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Healthcare workers' compliance with COVID-19 preventive measures, and associated factors, in Ethiopia: A systematic review and meta-analysis

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ABSTRACT

Objective Compliance with COVID-19 prevention measures limits infection occurrence and spread in healthcare settings. According to research conducted in Ethiopia, compliance with COVID-19 preventative strategies is inconsistent among healthcare providers. This systematic review and meta-analysis aimed to estimate the national pooled proportion of healthcare workers (HCWs) who adhere to COVID-19 preventive measures and associated factors with good compliance.

Design A systematic review and meta-analysis of all identified studies with cross-sectional study design.

Data sources A comprehensive search was conducted in PubMed/MEDLINE, POPLINE, HINARI, Science Direct, Cochrane Library databases and Google Scholar search engines from January 2020 to September 2021.

Data extraction and synthesis This review included all observational studies conducted in Ethiopia that reported the proportion of compliance with COVID-19 preventive measures and associated factors among HCWs. Two independent authors assessed the methodological quality of studies using Joanna Briggs Institute's meta-analysis of statistical assessment and review instrument. The effect estimates for pooled proportion and pooled OR (POR) were determined.

Results From retrieved 611 original studies, 21 studies were included in the meta-analysis with a total of n=7933 HCWs. The pooled proportion of good compliance with COVID-19 preventive measures among HCWs was 49.7% (95% CI: 42.3% to 57.1%). Being male (POR=2.21, 95% CI: 1.52 to 3.21), service years (>3 years) (POR=2.65, 95% CI: 1.94 to 3.64), training (POR=2.30, 95% CI: 1.78 to 2.98), positive attitude (POR=3.14, 95% CI: 1.66 to 5.94) and good knowledge (POR=2.36, 95% CI: 1.92 to 2.89) were factors significantly associated with good compliance towards COVID-19 preventive measures.

Conclusion Our study indicated that approximately one in every two HCWs had good compliance with COVID-19 preventive measures. There must be more emphasis on providing further training sessions for the HCWs to improve their compliance with COVID-19 preventative measures.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ A comprehensive literature search was conducted across all popular databases.
⇒ We have used the Joanna Briggs Institute meta-analysis of statistics assessment and review instrument evaluation checklist to ensure quality while conducting this review.
⇒ All included studies were cross-sectional in design, making causal effect linkages difficult to discern.
⇒ Each study's operational definition for categorising outcome variables differs slightly.
⇒ The proportion of healthcare workers compliant with COVID-19 preventative measures was assessed based on self-reporting, which may be influenced by social desirability.

INTRODUCTION

The WHO has named COVID-19 the second pandemic of the 21st century.[1] The virus produces a wide range of symptoms, from asymptomatic to severe acute respiratory distress syndrome and death. The COVID-19 pandemic is an unprecedented catastrophe and a global threat.[2 3] This highly contagious disease has spread like wildfire globally and has caused division, distrust, and inequality, and raised trade tensions among nations.[4 5] Due to a lack of human resources, personal protective equipment (PPE) and poor health systems, the pandemic spread quickly throughout Africa and killed millions of people including healthcare workers (HCWs).[1 5 6] In sub-Saharan Africa, the COVID-19 poses a serious threat to countries due to its devastating ramifications that include poverty, weakened health systems, and sociocultural impact on both the patients and the HCWs.[7–11]

In many countries, including Ethiopia, COVID-19 is a demoralising threat to HCWs, causing high levels of distress. HCWs, the frontline combatants in this pandemic, are at a high risk of contracting COVID-19 and transmitting it to patients.[12–14] As a result of the pandemic, HCWs have lost their lives. According to the WHO, globally, around 115 000 HCWs have died between January 2020 and May 2021.[15] Moreover, the WHO reported that 14% of COVID-19 victims are HCWs in low/middle-income countries, while the HCWs who are reported to have lost their lives in developed nations range from 17805 to 56977 from October 2020 to August 2021.[16–20] As of March 2021, it was reported that the COVID-19 seroprevalence among HCWs in Ethiopia ranged from 53.7% to 56.1%.[21]

To control the spread of COVID-19, the WHO and the Centers for Disease Control and Prevention have repeatedly emphasised preventive measures such as hand washing, maintaining social distance and using face masks.[22–24] These preventive measures are also used to ensure the quality of treatment and safeguard HCWs, patients, and communities.[25–27] Both surgical masks and N95 masks are effective in reducing the risk of COVID-19 transmission though they do not guarantee 100% protection against getting infected.[23 24] The efficiency of pandemic prevention strategies is determined by many critical factors, namely lack of laboratory infrastructures, trained staff and the level of HCWs' adherence to preventive measures. The awareness and attitude of HCWs toward the pandemic, excessive workload, a lack of PPE supplies and the working environment are all factors that increase the risk of exposure and influence HCWs' compliance with COVID-19 preventive measures.[28–32]

To prevent the spread of COVID-19, the Ethiopian government implemented several public health initiatives. Hand washing, wearing a face mask and social distancing were among the primary preventive strategies the government has promoted to the general public and HCWs through various media platforms.[33] Compliance with these preventive measures is required to curb the occurrence and spread of COVID-19.[34–36] In Ethiopia, studies conducted in various settings have indicated that compliance is not at the required level, and there is a large variation in compliance with COVID-19 preventive measures.[37–42] Given this information, this systematic review and meta-analysis (SRMA) was designed to determine the pooled proportion and factors associated with good compliance with COVID-19 preventive measures among HCWs using available evidence in Ethiopia.

REVIEW QUESTIONS

- What is the pooled proportion of compliance with COVID-19 preventive measures among HCWs in Ethiopia?
- What factors are strongly associated with Ethiopian HCWs' compliance with COVID-19 preventive measures?

METHODS

Patient and public involvement

This study had no direct patient or public engagement.

Systematic review and protocol registration

This SRMA was conducted to estimate the pooled proportion of HCWs' compliance with COVID-19 preventive measures and the associated factors. To ensure the usefulness of this SRMA to the readers, we developed a transparent, complete and accurate report of this review, using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis criteria[43] (online supplemental table 1). This systematic review followed the Joanna Briggs Institute (JBI) methodology for proportional evidence.[44]

Eligibility criteria

Inclusion criteria

Articles that met the following criteria were considered and included in the review.

The study assessed at least two COVID-19 preventive measure components, such as hand hygiene practice and PPE utilisation; medical equipment processing and healthcare waste management practice were included.

Language: only studies published in English were considered for inclusion.

Study setting: studies that were conducted in Ethiopia only.

