Review Article

Mehran Hesaraki, Majidreza Akbarizadeh, Sudabeh Ahmadidarrehsima,
Mahdieh Poodineh Moghadam and Fatemeh Izadpanah*

Knowledge, attitude, practice and clinical recommendations of health care workers towards COVID-19: a systematic review

Abstract

Objectives: This study aimed to evaluate the knowledge, attitude, practice, and clinical recommendations of health care workers (HCWs) towards COVID-19.

Methods: In this systematic review study, international databases (Web of Science, PubMed, and Scopus) were searched for the relevant studies published in English from the inception of databases until July 30, 2020. Hoy et al.'s tool was used to evaluate the quality of studies. All search steps, screening, selection of studies, quality assessment, and data extraction were performed separately by two researchers.

Results: Out of 3460 articles searched, 28 articles conducted on 16,427 HCWs were included in the study. Most of the HCWs had good knowledge (72.2%), a positive attitude (70.9%), and good practice (78.8%) towards COVID-19. The most important clinical recommendation to improve knowledge, attitude, and practice (KAP) was to provide HCWs with a periodic training program regarding COVID-19. The most important source of information for HCWs on COVID-19 was social networks.

Conclusions: Despite HCWs' good knowledge, attitude, and practice (KAP), it is recommended to periodically review KAP and carry out further studies in different countries as well. It is also recommended to use social media to improve KAP.

Introduction

Nowadays, coronavirus is known as a public health emergency throughout the world. On March 11, 2020, the World Health Organization (WHO) declared the coronavirus disease (COVID-19) a global pandemic [1]. COVID-19 was first reported on December 1, 2019, in Wuhan, Hubei Province, China [2]. Coronavirus is a newly emerging disease whose many dimensions are still unknown. The pathogenesis period of coronavirus ranges between 2 and 14 days, and more than 80% of cases have mild symptoms [3]. The latest statistics reveal that coronavirus has infected more than 25,886,392 people until 1 September, 2020, and led to the deaths of more than 860,218 people worldwide [4].

One of the most important risks associated with this disease is the very rapid spread of the disease so that more than 200,000 people worldwide were added daily to patients with COVID-19 [4]. The most common routes of transmission are travel, social interactions, and infectious transmission. Health care workers (HWCs) are more susceptible to the development and transmission of the disease than other groups. Studies have shown that the prevalence of coronavirus among HCWs in the Netherlands [5], the United States [6], and Italy [7, 8] was 15, 5.3, and 3.4–20%, respectively. Given that there is no definitive way to treat the disease, the only way to control the disease is to prevent it through adherence to standard precautions, increasing social distance, and washing hands [9]. With due attention to the newly emerging nature of coronavirus, the huge variety of the disease symptoms, different diagnostic tests, and the lack of vaccines and definitive coronavirus treatment, having sufficient knowledge, a positive

---

*Corresponding author: Fatemeh Izadpanah, MOH sq St, Laboratory Control of Food & Drug Research Centre, Tehran, Iran, Phone: +98-21-66434572, Fax: +98-21874631,
E-mail: fatemeh_izadpanah@yahoo.com
Mehran Hesaraki and Majidreza Akbarizadeh, Department of Pediatric, Zabol University of Medical Sciences, Zabol, Iran
Sudabeh Ahmadidarrehsima, Faculty of Nursing and Midwifery, Jiroft University of Medical Sciences, Jiroft, Iran
Mahdieh Poodineh Moghadam, Faculty of Nursing and Midwifery, Zabol University of Medical Sciences, Zabol, Iran

attitude, and good practice to deal with the disease are of great urgency. Having sufficient knowledge regarding COVID-19 in HCWs who are exposed to patients with COVID-19 day and night is doubly important. Low level of knowledge and negative attitude towards COVID-19 directly lead to late diagnosis, poor practice, poor adherence to infection control principles, and a faster spread of the disease [10, 11]. Despite the short time that has elapsed since the outbreak of the disease as well as conducting individual studies in this field, so far, there has been no comprehensive study in this regard. Determining the current status of HCWs' knowledge, attitude, and practice (KAP) towards coronavirus can greatly help policymakers to come up with a better plan to increase knowledge, create a positive attitude, and improve proper practice. Therefore, this study aimed to evaluate the knowledge, attitude, practice, and clinical recommendations of HCWs towards COVID-19.

Methods

Eligibility criteria

This systematic review was conducted using the Cochrane Handbook, and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [12] was used to report the study. In this study, cross-sectional studies on various health care workers (HCWs) published in English peer-reviewed journals were included in the study without any time limit. Qualitative, review and non-English studies were excluded. The outcomes measured in the included studies were knowledge, attitude, practice, and clinical recommendations of HCWS towards COVID-19.

Search strategy

International electronic Databases (Web of Science, PubMed, and Scopus) were searched for the relevant articles from the inception of databases until July 30, 2020. To provide a search strategy, the keywords were first identified with the help of Medical Subject Headings (MESH), Emtree, and combined with related words in published articles. A librarian who was experienced in work on systematic reviews contributed to determining the search strategy. The search strategy used for the PubMed was applied to search other databases as well. The PROSPERO was searched for ongoing reviews. The keywords used were: "knowledge" OR "attitude" OR "practice" OR "COVID-19" OR "coronavirus" OR "health care workers". We conducted the last search on 30 July 2020.

Selection of studies and data extraction

After searching databases, the articles were entered into EndNote software. Duplicate articles were removed after screening. In the next step, the titles of the articles were examined and irrelevant titles were removed. Then, the abstracts of the remaining articles were reviewed based on the inclusion criteria and irrelevant items were excluded. In the final step, the full text of the relevant articles was reviewed and the final included items were selected. First, the risk-of-bias (quality) of the included articles was assessed and the data were extracted. Selection of studies, screening, quality assessment, and data extraction was performed separately by two researchers.

