevention knowledge, might increase compliance [27]. In this sense, the current systematic review
suggests that it may be more effective to improve HCWs infection prevention practice through
regular in-service training [49]. A holistic approach is needed to address the scarcity of personal
protective equipment and the availability of running water supplies since the availability of these
factors also correlates positively with safe infection prevention practices [27,31].

**Limitations of the study**

This systematic review and meta-analysis have several limitations. The first limitation considered to
conduct this review was to include English language articles only. Second, all of the studies included
in this review were cross-sectional as a result; the outcome variable might be affected by other
confounding variables. Third, this meta-analysis represented only studies that were reported from the
four regions of the country—this irregular distribution of studies around the country may be under-
represented and could have limited the study found. Fourth, the majority of the studies included in this review had relatively small sample sizes which could have affected the estimated safe infection prevention practice reports. Fifth, a small number of studies were included in subgroup analyses which reduce the precision of the estimate and a considerable heterogeneity was identified among the studies. Lastly, almost all studies included in this meta-analysis were often based on self-reported data from healthcare providers, which tended to have overestimated compliance and limited the strengths of the findings.

Conclusions

Infection prevention practices in Ethiopia were significantly low, and only half of the healthcare workers reported safe practices. There were regional and professional variations in the prevalence on the safe practices-it is therefore important for all HCWs to adhere to the existing infection control guidelines strictly, and embedding them in everyday practice. It is also imperative for healthcare administrators to ensure the implementation of infection prevention and patient safety programs in all healthcare settings. Moreover, our study highlights the need to step-up efforts to intensify the current national infection prevention and patient safety initiatives as key policy direction by the Ethiopian Federal Ministry of Health (FMoH). Finally, to be successful, interventions need to be sustained over time in the context of patient safety culture.

Acknowledgments

The authors would like to thank Madda Walabu University Goba Referral Hospital Public Health Department staff for providing their unreserved support. We would like to thank for the valuable support we received from Mr. John Edward Quisido (assistant professor) as well as Dr. David Allison for their editorial and proofreading support.
Reference

1. Allegranzi B, Storr J, Dziekan G, Leotsakos A, Donaldson L, Pittet D. The First Global Patient Safety Challenge “Clean Care is Safer Care”: from launch to current progress and achievements. Journal of Hospital Infection. 2007 Jun 1;65:115-23.

2. Geffers C, Gastmeier P. Nosocomial infections and multidrug-resistant organisms in Germany: epidemiological data from KISS (the Hospital Infection Surveillance System). Deutsches Ärzteblatt International. 2011 Feb;108(6):87.

3. WHO, Health care-associated infections FACT SHEET. 2016.
   http://www.who.int/gpsc/country_work/gpsc_ccisc_fact_sheet_en.pdf

4. European Centre for Disease Prevention and Control, Point prevalence survey of healthcare associated infections and antimicrobial use in European acute care hospitals. Stockholm: ECDC; 2013.

5. CDC, Healthcare-Associated Infection Working Group of the Joint Public Policy Committee. Essentials of public reporting of healthcare- associated infections: a tool. Centers for Disease Control and Prevention (CDC).
   https://www.cste2.org/webpdfs/06107498EssentialsToolKit.pdf

6. Schmier JK, Hulme-Lowe CK, Semenova S, Klenk JA, DeLeo PC, Sedlak R, Carlson PA. Estimated hospital costs associated with preventable health care-associated infections if health care antiseptic products were unavailable. Clinicoecon Outcomes Res. 2016 May 13;8:197-205.

7. World Health Organization (WHO). Report on the Burden of Endemic Health Care-Associated Infection Worldwide. Geneva, Switzerland: WHO; 2011.

8. Bagheri Nejad S, Allegranzi B, Syed SB, Ellis B, Pittet D. Health-care associated infection in Africa: a systematic review. Bull World Health Organ. 2011;89(10):757–765

9. Federal Ministry of Health of Ethiopia. Infection prevention and patient safety reference manual for service providers and managers in healthcare facilities of Ethiopia. 2nd ed. Addis Ababa, Ethiopia. 2012.

10. Panesar SS, deSilva D, Carson-Stevens A, Cresswell KM, Salvilla SA, Slight SP, et al. How safe is primary care? A systematic review. BMJ Qual Saf. 2016 Jul;25(7):544-53.
11. Bedoya G, Dolinger A, Rogo K, Mwaura N, Wafula F, Coarasa J, Goicoechea A, Das J. Observations of infection prevention and control practices in primary health care, Kenya. Bulletin of the World health Organization. 2017 Jul 1;95(7):503.

12. World Health Organization. The world health report 2002: reducing risks, promoting healthy life. World Health Organization; 2002.

13. Auta A, Adewuyi EO, Tor-Anyiin A, Aziz D, Ogbole E, Ogbonna BO, Adeloye D. Healthcare workers’ occupational exposures to body fluids in 21 countries in Africa: systematic review and meta-analysis. Bulletin of the World Health Organization. 2017 Dec 1;95(12):831.