Study population: the study involving all HCWs or at least one profession (physicians, nurses, midwives, laboratory technicians and cleaners) was considered.

Study design: this review included all observational studies (cross-sectional, case–control and cohort) that reported the proportion of compliance and associated factors with COVID-19 preventive measures. On the other hand, the status of a paper's publication was considered, and both published and unpublished studies were valued.

Exclusion criteria

Papers that did not indicate the overall proportion of compliance with COVID-19 preventative measures, studies done among graduating health science or medical students/interns, qualitative research about COVID-19 preventive measures and published articles with unclear methodologies were excluded.

Measurement of outcome variables

This study had two main outcomes: the primary outcome variable was compliance with COVID-19 preventative measures, characterised as having good compliance/practice based on the operational definition of included studies. The total number of HCWs who had good practice divided by the total number of HCWs participating in the study multiplied by 100 was used to calculate the proportion of good compliance with COVID-19 preventive measures and was considered in the primary studies.

The second objective of this review was to determine the factor associated with HCWs' compliance with COVID-19 preventive measures. The natural logarithm-adjusted OR and 95% confidence levels of each included article were used to determine the relationship between good compliance with COVID-19 preventive measures and associated factors after calculating SE. Accordingly,

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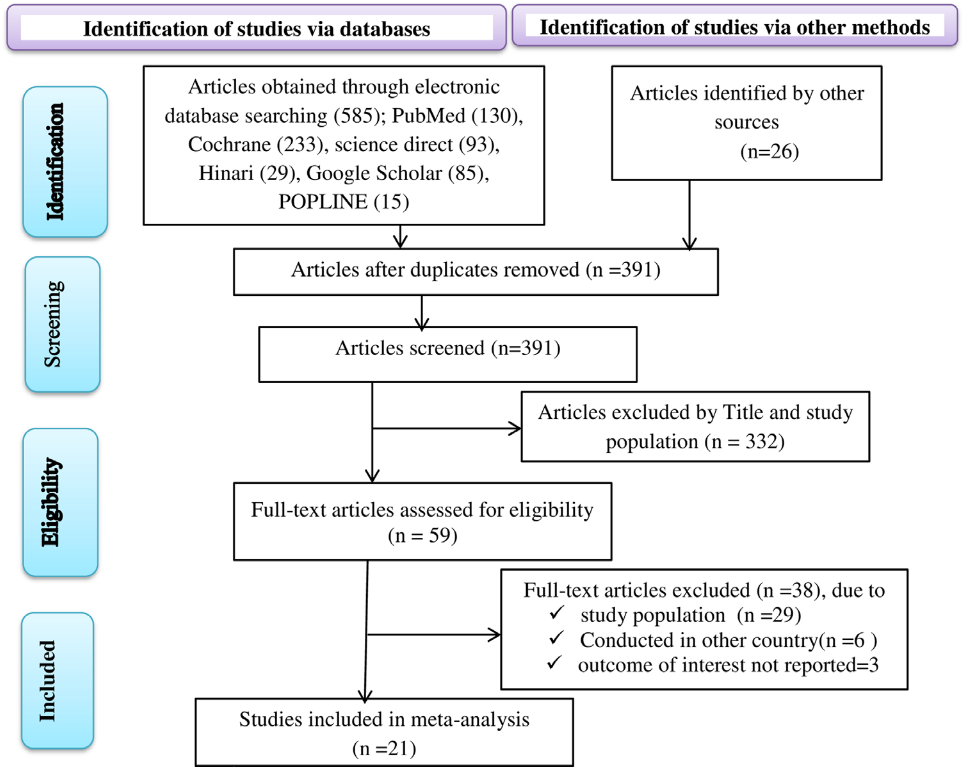

Figure 1 Flow chart of study selection for systematic review and meta-analysis of the proportion and determinants of compliance with COVID-19 preventive measures among healthcare workers in Ethiopia.

HCW gender (male and female), service year (lower and higher), training (yes and no), knowledge (good and poor) and attitude (positive and negative) regarding COVID-19 preventive measures were involved in determining pooled OR (POR).

Search strategy

A comprehensive search was conducted from 1 September 2021 to 30 October 2021, using PubMed/MEDLINE, POPLINE, HINARI, Science Direct, Cochrane Library databases and Google Scholar to retrieve all potentially relevant papers. All searches were confined to articles written in English.[41 42] Grey literature in observational studies was combined with the help of reference lists and subject matter specialists. On the other hand, various research facilities, including the Addis Ababa Digital Library, were searched for unpublished publications pertinent to this SRMA. EndNote V.X8 software was used to obtain and manage studies found through our search method. For the PubMed/MEDLINE search, the following phrases and keywords were used: "Professional Practice" OR compliance AND COVID-19 OR SARS-CoV-2 OR "Coronavirus Disease 2019 Virus" OR "SARS Coronavirus 2" AND "Health personnel" OR "Health Care Providers" OR Health Care Provider" OR "Professional, Health Care" AND Determinant OR "Epidemiologic Factors" OR "Epidemiologic Determinant" OR Determinant, Epidemiologic OR Factor associated OR Factors OR "Risk Factor" AND Prevention and control OR "preventive measures" 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 (online supplemental table 2).

Study selection and data extraction

All of the articles identified for this review were imported into the EndNote V.X8 software, and the duplicates were removed. Two authors (DZ and GB) independently reviewed and identified articles by their titles, abstracts and full texts based on the eligibility criteria. Following that, all the screened articles were collated, and any discrepancies that arose were resolved by mutual agreement. Full-text articles that were not fully available after at least two personal email contacts with the corresponding authors were omitted, as they did not report the outcomes of interest.

The data extraction format for the first outcome variable (proportion of good compliance) included the primary author, publication year, study region(s), type of health facility, study population, data collection method, major COVID-19 preventive measures, sample size, response rate and proportion of good compliance with 95% CI. Data were extracted in a two-by-two table format for the second outcome (factors). Each factor's natural log OR was determined based on the original research findings.

