

Assessment of Healthcare Workers' Performance toward the Coronavirus Disease-19 Pandemic in Healthcare Settings

Dina Refaat Hussien El-Sayed¹, Mohamed Mustafa Abd Algany², Samar Elhoseiny
Abdelraouf³



¹BSc.N. Faculty of Nursing, Zagazig University, Quality Specialist, Directorate of Health Affairs, Sharkia Governorate, Egypt.

²Lecturer of Community Health Nursing, Faculty of Nursing, Mansoura University, Egypt.

³Professor of Community Health Nursing, Faculty of Nursing, Mansoura University, Egypt

1.ABSTRACT

The coronavirus disease-19 pandemic (COVID-19) has challenged health systems worldwide, especially the health workforce, a pillar crucial for health system resilience. Therefore, this study aimed to assess healthcare workers' (HCW) performances related to the COVID-19 pandemic in healthcare settings. This was a descriptive cross-sectional study design on 339 HCWs in healthcare settings in Diarb Al-Souk village and Diarb Negm City, Sharkia. To gather the data, researchers employed a structured self-administered questionnaire to identify socio-demographic and occupational characteristics, as well as a structured observational checklist to evaluate performance. The current study shows that 99.7%, 94.7%, and 61.9% of HCWs exhibit inadequate performance concerning the "five moments of hand hygiene," the "hand hygiene technique with soap and water," and with alcohol-hand-based rub, 67.8%, 100%, 71.7%, 95%, 99.4%, 100%, and 99.7% toward hand hygiene, wearing a gown, mask with ties, mask with elastic headbands, respirator, goggles or face shield and gloves in sequence for donning personal protective equipment (PPE), respectively. Also, incompetent performance observed in 100% of PPE as follows: gown, respirator removal by touch technique, respirator removal by non-touch technique, and eyewear or face shield removal. In addition, 90% and 97.6% of the HCWs incompetently performed the mask with ties and the removal of the gloves, respectively. The researchers conclude that incompetence is observed in HCW performance during the COVID-19 pandemic. Finally, the researchers recommend that scheduled on-the-job training programs be conducted for all HCWs on COVID-19 pandemic infective preventive measures, their performance, and clinical monitoring and supervision of HCWs to ensure that they strictly adhere to COVID-19 pandemic infection prevention guidelines.

Keywords: Coronavirus Disease-19, Healthcare Workers, Infection Preventive Measures, Pandemic, Performance

2.Introduction

The coronavirus disease-19 pandemic (COVID-19) caused a heightened risk of occupational exposure for health and HCWs worldwide to a new fast-spreading disease and created the need to adapt roles and responsibilities for a wide range of tasks and professional settings (WHO, 2020).

The COVID-19 pandemic resulted in many infections and deaths among HCWs and their households. Undoubtedly, the health and care sector is one of the most severely hit by the COVID-19 pandemic. Those employed or contracted in it face multiple hazards that affect their physical, mental, and social well-being. HCWs have been documented to have a higher risk of infection with SARS-CoV-2 than the general population (Nguyen & Drew, 2020). Prevention and control of COVID-19 depend greatly on the education and awareness of HCWs.

To the researchers' best knowledge, no published work on the infection status among HCWs during the COVID-19 pandemic has been identified so far. In this study, the researcher obtained data from government official reports and carried out a data analysis of the infection status of the HCWs in healthcare settings during the COVID-19 pandemic outbreak. By conducting a quantitative descriptive cross-sectional study, the researchers aim to provide some thoughts and recommendations to protect HCWs worldwide, especially those working in healthcare settings in Egypt.

2.1 Aim of the Study

Assess healthcare workers' performances related to COVID-19 pandemic in health care settings.

2.2 Research Question

What are healthcare workers' performances related to COVID-19 pandemic?

3. Method

3.1 Study Design

A descriptive cross-sectional design was used in the conduct of the study.

