Systematic Review

Access this article online
Quick Response Code:

Website:
https://eurasianjpulmonol.org
DOI:
10.14744/ejp.2023.1001

SARS-CoV-2 infection among healthcare workers in Türkiye: A systematic review and meta-analysis

Ayşe Önal Aral

ORCID:
Ayşe Önal Aral: 0000-0003-4796-2664

Abstract:

BACKGROUND AND AIM: The pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is still ongoing, despite it has been three years since the first case was diagnosed in China in 2019. Healthcare workers (HCWs) are at the frontline in the fight against the virus, making them more susceptible to contacting the disease. This review aims to describe the clinical outcomes and risk factors for SARS-CoV-2 infection among HCWs in Türkiye before the vaccination campaign started in the country.

METHODS: Relevant studies conducted from December 2019 to January 13, 2021, were included. A literature search spanning from April 25, 2022 to May 29, 2022, was conducted in six databases. A random-effect model or fixed-effect model was used for meta-analysis. Publication bias was assessed with Egger's test. A total of 19 studies were included.

RESULTS: The total number of HCWs diagnosed with SARS-CoV-2 infection was 2,367, with a mean age of 35.238 (95% CI 33.878, 36.598). The proportion of females was 63% (95% CI 58.5, 67.2). The estimated pooled prevalence of SARSCoV-2 infection was 9.3% (95% CI 6.2, 13.6) by polymerase chain reaction (PCR) for the first two months and 3.1% (95% CI 2.3, 4.1) by antibody test for the third and fourth month of the pandemic. The proportion of infected HCWs was 17.0% (95% CI 14.5, 19.9) between the fourth and eighth months and 19.0% (95% CI 17.3, 20.8) at the eighth month of the pandemic by antibody test. The rate of hospitalization was 10% (95% CI 5.5, 17.5). The most prevalent symptom was myalgia with a rate of 41.2% (95% CI 29.7, 53.8). Hypertension was the most prevalent comorbidity with a rate of 5.9% (95% CI 3.2, 10.8). Inappropriate use of personal protective equiment (PPE) and more contact with patients were among the risk factors.

CONCLUSIONS: The results of this study showed that the rate of infected HCWs had increased exponentially from the beginning until the eighth month of the pandemic and was much higher compared to the general population in our country.

Keywords:

Healthcare workers, meta-analysis, prevalence, risk factors, SARS-CoV-2, systematic review, Türkiye

Department of Pulmonary Diseases, Ankara Gölbaşı State Hospital, Ankara, Türkiye

Address for correspondence:
Ayşe Önal Aral, Department of Pulmonary Diseases, Ankara Gölbaşı State Hospital, Ankara, Türkiye.
E-mail: aonal2@yahoo.com

Received: 11-01-2023
Revised: 20-02-2023
Accepted: 20-03-2023
Published: 11-05-2023

How to cite this article: Önal Aral A. SARS-CoV-2 infection among healthcare workers in Türkiye: A systematic review and meta-analysis. Eurasian J Pulmonol 2023;25:67-79.

Introduction

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infection, also known as Coronavirus Disease 2019 (COVID-19), was first detected in the Wuhan region of China in late 2019 and has since spread across the world. The World Health Organisation (WHO) declared it a "pandemic" on March 11, 2020. Tens of thousands of people have been infected with the virus, and many deaths have resulted from the disease. The pandemic is still ongoing, with emerging variants causing new waves. Healthcare workers (HCWs) are among the most vulnerable groups in terms of contracting the virus because they have to be in close contact with patients. Many studies have found that the rate of SARS-CoV-2 infection is higher among HCWs compared to the general population.[1,2] High rates of infection among HCWs could affect healthcare services due to sick leave, and infected HCWs could potentially contribute to the transmission of the infection not only in health facilities but also outside of them. Therefore, exploring the features of transmission and other characteristics of SARS-CoV-2 infection among HCWs is crucial to protect them from getting infected.

The first COVID-19 case in Türkiye was announced on March 11, 2020, by the country's Health Ministry. The total number of people with COVID-19 in Türkiye was 17,042,722, with 101,492 deaths according to the official report on November 27, 2022.[3] However, there were few official reports about the SARS-CoV-2 infection status among HCWs in Türkiye. In early December 2020, the health minister of the country announced that the number of HCWs with COVID-19 diagnosed by polymerase chain reaction (PCR) was more than 120,000, indicating that more than 10% of HCWs in Türkiye had contracted the disease.[4] However, there are studies in the literature exploring COVID-19 among HCWs in our country.

The aim of this review is to determine the rate of SARS-CoV-2 infection and its characteristics, as well as risk factors for the infection among HCWs in Türkiye before the vaccination campaign against the virus was started in the country.

Materials and Methods

Protocol and registration

This systematic review and meta-analysis were carried out following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. It was registered at the International Prospective Register of Systematic Reviews (www.crd.york.ac.uk/PROSPERO) with a registration number of CRD42022336299.

Search strategy and study selection

A literature search was conducted from April 25, 2022, to May 29, 2022, (O.A), in databases including Dergi Park, ULAKBIM TRDizin, PubMed, ScienceDirect, ResearchGate, and Google Scholar. The keywords used for the literature search were various combinations of: "COVID-19," "Coronavirus disease," "Coronavirus," "SARS-CoV-2," "Seroprevalence,"; "Prevalence," "Proportion," "Healthcare workers," "Healthcare personnel," "risk factors," and "Türkiye." The search language was both Turkish and English.

The studies providing epidemiological, clinical information, and outcome data on HCWs diagnosed with SARS-CoV-2 infection through PCR or antibody tests or clinically/radiologically in Türkiye from December 2019 to January 13, 2021, were included.

Excluded articles were those that did not have data concerning prevalence, clinical features, and outcomes, and those in which HCWs were tested or assessed for SARS-CoV-2 infection after January 13, 2021, when the vaccination campaign started in Türkiye. In addition, studies including HCWs working only in a specific department or belonging to a specific profession were not included in this study because they would not reflect the results of all HCWs regardless of the department they were working in the healthcare facility. In addition, grey literature was not included.

After the first seach, all relevant articles were screened by titles and abstracts according to eligibility criteria to select those articles to be included for full-text screening. After full-text screening for relevance, those meeting the eligibility criteria were selected for inclusion in the review.

Additionally, the references of the selected articles were hand-searched, and those meeting the inclusion criteria were included in this review.

The selected articles were in Turkish or English (Appendix 1).

Data extraction and quality assessement

All relevant data were independently extracted by two reviewers (O.A. and G.) from the selected articles. The following items were extracted from each included study: the first author's name; publication date; journal; artical language; the period in which the study was carried out or HCWs were assessed for SARS-CoV-2 infection; setting; study design; sample size; gender and age of the study participants; method of ascertainment for SARS-CoV-2 infection; SARS-CoV-2 infection prevalence with proportion and number of infected HCWs; gender, age, and profession of infected HCWs; symptoms; comorbidities; smoking; contact status; having co-worker with a positive test result for SARS-CoV-2; having a family member with a positive test result for SARS-CoV-2; disease severity; mortality; and risk factors associated with SARS-CoV-2 infection.

