Frontline Healthcare Workers’ Knowledge and Perception of COVID-19, and Willingness to Work during the Pandemic in Nepal

Dipak Prasad Upadhyaya 1,2,*, Rajan Paudel 2,†, Dilaram Acharya 3,†, Kaveh Khoshnood 4, Kwan Lee 3, Ji-Hyuk Yoo 3,†, Archana Shrestha 5,6,*, Bom BC 7, Sabin Bhandari 8, Ramgyan Yadav 7, Ashish Timalsina 7, Chetan Nidhi Wagle 7, Brij Kumar Das 7, Ramesh Kunwar 7, Binaya Chalise 9, Deepak Raj Bhatta 7 and Mukesh Adhikari 7,10,†

1 School of Medicine, Case Western Reserve University, Euclid Ave, Cleveland, OH 44106, USA
2 Central Department of Public Health, Institute of Medicine, Tribhuvan University, Kathmandu 44600, Nepal; paudel.rajan@gmail.com
3 Department of Preventive Medicine, College of Medicine, Dongguk University, Gyeongju 38066, Korea; dilaramacharya123@gmail.com (D.A.); kwaniya@dongguk.ac.kr (K.L.); skeyd@naver.com (J.-H.P.)
4 Department of Epidemiology of Microbial Diseases, Yale School of Public Health, Yale University, New Haven, CT 06510, USA; kaveh.khoshnood@yale.edu
5 Department of Public Health, School of Medical Sciences, Kathmandu University, Dhulikhel 45200, Nepal; archana@kusms.edu.np
6 Institute for Implementation Science and Health, Kathmandu 44600, Nepal
7 Ministry of Health and Population, Kathmandu 44600, Nepal; bombc2011@gmail.com (B.B.); Ramgderma@gmail.com (R.Y.); ashish.timalsina@gmail.com (A.T.); uchetan@hotmail.com (C.N.W.); dasbrijkumar@gmail.com (B.K.D.); ramesh.kunwar04@gmail.com (R.K.); deepakbhattaph@gmail.com (D.R.B.); mukesh.adhikari@yale.edu (M.A.)
8 B.P Koirala Institute of Health Sciences, Dharan 56700, Nepal; sabin7000@gmail.com
9 Graduate School for International Development and Cooperation, Hiroshima University, Hiroshima 739-8527, Japan; binayachalise@gmail.com
10 Department of Health Policy and Management, Yale School of Public Health, Yale University, New Haven, CT 06510, USA
* Correspondence: dipak.upadhyaya@cdph.tu.edu.np (D.P.U.); medhippo@dongguk.ac.kr (S.-J.Y.); Tel.: +977-9851121268 (D.P.U.); +82-10-6817-6330 (S.-J.Y.); Fax: +82-54-770-2825 (S.-J.Y.)
† Authors contributed equally as joint first author.

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Abstract: This study investigated the contextual factors associated with the knowledge, perceptions, and the willingness of frontline healthcare workers (FHWs) to work during the COVID-19 pandemic in Nepal among a total of 1051 FHWs. Multivariable logistic regression analysis was applied to identify independent associations between predictors and outcome variables. Of the total study subjects, 17.2% reported inadequate knowledge on COVID-19, 63.6% reported that they perceived the government response as unsatisfactory, and 35.9% showed an unwillingness to work during the pandemic. Our analyses demonstrated that FHWs at local public health facilities, pharmacists, Ayurvedic health workers (HWs), and those with chronic diseases were less likely to have satisfactory perceptions of government response to COVID-19 and were predictors of willingness to work during the COVID-19 pandemic. These results suggest that prompt actions are required to improve FHWs’ knowledge and perceptions of COVID-19.
knowledge of COVID-19, address negative perceptions of government responses, and motivate them through specific measures to provide healthcare services during the pandemic.

**Keywords:** COVID-19; frontline healthcare workers; knowledge; perception; willingness; Nepal

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1. Introduction

In December 2019, an outbreak of a pneumonia-like illness was first detected in Wuhan, Hubei Province of China [1], and subsequently, faced with an escalating number of cases beyond China, the World Health Organization (WHO) declared the outbreak a pandemic [2]. Based on available evidence, the infection is transmitted between individuals via nasopharyngeal droplets or saliva [3]. Furthermore, no vaccine or effective treatment for COVID-19 is currently available [3].

Nepal is a small country in South Asia that shares a border with China and observed its first case of COVID-19 on 25 January 2020 [4]. In the first half of May 2020, Nepal experienced an explosive increase in cases; more than three-fourths of all cases recorded to date occurred during this period. As of 4 October 2020, Nepal reported 132,246 cases and 739 deaths [5]. Concern has been expressed that health systems in low-income countries such as Nepal are not sufficiently resilient to tackle a crisis presented by COVID-19. Due to resource constraints and a weak health system structure, rapid diagnosis of suspected cases and contact tracing are challenging [6]. Studies have shown that knowledge of infectious diseases is greatest among doctors and nurses [7,8]. In addition, age, sex, educational status, and pre-existing medical conditions have been shown to affect health workers’ (HWs) knowledge of Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) [9,10].