3.2 Setting

This study was carried out in healthcare settings in Diarb Al-Souk village and Diarb Negm city, Sharkia Governorate.

3.3 Participants and Sampling

Healthcare workers on duty during the period of data collection at Diarb Al-Souk village health unit and Diarb Negm Hospital, Sharkia Governorate, over a period of three months were included in the study under the following criteria: both genders, different qualifications, and no restriction on years of experience.

A sample size of HCWs was calculated based on Krejcie and Morgan (1970); accordingly, the researchers recruited 339 HCWs out of 1359; this was carried out by a disproportionate quota sample.

3.4 Data Collection Tools

The researchers developed two tools after reviewing the relevant literature for the collection of data, as follows:

Tool (I) Healthcare workers' demographic and occupational characteristics self-administered questionnaire. The researchers identified demographic and occupational characteristics of HCWs that included gender, age, marital status, residence, socioeconomic status, educational level, working place, department, job title, years of experience, training on the COVID-19 pandemic, suspicion of being infected with the COVID-19 pandemic, action taken with a confirmed diagnosis, and transmission of infection with the COVID-19 pandemic to relatives.

Tool (II) Healthcare workers' performances toward the COVID-19 pandemic structured observational checklist. The researchers observed HCWs' performances regarding infection prevention and control measures during the COVID-19 pandemic, as mentioned below.

Health care workers' performance scoring system. The researchers awarded each correct step three marks and formulated a rubric format that provides specific expectations for three levels of healthcare workers' performances. The total score of performance ranged from (0 to 456).

According to the researchers' cut-off point, the performance levels were categorized into three categories:

- **Competent** = score of 80 % or more of the total score (364.8 and more).
- **Improving** = score of 50% to less than 80% of the total score (228 to less than 364.8).
- **Incompetent** = score less than 50% of the total score (less than 228).

3.5 Procedure

Administrative process. Faculty of Nursing, Mansoura University, issued an official letter to the director of the Directorate of Health Affairs, Sharkia Governorate, to obtain approval for conducting the study at the selected healthcare settings.

Ethical Considerations. The researchers obtained approval from the Research Ethics Committee, Faculty of Nursing, Mansoura University. Oral consent was obtained from each HCW before the start of the study. The researchers introduced themselves and gave a simple explanation of the aim and process of the study. They were assured that their participation in the study was voluntary, and the collected data was treated confidentially and only used for the purpose of the study. Participants were informed that they have the right to ask any question related to the study and that they have the right to withdraw at any time from the study without giving any reason.

Literature review. A review of the past, current, local, and international related literature using available source books, articles, periodicals, and magazines was necessary to become acquainted with all aspects of the study problem and to develop relevant tools for data collection.

Development of the study tools. The researchers developed the first and second tools of data collection, supported by reviewing the relevant literature.

Face and content validity. According to Litwin (1995), Maruish (2011), Miller (2010), Polit and Beck (2006), and Tavakol and Dennick (2011), face validity is established when an individual (or researcher) who is an expert on the research subject

reviewing the questionnaire (instrument) concludes that it measures the characteristic or trait of interest. Content validity pertains to the degree to which the instrument fully assesses or measures the construct of interest. Study tools were tested for appropriateness and had relevant items by five experts in community health nursing and infection prevention and control.

3.6 Tools reliability

Cronbach's alpha test tested the reliability of the tool using SPSS v24, as its value was 0.95 for HCWs' performances toward the COVID-19 pandemic's performance observational checklist.

Pilot study. The researchers conducted it on 10% (34) of the study participants, recruited conveniently from the same study settings, to test the content validity, reliability, and applicability of the study tools. According to the results, the necessary modifications were made. Participants in the pilot study were excluded from the main sample of the study.

3.7 Field work phase

Data collection period. Data collection lasted approximately three months, from the beginning of December 2020 to the end of February 2021. The researchers visited Diarb Al-Souk village health unit and Diarb Negm Hospital six days a week, two days each, except Friday.