Any disagreements between the reviewers were resolved through discussion.

The methodological quality of the included studies was independently assessed by two reviewers using the Joanna Briggs Institute's (JBI) checklist for prevalence studies. This is a 9-point scale where a score of 8–9 indicates low risk of bias, a score of 5–7 indicates moderate risk, and ≤4 indicates high risk of bias.[5]

Any disagreements between the reviewers were resolved through discussion.

Data synthesis and analysis

The distribution of dichotomous variables was described by calculating percentages, 95% confidence intervals, heterogeneity, and publication bias for each variable. The measure of heterogeneity was reported by including Cochran's Q statistics, I^2, and Tau square (T^2) index. Heterogeneity was defined as $I^2>50$.

Random-effect model was used to estimate the pooled prevalence and 95% CI if $p<0.05$, and fixed-effect model was used if $p>0.05$ for Cochrane's Q statistics.

Publication bias was assessed with Egger's test, and publication bias was defined if the p-value was <0.05 for Egger's test.

Comprehensive Meta-Analysis (CMA) software (version 3.0, Biostat Inc., Englewood, NJ, USA) was used for the quantitative synthesis of the data.

Results

Study selection

A total of 875 articles were initially identified from the databases. Of those, 10 articles were duplicates. After removing the duplicates, 865 articles were screened by titles and abstracts. Following the exclusion of 842 articles that did not meet the inclusion criteria, 23 articles were selected for full-text review. One more article was excluded because the full-text was not available within the timeframe of literature searching for this review. After full-text assessment, five articles were excluded. Of the five excluded articles, two had participants that were the same as those in other two included articles, while another excluded article did not have sufficient data. The other two excluded articles did not meet the inclusion criteria (Appendix 1). Finally, 17 articles were selected from databases for the review.[6–22] Additionally, searching the references of the selected articles yielded two more articles that met the inclusion criteria,[23,24] bringing the total number of articles reviewed for this study to 19 [Fig. 1].

Study characteristics

Table 1 provides a summary of the characteristics of the included articles. Out of the 19 reviewed studies, 14 were in English, while five were in Turkish. Only one study was multicenter, and the rest were carried out at a single center. The total number of participants from the included studies was 12,342, while the number of HCWs diagnosed with COVID-19 was 2,367. Of these cases, a total of 35 were diagnosed clinically/radiologically in three studies, and the rest were diagnosed through PCR or antibody test. The study participants who were tested using PCR were those with symptoms suggesting COVID-19 disease or those who had been in close contact with infected cases. Conversely, those tested using antibody test were all volunteer HCWs. Among the reviewed studies, 11 explored the prevalence of COVID-19 disease among HCWs as well as their characteristics.

Most of the studies had a moderate risk of bias in terms of methodological quality, as assessed by the JBI checklist (Table 1).

Risk of bias in the studies

Most of the studies showed considerable heterogeneity ($I^2>75\%$). A few studies had evidence of publication bias, as demonstrated by Egger's test ($p<0.05$) (Table 2).

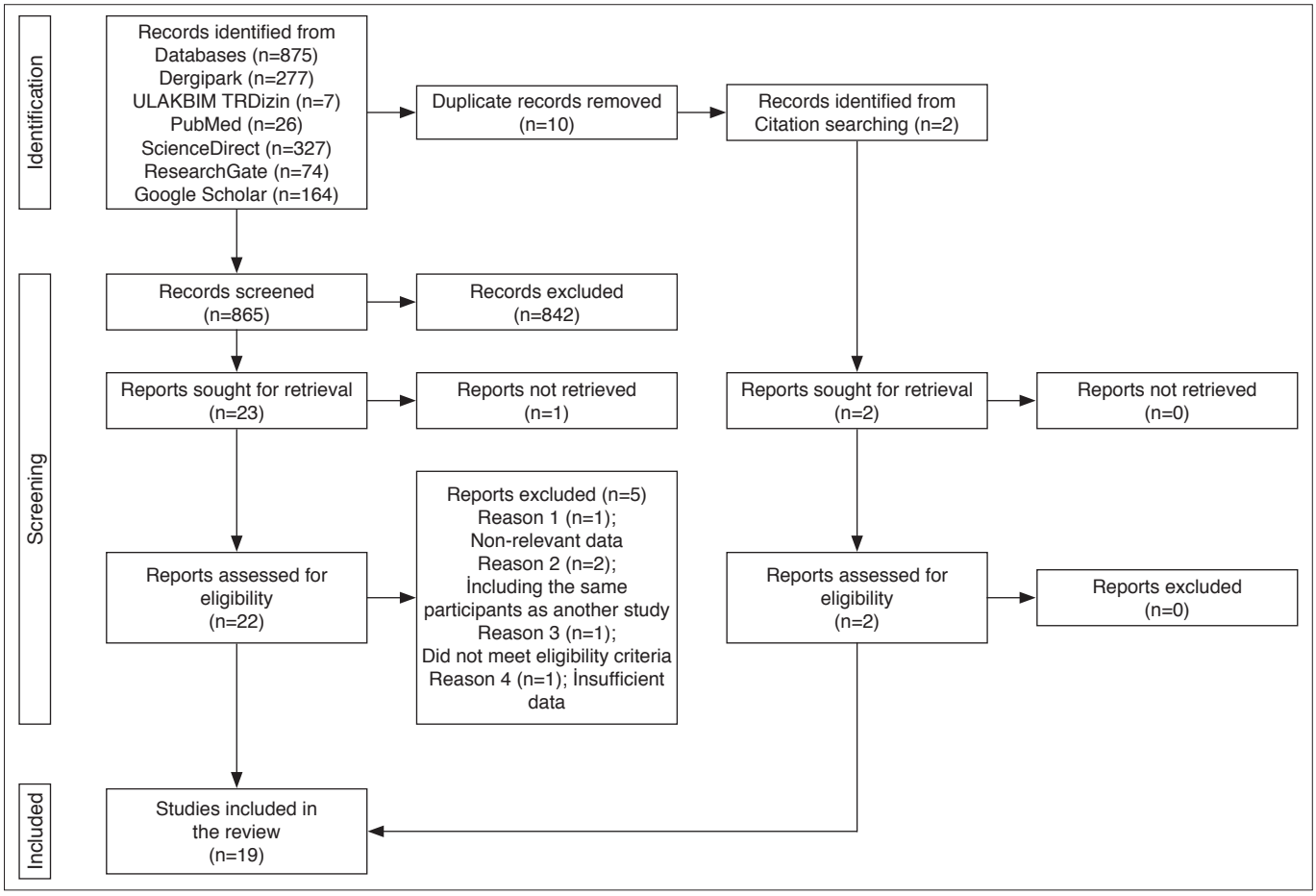

Figure 1: Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flowchart

When it came to the studies that were included in the meta-analysis for the estimation of pooled prevalence of SARS-CoV-2 infection among HCWs, a funnel plot was drawn for the studies using the antibody test [Fig. 2], in addition to Egger's test. There was no publication bias. Hovewer, a funnel plot could not be drawn for the studies using the PCR test because the number of those studies was less than three.