The consensus method was used for solving controversies between two researchers in selecting the final included studies. Extracted items were included: id, author, year, country, study design, number of participants, target population, instrument (type, items, reliability, and validity), study outcome measure, sampling method, method of data collection, age, gender (male/female), main outcomes (knowledge/ awareness, attitude, practice), sources of information, and clinical recommendations to the improvement of HCWs KAP.

Quality assessment

Hoy et al. standard tool was used to assess the quality of the methodology of the studies [13]. This tool consisted of 10 items and evaluated the quality of the methodology of observational studies in two dimensions including external validity (target population, sampling method and procedure, and minimum non-response bias) and internal validity (data collection method, outcome definition, study instrument, and data collection procedure). The quality of the studies was separately assessed by two researchers. Tables were used to display the results.

Results

Study selection

After searching the databases, 3,460 articles were found, of which 2,829 articles remained after deleting duplicates. Out of 2,829 articles, 2,788 articles were excluded due to not

meeting the inclusion criteria. Of the remaining 41 studies with reviewed full-text, 28 studies were included in the systematic review study, and 13 studies were excluded from the study. Of the 13 articles excluded, there were 2 reviews, 6 letters to the editor, 2 qualitative studies, and 3 articles published in the non-English language (Figure 1).

Study characteristics

Of 28 cross-sectional studies conducted on 16,427 HCWs were entered into the systematic review. All the studies were carried out in 2020. Most of the studies were conducted in Turkey (n=5), China (n=3), and India (n=3). Out of 28 studies, 15 studies were performed on a set of HCWs and there were also some studies conducted specifically on dentists or physicians (n=3) and nurses (n=2). In all the studies, the tools used were researcher-made. The most common type of sampling method used in studies was convenience sampling (n=19). The mean age of participants was 32.8 years. In most studies (n=26), the gender of participants was specified. Out of 14,465 participants in 26 studies, most of them were women (n=8671) (Table 1).

Main results

Tools

Different tools were used in all 28 included studies. In most studies (n=26), the tools used were researcher-made. In all

Figure 1: Study selection process.

studies, the content of the tools was developed using national, the World Health Organization (WHO), and the Centers for Disease Control and Prevention (CDC) guidelines. In the included studies, several researchers were provided with tools in a pilot program to determine the validity of the tools. Moreover, Cronbach's alpha was used to determine the reliability of the tools. It ranged from 0.71 to 0.81 in different studies. In 25 studies, the number of items was mentioned. The number of questions in tools ranged from 5 to 45 questions (Table 1).

Knowledge, attitude, and practice of HCWs towards COVID-19

Out of 28 studies, 26 studies evaluated the level of knowledge of HCWs towards COVID-19. The level of knowledge/awareness in each study were expressed as the percentage of participants with sufficient knowledge towards COVID-19. Of 26 studies, 25 studies conducted on 14,097 individuals showed the percentage of participants with sufficient knowledge. Knowledge was expressed at sufficient, moderate, and poor level in the included studies. The level of knowledge of HCWs in different studies ranged from 26.5 to 96.89%. Based on the general classification of the level of knowledge, a score of 1–33, 33–66, and 66–100% suggested poor, moderate, and good knowledge, respectively. In most studies (n=17, 68%), participants had good knowledge of COVID-19, and in 7 studies (28%), they had moderate knowledge towards COVID-19. Moreover, in one study, participants had poor knowledge. In general, 72.2% of participants had sufficient knowledge of COVID-19. In one study, the mean level of knowledge was reported at 6.26, indicating poor knowledge of HCWs towards COVID-19.

Out of 28 studies, 16 studies evaluated the attitude of HCWs towards COVID-19. In 15 studies, the level of attitude was expressed as the percentage of participants with a positive attitude towards COVID-19. In different studies, 16.7–96.4% of participants had a positive attitude towards COVID-19. In general, in most studies (n=10, 66%), more than 70% of participants had a positive attitude towards COVID-19. Furthermore, in 4 studies, less than 50% of participants had a positive attitude towards COVID-19. Overall, the results revealed that more than 70.9% of HCWs had a positive attitude towards COVID-19. In one remaining study, the mean level of attitude was reported at 8.43, indicating a positive attitude towards COVID-19.

Out of 28 studies, 9 studies evaluated the practice of HCWs towards COVID-19. In the included studies, HCWs' practice was reported as the percentage of participants with good practice towards COVID-19. The participants'
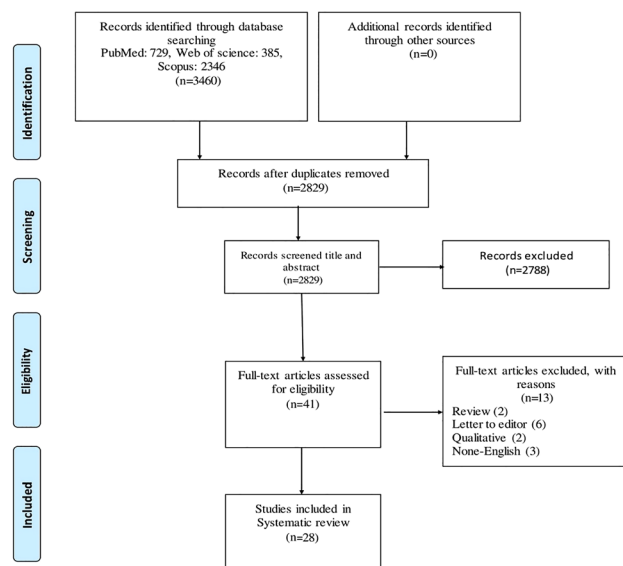
Table 1: Knowledge, attitude, related factors, barriers and recommendations for the practice among nurses towards cancer pain management.