The researchers visited the previously mentioned settings over interchangeably many weeks' days to ensure interviewing different members of the HCWs, covering different work shifts. Each interview took from 15 to 20 minutes.

The researchers distributed tool I to HCWs individually to collect their socio-demographic and occupational characteristics.

The researchers observed HCWs' performance toward infection prevention and control measures during the COVID-19 pandemic by using Tool II.

3.8 Statistical Analysis

Quantitative data related to age was organized, categorized, and tabulated. Suitable statistical tests were used to present the obtained data and test the significance of the results. IBM's SPSS statistics (Standing for Statistical Product and Service Solutions) for Windows (version 24) was used for statistical analysis of the collected data. Then, simple frequency tables were used to present the results: arithmetic mean \pm standard deviation for continuous variables and percentages for

categorical variables.

4. Results

As shown in Table 1, 55.5%, 49%, 61.9%, 62.2%, 85.5%, and 31.3% of HCWs are females, aged from 30 to 45 years with a mean age of 35.59 (8.83) years, married, residents of rural areas, had moderate economic status, and graduated from technical institutes, respectively.

Table 2 illustrates that 56.3% and 41.9% of HCWs worked in hospitals and managerial offices, respectively. In relation to job title, physicians, nurses, pharmacists, dentists, laboratory technicians, and physiotherapists represented 8.8%, 18.3%, 12.1%, 6.8%, 6.8%, and 4.7%, respectively. Years of experience among 50.7% of HCWs were more than 10 years, with a mean of 12.28 (8.13) years, and 31% of them trained during the COVID-19 pandemic, from one to three times or more.

Table 3 reveals that 45.3% of the HCWs were suspected of being infected with the COVID-19 pandemic, while 22.4% were confirmed to be infected with it; 73.5% of the HCWs confirmed to be infected with the COVID-19 pandemic did not receive any healthcare procedures. Finally, 28% of the HCWs transmitted the COVID-19 pandemic to their relatives.

Table 4 explains that incompetent performance was observed among 99.7%, 94.7%, and 61.9% of HCWs related to five moments of hand hygiene, hand hygiene technique with soap and water, and alcohol-hand-based rub.

Tables 5 and 6 illustrate the performance of donning and donning off personal protective equipment. Results reveal that 67.8%, 100%, 71.7%, 95%, 99.4%, 100%, and 99.7% of HCWs were incompetent in their performance-related activities, wearing a gown, mask with ties, mask with elastic headbands, respirator, goggles or face shield, and gloves in sequence for donning PPE, respectively (Table 5).

Table 6 illustrates that 100% of the HCWs were incompetent in their performance towards PPE, as follows: gown, respirator removal by touch technique, respirator removal by non-touch technique, and eyewear or face shield removal. In addition, 90% and 97.6% of the HCWs incompetently performed the mask with ties and the removal of the gloves, respectively.

Table 1. Socio-demographic characteristics of healthcare workers

	n=(339)	%
Gender		
- Males	151	44.5
- Females	188	55.5
Age		
- Less than 30 years	119	35.1
- 30 to 45 years	166	49
- More than 45	54	15.9
Mean(SD)	35.59	(8.83)
Residence		
- Urban	128	37.8
- Rural	211	62.2
Educational level		
- Read and write, primary, preparatory	11	3.3
- Secondary (general and technical of 3 or 5 years)	81	23.9
- Technical institutes degree	106	31.3
- Bachelor degrees	94	27.7
- Postgraduate degrees (Diploma, Master, Doctorate)	47	13.7