Quality assessment

The JBI meta-analysis of statistics assessment and review instrument quality evaluation tool for proportion studies was used to assess the quality of the appended studies to

Table 1 Descriptive summary of 21 studies included in the meta-analysis with compliance with COVID-19 preventive measures among healthcare workers (HCWs) in Ethiopia

No	Author (year)	Region	Type of health facility	Data collection method	Sample size	Good compliance of HCWs by gender: Male (%)	Good compliance of HCWs by gender: Female (%)	Overall proportion of compliance with 95% CI
1	Birhanu *et al* (2021)[38]	Harari	Hospital and health centre	Interview	418	60.51	39.49	37.6 (32.9 to 42.2)
2	Mersha *et al* (2021)[39]	SNNPR	Hospital and health centre	Interview	428	50.33	49.67	35.3 (30.7 to 39.8)
3	Baye *et al* (2021)[40]	Addis Ababa	Hospital	Self-administered	304	57.80	42.20	35.9 (30.5 to 41.2)
4	Mindaye *et al* (2021)[56]	Addis Ababa	Hospital	Self-administered	422	Not reported		70 (65.6 to 74.4)
5	Tadesse *et al* (2020)[67]	Addis Ababa	Hospital	Self-administered	408	Not reported		33.3 (28.8 to 37.9)
6	Tesfaye *et al* (2021)[66]	Addis Ababa	Hospital	Self-administered	295	Not reported		29.8 (24.6 to 35.0)
7	Kassie *et al* (2020)[41]	Amhara	Hospital and health centre	Self-administered	630	58.20	41.80	38.7 (34.9 to 42.5)
8	Birhane *et al* (2020)[52]	Amhara	Hospital and health centre	Self-administered	183	72.00	28.00	68.3 (61.6 to 75)
9	Bitew *et al* (2021)[58]	Amhara	Hospital	Self-administered	408	Not reported		55.0 (50.2 to 59.8)
10	Mulu *et al* (2020)[59]	Amhara	Hospital and health centre	Self-administered	398	55.87	44.13	62.0 (57.2 to 66.8)
11	Shibabaw and Teferi (2021)[62]	Amhara	Hospital	Interview	104	Not reported		59.6 (50.2 to 69.0)
12	Walle *et al* (2021)[65]	Amhara	Hospital	Self-administered	372	76.79	23.21	60.2 (55.2 to 65.2)
13	Jemal *et al* (2021)[42]	Four and above regions	Hospital	Self-administered	397	Not reported		63.5 (58.8 to 62)
14	Tadesse *et al* (2020)[67]	Tigray	Hospital	Self-administered	415	Not reported		67 (62.5 to 71.5)
15	Gebremeskel *et al* (2020)[57]	Tigray	Hospital	Interview	387	44.58	55.42	64.3 (59.5 to 69.1)
16	Hailu *et al* (2021)[53]	Oromiya	Hospital	Interview	280	53.28	46.72	48.9 (43.1 to 54.8)
17	Zenbaba *et al* (2021)[54]	Oromiya	Hospital	Interview	654	59.57	40.43	21.6 (18.5 to 24.8)
18	Tsegaye *et al* (2021)[55]	Oromiya	Hospital and health centre	Self-administered	330	69.81	30.19	64.2 (59.0 to 69.4)
19	Adola *et al* (2021)[60]	Oromiya	Hospital and health centre	Self-administered	275	Not reported		61.8 (56.1 to 67.5)
20	Gebremedhin *et al* (2021)[61]	Oromiya	Health post	Interview	421	Not reported		46.1 (41.3 to 50.9)
21	Etafa *et al* (2021)[64]	Oromiya	Hospital	Self-administered	404	Not reported		22.0 (18.0 to 26.0)

SNNPR, Southern Nations, Nationalities, and Peoples' Region.

determine the risks of bias.[45] The JBI parameters include: appropriate sampling frame, proper sampling technique, study subject and setting description, sufficient data analysis, use of valid methods for the identified conditions, valid measurement for all participants, use of appropriate statistical analysis, outcome measure validly and reliably, in which 50% or higher score of overall parameters considered as low risk of bias.[45] To determine the level of risk, each parameter's requirements were marked as '1' if 'yes' for low risk of bias and '0' if 'no' for high risk. Accordingly, risks of bias were categorised as low (total score of ≤2), moderate (total score of 3–4) or high (total score of >5) in terms of their likelihood.[45 46] Two authors (DZ and GB) assessed the quality of the studies included. Finally, papers with a score of 5 or higher, indicating a high risk of bias, were ruled out (online supplemental table 3).

Data synthesis and strategy

Data were extracted into a Microsoft Excel spreadsheet before being exported to STATA V.16 software. Each primary study's characteristics were listed in a Microsoft Excel spreadsheet, and SEs were calculated using the formula: $SE=\sqrt{p\,(1-p)/n}$ from each original study. The p values of the Cochrane Q-test and I^2 statistics were used to examine heterogeneity in reported proportion.[47] Because the test statistic revealed high heterogeneity among the studies (I^2=98.7%, p=0.001), the DerSimonian-pooled Laird's effect was estimated using a random-effects model. The effect sizes were expressed as a percentage for pooled proportion and POR for factors associated with COVID-19 preventive measures. The Higgins I^2 test statistics were used to calculate the percentage of total variance owing to heterogeneity across studies.[47–51] Although there is no exact criterion for when heterogeneity becomes significant, some researchers recommend low heterogeneity when I^2 values are between (25%–50%), moderate (50%–75%) and high (>75%).[47–51] According to the indicated category of I^2, there was a huge variety between the studies included in this review. We conducted subgroup analysis by region, type of healthcare facility, sample size, data collection technique, major components of COVID-19 preventative measures assessed and response rate to characterise the source of heterogeneity. The results of the meta-analysis were portrayed on the forest plot. For meta-regression, a funnel plot was used to assess publication bias. The plot resembles a symmetrical huge inverted funnel in the absence of publication bias. The publication bias was objectively appraised using Egger's weighted regression and Begg's rank correlation tests ($p<0.05$), in which both the tests were not found to be statistically significant. The leave-one-out sensitivity meta-analysis was performed to explore the sturdiness of the findings.

Table 2 Factors towards the heterogeneity of compliance with COVID-19 preventive measures among HCWs based on univariate meta-regression

Variable	Coefficient	P value	95% CI
Year of publication	−8.18	0.327	−24.52 to 8.18
Sample size	−0.053	0.060	−0.11 to 0.002
Response rate	0.53	0.357	−0.60 to 1.66
The quality score of the study	−2.92	0.733	−19.74 to 13.89
Study period by month	−2.67	0.265	−11.24 to 6.58

HCWs, healthcare workers.