Author (Year)	Country	Studies characteristics (1) Design, (2) Outcome measure, (3) Sampling methods, (4) Method of data collection, (5) Risk of bias	Tools (1) 1Type, (2) Items, (3) Reliability and validity	Participants (1) 1Target populations (2) Number of participants (3) Age (4) Gender (Male/Female)	Knowledge/Awareness (1) 1Percent or mean, (2) Level, (3) Source of information	Attitude (Percent)	Practice (1) 1Percent (2) Level
Abdel Wahed, W. Y. (2020) [14]	Egypt	(1) Cross-sectional, (2) Knowledge, attitudes, (3) Convenience, (4) online, and interview, (5) Low	(1) Researcher made, (2) 24, (3) Approved:0.70	(1) HCWs, (2) 407, (3) 34.95, (4) 206/201	(1) 80.4, (2) Good, (3) Ministry of health and population (MOHP) and WHO website, social media, newspaper, television, physicians, Friends/Family	95.6	–
Ahmed, N. (2020) [15]	Saudi Arabia	(1) Cross-sectional, (2) Knowledge, awareness and practice, (3) Consecutive, (4) online, (5) Low	(1) Researcher made, (2) 31, (3) Approved (0.71)	(1) HCWs, (2) 810, (3) 22–45, (4) 388/422	Courses (1) 52, (2) Moderate	96.4	(1) 72, (2) Good
Alhaj, A. K. (2020) [16]	Kuwait	(1) Cross-sectional, (2) Knowledge, (3) Simple random, (4) Interview, (5) Low	(1) Standard, (2) 27, (3) Approved	(1) Neurosurgery residents, (2) 52, (3) NR, (4) 38/14	(1) 60, (2) Moderate	–	–
Apaijitt, P. (2020) [17]	Thailand	(1) Cross-sectional, (2) Knowledge, (3) Census, (4) Interview, (5) Low	(1) Researcher made, (2) 10, (3) Approved	(1) HCWs, (2) 124, (3) 36.7, (4) 42/82	(1) 6.26, (2) Poor		
Bhagavathula, A. S. (2020) [18]	UAE	(1) Cross-sectional, (2) Knowledge, (3) Simple random, (4) Online, (5) Low	(1) The researcher made, (2) 23, (3) Approved	(1) HCWs, (2) 453, (3) 25–64, (4) 234/219	(1) 39, (2) Moderate, (3) TV, newspapers, radio, social media, and family and friends.		
Çalışkan, F. (2020) [19]	Turkey	(1) Cross-sectional, (2) Knowledge, attitude, (3) Consecutive, (4) Online, (5) Low	(1) Researcher made, (2) 45, (3) Approved	(1) Doctors, (2) 290, (3) 31.8, (4) 179/111	(1) 96.9, (2) Good	41	

Table 1: (continued)

Author (Year)	Country	Studies characteristics (1) Design, (2) Outcome measure, (3) Sampling methods, (4) Method of data collection, (5) Risk of bias	Tools (1) Type, (2) Items, (3) Reliability and validity	Participants (1) Target populations (2) Number of participants (3) Age (4) Gender (Male/Female)	Knowledge/Awareness (1) Percent or mean, (2) Level, (3) Source of information	Attitude (Percent)	Practice (1) Percent Level (2) Level
Chatterjee, S. S. (2020) [20]	India	(1) Cross-sectional, (2) Knowledge, attitude, practice, (3) Consecutive, (4) Online, (5) Low	(1) The researcher made, (2) NR*, (3) Approved	(1) Doctors, (2) 152, (3) 42.05, (4) 119/33	(1) 38.8 (2) Moderate	86.8	(1) 95.4 (2) Good
Dost, B. (2020) [21]	Turkey	(1) Cross-sectional, (2) Knowledge, attitude, (3) Consecutive, (4) Online, (5) Low	(1) The researcher made, (2) 13, (3) Approved	(1) Anesthesiology specialists, (2) 346, (3) 37.2, (4) 133/213	(1) 92.6 (2) Good	94.9	
Duruk, G. (2020) [22]	Turkey	(1) Cross-sectional, (2) Attitude, (3) Census, (4) Online, (5) Low	(1) The researcher made, (2) 22, (3) Approved	(1) Dentists, (2) 1958 (3) 32.5, (4) 415/1153		16.7	
Elhadi, M. (2020) [23]	Libya	(1) Cross-sectional, (2) Knowledge (3) Consecutive, (4) paper-based, (5) Moderate	(1) Researcher made, (2) 24, (3) Approved	(1) HCWs, (2) 1024, (3) 35.5, (4) 375/649	(1) 26.5 (2) Poor		
Erbas, M. (2020) [24]	Turkey	(1) Cross-sectional, (2) attitude, (3) Consecutive, (4) Online, (5) Low	(1) Researcher made, (2) 1, (3) Approved	(1) Physicians, (2) 248, (3) 37.2, (4) 122/126		46.96	
Escalera-Antezana, J. P. (2020) [25]	Colombia	(1) Cross-sectional, (2) knowledge, (3) Consective, (4) Online, (5) Low	(1) Researcher made, (2) 5, (3) Approved	(1) HCWs, (2) 1165, (3) 33.5, (4) 444/721	(1) 34.8 (2) Moderate		
Giao, H. (2020) [26]	Vietnam	(1) Cross-sectional, Knowledge and (2) Knowledge attitude,	(1) Standard, (2) 23, (3) Approved	(1) 1HCWs, (2) 327, (3) 330.1,	(1) 88.4, (2) Good, (3) TV, social media, friends	93.3	