Table 2. Occupational characteristics of healthcare workers

Item	n=(339)	%
Working place		
- Health Management	105	31
- Hospital	191	56.3
- Health unit	43	12.7
Department		
- Sections of isolation and screening	17	5
- Rays departments	11	3.2
- Pharmacy	25	7.4
- Outpatients	65	19.2
- Laboratory	29	8.6
- Internal	19	5.6
- Critical and specialized	31	9.1
- Administrative	142	41.9
Job title		
- Clerk	26	7.1
- Worker	17	5
- Technician	39	11.5
- Statistician	11	3.2
- Rural pioneer	3	0.9
- Physiotherapist	16	4.7
- Physician	30	8.8
- Pharmacist	41	12.1
- Nurses	62	18.3
- Laboratory technician	23	6.8
- Health supervisor	21	6.2
- Dentist	23	6.8
- Administrator	27	8
Years of experience		
- Less than 10 years	172	50.7
- 10 – 20 years	113	33.3
- More than 20 years	54	15.9
Mean(SD)	12.28 (8.13)	
Training during the Covid-19 pandemic		
- 1	59	17.4
- 2	37	10.9
- 3 or more	9	2.7

Knowledge of Female Health Care Workers

Table 3. History of the coronavirus disease-19 pandemic among the healthcare workers

Item	n=(339)	%
Suspected to be infected with the COVID-19 pandemic	184	54.3
Confirmed diagnosis with the COVID-19 pandemic	76	22.4
The action was taken with a confirmed diagnosis of the Covid-19 pandemic		
- Nothing	249	73.5
- Hospital isolation, and administration of medication	34	10
- Home isolation, and administration of medication	56	16.5
Transmit infection with the COVID-19 pandemic to relatives	42	28

Table 4. Healthcare workers' performance of hand hygiene

Items	n=(339)	%
Five moments of hand hygiene (15 marks)		
- Improving	1	0.3
- Incompetent	338	99.7
Hand hygiene technique with soap and water (33 marks)		
- Improving	18	5.3
- Incompetent	321	94.7
Hand hygiene technique with alcohol-hand-based rub (24 marks)		
- Improving	129	38.1
- Incompetent	210	61.9

Table 5. Healthcare workers' performance in donning personal protective equipment

Items	n=(339)	%
Sequence for donning PPE		
Hand hygiene (6 marks)		
- Improving	109	2.2
- Incompetent	230	67.8
Gown (21 marks)		
- Incompetent	339	100
Mask		
Mask has ties (9 marks)		
- Competent	31	9.1
- Improving	65	19.2
- Incompetent	243	71.7
Mask has elastic headbands (15 marks)		
- Improving	17	5
- Incompetent	322	95
Respirator (21 marks)		
- Improving	2	0.6
- Incompetent	337	99.4
Goggles or face shield (18 marks)		
- Incompetent	339	100
Gloves (36 marks)		
- Improving	1	0.3
- Incompetent	338	99.7

Table 6. Healthcare workers' performance in doffing personal protective equipment

Items	n= (339)	%
Sequence for doffing PPE		
Gown (18 marks)		
- Incompetent	339	100
Mask (12 marks)		
- Competent	8	2.4
- Improving	26	7.7
- Incompetent	305	90
Respirator removal by touch technique (15 marks)		
- Incompetent	339	100
Respirator removal by non-touch technique (27 marks)		
- Incompetent	339	100
Eyewear and face wear removal (18 marks)		
- Incompetent	339	100
Gloves (39 marks)		
- Improving	8	2.4
- Incompetent	331	97.6

5. Discussion

The impacts of the COVID-19 pandemic worldwide are conspicuous, as it prominently affects the healthcare features of various nations (Jazieh & Kozlakidis, 2020). According to WHO (2021a), the universal cost of the COVID-19 pandemic has been enormous. By the conclusion of 2021, records of at least 282 million collectively definite patients and 5.4 million mortalities were reported. Such numbers represented a clue for the marked underestimation of the real magnitude of the COVID-19 pandemic morbidities and mortality.