RESULTS

The systematic literature search resulted in the retrieval of 611 articles. Of these, 391 articles were screened on title and abstract after duplicates were removed, and 332 articles that did not meet inclusion criteria were excluded. As a result, 59 full-text papers were screened for eligibility based on the preset criteria, and 38 articles were excluded because the study population and study sites were not reported (online supplemental table 4). Finally, 21 eligible studies were included in the meta-analysis (figure 1).[38–42 52–67]

Description of the included studies

The included studies were cross-sectional design in nature and were published between 1 January 2020 and 30 September 2021. A total of 7933 study participants were included in the current meta-analysis to estimate the pooled proportion of good compliance with COVID-19 preventive measures among HCWs. In the present meta-analysis, six studies were from Amhara,[41 53 58 59 62 65] seven studies from the Oromiya region,[38 53–55 60 61 64] four from Addis Ababa,[40 56 63 66] one from Southern Nations, Nationalities, and Peoples' Region (SNNPR),[39] two from Tigray region,[57 67] and one study conducted in Oromiya, Amhara, Addis Ababa, Tigray, and SNNPR.[42] However, none of the studies reported from Benishangul-Gumuz, Gambella and Dire Dawa regions (table 1).

The proportion of good compliance with COVID-19 preventive measures

In this meta-analysis, the pooled proportion of good compliance with COVID-19 preventive measures among HCWs in Ethiopia was found to be 49.7% (95% CI: 42.3% to 57.1%). High heterogeneity was observed across the included studies (I^2=98.0%, $p<0.001$). As a result, a random-effects model was used to estimate the pooled proportion of good compliance with COVID-19 preventive measures among HCWs in Ethiopia. From included studies, the highest proportion of good compliance with COVID-19 preventive measures was found to be 70% (95% CI: 65.6% to 74.4%) as reported by Mindaye *et al*,[56] whereas the lowest proportion of good compliance was 21.6% (95% CI: 18.5% to 24.8%) as reported by Zenbaba *et al*.[54] To identify possible sources of heterogeneity, different factors associated with heterogeneity, such as year of publication, quality score and sample size, were investigated using a univariate meta-regression model. Unfortunately, none of the factors were identified as a significant source of heterogeneity (table 2 and figure 2).

Sensitivity analysis

A leave-one-out sensitivity analysis was used to test the findings' reliability. The findings from sensitivity analyses

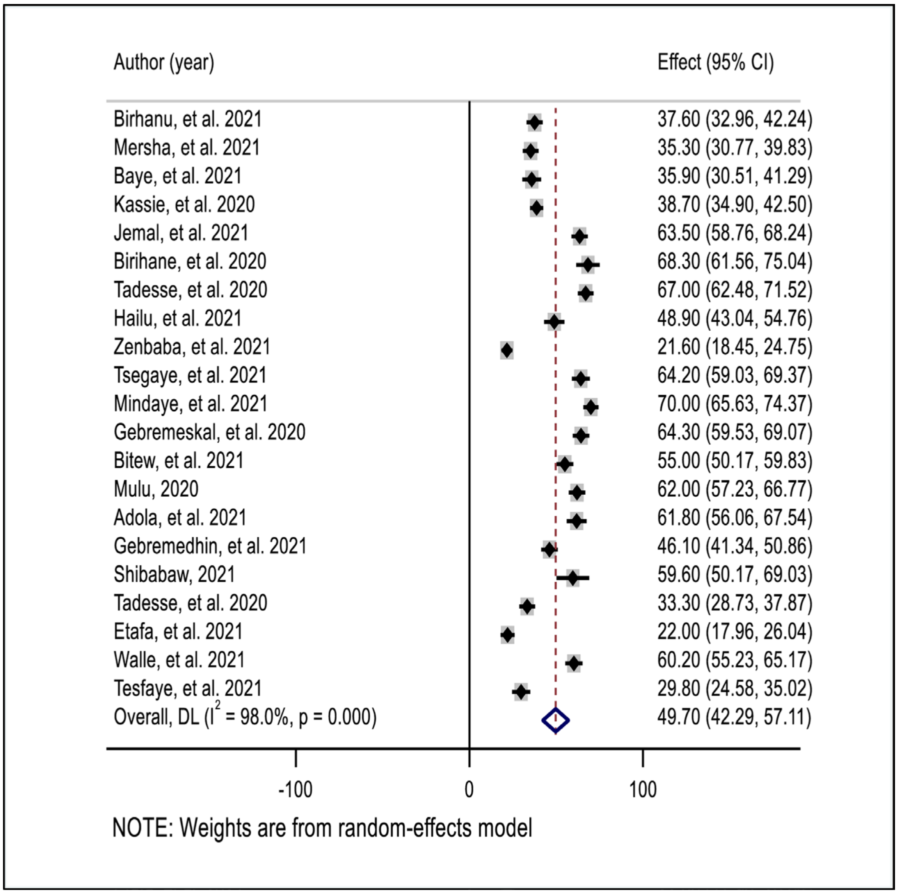

Figure 2 Forest plot of the pooled proportion of good compliance with COVID-19 preventive measures among healthcare workers in Ethiopia.

revealed that using the random-effects model was robust. No study impacted the pooled proportion of good compliance with COVID-19 preventive measures among HCWs. After a single study was removed from the meta-analysis, the pooled proportion of good compliance with COVID-19 preventive measures was close to the real effect size (figure 3).

Publication bias

Asymmetry in the funnel plot was used to check for publication bias. The funnel plot revealed that the distribution of articles was slightly uneven. We used Begg's and Egger's tests objectively to confirm the asymmetry. Both Egger's and Begg's tests revealed a statistically insignificant publication bias in the proportion of good compliance with COVID-19 preventative measures among HCWs ($p=0.068$ and $p=0.381$, respectively) (figure 4).

Subgroup analysis

In this meta-analysis, we performed a subgroup analysis based on the region of the country, where studies were conducted, and the sample size. Accordingly, the highest proportion of good compliance with COVID-19 preventive measures was observed in the Tigray region with a proportion of 65% (95% CI: 62.4% to 69.0%), followed by Amhara and Oromiya regions, 57.1% (95% CI: 47.6% to 66.6%) and 44.0% (95% CI: 28.0% to 59.7%), respectively. The significant heterogeneity between the groups (regions) was observed ($p<0.001$). The proportion of good compliance with COVID-19 preventive measures was 52.5% (95% CI: 40.6% to 64.2%) and 48.3% (95% CI: 38.9% to 57.7%) among studies having a sample size of ≤370 and >370, respectively. The proportion of compliance with COVID-19 preventive measures was computed with the included studies' data collection period (month). The proportion of good compliance with COVID-19 preventive measures was 51.5% (95% CI: 42.4% to 60.5%) among studies conducted from March to June 2020 and 48.9% (95% CI: 18.5% to 79.3%) for studies conducted from October to December 2020. We also conducted a subgroup analysis based on the study setting. Accordingly, the pooled proportion of good compliance with COVID-19 preventive measures was 49.3% in studies conducted exclusively in hospitals and 52.4% among studies that included health centres and hospitals. Of all the subgroup analyses, the region of included studies was found to be a significant source of variability/heterogeneity across the studies (table 3).