Table 1: (continued)

Author (Year)	Country	Studies characteristics	Tools	Participants	Knowledge/Awareness	Attitude (Percent)	Practice
		(1) Design, (2) Outcome measure, (3) Sampling methods, (4) Method of data collection, (5) Risk of bias	(1) Type, (2) Items, (3) Reliability and validity	(1) Target populations, (2) Number of participants, (3) Age, (4) Gender (Male/Female)	(1) Percent or mean, (2) Level, (3) Source of information		(1) Percent (2) Level
		(3) Consecutive, (4) paper-based, (5) Low		(4) 85/242			
Huang, H. P. (2020) [27]	China	(1) Cross-sectional, (2) Knowledge, (3) Consecutive, (4) Online, (5) Low	(1) The researcher made, (2) 10, (3) Approved (0.81)	(1) Nurses, (2) 979, (3) 29.68, (4) 45/934	(1) 38.7, (2) Moderate		
Hussain, I. (2020) [28]	Pakistan	(1) Cross-sectional, (2) Knowledge, attitude, and practice, (3) Census, (4) Online, (5) Low	(1) Researcher made, (2) 34, (3) Approved (0.76)	(1) HCWs, (2) 114, (3) 26, (4) 74/37	(1) 90.7, (2) Good	90	(1) 90 (2) Good
Kamate, S. K. (2020) [29]	Global	(1) Cross-sectional, (2) Knowledge, attitude and practice, (3) Convenience and snowball, (4) Online, (5) Low	(1) Researcher made, (2) 24, (3) Approved (0.79)	(1) Dentists, (2) 860, (3) NR, (4) NR	(1) 92.7, (2) Good, (3) Newspapers, TV, and social media	87.2	(1) 79.5 (2) Good
Kara, E. (2020) [30]	Turkey	(1) Cross-sectional, (2) Knowledge, and practice, (3) Consecutive, (4) Interview, (5) Moderate	(1) The researcher made, (2) 22, (3) Approved	(1) Pharmacists, (2) 237, (3) 22–60, (4) 65/172	(1) 91.1, (2) Good, (3) TV, newspaper, Internet, social media, and friends/family		(1) 96 (2) Good
Khader, Y. (2020) [31]	Jordan	(1) Cross-sectional, (2) Awareness, and attitude, (3) Simple random, (4) Online, (5) Low	(1) The researcher made, (2) NR, (3) Approved	(1) Dentists, (2) 368, (3) 32.9, (4) 123/245	(1) 85.9, (2) Good	74.4	
	India	(1) Cross-sectional,			(1) 95.5		

Table 1: (continued)

Author (Year)	Country	Studies characteristics (1) Design, (2) Outcome measure, (3) Sampling methods, (4) Method of data collection, (5) Risk of bias	Tools (1) Type, (2) Items, (3) Reliability and validity	Participants (1) Target populations, (2) Number of participants, (3) Age, (4) Gender (Male/Female)	Knowledge/Awareness (1) Percent or mean, (2) Level, (3) Source of information	Attitude (Percent)	Practice (1) Percent (2) Level
Kotian, R. P. (2020) [32]		(2) Knowledge, (3) Consecutive, (4) Online, (5) Low	(1) The researcher made, (2) 15, (3) Approved	(1) Medical imaging professionals, (2) 550, (3) 23.39, (4) 312/238	(2) Good		
Modi, P. D. (2020) [33]	India	(1) Cross-sectional, (2) Awareness, (3) Convenience, (4) Online, (5) Low	(1) The researcher made, (2) 17, (3) Approved	(1) HCWs, (2) 1562, (3) 18-45, (4) 377/1185	(1) 71.2, (2) Good		
Moro, M. (2020) [34]	Italy	(1) Cross-sectional, (2) knowledge, and attitudes, (3) Census, (4) Online, (5) Low	(1) The researcher made, (2) 7, (3) Approved	(1) HCWs, (2) 1102, (3) NR, (4) NR	(1) 71.6, (2) Good	57.8	
Nemati, M. (2020) [35]	Iran	(1) Cross-sectional, (2) Knowledge, (3) Consecutive, (4) Online, (5) Low	(1) Researcher made, (2) NR, (3) Approved	(1) Nurses, (2) 85, (3) 16.35, (4) 12/73	(1) 56.5, (2) Moderate, (3) WHO, and MOH, social media		
Olum, R. (2020) [36]	Uganda	(1) Cross-sectional, (2) Knowledge, attitude, and practices, (3) Census, (4) Online, (5) Low	(1) The researcher made, (2) 21, (3) Approved	(1) HCWs, (2) 136, (3) 34, (4) 87/49	(1) 69, (2) Moderate	21	(1) 74, (2) Good
Papagiannis, D. (2020) [37]	Greece	(1) Cross-sectional, (2) Knowledge, attitude, and practices, (3) Convenience, (4) Interview, (5) Low	(1) The researcher made, (2) 18, (3) Approved	(1) HCWs, (2) 461, (3) 44.2, (4) 119/341	(1) 88.2, (2) Good	84.8	(1) 24.2, (2) Poor
Putrino, A. (2020) [38]	Italian	(1) Cross-sectional,		(1) Dentists,	(1) 73,		

Table 1: (continued)