Results of meta-analysis

1. Demographic characteristics

The total number of HCWs with SARS-CoV-2 analyzed in the included studies was 2,367. The mean age of the patients was 35.238 (95% CI 33.878, 36.598). The proportion of females was 63% (95% CI 58.5, 67.2). The proportion of doctors among infected HCWs was 17.4% (95% CI 13.2, 22.5), while it was 36.3% (95% CI 31.6, 41.3) for nurses (Table 2).

2. Clinical Manifestations

The proportion of infected HCWs that were symptomatic was 80% (95% CI 75.8, 83.6), while the proportion of asymptomatic cases was 19% (95% CI 14.8, 23.9). The rate of hospitalization was 10% (95% CI 5.5, 17.5), and the rate of those requiring Intensive Care Unit (ICU) treatment was 1.1% (95% CI 0.4, 2.8).

The most prevalent symptom was myalgia with a rate of 41.2% (95% CI 29.7, 53.8), followed by cough at 38.4% (95% CI 29.4, 48.2), fatigue at 34.8% (95% CI 29.1, 43.6), and fever at 27.7% (95% CI 19.0, 38.6) (Table 2).

3. Comorbidities

The prevalence of hypertension, asthma and diabetes mellitus was 5.9% (95% CI 3.2, 10.8), 4.8% (95% CI 3.5, 6.4), and 3.4% (95% CI 2.0, 5.7), respectively (Table 2).

4. Other Characteristics

The proportion of smoker HCWs infected with SARS-CoV-2 was 21.2% (95% CI 16.1, 27.3). The rate of those who had a co-worker with COVID-19 was 43.6% (95% CI 28.2, 60.3) (Table 2).

Table 1. The main characteristics of the included studies

Author, publication year	Journal	Language	Study date (M-M/Y)	Study design	City/setting	Diagnostic test	Sample size (n)	HCWs with COVID-19 (n)	Proportion of infected HCWs (%)	JBI score
Korkusuz et al. (2021)	Istanbul Medical Journal	English	03-04/20	Retropective, cross-sectional	Istanbul/single center	PCR (=Rotor Gene Q, QIAGEN, Germany)	1425	165	11.5	7
Durmaz et al. (2022)	Journal of the Pakistan Medical Association	English	03-05/20	Retrospective cohort	Izmir/single center	PCR	845	27	3.2	8
Güldaval et al. (2020)	Tuberk Toraks	English	03-05/20	Retrospective, cross-sectional	Izmir/single center	PCR	49	49		5
Çelebi et al. (2020)	American Journal of Infection Control	English	03-05/20	Prospective, case-control	Zonguldak/ single center	PCR	703	50	7.1	6
Demir et al. (2021)	Maltepe Medical Journal	English	03-06/20	Retrospective, cross-sectional	Istanbul/ single center	PCR	31	31		8
Kaya et al. (2021)	Medical Journal of Tokat Gaziosmanpasa University	Turkish	03-06/20	Retrospective cross-sectional	Istanbul/ single center	PCR	415	89		5
Eser et al. (2022)	Turkish Journal of Public Health	English	03-07/20	Prospective, cross-sectional	Manisa/ single center	PCR or antibody test (=COV2T, Siemens, ELISA)	1177	18	1.5 (=by antibody test or PCR) 1.0 (=by antibody test)	6
Emecen et al. (2021)	Infectious diseases	English	03-11/20	Retrospective, cross-sectional	Izmir/single center	PCR	149	149		5
Elarslan et al. (2021)	Medical Research Journal	English	03-11/20	Retrospective, cross-sectional	Istanbul/ single center	PCR	79	79		4
Polat et al. (2022)	Cam and Sakura Med J	English	03/20-01/21	Retrospective, cross-sectional	Istanbul/ single center	PCR	446	446		6
Madran et al. (2020)	Infect Dis Clin Microbiol	English	04-05/20	Prospective, cross-sectional	Istanbul/ single center	PCR or antibody test (=Ovios COVID-19 IgM/IgG rapid Cassette test/ Elecsys, ROCHE) or Clinically/radiologically	624	51	8.1	7
Eren et al. (2020)	Klimik Journal	Turkish	04-06/20	Retrospective, cross-sectional	Kayseri/ single center	PCR or clinically/ radiologically	82	82		8
Pınar et al. (2022)	Cukorova Medical Journal	Turkish	04/20-01/21	Retrospective, cross-sectional	Ankara/ single center	PCR or clinically/ Radiologically	180	180		8
Gümüş et al. (2021)	Mikrobiyol Bul	Turkish	05-06/20	Prospective, cross-sectional	Adana/ single center	Antibody test (=ARCHITECT, Abbott)	572	21	3.7	7
Alkurt et al. (2021)	PLoS ONE	English	05-06/20	Prospective, cross-sectional	Istanbul, Kocaeli/ multicenter	PCR or antibody test (=ARCHITECT, Abbott)	932	141	2.7 (=by antibody test)	6
Pınarlık et al. (2021)	Infectious disease reports	English	05-12/20	Prospective, cross-sectional	Istanbul/ single center	PCR or antibody test (=Elecsys, ROCHE)	1732	283	16.3	7
Karslıgil et al. (2021)	European Journal of Therapeutics	English	06-07/20	Prospective, cross-sectional	Gaziantep/ single center	Antibody test (=Euroimmun, ELISA, Germany)	186	5	2.7	6
Arslan et al. (2021)	FLORA	Turkish	06-11/20	Retrospective, cross-sectional	Konya/ single center	Antibody test (=Euroimmun, ELISA, Germany/Vircell, ELISA, Spain)	741	126	17.0	6
Sonmezer et al. (2022)	Vaccines	English	10/20	Prospective, cross-sectional	Ankara/ single center	Antibody test (=Euroimmun, ELISA, Germany)	1974	375	19.0	6

M-M/Y: Month-month/year, HCWs: Healthcare workers, PCR: Polymerase chain reaction, JBI: Joanna Briggs Institute's checklist, PCR: Polymerase chain reaction

Table 2. Meta-analysis of characteristics of healthcare workers infected with SARS-CoV-2