Factors associated with good compliance towards COVID-19 preventive measures

The relationship between the gender of HCWs and their compliance with COVID-19 preventive measures was

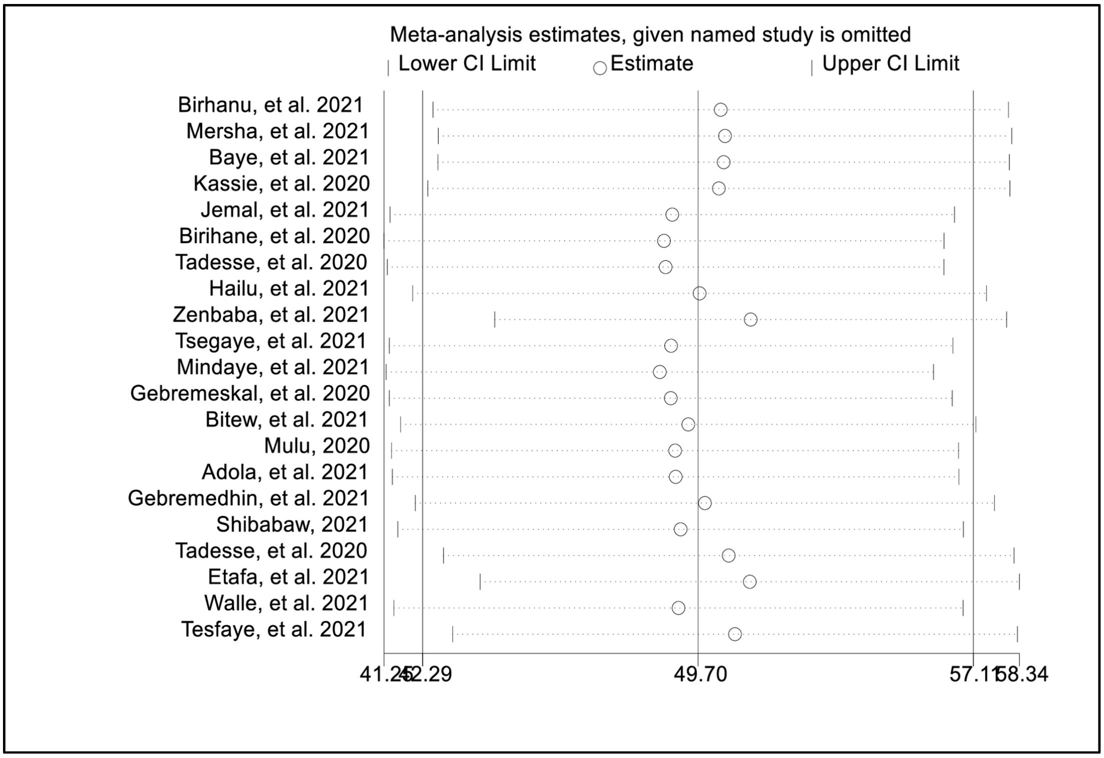

Figure 3 Sensitivity analysis of prevalence for each study being removed at a time: proportion and 95% CI of good compliance with COVID-19 preventive measures among healthcare workers in Ethiopia.

explored in this meta-analysis from four studies.[38 41 55 57] It was found that male HCWs were 2.2 times more likely to adhere to COVID-19 preventive measures than the female HCWs (POR: 2.21, 95% CI: 1.52 to 3.21). The test statistics revealed moderate heterogeneity among the included studies (I^2=57.2%, p=0.025). As a result, the association was determined using a random-effects meta-analysis approach (figure 5). Similarly, four studies[41 54 55 65] examined the relationship between service years and good compliance with COVID-19 preventive measures. The findings of this meta-analysis revealed that HCWs with higher service years (≥3 years) were 2.7 times more likely to adhere to COVID-19 preventive measures than those with shorter service years (<3 years) (POR: 2.65, 95% CI: 1.94 to 3.64). A fixed-effects model was implemented because there was no heterogeneity among the studies (I^2=0.0%, p=0.413) (figure 6).

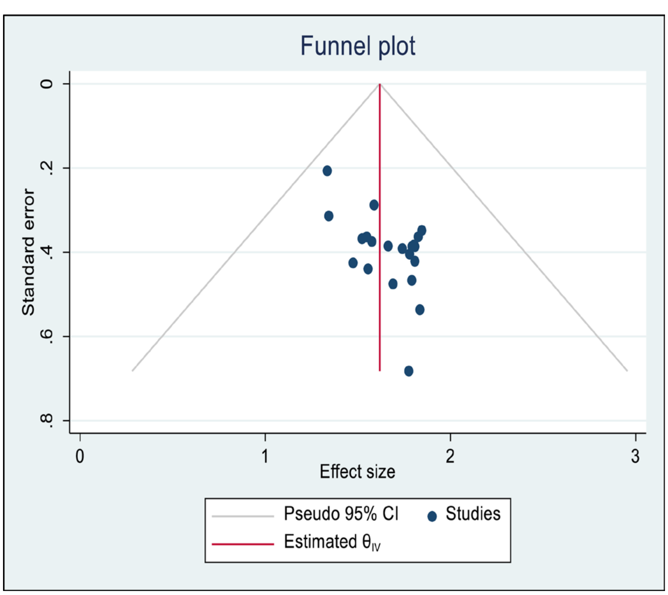

Figure 4 Funnel plot with 95% confidence limits of the pooled proportion of compliance with COVID-19 preventive measures among healthcare workers in Ethiopia.

In the same way, four studies[38 59 61 64] were used to observe the relationship between being trained on COVID-19 preventive measures and good compliance with preventive measures. The probabilities of good compliance with COVID-19 preventive measures were 2.3 times greater among HCWs who had received COVID-19 preventive measures training than among HCWs who had not received training (POR: 2.30, 95% CI: 1.78 to 2.98). The fixed-effects model was used because there was no heterogeneity in the included studies (I^2=0.0%, p=0.983) (figure 7).