Author (Year)	Country	Studies characteristics	Tools	Participants	Knowledge/Awareness	Attitude (Percent)	Practice
		(1) Design, (2) Outcome measure, (3) Sampling methods, (4) Method of data collection, (5) Risk of bias	(1) Type, (2) Items, (3) Reliability and validity	(1) Target populations, (2) Number of participants, (3) Age, (4) Gender (Male/Female)	(1) Percent or mean, (2) Level, (3) Source of information		(1) Percent (2) Level
		(2) Knowledge, (3) Convenience, (4) Online, (5) Low	(1) The researcher made, (2) 25, (3) Approved	(2) 535, (3) 35–60, (4) 261/274	(2) Good, (3) Television, newspapers, social media, and scientific literature		
Saqlain, M. (2020) [39]	Pakistan	(1) Cross-sectional, (2) Knowledge, attitude, practice, (3) Convenience, (4) Online, (5) Low	(1) Researcher made, (2) 28, (3) Approved (0.77)	(1) HCWs, (2) 414, (3) NR, (4) 209/205	(1) 93.2, (2) Good	8.43	(1) 88.7, (2) Good
Shi, Y (2020) [40]	China	(1) Cross-sectional, (2) Knowledge and attitude, (3) Convenience, (4) Online, (5) Low	(1) The researcher made, (2) 33, (3) Approved	(1) HCWs, (2) 311, (3) 33.74, (4) 202/99	(1) 89.51, (2) Good	77.17	
Zhang, M. (2020) [41]	China	(1) Cross-sectional, (2) Knowledge, and practice, (3) Convenience, (4) Interview, (5) Low	(1) The researcher made, (2) 16, (3) Approved	(1) HCWs, (2) 1357, (3) NR, (4) 724/633	(1) 89, (2) Good		(1) 89.7, (2) Good

*NR: non-reported.

practice score was reported to be between 24.2 and 96%. In most studies (n=8, 88.8%), participants performed good practice. In general, 78.8% of HCWs had good practice towards the adherence to COVID-19-related infection control principles (Table 1).

Source of information and clinical recommendation to improve KAP of COVID-19 among HCWs

Out of 28 studies, 23 studies reported clinical recommendations to improve KAP among HCWs. The most important clinical recommendations to improve HCWs' KAP towards COVID-19 were: Continued education program for HCWS about coronavirus (n=11), providing the sufficient quantities of PPE and training of all HCWs (n=10), and Participate in online webinars provided by the CDC and WHO to update awareness about COVID-19 (n=3) (Table 2).

Concerning the resources of information for HCWs used to improve KAP, the most important sources of information were social media (n=7), television (n=7), and newspapers (n=6) (Table 1).

Discussion

Today, coronavirus is regarded as the most important health, economic, psychological, and social challenge. This study aimed to evaluate the knowledge, attitude, practice, and clinical recommendations of HCWs towards COVID-19. To do so, databases were searched for the relevant studies up to July 30, 2020. Of 28 cross-sectional studies conducted on 16,427 HCWs in more than 18 countries entered into the final stage of the systematic review. In most studies, researcher-made tools were used. Regarding knowledge, the results showed that in most studies, HCWs had good knowledge of COVID-19. In general, 72.2% of participants had sufficient knowledge of COVID-19. According to researchers' searching, so far, there has been no review study in this regard. However, in a systematic review generally conducted on infection control, the results demonstrated that in most included studies, participants had sufficient knowledge of the infection control principles [42], which is in line with the findings of the present study.

Regarding individual studies, the results of the present study also confirm the findings of individual studies conducted on medical students in Jordan [43], Philippines [44], and India [26], which can be due to the similarities in methodology and the level of communication on coronavirus topics among most of the medical students. Unlike the present study in which the level of knowledge towards COVID-19 was 72.2%, in studies conducted on the general population in Turkey (36%) [45], India (63%) [46], and Iran (4.8–7.3%) [47], participants had low knowledge regarding COVID-19. The reason for such discrepancy may reside in differences in the study populations and the sample size of the studies reviewed.

Concerning attitudes in different studies, between 16.7 and 96.4% of participants had a positive attitude towards COVID-19. In general, in most studies, more than 70% of participants had a positive attitude towards COVID-19, which corroborates with a systematic review study regarding general infection principles among nurses. Furthermore, the results of the present study are consistent with those of the individual studies on the general population in Malaysia (83.1%) [48], Indonesia (96%) [49], the exact cause of which is unknown; however, it may be due to health policies and training groups involved in increasing knowledge about COVID-19. In Alobuia WM's study conducted on the general population in the United States (27–52%) [50], it was found that participants had a negative attitude towards COVID-19, which is inconsistent with the findings of the present study. It can be due to a lower level of knowledge regarding COVID-19 in the general population, the unknown nature of coronavirus, the sudden outbreak of coronavirus in the world, and the difference in the type of study population in the two studies. Regarding practice, in most studies, participants performed good practice. Overall, 78.8% of HCWs had good practice towards the adherence to COVID-19-related infection control principles, which is inconsistent with the findings of the review study on nurses [42], which indicated that nurses performed a moderate to poor practice regarding infection control. Moreover, this result confirms the findings of M. K. Al-Hanawi's study conducted in Saudi Arabia [51].

Providing HCWs with COVID-19-related training programs as well as with the PPE equipment and the required practical skills and taking part in online webinars to increase the level of knowledge towards COVID-19 were among the most important clinical recommendations to improve HCWs' KAP towards COVID-19. The clinical recommendations presented are consistent with the results of previous studies [42, 52, 53]. The most important source of information for HCWs to improve KAP was social networks. With due attention to the increasing prevalence of the disease and the lack of definitive treatment and since the only way to control the disease is to create social distance and be quarantined, social networks play a substantial role in increasing the level of knowledge towards COVID-19 [54–56]. Since the outbreak of the coronavirus, countries have applied various social networks such as Facebook, Twitter, Instagram, and WhatsApp to raise the level of

Table 2: Clinical recommendations to improve knowledge, attitude, and practice of HCWs towards COVID-19.