The COVID-19 pandemic's consecutive influences affect health organizations and put them under massive stress in both well-developed and underdeveloped nations. Along with enlarged patient numbers, HCWs have been at the frontiers of SARS-CoV-2 exposure, and WHO estimations report that about 116 000 HCWs died due to the COVID-19 pandemic starting from January 2020 to May 2021 (WHO, 2021b).

Therefore, HCWs are at elevated risk in the war against the COVID-19 pandemic, as many HCWs were disease-ridden and passed away with the COVID-19 pandemic, and many were isolated to inhibit the dissemination of such infection (Nagesh & Chakraborty, 2020). As well, HCWs have been at greater health risks for psychological stress, fatigue, long working hours, work-related burnout, stigma, and violence (Gupta et al., 2021).

Healthcare organizations seemed incapable of absorbing and managing unexpected and continuous burdens on the healthcare load, particularly in acute care settings. Although

eventuality strategies were introduced and often applied, healthcare organizations appeared incapable of coping with the abrupt, intense rush to request them (Hick et al., 2020).

Hand sanitation, appropriate hand washing, and individual protection tools significantly decrease the spread of the COVID-19 pandemic in health services and organizations. Therefore, sufficient training and assets are vital for health authorities and professionals to avoid contagion to new patients receiving care in health services (WHO, 2020).

To the researchers' knowledge, limited research studies in Egypt have studied the COVID-19 pandemic among HCWs. The main concern of this study was to assess healthcare workers' performances related to the COVID-19 pandemic in healthcare settings.

The results of the present study illustrate that less than half of the HCWs are suspected to be infected with the COVID-19 pandemic, while less than one-fourth are confirmed diagnosed with it, and less than three-fourths out of those confirmed diagnosed have nothing. More than one-fourth of the HCWs' relatives have acquired the COVID-19 pandemic via them. That prevalence can be explained because more than half of the study participants work in hospitals and direct contact with patients, respectively.

These results are similar to the former seropositive prevalence research that has predicted different rates of COVID-19 pandemic IgG seropositivity amongst HCWs, with figures in the range of 4 to 40% (Self et al., 2020; Sood et al.,

2020; Iruretagoyena et al., 2021; Moncunill et al., 2021; Venugopal et al., 2021).

Furthermore, Iruretagoyena et al. (2021) reported that the seropositive prevalence among HCWs in Chile was 24%, while Venugopal et al. (2021) reported that 27% of HCWs in a New York City hospital tested seropositive for the COVID-19 pandemic. A previous Egyptian cross-sectional study stated that, according to a self-report, 89.2% of HCWs indicated they were more predisposed to the COVID-19 pandemic (Abdel Wahed et al., 2020). Abdelmoniem et al. (2021) reported that the rate of the COVID-19 pandemic in asymptomatic HCWs of Egyptian tertiary care by PCR-RT was 14.3%.

Results of the present study reflect that incompetent performance is observed in HCWs' performance in five moments of hand hygiene: hand hygiene technique with soap and water, alcohol-hand-based rub, sequence of donning PPE: hand hygiene, wearing a gown, mask with ties, mask with elastic headbands, respirator, and goggles or face shield and gloves, respectively. Also, in doffing PPE, it is as follows: gown, respirator removal by touch technique, respirator removal by non-touch technique, eyewear or face shield, as well as a doffing mask with ties and gloves. From the researcher's point of view, only almost one-third of the HCWs have been trained during the COVID-19 pandemic, from one to three times or more. Furthermore, facing devastating experiences can explain their blunder in performance.

Personal protective equipment provides significant safety for work-related contact with the COVID-19 pandemic, besides the standard contagion avoidance procedures such as distancing and hand hygiene. References concerning the proper practice of PPE have been delivered by both international and national administrations such as WHO and CDC (Gaikwad et al., 2022).

In the study of Abdel Wahed et al. (2020), they reported an overall positive attitude regarding infection control measures by HCWs such as face masking, hand washing, and avoiding skin and eye touching, while they reported that medical doctors had a poor attitude towards the COVID-19 pandemic status in Egypt and the Egyptian authorities' role in controlling and prevention.