14. Endalafer N, Gebre-Selassie S, Kotiso B. Nosocomial bacterial infections in a tertiary hospital in Ethiopia. Journal of Infection Prevention. 2011 Jan;12(1):38-43.

15. Walelegn W, Adera K, Feleke M. Point prevalence of hospital-acquired infections in two teaching hospitals of Amhara region in Ethiopia. Drug Healthc Patient Saf. 2016;8:71–6.

16. Amenu D, Belachew T, Araya F. Surgical site infection rate and risk factors among obstetric cases of Jimma University Specialized Hospital, Southwest Ethiopia. Ethiopian journal of health sciences. 2011;21(2):91-100.

17. Ali S, Birhane M, Bekele S, Kibru G, Teshager L, Yilma Y, Ahmed Y, Fentahun N, Assefa H, Gashaw M, Gudina EK. Healthcare associated infection and its risk factors among patients admitted to a tertiary hospital in Ethiopia: longitudinal study. Antimicrobial Resistance & Infection Control. 2018 Dec;7(1):2.

18. Gedebou M, Habte-Gabr E, Kronvall G, Yoseph S. Hospital-acquired infections among obstetric and gynaecological patients at Tikur Anbessa hospital, Addis Ababa. J Hosp Infect. 1988;11(1):50–9

19. Gebresilassie A, Kumei A, Yemane D. Standard precautions practice among health care workers in public health facilities of Mekelle special zone, northern Ethiopia. J Community Med Health Educ. 2014;4(3):286

20. Geberemariyam BS, Donka GM, Wordofa B. Assessment of knowledge and practices of healthcare workers towards infection prevention and associated factors in healthcare facilities of West Arsi District, Southeast Ethiopia: a facility-based cross-sectional study. Arch Public Health. 2018;76(1):69.
21. WHO. Infection prevention and control. Available at: https://www.who.int/campaigns/world-antibiotic-awareness-week/2017/posters/infection-prevention-control.pdf?ua=1. Accessed (September 20, 2019).

22. Sickbert-Bennett EE, DiBiase LM, Willis TM, Wolak ES, Weber DJ, Rutala WA. Reduction of healthcare-associated infections by exceeding high compliance with hand hygiene practices. Emerging infectious diseases. 2016 Sep;22(9):1628.

23. Pittet D, Hugonnet S, Harbarth S, Mourouga P, Sauvan V, Touveneau S, Perneger TV. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. The Lancet. 2000 Oct 14;356(9238):1307-12.

24. Allegranzi B, Nejad SB, Combescure C, Graafmans W, Attar H, Donaldson L, Pittet D. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. The Lancet. 2011 Jan 15;377(9761):228-41.

25. Nejad SB, Allegranzi B, Syed SB, Ellis B, Pittet D. Health-care-associated infection in Africa: a systematic review. Bulletin of the World Health Organization. 2011;89:757-65.

26. Samuel SO, Kayode OO, Musa OI, Nwigwe GC, Aboderin AO, Salami TA, Taiwo SS. Nosocomial infections and the challenges of control in developing countries. African journal of clinical and experimental microbiology. 2010;11(2).

27. Sahiledengle B, Gebresilassie A, Getahun T, Hiko D. Infection prevention practices and associated factors among healthcare workers in governmental healthcare facilities in Addis Ababa. Ethiopian journal of health sciences. 2018;28(2):177-86.

28. Aiken AM, Karuri DM, Wanyoro AK, Macleod J. Interventional studies for preventing surgical site infections in sub-Saharan Africa—a systematic review. International Journal of Surgery. 2012 Jan 1;10(5):242-9.

29. Sahiledengle B. Stethoscope disinfection is rarely done in Ethiopia: What are the associated factors? PLoS ONE. 2019: 14(6):e0208365.

30. Sahiledengle B. Decontamination of patient equipment: nurses’ self-reported decontamination practice in hospitals of southeast Ethiopia. BMC Res Notes (2019) 12:392.

31. Gulilat K, Tiruneh G. Assessment of knowledge, attitude and practice of health care workers on infection prevention in health institution Bahir Dar city administration. Sci J Public Health. 2014;2(5):384–3
32. Sahiledengle B. Instrument processing knowledge and practice amongst healthcare workers in Addis Ababa, Ethiopia. International Journal of Infection Control. 2018;14(2).

33. Yohannes T, Kassa G, Laelago T, Guracha E. Health-Care Workers’ Compliance with Infection Prevention Guidelines and Associated Factors in Hadiya Zone, Southern Ethiopia: Hospital Based Cross Sectional Study. Epidemiology international journal. 2019. 3(1): 1-13.

34. 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:e1000097.

35. Newcastle-Ottawa Scale customized for cross-sectional studies In. available from https://static-content.springer.com/esm/.../12889_2012_5111_MOESM3_ESM.doc.

36. Higgins, J. P. T., S. G. Thompson, J. J. Deeks, and D. G. Altman. 2003. Measuring inconsistency in meta-analyses. British Medical Journal. 327: 557–560.