Author (year) clinical recommendation	Abdel Wahed, W. Y. (2020) [14]	Ahmed, N. (2020) [15]	Alhaj, A. K. (2020) [16]	Apaijitt, P. (2020) [17]	Bhagavathula, A. S. (2020) [18]	Çalışkan, F. (2020) [19]	Chatterjee, S. S. (2020) [20]	Dost, B. (2020) [21]	Elhadi, M. (2020) [23]	Escalera-Antezana, J. P. (2020) [25]	Giao, H. (2020) [26]	Hussain, I. (2020) [28]	Kamate, S. K. (2020) [29]	Kara, E. (2020) [30]	Khader, Y. (2020) [31]	Modi, P. D. (2020) [33]	Moro, M. (2020) [34]	Nemati, M. (2020) [35]	Olum, R. (2020) [36]	Papagiannis, D. (2020) [37]	Saqlain, M. (2020) [39]	Shi, Y (2020) [40]	Zhang, M. (2020) [41]
Continued education program for HCWS about coronavirus	✓	✓	✓	✓	✓	✓		✓	✓		✓					✓			✓	✓			
Providing sufficient quantities of PPE and training of all HCWs.	✓	✓	✓		✓		✓		✓			✓					✓				✓	✓	✓
Participate in online webinars provided by the CDC and WHO to update awareness about COVID-19.		✓																			✓	✓	
Continued medical, financial and psychological support for HCWs	✓	✓				✓	✓																
Applied the infection control guidelines in hospitals' daily routines.								✓					✓		✓								
Participate in online webinars provided by the CDC and WHO to update awareness about COVID-19.										✓						✓		✓					
Use social media to spread awareness among HCWs.													✓	✓									
Periodic assessment of HCWs KAP towards COVID-19																	✓		✓				

knowledge among HCWs and the general population [23, 57].

Limitations and strengths

The most important limitations of this study are as follows:
(1) All the included studies were descriptive, and a non-random sampling method was used to select the participants. When interpreting the results, the specific limitations of these studies should be taken into account, which may limit the generalizability of the results as well.
(2) In some of the studies included, there was incomplete information, so the authors were contacted to receive the information.
(3) Another limitation is the language of studies- only studies in English entered the final stage.
(4) And the use of researcher-made tools in various studies is another limitation, which did not allow us to conduct a meta-analysis.

Despite the limitations stated, there are also some strengths associated with this study. Firstly, according to the best information provided by the researchers, this study was the first systematic review in this field. Secondly, in this study, all possible dimensions of knowledge, attitude, practice, sources of information, and related clinical recommendations were also discussed.

Conclusion

The results of this study revealed that in most of the included studies, HCWs had good knowledge, a positive attitude, and good practice towards COVID-19. The most important clinical recommendation was to improve the KAP by providing relevant training programs. Moreover, social networks were the most important source of information applied. With due attention to the limitations of the present study, it is recommended that future studies with a larger sample size be conducted periodically in different countries. The results of the current study can be applied to HCWs and health policy-makers to improve KAP.

References

1. WHO. Director-General's opening remarks at the media briefing on COVID-19—11 March 2020; 2020. Available from: https://www.who.int/dg/speeches/detail/who-director-general-sopening-remarks-at-the-media-briefing-on-covid-19—11-march-2020.
2. Zu ZY, Jiang MD, Xu PP, Chen W, Ni QQ, Lu GM, et al. Coronavirus disease 2019 (COVID-19): a perspective from China. Radiology 2020;296:200490.
3. CDC. Coronavirus disease 2019 (COVID-19); 2020. Available from: https://www.cdc.gov/coronavirus/2019-ncov/about/transmission.html.
4. Worldometers. Covid-19 coronavirus pandemic; 2020. Available from: https://www.worldometers.info/coronavirus/.
5. Sikkema RS, Pas SD, Nieuwenhuijse DF, O'Toole Á, Verweij J, van der Linden A, et al. COVID-19 in health-care workers in three hospitals in the south of the Netherlands: a cross-sectional study. Lancet Infect Dis 2020;20:1273–80.
6. Mani NS, Budak JZ, Lan KF, Bryson-Cahn C, Zelikoff A, Barker GE, et al. Prevalence of COVID-19 Infection and Outcomes Among Symptomatic Healthcare Workers in Seattle. Washington: Clinical Infectious Diseases; 2020.
7. Fusco F, Pisaturo M, Iodice V, Bellopede R, Tambaro O, Parrella G, et al. COVID-19 among healthcare workers in a specialist infectious diseases setting in Naples, Southern Italy: results of a cross-sectional surveillance study. J Hosp Infect 2020;105:596–600.
8. Remuzzi A, Remuzzi G. COVID-19 and Italy: what next? Lancet 2020;395.
9. Liang T. Handbook of COVID-19 prevention and treatment. The First Affiliated Hospital, Zhejiang University School of Medicine Compiled According to Clinical Experience; 2020.
10. McEachan R, Taylor N, Harrison R, Lawton R, Gardner P, Conner M. Meta-analysis of the reasoned action approach (RAA) to understanding health behaviors. Annu Behav Med 2016;50:592–612.
11. Omrani A, Shalhoub S. Middle East respiratory syndrome coronavirus (MERS-CoV): what lessons can we learn? J Hosp Infect 2015;91:188–96.
12. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6:e1000097.
13. Hoy D, Brooks P, Woolf A, Blyth F, March L, Bain C, et al. Assessing risk of bias in prevalence studies: modification of an existing tool and evidence of interrater agreement. J Clin Epidemiol 2012;65:934–9.
14. Abdel Wahed WY, Hefzy EM, Ahmed MI, Hamed NS. Assessment of knowledge, attitudes, and perception of health care workers regarding COVID-19, A cross-sectional study from Egypt. J Community Health 2020;45:1–10.
15. Ahmed N, Shakoor M, Vohra F, Abduljabbar T, Mariam Q, Rehman MA. Knowledge, awareness and practice of health care professionals amid SARS-CoV-2, corona virus disease outbreak. Pak J Med Sci 2020;36(Covid19-s4):S49–s56.
16. Alhaj AK, Al-Saadi T, Mohammad F, Alabri S. Neurosurgery residents' perspective on COVID-19: knowledge, readiness, and impact of this pandemic. World Neurosurg 2020;139:e848–58.