We determined the association between good knowledge and compliance with COVID-19 preventive measures using seven studies.[39 40 54 55 58 59 61] It was found that HCWs with good knowledge of COVID-19 preventative measures were 2.4 times more likely to comply with COVID-19 preventive measures than HCWs with poor knowledge (POR: 2.36, 95% CI: 1.92 to 2.89) (figure 8). A fixed-effects model was examined because there was no heterogeneity among the included studies (I^2=0.0%, p=0.853). Similarly, four studies[39 41 61 65] examined the relationship between positive attitude and good compliance of HCWs with COVID-19 preventive

Table 3 The subgroup proportion of compliance with COVID-19 preventive measures among healthcare workers in Ethiopia, 2020–2021

Variables	Subgroup	No of included studies	Sample size	Proportion (95% CI)	Heterogeneity across the studies		Heterogeneity between groups (p value)
					I^2 (%)	P value	
Region	Amhara	6	2095	57.1 (47.6 to 66.6)	94.1	<0.001	<0.001
	Addis Ababa	4	1429	42.3 (22.8 to 61.8)	98.5	<0.001	
	Oromiya	6	2292	44.0 (28.0 to 59.7)	98.6	<0.001	
	Tigray	2	802	65.7 (62.4 to 69.0)	0	0.421	
	SNNPR	1	428	35.3 (30.8 to 39.8)	0		
	Harari	1	418	37.6 (33 to 42.2)	0		
	Four and above regions	1	397	63.5 (58.8 to 68.3)	99.5	<0.001	
Types of health facility	Hospital	13	4850	48.5 (37.8 to 59.2)	98.5	<0.001	0.553
	Health centre and hospital	7	2662	52.4 (41.8 to 63.1)	97.0	<0.001	
	Health post	1	421	46.1 (41.3 to 50.9)	0		
Sample size	≤370	7	1771	52.5 (40.6 to 64.2)	98.8	<0.001	0.720
	>370	14	6162	48.3 (38.9 to 57.7)	98.8	<0.001	
Response rate	≤95%	8	2637	50.2 (39.6 to 60.9)	97.0	<0.001	0.991
	>95%	13	5296	50.1 (40.6 to 59.7)	98.4	<0.001	
Data collection method	Interview	5	2160	46.2 (28.7 to 63.8)	98.4	<0.001	0.029
	Interview and observation	1	428	35.3 (30.8 to 39.8)	0		
	Self-administered	16	6084	52.3 (44.4 to 60.2)	97.7	<0.001	
Study period by month	March–June 2020	12	4017	51.5 (42.4 to 60.5)	97.6	<0.001	0.785
	June–September 2020	5	1706	46.7 (31.0 to 62.4)	97.9	<0.001	
	October–December 2020	3	1326	48.9 (18.5 to 79.3)	99.3	<0.001	
	January–February 2021	1	421	46.1 (41.3 to 50.9)	0		

Four and above regions include Oromiya, Amhara, Tigray, SNNPR, etc.
SNNPR, Southern Nations, Nationalities, and Peoples' Region.

measures. When comparing HCWs with a positive attitude with HCWs with a negative attitude, the odds of good compliance with COVID-19 preventive measures were three times higher (POR: 3.14, 95% CI: 1.66 to 5.94). The random-effects model was used since the included studies had higher heterogeneity (I^2=84.5%, p=0.001) (figure 9).

DISCUSSION

The COVID-19 pandemic is a global public health concern. Many people have died, and thousands of HCWs have tested positive for combating the COVID-19 epidemic on the front line with inadequate PPE.[68–70] COVID-19 preventive measures compliance among HCWs in Ethiopia has been exceedingly inconsistent. Hence, estimating the national pooled proportion of Ethiopian HCWs' good compliance with COVID-19 preventive measures and associated factors may be crucial in informing healthcare planners and policymakers. The overall pooled proportion of compliance with COVID-19 preventive measures among HCWs obtained from this review was 49.7%. Despite an increase in COVID-19 cases, test positivity and deaths reported in Ethiopia during the second half of 2020–March 2021, HCW compliance with preventative measures in Ethiopia was not at the intended level as per the COVID-19 prevention guidelines.[33 70 71] This result was lower than previous study findings, which showed 60% in Ethiopia[72] and 70% in 45 countries.[73] This discrepancy could be because of the period covered by the study (early vs late COVID-19 pandemic), the inclusion of several studies in the analysis, and differences in COVID-19 prevention facilities and supplies (such as PPE shortages and hand washing sinks with water and soap in healthcare facilities). Variation in sample size,

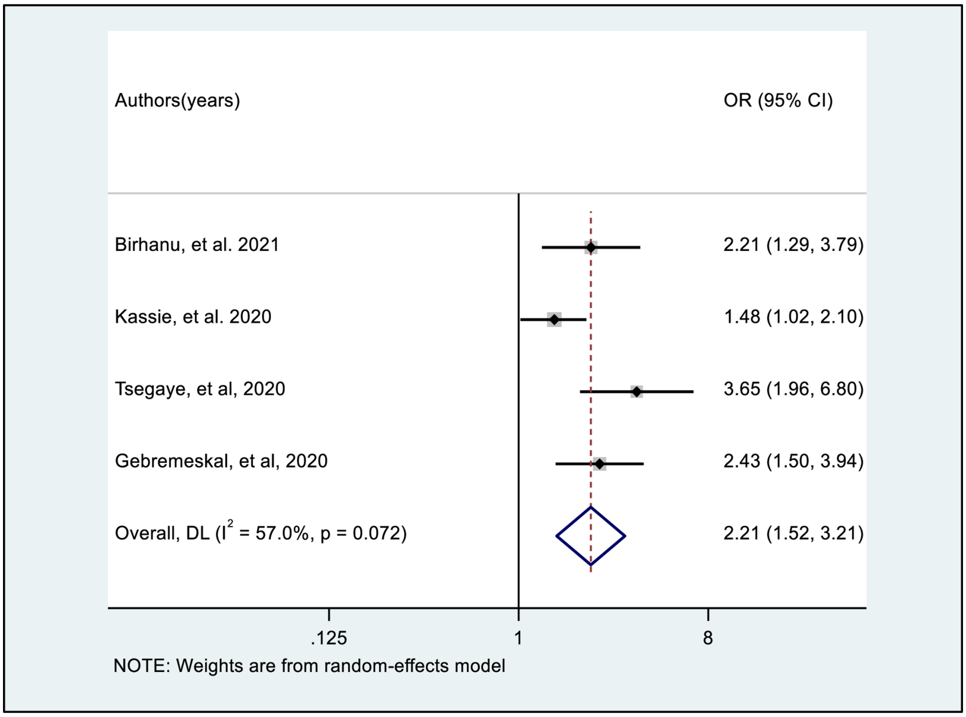

Figure 5 The pooled OR of the association between sex of healthcare workers and compliance with COVID-19 preventive measures in Ethiopia.

data collection methods, study period and HCW characteristics between studies may result in high variability in our study. We used sensitivity and subgroup analysis to address this problem. Besides, the estimated pooled proportion of compliance with COVID-19 preventative measures was stable and not dependent on a single study. The subgroup analysis by region, sample size, types of healthcare facilities, and study period or data collection month was also used to evaluate the likelihood of the source of heterogeneity. The Tigray region had the highest proportion of good compliance with COVID-19 prevention measures, while the SNNPR had the lowest.