The paramount method for HCWs to avoid the contagion of the COVID-19 pandemic is through training, practicing, and establishing competency in donning and doffing PPE (Ortega et

al., 2020). Firm adherence to the putting and removing steps of PPE would diminish the probability of contagion exposure. Moreover, producing awareness about infection control procedures and breaches that are frequently encountered by HCWs with their results is essential and could help guide upcoming plans to handle the crisis (Gaikwad et al., 2022).

Despite its aids, PPE is linked to an important negative effect on skills such as communication, vision, and comfort, as well as a minor negative effect on decisions and technical skills. Improving PPE should be taken into consideration, particularly during pandemics (Alarfaj et al., 2021).

6. Conclusion

The researchers conclude that incompetence is observed in HCWs' performance in five moments of hand hygiene: hand hygiene technique with soap and water, alcohol-hand-based rub, sequence of donning PPE: hand hygiene, wearing a gown, mask with ties, mask with elastic headbands, respirator, and goggles or face shield and gloves, respectively. Also, in doffing PPE as follows: gown, respirator removal by touch technique, respirator removal by non-touch technique, and eyewear or face shield; as well, in doffing masks with ties and gloves.

7. Recommendations

- Conduct scheduled on-the-job training programs for all HCWs on the COVID-19 pandemic infective preventive measures to update their knowledge and performance.
- Close monitoring and supervision of HCWs to ensure that they strictly adhere to the COVID-19 pandemic infection prevention guidelines.
- Emphasize hand hygiene as a milestone in infection prevention and control measures.
- Permit a visualization of infection prevention and control policy and procedures to be available that would serve as guidance for HCWs in the three healthcare settings.
- Carry out further research to explore the phenomena of the COVID-19 pandemic from different aspects and explore factors that contribute to HCWs' adherence to infection prevention and control measures.