The primary sources of information about COVID-19 are from international health organizations such as the Center for Disease Control (CDC), the WHO and Ministry of Health, and social media. Moreover, the effectiveness of healthcare sectors during public health emergencies primarily depends on the availability, motivation, and skills of frontline healthcare workers (FHWs), and thus knowledge and their perceived willingness to work during uncertain times is essential [11], because appropriate perceptions and willingness to work during a pandemic are prerequisites of HW motivation to provide necessary treatment and to take the preventive actions required for the impact of a pandemic. Studies have shown that factors such are perceived personal risks, availability of personal protective equipment, family care obligations, HW gender, type of employment, personal confidence, defined role, dissemination of timely information, appropriate training, and personal health problems influence perceptions and willingness to work during pandemics [11–14]. In the present study, FHWs were defined as doctors, nurses, paramedics, laboratory workers, pharmacists, pathologists, and public health workers who were directly involved in COVID-19 prevention and control and who have direct contact with confirmed or suspected cases during patient intake, screening, inspection, testing, transport, treatment, nursing, specimen collection, or pathogen detection.

The present study explored factors associated with the knowledge of COVID-19 of FHWs, their reactions to government interventions, and, most importantly, their perceived willingness to work during the pandemic. This study could also provide valuable and actionable information to Nepalese policymakers to allow the judicious allocation of scarce resources in the short run. In the long term, this study might guide those developing policies and programs. That might be instrumental in ensuring preparedness to meet the challenges posed by similar crises. Given this background, we aimed to investigate the contextual factors associated with the perceptions and willingness to work among Nepalese frontline healthcare workers during the COVID-19 pandemic to improve the prevention and management of future similar outbreaks.
2. Materials and Methods

2.1. Study Design, Participants, and Sampling

We conducted a nationwide web-based cross-sectional study using an online questionnaire between 1 May and 10 June 2020 among FHWs in Nepal in accord with the Checklist for Reporting Results of Internet Surveys (CHERRIES) [15]. All participating FHWs were aged 18 to 60 years old and ranged from high-level officials of the Ministry of Health and Population to paramedics working at the grassroots level in all seven provinces of Nepal, and excluded those subjects who were had mentally ill or unwilling to participate in the study. The research questionnaire was distributed to FHWs using the health workers’ network. Firstly, we had a medical doctor or a public health professional in each of the seven provinces to act as a coordinator and co-investigator in the team. Secondly, these seven coordinators sent FHWs they knew a link of the questionnaire and asked that these individuals send a Google link to other FHWs they knew. Fischer’s arctanh transformation as a power of 90% and a minimum correlation of 0.1 showed that the minimum sample size required was \( n = 1046 \).

2.2. Survey Instrument and Data Collection

The online questionnaire included 33 questions on socioeconomic characteristics, HWs’ knowledge of COVID-19, perception toward government response to COVID-19, and perceived willingness to work during the pandemic. The responses were rated using a 5-point Likert Scale (“Strongly Agree”, “Agree”, “Neutral”, “Disagree” to “Strongly Disagree”). The sociodemographic characteristics investigated included age, gender, caste/ethnicity, and marital status. This section of the questionnaire also included questions about chronic diseases of HWs, their caretaking responsibilities for dependent family members, nature of their employment, and type of health facility at which they worked. There were three outcomes variables—knowledge of COVID-19, perception of government response in the management of COVID-19, and willingness to work during the COVID-19 pandemic. Knowledge of COVID-19 of the subjects was assessed using 20 structured questions that included information about COVID-19 such as agent, host and environmental factors, modes of transmission, diagnosis, and preventive and control measures. Likewise, perception of government response in the management of COVID-19 consisted of 25 structured questions that contained the information-timeliness of information updates from health authorities, whether there was shortage of personal protective equipment and other logistics, effectiveness of existing government response to the COVID-19 pandemic, and adequate support from government administrative bodies. Similarly, we had 35 structured questions to measure the willingness of FHWs to work during the pandemic that included information relating to self-infection, time factors, rationality, training, work place, work environment and liberty given to work during the COVID-19 pandemic. We dichotomized the health workers’ knowledge of COVID-19 (total score of 20, one score per question) into “adequate knowledge” for those whose score were >12 of 20 knowledge-related questions (60%) and “inadequate knowledge” for those <12 (<60%). Similarly, health workers’ perception of government responses to COVID-19 prevention and control consisted of 25 questions for which those who scored >60% (>15 of 25) were categorized as having a “satisfactory perception” or “unsatisfactory perception <15”. Further, health workers’ willingness to work had a total of 35 questions that were categorized into “willing to work” >21 (>60%) and “unwilling to work” <21 score. Knowledge of COVID-19 was assessed based on knowledge of the causative agent, mode of transmission, proper use of Personal Protective Equipment (PPE), infection prevention measures, and public health impact of the pandemic. Reaction to government response was determined by assessing response effectiveness, timeliness of information provided, provision of supplies, support received from administrative staff, and elected representatives. Factors influencing willingness to work during the pandemic were risk of self-infection, healthcare service rationing, the requirement to work overtime, working with untrained HWs, deployment to another duty station, family risk, and ability to choose whether to work or not during the pandemic.
The questionnaire was prepared based on national COVID-19 guidelines issued by the Ministry of Health and Population of Nepal [16] and the World Health Organization resource center guidelines for HWs on COVID-19 [17]. A team of medical doctors, public health workers, and an academic assessed the questionnaire for validity and relevance. Before conducting the survey, we conducted a pilot study on 30 participants to assess the questionnaire items’ reliability. The analysis revealed an overall Cronbach’s alpha score of 0.77, indicating higher internal consistency [18]. The questionnaire was prepared as a Google Form, and Facebook Messenger was used to send the Google form link to participants [19,20]. Only two research team members had access to the data repository to maintain data confidentiality, stored on a password-protected computer.