17. Apaijitt P, Wiwanitkit V. Knowledge of coronavirus disease 2019 (COVID-19) by medical personnel in a rural area of Thailand. Infect Control Hosp Epidemiol 2020;1:1243–4.

18. Bhagavathula AS, Aldhaleei WA, Rahmani J, Mahabadi MA, Bandari DK. Knowledge and perceptions of COVID-19 among health care workers: cross-sectional study. JMIR Pub Health Surveil 2020;6:e19160.

19. Çalişkan F, Dost B. The evaluation of knowledge, attitudes, depression and anxiety levels among emergency physicians during the COVID-19 pandemic. Signa Vitae 2020;16:163–71.

20. Chatterjee SS, Bhattacharyya R, Bhattacharyya S, Gupta S, Das S, Banerjee BB. Attitude, practice, behavior, and mental health impact of COVID-19 on doctors. Indian J Psychiatr 2020;62: 257–65.

21. Dost B, Koksal E, Terzi Ö, Bilgin S, Ustun YB, Arslan HN. Attitudes of anesthesiology specialists and residents toward patients infected with the novel coronavirus (COVID-19): a national survey study. Surg Infect 2020;21:350–6.

22. Duruk G, Gümüşboğa ZS, Çolak C. Investigation of Turkish dentists' clinical attitudes and behaviors towards the COVID-19 pandemic: a survey study. Braz Oral Res 2020;34:e054.

23. Elhadi M, Msherghi A, Alkeelani M, Zorgani A, Zaid A, Alsuyihili A, et al. Assessment of healthcare workers' levels of preparedness and awareness regarding COVID-19 infection in low-resource settings. Am J Trop Med Hyg 2020;103:828–33.

24. Erbas M, Dost B. Evaluation of knowledge and attitudes among intensive care physicians during the COVID-19 pandemic: a cross-sectional survey. Sao Paulo Med J - Revista Paulista de Medicina 2020;138:317–21.

25. Escalera-Antezana JP, Cerruto-Zelaya PE, Apaza-Huasco M, Miranda-Rojas SH, Flores-Cárdenas CA, Rivera-Zabala L, et al. Healthcare workers' and students' knowledge regarding the transmission, epidemiology and symptoms of COVID-19 in 41 cities of Bolivia and Colombia. Trav Med Infect Dis 2020;37: 101702.

26. Giao H, Han NTN, Khanh TV, Ngan VK, Tam VV, An PL. Knowledge and attitude toward COVID-19 among healthcare workers at district 2 hospital, Ho chi Minh city. Asian Pac J Trop Med 2020;13: 260–5.

27. Huang HP, Zhao WJ, Li GR. Survey on knowledge and psychological crisis related to COVID-19 among nursing staff: a cross-sectional study. JMIR Formative Res 2020;4:e20606.

28. Hussain I, Majeed A, Imran I, Ullah M, Hashmi FK, Saeed H, et al. Knowledge, attitude, and practices toward COVID-19 in primary healthcare providers: a cross-sectional study from three tertiary care hospitals of Peshawar, Pakistan. J Community Health 2021; 46:441–9.

29. Kamate SK, Sharma S, Thakar S, Srivastava D, Sengupta K, Hadi AJ, et al. Assessing Knowledge, Attitudes and Practices of dental practitioners regarding the COVID-19 pandemic: a multinational study. Dent Med Probl 2020;57:11–7.

30. Kara E, Demİrkan K, Ünal S. Knowledge and attitudes among hospital pharmacists about COVID-19. Turk J Pharm Sci 2020;17: 242–8.

31. Khader Y, Al Nsour M, Al-Batayneh OB, Saadeh R, Bashier H, Alfaqih M, et al. Dentists' awareness, perception, and attitude regarding COVID-19 and infection control: cross-sectional study among Jordanian dentists. JMIR Pub Health Surveil 2020;6: e18798.

32. Kotian RP, Faujdar D, Kotian SP, D'souza B. Knowledge and understanding among medical imaging professionals in India during the rapid rise of the covid-19 pandemic. Health Technol 2020;10:1415–20.

33. Modi PD, Nair G, Uppe A, Modi J, Tuppekar B, Gharpure AS, et al. COVID-19 awareness among healthcare students and professionals in Mumbai Metropolitan region: a questionnaire-based survey. Cureus 2020;12:e7514.

34. Moro M, Vigezzi GP, Capraro M, Biancardi A, Nizzero P, Signorelli C, et al. 2019-novel coronavirus survey: knowledge and attitudes of hospital staff of a large Italian teaching hospital. Acta Biomed: Atenei Parmensis 2020;91:29–34.