In comparison with research conducted in other regions, most of the studies included were from the Amhara and Oromiya regions, respectively. This discrepancy could be explained by differences in the skills and experiences of HCWs and the number of studies identified or done in different locations, universities or research

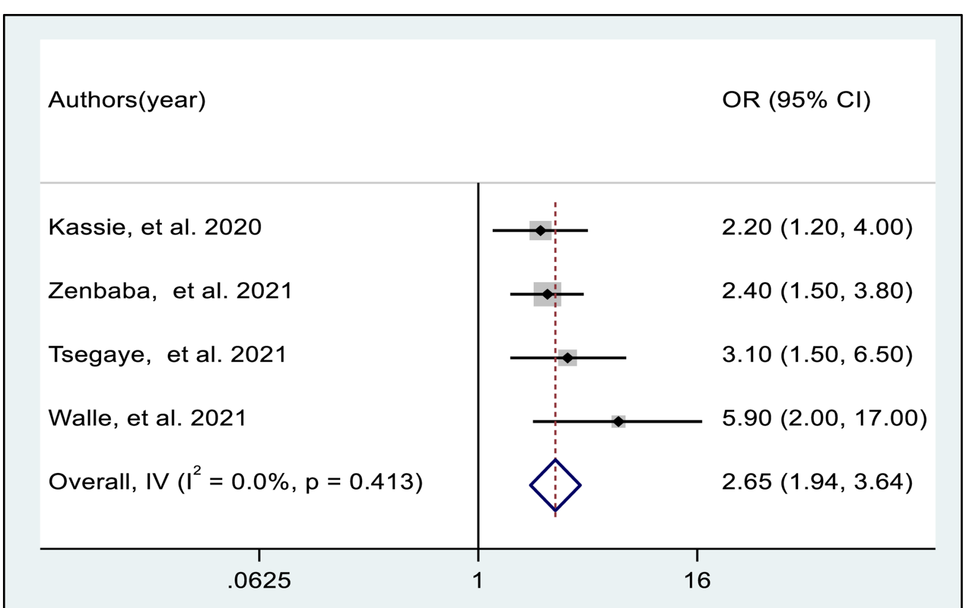

Figure 6 The pooled OR of the association between service year of healthcare workers and compliance with COVID-19 preventive measures in Ethiopia.

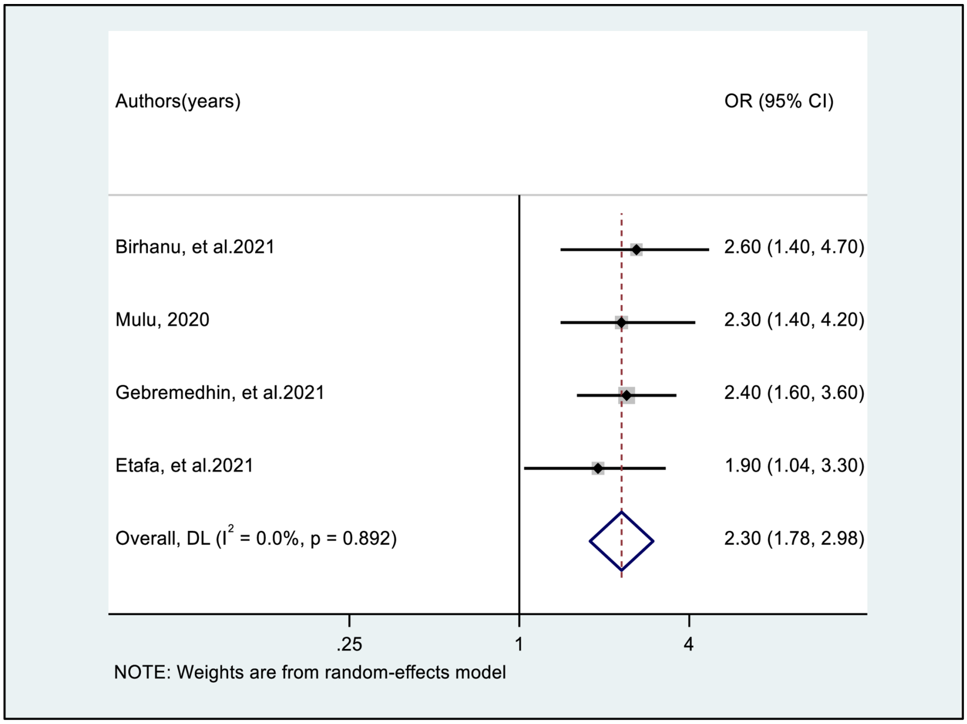

Figure 7 The pooled OR of the association between the training of healthcare workers and compliance with COVID-19 preventive measures in Ethiopia.

institutes. Another reason for the difference could be the discrepancy in HCWs' environmental architecture and behavioural characteristics. Based on our study findings, it is emphasised that the future training to improve compliance should target groups considered to be less compliant currently. Besides, the methods for assessing the post-training competence must be developed in all regions of Ethiopia.