Item	No. of studies	Prevalence (%)	95% CI	Q	I^2	T^2	p	Egger's test (p)
Demographic characteristics								
Age (years, mean)	9	35.238	[33.878, 36.598]	40.275	80.137	3.348	<0.001	1.831 (0.109)
Female	13	0.630	[0.585, 0.672]	32.470	63.043	0.063	0.001	0.284 (0.781)
Doctor	14	0.174	[0.132, 0.225]	71.733	81.877	0.255	<0.001	1.237 (0.239)
Nurse	14	0.363	[0.316, 0.413]	51.916	74.959	0.095	<0.001	1.121 (0.284)
Asthma	5	0.048	[0.035, 0.064]	8.130	50.799	0.195	0.087	1.661 (0.195)
Diabetes mellitus	9	0.034	[0.020, 0.057]	19.964	59.927	0.377	0.010	0.436 (0.675)
Hypertension	8	0.059	[0.032, 0.108]	41.445	83.110	0.720	<0.001	0.796 (0.455)
Clinical manifestations								
Symptomatic	6	0.800	[0.758, 0.836]	9.554	47.665	0.090	0.089	0.289 (0.786)
Asymptomatic	11	0.190	[0.148, 0.239]	23.544	57.527	0.134	<0.001	0.068 (0.946)
Hospitalized	9	0.100	[0.055, 0.175]	70.698	88.684	0.802	<0.001	1.743 (0.125)
Taking ICU treatment	4	0.011	[0.004, 0.028]	0.823	0	0	0.844	8.054 (0.015)
Symptoms								
Fever	9	0.277	[0.190, 0.386]	87.812	90.89	0.472	<0.001	1.665 (0.139)
Cough	10	0.384	[0.294, 0.482]	76.077	88.170	0.338	<0.001	0.121 (0.905)
Fatigue	4	0.348	[0.291, 0.436]	4.551	34.073	0.036	0.208	1.861 (0.203)
Headache	6	0.217	[0.128, 0.343]	36.578	86.330	0.498	<0.001	1.681 (0.167)
Nausea/vomiting	3	0.136	[0.109, 0.170]	2.998	33.286	0.065	0.223	2.552 (0.237)
Loss of Smell	4	0.106	[0.075, 0.149]	2.375	0	0	0.498	0.112 (0.920)
Loss of taste and smell	3	0.253	[0.101, 0.506]	48.897	95.910	0.817	<0.001	2.708 (0.225)
Myalgia	7	0.412	[0.297, 0.538]	69.747	91.397	0.396	<0.001	3.258 (0.022)
Running nose	3	0.150	[0.065, 0.310]	9.737	79.460	0.525	0.008	1.162 (0.452)
Shortness of breath	8	0.234	[0.160, 0.329]	61.190	88.560	0.380	<0.001	0.811 (0.448)
Sore throat	9	0.31	[0.263, 0.361]	17.916	55.347	0.057	0.022	1.288 (0.238)
Diarrhea	6	0.160	[0.119, 0.213]	11.335	55.890	0.088	0.045	3.268 (0.031)
Other characteristics								
Smoker	6	0.212	[0.161, 0.273]	16.504	69.705	0.104	0.006	1.188 (0.300)
Contact status (high risk)	11	0.428	[0.275, 0.595]	292.843	96.585	1.189	<0.001	0.906 (0.388)
Having co-worker with COVID-19	7	0.436	[0.282, 0.603]	93.234	93.565	0.717	<0.001	4.913 (0.004)
Having family member with COVID-19	9	0.235	[0.161, 0.330]	94.889	91.569	0.422	<0.001	3.259 (0.014)

No.: Number, CI: Confidence interval, Q: Cochran's Q statistic for heterogeneity, I^2: İndex for the degree of heterogeneity, T^2: Tau-squared measure of heterogeneity, ICU: Intensive care unite, Contact status (high risk): Working in COVID clinics

5. Prevalence of SARS-CoV-2

Among the included studies for this review, those exploring COVID-19 prevalence with a specific test were grouped according to the period in which they were conducted. Two studies using the PCR test were carried out for the first two months after the pandemic started in the country.[14,20] The estimated pooled prevalence of SARS-CoV-2 infection among HCWs by the PCR test was 9.3% (95% CI 6.2, 13.6) for this period (Table 3). Three studies using the antibody test were conducted in the third and fourth months of the pandemic.[7,18,19] The estimated pooled prevalence was 3.1% (95% CI 2.3, 4.1) by the antibody test for this period (Table 3). Additionally, a forest plot was drawn to demonstrate these results [Fig. 3]. Hovewer, the proportion of infected HCWs was 17.0% (95% CI 14.5, 19.9) between the fourth and eighth months[8] and 19.0% (95% CI 17.3, 20.8) at the eighth month of the pandemic by the antibody test.[9]

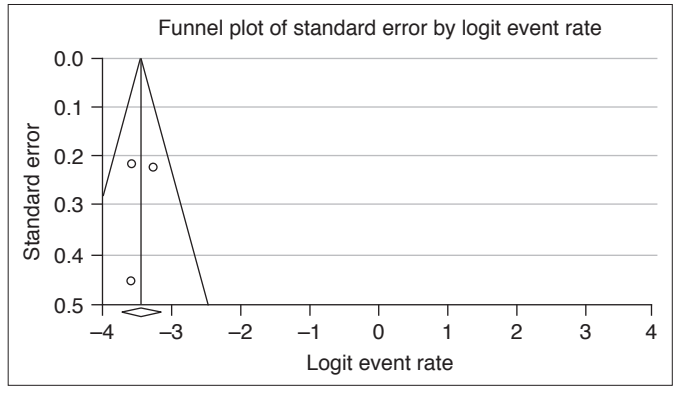

Figure 2: Funnel plot for the studies using antibody tests

Table 3. Meta-analysis of SARS-CoV-2 infection prevalence among healthcare workers

PCR test	Prevalence	95% CI	Egger's test
Korkusuz et al. (2021)	0.116	[0.100, 0.133]	The number of studies must be greater than two
Çelebi et al. (2020)	0.071	[0.054, 0.093]	
Fixed effect model	0.103	[0.091, 0.117]	
Random effect model	0.093	[0.062, 0.136]	
Heterogeneity I^2=90.143, t^2=0.130, p=0.001			
Antibody test			
Gümüş et al. (2021)	0.037	[0.024, 0.056]	t-value=0.283 p-value=0.823
Alkurt et al. (2021)	0.027	[0.018, 0.041]	
Karslıgil et al. (2021)	0.027	[0.011, 0.063]	
Fixed effect model	0.031	[0.023, 0.041]	
Random effect model	0.031	[0.020, 0.047]	
Heterogeneity I^2=0, t^2=0, p=0.565			

PCR: Polymerase chain reaction, CI: Confidence interval, I^2: Index for the degree of heterogeneity, T^2: Tau-squared measure of heterogeneity

There was only one cohort study exploring the COVID-19 rate among HCWs having contact with the infected individuals.[23] It was carried out for the first three months of the pandemic in the country using the PCR test. They found the infection rate to be 3.2%.

Risk Factors

Among the 19 included studies, risk factors for SARS-CoV-2 infection were reported in nine studies. Inappropriate use of personal protective equitment (PPE) such as face masks, dealing with COVID-19 patients, having co-workers with COVID-19, and being overweight were among the risk factors (Table 4).