35. Nemati M, Ebrahimi B, Nemati F. Assessment of iranian nurses' knowledge and anxiety toward covid-19 during the current outbreak in Iran. Arch Clin Infect Dis 2020;15(COVID-19): e102848.

36. Olum R, Chekwech G, Wekha G, Nassozi DR, Bongomin F. Coronavirus disease-2019: knowledge, attitude, and practices of health care workers at Makerere University teaching hospitals, Uganda. Front Public Health 2020;8:181.

37. Papagiannis D, Malli F, Raptis DG, Papathanasiou IV, Fradelos EC, Daniil Z, et al. Assessment of knowledge, attitudes, and practices towards new coronavirus (SARS-CoV-2) of health care professionals in Greece before the outbreak period. Int J Environ Res Publ Health 2020;17:4925.

38. Putrino A, Raso M, Magazzino C, Galluccio G. Coronavirus (COVID-19) in Italy: knowledge, management of patients and clinical experience of Italian dentists during the spread of contagion. BMC Oral Health 2020;20:200.

39. Saqlain M, Munir MM, Rehman SU, Gulzar A, Naz S, Ahmed Z, et al. Knowledge, attitude, practice and perceived barriers among healthcare professionals regarding COVID-19: a Cross-sectional survey from Pakistan. J Hosp Infect 2020;105:419–23.

40. Shi Y, Wang J, Yang Y, Wang Z, Wang G, Hashimoto K, et al. Knowledge and attitudes of medical staff in Chinese psychiatric hospitals regarding COVID-19. Brain, Behavior, & Immunity - Health 2020;4:100064.

41. Zhang M, Zhou M, Tang F, Wang Y, Nie H, Zhang L, et al. Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. J Hosp Infect 2020;105: 183–7.

42. Nasiri A, Balouchi A, Rezaie-Keikhaie K, Bouya S, Sheyback M, Al Rawajfah O. Knowledge, attitude, practice, and clinical recommendation toward infection control and prevention standards among nurses: a systematic review. Am J Infect Contr 2019;47:827–33.

43. Alzoubi H, Alnawaiseh N, Al-Mnayyis A, Lubad M, Aqel A, Al-Shagahin H. COVID-19-knowledge, attitude and practice among medical and non-medical University Students in Jordan. J Pure Appl Microbiol 2020;14:17–24.

44. Baloran ET. Knowledge, attitudes, anxiety, and coping strategies of students during COVID-19 pandemic. J Loss Trauma 2020;25:635–42.

45. Yıldırım M, Güler A. COVID-19 severity, self-efficacy, knowledge, preventive behaviors, and mental health in Turkey. Death Stud 2020:1–8. https://doi.org/10.1080/07481187.2020.1793434 [Epub ahead of print].

46. Gudi SK, Chhabra M, Undela K, Venkataraman R, Mateti UV, Tiwari KK, et al. Knowledge and beliefs towards universal safety precautions during the coronavirus disease (COVID-19) pandemic among the Indian public: a web-based cross-sectional survey. Drugs Ther Perspect 2020;36:413–20.

47. Honarvar B, Lankarani KB, Kharmandar A, Shaygani F, Zahedroozgar M, Rahmanian Haghighi MR, et al. Knowledge, attitudes, risk perceptions, and practices of adults toward COVID-19: a population and field-based study from Iran. Int J Publ Health 2020;65:1–9.

48. Azlan AA, Hamzah MR, Sern TJ, Ayub SH, Mohamad E. Public knowledge, attitudes and practices towards COVID-19: a cross-sectional study in Malaysia. PloS One 2020;15: e0233668.

49. Sari DK, Amelia R, Dharmajaya R, Sari LM, Fitri NK. Positive correlation between general public knowledge and attitudes regarding COVID-19 outbreak 1 Month after first cases reported in Indonesia. J Community Health 2021;46:182–9.

50. Alobuia WM, Dalva-Baird NP, Forrester JD, Bendavid E, Bhattacharya J, Kebebew E. Racial disparities in knowledge, attitudes and practices related to COVID-19 in the USA. Oxford, England: J Public Health 2020;42:470–8.

51. Al-Hanawi MK, Angawi K, Alshareef N, Qattan AMN, Helmy HZ, Abudawood Y, et al. Knowledge, attitude and practice toward COVID-19 among the public in the Kingdom of Saudi Arabia: a cross-sectional study. Front Public Health 2020;8:217.

52. Söğüt S, Dolu İ, Cangöl E. The relationship between COVID-19 knowledge levels and anxiety states of midwifery students during the outbreak: a cross-sectional web-based survey. Psychiatr Care 2021;57:246–52.

53. Abdelhafiz AS, Mohammed Z, Ibrahim ME, Ziady HH, Alorabi M, Ayyad M, et al. Knowledge, perceptions, and attitude of egyptians towards the novel coronavirus disease (COVID-19). J Community Health 2020;45:1–10.

54. Courtney K. The use of social media in healthcare: organizational, clinical, and patient perspectives. Enabling health and healthcare through ICT: available, tailored and closer 2013;183:244.

55. Farnan JM, Snyder Sulmasy L, Worster BK, Chaudhry HJ, Rhyne JA, Arora VM. Online medical professionalism: patient and public relationships: policy statement from the American College of Physicians and the Federation of State Medical Boards. Annu Intern Med 2013;158:620–7.

56. Wilder-Smith A, Freedman DO. Isolation, quarantine, social distancing and community containment: pivotal role for old-style public health measures in the novel coronavirus (2019-nCoV) outbreak. J Trav Med 2020;27:taaa020.

57. Sahni H, Sharma H. Role of social media during the COVID-19 pandemic: beneficial, destructive, or reconstructive? Int J Acad Med 2020;6:70.