8. References

- 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. *Journal of community health*. 2020 Dec;45(6):1242-51.
- Abdelmoniem R, Fouad R, Shawky S, Amer K, Elnagdy T, Hassan WA, Ali AM, Ezzelarab M, Gaber Y, Badary HA, Musa S. SARS-CoV-2 infection among asymptomatic healthcare workers of the emergency department in a tertiary care facility. *Journal of Clinical Virology*. 2021 Jan 1;134:104710.
- Alarfaj MA, Foula MS, Alshammary S, Nwesar FA, Eldamati AM, Alomar A, Abdulmomen AA, Alarfaj L, Almulhim A, Alarfaj O, Zakaria HM. Impact of wearing personal protective equipment on the performance and decision making of surgeons during the COVID-19 pandemic: An observational cross-sectional study. *Medicine*. 2021 Sep 9;100(37).
- Gaikwad UN, Bose O, Padhi A, Jindal A, Nagpure K, Bhargava A, Das P. A retrospective observational insight into COVID-19 exposures resulting from personal protective equipment (PPE) breaches. *PloS one*. 2022 May 17;17(5):e0268582.
- Gupta N, Dhamija S, Patil J, Chaudhari B. Impact of COVID-19 pandemic on healthcare workers. *Industrial Psychiatry Journal*. 2021 Oct;30(Suppl 1):S282.
- Hick JL, Hanfling D, Wynia MK, Pavia AT. Duty to Plan: Health Care, Crisis Standards of Care, and Novel Coronavirus SARS-CoV-2. *NAM Perspectives*. Discussion paper. Washington, DC: National Academy of Medicine. (2020).
- Iruretagoyena M, Vial MR, Spencer-Sandino M, Gaete P, Peters A, Delgado I, Perez I, Calderon C, Porte L, Legarraga P, Anderson A. Longitudinal assessment of SARS-CoV-2 IgG seroconversion among front-line healthcare workers during the first wave of the Covid-19 pandemic at a tertiary-care hospital in Chile. *BMC infectious diseases*. 2021 Dec;21(1):1-0.
- Jazieh AR, Kozlakidis Z. Healthcare transformation in the post-coronavirus pandemic era. *Frontiers in Medicine*. 2020 Jul 28;7:429.
- Litwin, M. (1995). *How to Measure Survey Reliability and Validity*. Thousand Oaks, CA: Sage Publications.
- Maruish, M. E. (2011). *User's Manual for the SF Health Survey*. 3rd ed. Lincoln, RI: Quality Metric Incorporated.
- Miller, M. J. (2010, Oct10). *Graduate Research Methods*. http://www.michaeljmillerphd.com/res500.../reliability_and_validity.
- Moncunill G, Mayor A, Santano R, Jiménez A, Vidal M, Tortajada M, Sanz S, Méndez S, Llupià A, Aguilar R, Alonso S. SARS-CoV-2 seroprevalence and antibody kinetics among health care workers in a Spanish hospital after 3 months of follow-up. *The Journal of infectious diseases*. 2021 Jan 1;223(1):62-71.
- Nagesh S, Chakraborty S. Saving the frontline health workforce amidst the COVID-19 crisis: Challenges and recommendations. *Journal of Global Health*. 2020;10(1). pmid:32373323.
- Nguyen, L. H., & Drew, D. A. (2020). Graham MS et al. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study. *Lancet Public Health*, 5(9), e475-e483.
- Ortega R, Gonzalez M, Nozari A, Canelli R. Personal Protective Equipment and Covid-19. *N Engl J Med*. 2020:e105.
- Polit D.F, Beck C.T. (2006). The content validity index: *Are you sure you know what's being reported? Critique and recommendations*. *Res Nurs Health*.
- Self WH, Tenforde MW, Stubblefield WB, Feldstein LR, Steingrub JS, Shapiro NI, Ginde AA, Prekker ME, Brown SM, Peltan ID, Gong MN. Seroprevalence of SARS-CoV-2 among frontline health care personnel in a multistate hospital network—13 academic medical centers, April–June 2020. *Morbidity and Mortality Weekly Report*. 2020 Sep 9;69(35):1221.

Knowledge of Female Health Care Workers

- Sood N, Simon P, Ebner P, Eichner D, Reynolds J, Bendavid E, Bhattacharya J. Seroprevalence of SARS-CoV-2-specific antibodies among adults in Los Angeles County, California, on April 10-11, 2020. *Jama*. 2020 Jun 16;323(23):2425-7.
- Tavakol M, Dennick R. (2011). *Making sense of Cronbach's alpha*. *Int J Med Educ*;2:535.
- Venugopal U, Jilani N, Rabah S, Shariff MA, Jawed M, Batres AM, Abubacker M, Menon S, Pillai A, Shabarek N, Kasubhai M. SARS-CoV-2 seroprevalence among health care workers in a New York City hospital: A cross-sectional analysis during the COVID-19 pandemic. *International Journal of Infectious Diseases*. 2021 Jan 1;102:63-9.
- World Health Organization, (WHO). (2020). *Coronavirus disease (COVID-19) Situation Report -184*. *national: WHO*.
- World Health Organization, 2. (2020). *Transmission of SARS-CoV-2: implications for infection prevention precautions: scientific brief, 09 July 2020* (No. WHO/2019-nCoV/Sci_Brief/Transmission_modes/2020.3). World Health Organization.
- World Health Organization. (2020). *Health workforce policy and management in the context of the COVID-19 pandemic response: interim guidance, 3 December 2020* (No. WHO/2019-nCoV/health_workforce/2020.1). World Health Organization.
- World Health Organization. (2020). *Public health surveillance for COVID-19: interim guidance, 16 December 2020* (No. WHO/2019-nCoV/SurveillanceGuidance/2020.8). World Health Organization.