Discussion

In this systematic review and meta-analysis, we reviewed 19 studies, and a total of 2,367 infected HCWs were analyzed. The estimated pooled prevalence of SARS-CoV-2 infection among HCWs was 9.3% (95% CI 6.2, 13.6) by PCR test for the first two months of the pandemic (Table 3). For the third and fourth months of the pandemic that corresponded with the first wave, it was 3.1% (95% CI 2.3, 4.1) by antibody test (Table 3). Hovewer, the proportion of infected HCWs was 17.0% (95% CI 14.5, 19.9) between the fourth and eighth months[8] and 19.0% (95% CI 17.3, 20.8) at the eighth month of

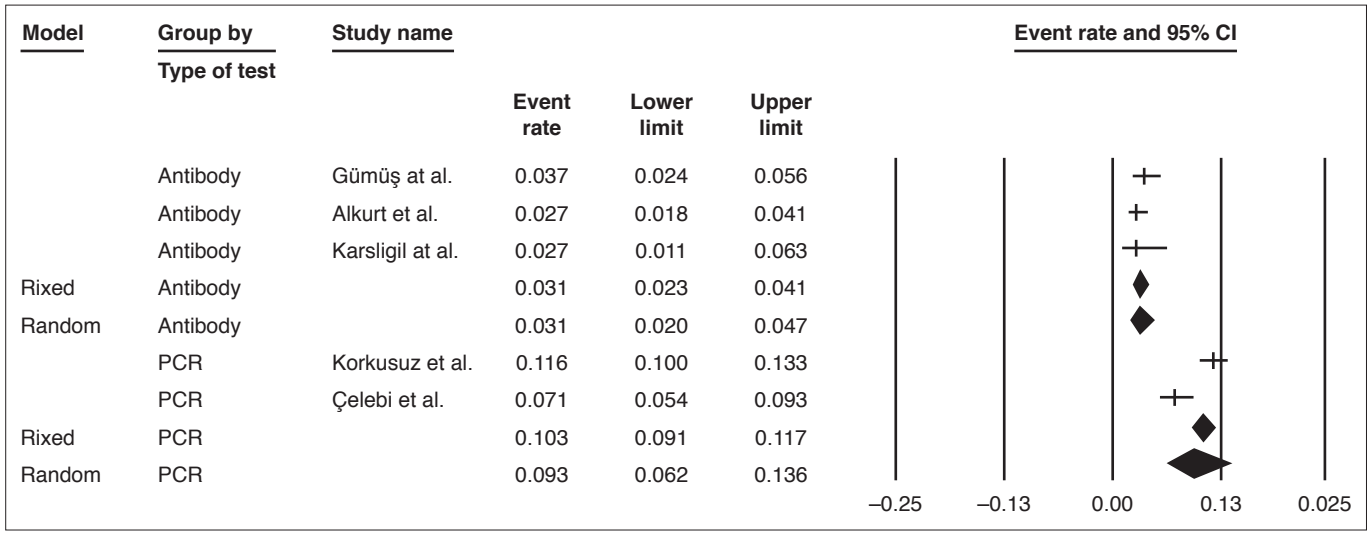

Figure 3: Forest plot for the studies included in the meta-analysis for SARS-CoV-2 prevalence among HCWs

CI: Confidence interval, PCR: Polymerase chain reaction, HCWs: Healthcare workers

Table 4. Risk factors for SARS-CoV-2 infection among HCWs

Reference	Data
Durmaz et al. (2022)	1. HCWs who engaged in risky contact without a mask were at a risk of COVID-19, 3.76 (95% CI 1.57, 9.00) times more than those who wore a mask (p=0.003) 2. Those whose source of contact was an HCW had a 4.21 (95% CI 1.58, 11.23) times higher risk than those with a patient or external source (p=0.004) 3. Those with more than one contact had a 2.82 (95% CI 1.03, 7.70) times higher COVID-19 risk than those with the first contact (p=0.044) 4. Healthcare service staff were reported to have a 2.10 (95% CI 0.28, 15.72) times higher risk compared to those involved in technical services (p=0.471) 5. Contacts that took place in areas where services were provided for COVID-19 patients carried a 1.70 (95% CI 0.78, 3.71) times higher risk of infection than those in other hospital areas or social areas (p=0.186) 6. Being in the high-risk group entailed a 3.60 (95% CI 1.19, 10.89) times higher risk of turning into a COVID-19 case compared to the low-risk group (p=0.024)
Çelebi et al. (2020)	1. The infection rate among HCWs who worked in COVID-19 units was higher (RR=2.449, 95% CI 1.062, 5.649, p=0.027) 2. The presence of a SARS-CoV-2 positive person in the household (p=0.016) 3. Inappropriate use of personal protective equipment while caring for patients with COVID-19 infection (p=0.003) 4. Staying in the same personnel break room as an HCW without a medical mask for more than 15 minutes (p=0.000) 5. Consuming food within 1 m of an HCW (p=0.003) 6. Failure to keep a safe social distance from an HCW (p=0.003) 7. Inappropriate use of PPE during the care of suspected or confirmed cases of COVID-19 (OR=11.295, 95% CI 2.183, 59.429, p=0.04) 8. Staying in the same personnel break room as other HCWs without wearing a medical mask for more than 15 minutes (OR=7.422, 95% CI 1.898, 29.020, p=0.04)
Eser et al. (2022)	1. The highest prevalence of infection (PCR positives or antibody positives) was found in auxiliary health workers (3.7%) which is significantly higher than the other health personnel (p=0.043) 2. The presence of symptoms of a new disease that did not exist before in the last 15 days (p=0.021) 3. The presence of a family member who had symptoms before the last 15 days (p=0.004) 4. Being overweight or obese (p=0.001) 5. Consulting to the hospital surveillance unit as a potential contacted person (p<0.001)
Madran et al. (2020)	1. Working in high-risk areas (OR=5.2, 95% CI 1.99, 13.6, p=0.001) 2. Not using proper PPE (OR=5.9, 95% CI 1.66, 21.2, p=0.006)
Gümüş et al. (2021)	1. Staying in the rooms of patients with COVID-19 for more than 30 minutes (p<0.05). 2. Probability of contracting SARS-CoV-2 was 12 times higher in HCWs having an infected co-worker at the hospital, four times higher for those having an infected family mamber or roommate, and six times higher for those having an infected person in their social environment (p<0.05) 3. Seropositivity rate was higher among non-smokers than smokers (p<0.05) 4. Seropositivity rate was 12 times higher among those taking hydroxychloroquine prophylaxis because of risky contact than those not taking it (p<0.05, 95% CI 4.11, 40.64)
Alkurt et al. (2021)	1. Seropositivity rate was higher in HCWs working in non-pandemic clinics, OR=2.89 (95% CI 1.04, 8.61, p=0.05)
Pınarlık et al. (2021)	1. Being janitorial staff (OR=2.24, 95% CI 1.21, 4.14, p=0.011) 2. Being a medical secretary (OR=4.17, 95% CI 2.12, 8.18, p<0.001) 3. Having at least one household member with a COVID-19 diagnosis (OR=8.98, 95% CI 6.64, 12.15, p<0.001) 4. Number of household members >3 (OR=1.67, 95% CI 1.26, 2.22, p<0.001)
Karslıgil et al. (2021)	1. Full use of PPE significantly reduced the rate of seropositivity (p<0.05) 2. Reduction in contact time significantly reduced the rate of seropositivity (p<0.05)
Sonmezer et al. (2022)	1. Frontline HCWs who had contact with patients (RR=2.1, 95% CI 1.51, 2.92) 2. HCWs working in the COVID-19 units, intensive care units, or emergency department (RR=1.61, 95% CI 1.12, 2.32) had a notably higher anti-SARS-CoV-2 IgG compared to the rest of HCWs who had no daily patient contacts (p<0.0001)