We also did a subgroup analysis based on types of healthcare facilities and the data collection period of

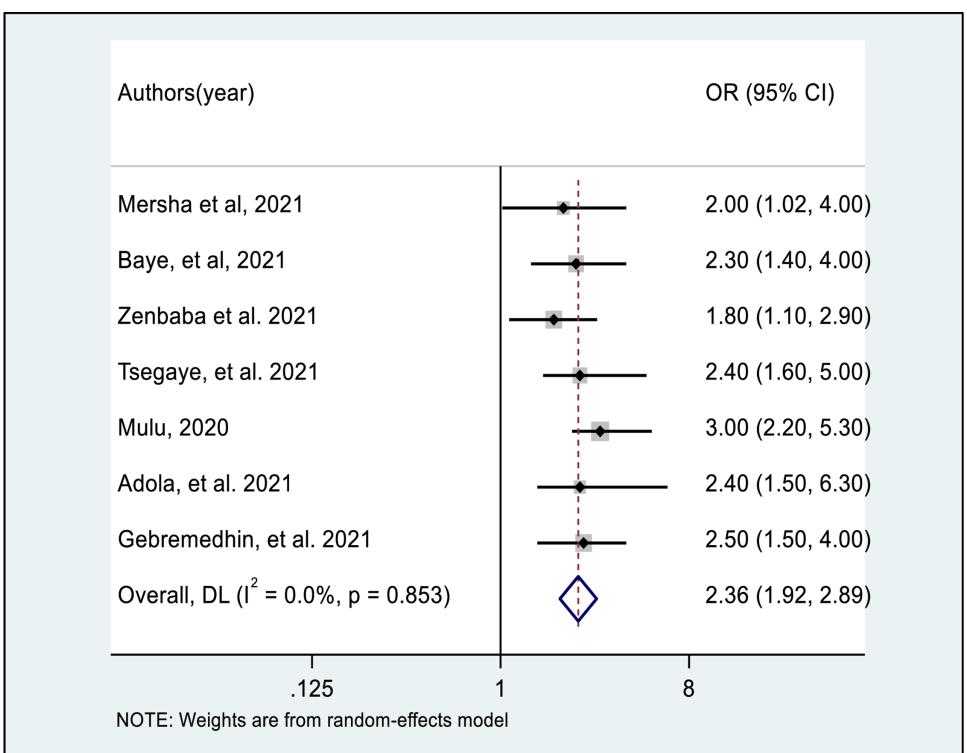

Figure 8 The pooled OR of the association between knowledge of healthcare workers and compliance with COVID-19 preventive measures in Ethiopia.

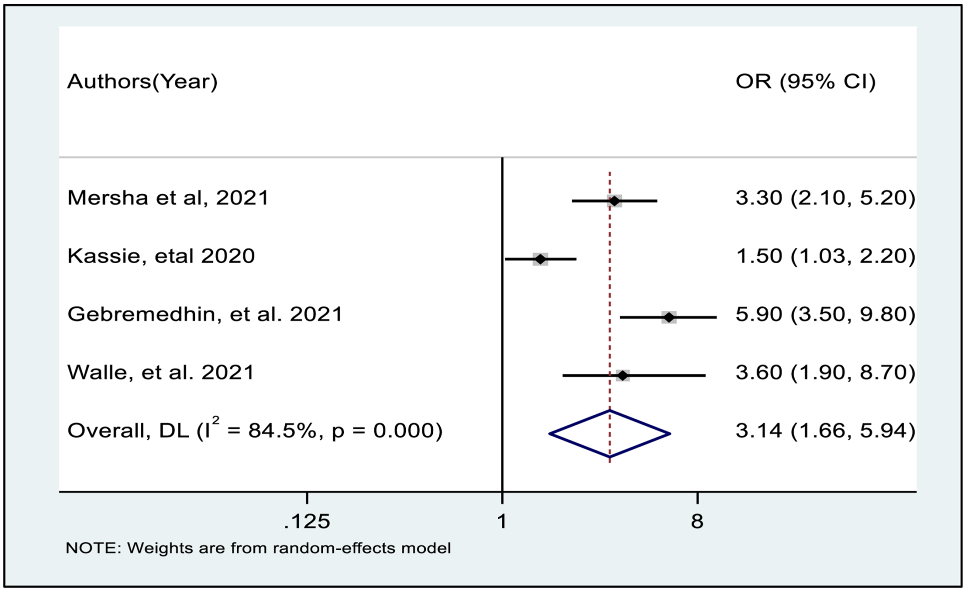

Figure 9 The pooled OR of the association between attitude of healthcare workers and compliance with COVID-19 preventive measures in Ethiopia.

each study. Accordingly, there was a higher proportion of good compliance with COVID-19 preventive measures among studies conducted in hospitals/health centres from March to June 2020. Because the majority of the studies included in this review were conducted immediately after the onset of the COVID-19 pandemic in Ethiopia, HCWs may be fearful. Another reason for this could be differences in infrastructure and PPE supplies when implementing COVID-19 preventive measures in healthcare facilities (hospitals vs health centres).

The other objective of this study was to determine the factors associated with good compliance towards COVID-19 preventive measures. As a result, sex, service year, attitude, training and knowledge of COVID-19 preventive measures were identified as factors associated with good compliance towards COVID-19 preventive measures. Male HCWs were more likely to adhere to COVID-19 preventive measures than female HCWs. This finding agreed with prior research undertaken in Ethiopia[74] and Greece.[75] This gender difference could be related to women's work overload at work and home (childcare, meal preparation and so on).

Similarly, HCWs with more service years (>3) had a higher likelihood of good compliance than their counterparts. This difference could be explained by the fact that as HCWs' service years increase, so does their exposure to and fear of a pandemic, prompting them to implement more stringent preventive measures. The relationship between being trained on COVID-19 preventive measures and good compliance with those measures, on the other hand, was investigated. Healthcare employees who had received COVID-19 prevention training were more likely to adhere to COVID-19 preventive measures than HCWs who had not received training. This difference is due to the fact that providing COVID-19 preventive measures training to HCWs is crucial for enhancing practical skills and ensuring COVID-19 preventive measures compliance. Furthermore, healthcare personnel with a high understanding of COVID-19 preventive measures were more likely to comply than those with a poor understanding. This difference could be attributed to proper COVID-19 prevention training and duration, the availability of reading materials/internet connection and personal obligations. Furthermore, thorough training promotes behaviour improvement and ensures that HCWs follow the infection prevention guidance properly.[76] In contrast, healthcare personnel with a positive attitude towards COVID-19 preventive measures had a higher likelihood of good compliance with COVID-19 preventive measures than their counterparts. This difference could be because a positive attitude towards preventive efforts can aid in the eradication of the COVID-19 pandemic by improving adherence to prevention guidelines.[77]

CONCLUSION

Our study indicated that approximately one in every two HCWs had good compliance with COVID-19 preventive measures. There were regional variations in compliance with COVID-19 preventive measures among HCWs. Good compliance was associated with being male, having a longer service year, training, good knowledge and a positive attitude toward COVID-19 preventive measures. This research can create a framework for HCWs, policymakers and other stakeholders to implement interventions. The focus should be on closing gaps in knowledge, attitude, and practice through expanded in-service training and quality improvement activities aimed at improving team self-assessment of compliance levels, with additional support provided to those identified as non-compliant.

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