37. Knapp G, Hartung J. Improved tests for a random effects meta-regression with a single covariate. Statistics in medicine. 2003; 22: 2693-2710.

38. Hussein S, Estifanos W, Melese E, Moga F. Knowledge, attitude and practice of infection prevention measures among health care workers in wolaitta sodo Otona teaching and referral hospital. J Nurs Care. 2017;6(416):2167-1168.

39. Bekele I, Yimam I, Akele G. Adherence to Infection Prevention and Factors among Nurses in Jimma University Medical Center. Immunome Research. 2018;14(2):1-7.

40. Asmr Y, Beza L, Engida H, Bekelcho T, Tsegaye N, Aschale Y. Assessment of Knowledge and Practices of Standard Precaution against Blood Borne Pathogens among Doctors and Nurses at Adult Emergency Room in Addis Ababa, Ethiopia. Emergency medicine international. 2019;2019.

41. Abreha N. Assessment of knowledge and practice towards infection prevention and associated factors among nurses working in adult and pediatric emergency in Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia 2017/18 (Master thesis. Addis Ababa University). Addis Ababa University. 2018.

42. Yallew WW. Hospital acquired infections and infection prevention practices in teaching hospitals in the Amhara regional state, Ethiopia. Dissertation for the degree of doctor of philosophy (PhD) in public health. Addis Ababa University, Ethiopia. May, 2017
43. Shiferaw T, Beyene G, Kassa T, Sewunet T. Bacterial contamination, bacterial profile and antimicrobial susceptibility pattern of isolates from stethoscopes at Jimma University Specialized Hospital. Annals of clinical microbiology and antimicrobials. 2013 Dec;12(1):39.

44. Schabrun S, Chipchase L. Healthcare equipment as a source of nosocomial infection: a systematic review. Journal of Hospital Infection. 2006 Jul 1;63(3):239-45.

45. Reda AA, Fisseha S, Mengistie B, Vandeweerd J-M (2010) Standard Precautions: Occupational Exposure and Behavior of Health Care Workers in Ethiopia. PLoS ONE 5(12): e14420.

46. Gebremariyam BS. Determinants of occupational body fluids, healthcare workers' precautionary practices: a hospital-based study in Addis Ababa, Ethiopia. Ethiop J Health Dev 2019;33(1):4-11.

47. Knox A. Guidelines for cleaning, disinfection and sterilisation of patient care equipment. Infection control committee. NHS Dumfries and Galloway Board-wide. 2010;1:54.

48. Bouchoucha S, Bucknall T, Hutchinson A, Russo P. Patient participation in infection prevention and control: A systematic review. Infection, Disease & Health. 2018 Nov 1;23:S17.

49. Sahiledengle B, Zenbaba D, Allison D. Enhancing Healthcare Workers’ Infection Prevention and Patient Safety Awareness: In-service Training at Goba Referral Hospital. Ethiopian Health Care Quality Bulletin. 2019: 1:95-100.
Supporting information

S1 File. Table. PRISMA Checklist
S2 File. Search Strategy (Full searching strategies for PubMed)
S3 File. Search Strategy (Example Google scholar)
S4 File. Table: Methodology quality assessment of included and excluded studies
Articles identified through electronic database searching: PubMed (130), Google Scholar (20), Science Direct (33), Cochrane Library (3) (N = 186)

Additional records identified through other sources (n = 1)

Records after duplicates removed (n = 137)

Records screened (n = 137)

Records excluded (n = 118)

Full-text articles assessed for eligibility (n = 19)

Studies included in qualitative synthesis (n = 10)

Studies included in quantitative synthesis (meta-analysis) (n = 10)

Full-text articles excluded (n = 9)
  • 1 not justified sample size
  • 3 no description of sampling strategy
  • 3 unclear methodology
  • 2 no outcome of interest
| Study                        | ID            | ES (95% CI)              |
|------------------------------|---------------|--------------------------|
| Sahiledengle B., et al (2018)|              | 66.10 (62.34, 69.86)    |
| Geberemariyam BS., et al (2018)|            | 36.30 (32.60, 40.00)    |
| Hussen SH., et al (2017)      |              | 60.50 (54.68, 66.32)    |
| Bekele I., et al (2018)       |              | 61.10 (54.81, 67.39)    |
| Yohannes T., et al (2019)     |              | 15.00 (10.77, 19.23)    |
| Yallew WW., et al (2015)      |              | 55.00 (50.20, 59.80)    |
| Gebresilassie., et al (2014)  |              | 42.90 (38.49, 47.31)    |
| Gulilat K., et al (2014)      |              | 54.20 (49.01, 59.39)    |
| Asmr Y., et al (2019)         |              | 60.00 (51.34, 68.66)    |
| Abreha N., et al (2018)       |              | 72.50 (64.07, 80.93)    |
| Overall (I-squared = 98.0%, p = 0.000) |          | 52.21 (40.99, 63.44)    |

NOTE: Weights are from random effects analysis