HCWs: Healthcare workers, CI: Confidence interval, PPE: Personal protective equitment, OR: Odds ratio, RR: Relative risk

the pandemic[9] by antibody test, which corresponded with the second wave of the pandemic in our country. These findings showed that the number of HCWs with COVID-19 had increased exponentially within eight months from the beginning of the pandemic in Türkiye. This finding was similar to the results of other studies.

One study was carried out by Korona-Glowniak et al.[25] in Poland, including volunteer HCWs. They found that the seroprevalence of COVID-19 among HCWs was 2.4% in May 2020 (first outbreak) and 22.9% in December 2020 (second outbreak), (Odds Ratio (OR):12.1, 95% CI 4.6, 31.3; p<0.0001). In another study carried out by Hildebrandt et al.[26] in Germany, the seroprevalence of SARS-CoV-2 was 1.1% during the first wave (June-September 2020), 13.2% in the second wave (October 2020-January 2021), and 29.3% in the third wave (February-June 2021). In the meta-analysis by Hossain et al.[27] that included studies from the USA, European, and East Asian countries, the estimated pooled prevalence was 5.7% (4.0, 7.4) in the months of February-April 2020, 8.2% (6.2, 10) in April-May, and 9.9% (6.9, 12.9) in May-September. All of these results show that the number of infected HCWs increased in both our country and other countries as the pandemic progressed.

According to official sources, the number of infected people in the general population was 120,204 at the end of the second month, 201,098 at the forth month, and 377,473 at the eighth month of the pandemic in our country.[3] It means the rate of SARS-CoV-2 infection in the general population had increased more than three times within eight months of the pandemic, although the rate of infected HCWs increased six times in the same period of time. These findings showed that SARS-CoV-2 infection was much more common among HCWs compared to the general population in our country. Our finding was consistent with other studies.[1,2] Strict measures like mandatory face mask wearing and lockdown may have caused the lower rate of SARS-CoV-2 infection among the general population compared to HCWs.

In our study, the age of the infected HCWs as a group was young, with the mean age of 35.238 (95% CI 33.87, 36.59). The rate of female (63%) was higher than males. Most of the infected HCWs (42.8%) had worked in "high risk" areas like the emergency room (ER), intensive care unit (ICU), and COVID clinic. This shows that facing COVID-19 patients had increased the risk of infection. The rate of those having co-workers with COVID-19 (43.6%) was higher than those having infected family members (23.5%) (Table 2). This suggests that in-hospital transmission among HCWs may have been common.

Interestingly, none of the included studies reported any mortality.

Among the included studies in this review, nine of them reported risk factors for COVID-19 among HCWs (Table 4).

Inappropriate use of PPE while dealing with patients with COVID-19 was a risk factor.[15,20,23] In contrast, full use of PPE significantly reduced the rate of seropositivity (p<0.05).[18] The infection rate among HCWs who worked in COVID-19 units was higher (Relative Risk (RR)=2.449, 95% CI 1.062, 5.649, p=0.027).[20] This finding was consistent with the result of the study by Kayı I et al.[28] In contrast, the seropositivity rate was higher in HCWs working in non-pandemic clinics (OR=2.89, 95% CI 1.04, 8.61, p=0.05) in another study.[19] Having an infected houshold member significantly increased the risk of infection.[6,7,10,20] Similarly, having a co-worker with COVID-19 was among the risk factors.[7,23] In addition, failure to keep a safe social distance from an HCW (p=0.003) and staying in the same personnel break room as other HCWs without wearing a medical mask for more than 15 minutes increased the risk of infection (OR=7.422, 95% CI 1.898, 29.020, p=0.04).[20]

In the study by Eser et al.,[10] they found that the highest prevalence of infection (PCR positives or antibody positives) was among auxiliary health workers. This may have resulted from poor adherence to measures among them. Interestingly, Gümüş et al.[7] found that the seropositivity rate was higher among non-smokers than smokers (p<0.05). Also, they found that the seropositivity rate was 12 times higher among those taking hydroxychloroquine prophylaxis because of risky contact than those not taking that (p<0.05, 95% CI 4.11, 40.64).

Pınarlık et al.[6] found that the number of household members >3 increased the risk of infection (OR=1.67, 95% CI 1.26, 2.22, p<0.001). Also, being janitorial staff (OR=2.24, 95% CI 1.21, 4.14, p=0.011) and being a medical secretary (OR=4.17, 95% CI 2.12, 8.18, p<0.001) increased the risk of infection. This may have resulted from poor adherence to measures against the virus among them because of their carelessness.

One of the weaknesses of this study is that the number of studies exploring COVID-19 prevalence with a specific method among HCWs in our country was few. Additionally, the participants in the included studies using antibody tests were all volunteer HCWs, which may not have reflected the prevalence correctly. Another point is

that we could not obtain any data on the rate of death among HCWs with COVID-19 because none of the included studies had reported any death.

This study is the only systematic review conducted on COVID-19 among HCWs in our country, which is a strenght of this study as it sheds light on the status of COVID-19 among HCWs in Türkiye before the vaccination era. Additionally, because we conducted a comprehensive literature search in several databases, we believe that the number of missing studies was likely too small to significantly affect the results.

Conclusion

The results of this systematic review showed that the rate of infected HCWs had increased exponentially from the beginning until the eighth month of the pandemic in our country. COVID-19 disease was much more common among HCWs compared to the general population. Inappropriate use of PPE while dealing with patients, increased contact with patients, and having co-workers or family members with COVID-19 were among the risk factors for contracting the disease. These findings suggest that protective measures are crucial in terms of protecting HCWs from getting infected with the virus. In this context, it is important to provide HCWs with proper PPE and working conditions, as well as to apply strict measures against the virus at healthcare facilities and public places. We recommend that wearing face masks should be mandatory for all people being in healthcare facilities, including HCWs, other workers, and patients, untill the pandemic ends, given that the pandemic is still ongoing with new variants emerging worldwide despite vaccination campaigns against the virus.

Acknowledgement
I would like to thank Turkish Respiratory Society for providing statistician (G) who helped me with the data extraction and quality assessement of the included studies as well as performing statistical analysis for this study.

Conflicts of interest
There are no conflicts of interest.

Financial support and sponsorship
Nil.

Peer-review
Externally peer-reviewed.

References

1. Nguyen LH, Drew DA, Graham MS, Joshi AD, Guo CG, Ma W, et al. Risk of Covid-19 among front-line health-care workers and the general community: A prospective cohort study. Lancet Public Health 2020;5(9):e475–83.
2. Harith AA, Ab Gani MH, Griffiths R, Abdul Hadi A, Abu Bakar NA, Myers J, et al. Incidence, prevalence, and sources of Covid-19 infection among healthcare workers in hospitals in Malaysia. Int J Environ Res Public Health 2022;19(19):12485. [CrossRef]
3. T.C. Sağlık Bakanlığı. COVID-19 Genel Koronavirus Tablosu. Available at: covid19.saglik.gov.tr/TR-66935/genel-koronavirus-tablosu/html. Accessed Apr 24,2023.
4. Medimagazin. Koronavirüs. Available at https://medimagazin.com.tr/koronavirus Accesed Apr 24,2023.
5. Munn Z, Moola S, Lisy K, Riitano D, Tufanaru C. Methodological guidance for systematic reviews of observational epidemiological studies reporting prevalence and cumulative incidence data. Int J Evid Based Healthc 2015;13(3):147–53. [CrossRef]
6. Pınarlık F, Genç Z, Kapmaz M, Tekin S, Ergönül Ö. Risk groups for SARS-CoV-2 infection among healthcare workers: Community versus hospital transmission. Infect Dis Rep 2021;13(3):724–9. [CrossRef]
7. Gümüş HH, Demiroğlu YZ, Alışkan HE, Ödemiş İ, Ceylan Ö, Poçan AG, et al. Covid-19 pandemisinde sağlık çalışanlarının antikor taraması ve risk değerlendirmesi. Mikrobiyol Bul 2021;55(3):357–73.
8. Arslan GK, Özdemir M, Kaya H, Feyzioğlu B, Kepenek Kurt E, Erayman İ. Bir üniversite hastanesi sağlık çalışanlarında Covid-19 seroprevalansı. Flora 2021;26(3):384–91. [CrossRef]
9. Sonmezer MC, Erul E, Sahin TK, Al IR, Cosgun Y, Korukluoglu G, et al. Seroprevalence of SARS-CoV-2 antibodies and associated factors in healthcare workers before the era of vaccination at a tertiary care hospital in Turkey. Vaccines 2022;10(258):1–9. [CrossRef]
10. Eser E, Senol S, Akçalı S, Ecemiş T, Dündar P, Çiçek K, et al. SARS-CoV-2 seroprevalence in health care workers in a third level hospital in Turkey. Turk J Public Health 2022;20(1):117–28. [CrossRef]
11. Demir Ş, İpek BÖ, Apaydın H, Akgün FS, Karadeniz A, Sitar ME, et al. Clinical, laboratory and imaging findings of healthcare workers infected with Covid-19 in a single tertiary healthcare center. Maltepe Med J 2021;13(2):52–6. [CrossRef]
12. Pınar MA, Sarı G, Koyuncu A, Üzmezoğlu B, Şimşek C. Sağlık çalışanlarında Covid-19 enfeksiyon kaynaklarının belirlenmesi: Retrospektif 180 vakanın analizi. Cukurova Med J 2022;47(1):341–9. [CrossRef]
13. Eren E, Çelik İ, Yıldız M, Topaloğlu US, Kılınç Toker A, Arman Fırat E, et al. Covid-19 geçiren sağlık çalışanlarının değerlendirilmesi. Klimik J 2020;33(3):230–4.
14. Korkusuz R, Şenoğlu S, Polat Ö, Karaosmanoğlu HK, Yaşar KK. Prevalence and associated risk factors of Covid-19 infection among healthcare workers in a pandemic hospital. Istanbul Med J 2021;22(4):267–74. [CrossRef]
15. Madran B, Keske Ş, Beşli Y, Bozkurt İ, Ergönül Ö. The risk of SARS-CoV-2 ınfection among healthcare workers. Infect Dis Clin Microbiol 2020;2(2):54–60. [CrossRef]
16. Polat G, Arslan HK, Mimaroğlu F, Polat İ. Evaluation of the route of transmission and clinical course of SARS-CoV-2 ınfection in healthcare workers at Istanbul Medipol University Hospital. CSMJ 2022;2(1):19–25. [CrossRef]
17. Emecen AN, Basoglu Sensoy E, Sezgin E, Yildirim Ustuner B, Keskin S, Siyve N, et al. Transmission dynamics and timing of key

events for SARS-CoV-2 infection in healthcare workers. Infect Dis 2021;53(7):531–7. [CrossRef]

18. Karslıgil T, Akdoğan H. COVID-19 seroprevalence among healthcare workers in a university hospital in Southeastern Turkey. Eur J Ther 2021;27(2):106–12. [CrossRef]
19. Alkurt G, Murt A, Aydin Z, Tatli O, Agaoglu NB, Irvem A, et al. Seroprevalence of coronavirus disease 2019 (Covid-19) among health care workers from three pandemic hospitals of Turkey. PLoS ONE 2021;16(3):e0247865. [CrossRef]
20. Çelebi G, Pişkin N, Bekleviç AÇ, Altunay Y, Keleş AS, Tüz MA, et al. Specific risk factors for SARS-CoV-2 transmission among health care workers in a university hospital. Am J Infect Control 2020;(48):1225–30. [CrossRef]
21. Elarslan S, Güdük Ö, Sertbaş Y. Clinical characteristics of health care workers infected with Covid-19 at the single-center hospital in Turkey. Med Res J 2021;6(1):33–9. [CrossRef]
22. Kaya SD, Öngörü P, Kaya B, Şahin S, Aktaş SÇ, Öcalan GA, et al. Türkiye'de Covid-19 pandemisinin ilk dalgasında sağlık çalışanlarının değerlendirilmesi. Gaziosmanpaşa Üniversitesi Tıp Fakültesi Dergisi. 2021;13(3):250–61.
23. Durmaz S, Kucuk EF, Simsek S, Durgun K, Karakas EB, Durusoy R. Outcomes of Covid-19 contact tracing in hospital healthcare workers: A retrospective cohort study. J Pak Med Assoc 2022;72(4):707–13. [CrossRef]
24. Güldaval F, Anar C, Gayaf M, Büyükşirin M, Polat G, Karadeniz G, et al. Clinical presentation of health care workers with symptoms of coronavirus disease 2019 at the İzmir tertiary education hospital, during an early phase of the pandemic. Tuberk Toraks 2020;68(3):218–26. [CrossRef]
25. Korona-Głowniak I, Mielnik M, Podgajna M, Grywalska E, Hus M, Matuska K, et al. SARS-CoV-2 seroprevalence in healthcare workers before the vaccination in Poland: evolution from the first to the second pandemic outbreak. Int J Environ Res Public Health 2022;19(4):2319. [CrossRef]
26. Hildebrandt A, Hökelekli O, Uflacker L, Rudolf H, Paulussen M, Gatermann SG. Seroprevalence of SARS-CoV-2 antibodies in employees of three hospitals of a secondary care hospital network in Germany and an associated fire brigade: Results of a repeated cross-sectional surveillance study over 1 year. Int J Environ Res Public Health 2022;19(4):2402. [CrossRef]
27. Hossain A, Nasrullah SM, Tasnim Z, Hasan MK, Hasan MM. Seroprevalence of SARS-CoV-2 IgG antibodies among health care workers prior to vaccine administration in Europe, the USA and East Asia: A systematic review and meta-analysis. E Clinical Medicine 2021;33:100770. [CrossRef]
28. Kayı İ, Madran B, Keske Ş, Karanfil Ö, Arribas JR, Pshenichnaya N, et al. The seroprevalence of SARS-CoV-2 antibodies among health care workers before the era of vaccination: a systematic review and meta-analysis. Clin Microbiol Infect 2021;27(9):1242–9. [CrossRef]

Appendix 1. Literature search and Article selection process

Searching databases for relevant articles using key words:

English: PubMed, ScienceDirect, ResearchGate, Google Scholar

Key words:

1. ("COVID-19″ OR "Coronavirus disease" OR "Coronavirus" OR "SARS-CoV-2″) AND (“Seroprevalence” OR “Prevalence” OR “Proportion”) AND ("Healthcare workers" OR “Healthcare personnel”) AND “Turkey”
2. ("COVID-19″ OR "Coronavirus disease" OR "Coronavirus" OR "SARS-CoV-2″) AND (“Risk factors”) AND ("Healthcare workers" OR “Healthcare personnel”) AND “Turkey”

Türkçe: DergiPark, TR Dizin (Ulakbim), Google Akademik

Anahtar kelimeler:

1. (“COVID-19” veya SARS CoV 2 veya “koronavirüs”) + (“seroprevalans” veya “prevalans” veya “oran”) + (“sağlık çalışanları” veya “sağlık personeli”) + “Türkiye”
2. (“COVID-19” veya “SARS CoV 2” veya “koronavirüs”) + (“risk faktörleri”) + (“sağlık çalışanları” veya “sağlık personeli”) + “Türkiye”

Example:

For Science Direct; (“SARS CoV 2” OR “COVID-19”) AND “Healthcare workers” AND “Turkey”

For DergiPark: “SARS CoV 2” + “sağlık çalışanları”+ “Türkiye”

Result of the first searching of databases for each database;

1. Dergi Park: Total=277
2. ULAKBIM TRDizin: Total=7
3. PubMed: Total=26
4. ScienceDirect: Total=327
5. ResearchGate: Total=74
6. Google Scholar: Total=164

Total=875

Duplicate=10

Records identified through Databases search (n=875)

Records after duplicate removal (n=865) (Duplicate=10)

Records reviewed by Title and Abstract (n=865)

Excluded records (n=842)

No Access to full text (=1)

Articles assessed by a Full-Text Review (n=22)

Excluded articles (n=5)

Records identified and included through other sources (n=2); from References of the selected articles

Articles included in the review (n=19)

No Access to full text (n=1)

1. Çavdar S, Tokaç AZ, Ataç Ö, Sezerol MA, Taşçı Y, Hayran O.

COVID-19 prevalence among primary healthcare workers ;

ESTÜDAM Public Health Journal. 2022;7(2):326-39

Excluded because the full text of the article was not accessed. It was asked the correspondent author of the study via e-mail and she told that it would be published later. It was not published within the time frame determined for literature searching of this review.

Excluded Articles after Full-text assessement (n=5)

1. Özdemir A, Demir Çuha M, Telli Dizman G, Alp A, Metan G, Şener B. SARS-CoV-2 Seroprevalence Among Healthcare Workers: Retrospective Analysis of the Data From A University Hospital in Turkey. Mikrobiyol Bul. 2021 Apr;55(2):223-232. doi: 10.5578/mb.20219908
   Excluded because some of the study participants was the same as those in another study (Sonmezer et al.) carried out at the same healthcare facility (Hacettepe University Hospital) that was included in this review.

Appendix 1. Cont.

Excluded Articles after Full-text assessement (n=5)

2. Durusoy R, Ata A, Geçim C, Filis N. The surveillance, exposure investigation and contact tracing of COVID-19 cases at Ege University Medical School's Hospital Turkish Journal of Public Health 18 (2020): 25-39.
   Excluded because some of the study participants was the same as those in another study (Durmaz et al.) carried out at the same healthcare facility (Ege University Hospital) that was included in this review.
3. Seyfi Durmaz, Aysu Ata Taneler, Aysun Cevhertas. A University hospital healthcare workers' high-risk contact with patients diagnosed with coronavirus disease (COVID-19): a cross- sectional evaluation. Ege Journal of Medicine. 2021; 60 (2): 145-154.
   Excluded because it included unrelevant results.
4. Uzun Şahin C, Kulakaç N. Determination of the Factors Affecting the COVID-19 Knowledge Levels and the Status of Being Diagnosed with COVID-19 in Healthcare Employees Struggling with Pandemic. Gümüşhane University Journal of Health Sciences. 2022; 11(1): 202-211.
   Excluded because it was unclear which period of time study participants had been tested or assessed for SARS CoV 2 infection. It was asked the study's correspondent author via e-mail but she did not answer.
5. Öztürk C, Köse E, Duran P, Kahraman G, Memiş N, Kayabaşı E, Öksüz Ş, Şahin İ, Çalışkan E. Investigation of SARS CoV 2 IgG Seropositivity in health Care Workers Journal of Duzce University Health Sciences Institute / J DU Health Sci Inst ISSN: 2146-443X. 2021; 11(3): 382-385.
   Excluded because study participants were working Pandemic clinics, ICU and Pandemic laboratory dealing with only COVID-19 disaese patients.

Articles included after Reference search (=2)

1. Güldaval F, Anar C, Gayaf M, et al. Clinical presentation of health care workers with symptoms of coronavirus disease 2019 at the İzmir tertiary education hospital, during an early phase of the pandemic. Tuberk Toraks 2020;68(3):218-226.
2. Durmaz S, Küçük EF, Şimşek S, Durgun K, Karakaş EB, Durusoy R. Outcomes of COVID-19 contact tracing in hospital healthcare workers: a retrospective cohort study. Journal of the Pakistan Medical Association. 2022.

Another notice (=1)

1. Karslıgil T, Akdoğan H. COVID-19 Seroprevalence among Healthcare Workers in a University Hospital in Southeastern Turkey. Eur J Ther 2021;27(2):106-112
   Exact time period in which study participants had been tested for SARS CoV 2 infection was not clear in this article. So, It was asked correspondent author of the article and he explained that it was from June 29, 2020 to July 9, 2020.