2.3. Data Management and Statistical Analysis

The data collected were downloaded in the form of a spreadsheet and checked for duplications and technical errors. After confirming the completeness, we exported the data to R Studio Software (R studio, Boston, MA, USA, version 1.2.5042) for full analysis. Sociodemographic characteristics were subjected to descriptive analysis using the Table 1 package in R software, and results are presented as frequencies, percentages, or as means and standard deviations. Univariate logistic regression analysis was used to assess factors associated with adequate knowledge, satisfaction with the government response, and willingness to work using the finalfit package in R [21]. Parsimonious multivariate models were created for each dependent variable and included independent variables found to be significant ($p$-value < 0.05) by univariate analysis. The data did not show the overly inflated outliers. We also checked for multicollinarity before entering variables to multivariable logistic regression analysis. Coefficients in the regression models were transformed into odds ratios with 95% confidence intervals. $p$-values of <0.05 were considered significant.

2.4. Ethics Statement

The study's ethical approval was obtained from the Nepal Health Research Council (approval no: 329/2020 P). The first page of the questionnaire detailed the study objective, benefits, and harm. HWs provided e-consent before participating in the study. Participants were informed that they could leave the study at any time. Participation was voluntary and anonymous.

3. Results

3.1. Sociodemographic Characteristics

A total of 1051 FHWs participated in the study—725 (68%) were men, with a median age of 31 years. The majority (57.4%) were of Brahmin/Chhetri caste/ethnicity, married (64.4%) and only 35.3% were medical doctors. Province-wise study subjects ranged from 6.6% (lowest) in Gandaki Province to the highest (19.4%) being from Bagmati Province. Nearly 60% of FHWs were permanent government employees. More than 25% worked in local-level public health facilities, such as health posts, primary healthcare centers, community health units, and urban health centers; 13.5% of FHWs reported having a chronic disease; 64% of FHWs had family members of younger than five years old or more than 60 years old who needed their care and support (Table 1).
Table 1. Sociodemographic characteristics of health workers in Nepal.

| Sociodemographic Characteristics | Frequency (%) |
|----------------------------------|---------------|
| **Age, in years, Median**        | 31.0 (8)      |
| **Gender**                       |               |
| Female                           | 326 (31.0)    |
| Male                             | 725 (68.0)    |
| **Caste/ethnicity**              |               |
| Brahmin/Chhetri                  | 603 (57.4)    |
| Madhesi/Muslim                   | 209 (19.9)    |
| Janajati                         | 174 (16.6)    |
| Dalit                            | 34 (3.2)      |
| Other                            | 31 (2.9)      |
| **Marital Status**               |               |
| Married                          | 677 (64.4)    |
| Unmarried                        | 374 (35.6)    |
| **Professional Category**        |               |
| Doctor                           | 371 (35.3)    |
| Paramedics                       | 308 (29.3)    |
| Nurse/Midwife                    | 173 (16.5)    |
| Public Health Workers            | 122 (11.6)    |
| Lab Worker                       | 51 (4.9)      |
| Other (Pharmacist, Ayurveda HW etc.) | 26 (2.5) |
| **Province**                     |               |
| Province 1                       | 193 (18.4)    |
| Province 2                       | 156 (14.8)    |
| Bagmati Province                 | 204 (19.4)    |
| Gandaki Province                 | 69 (6.6)      |
| Province 5                       | 153 (14.6)    |
| Karnali Province                 | 111 (10.6)    |
| Far-West Province                | 165 (15.7)    |
| **Type of Job**                  |               |
| Permanent                        | 613 (58.3)    |
| Temporary or Contract            | 438 (41.7)    |
| **Types of Health Facility**     |               |
| Federal and Provincial managerial agencies Ø | 134 (12.7) |
| Teaching Hospital                | 191 (18.2)    |
| Public Hospital                  | 240 (22.8)    |
| Private Hospital                 | 132 (12.6)    |
| Local public health facilities § | 292 (27.8)    |
| Local-level managerial agencies ⊗| 62 (5.9)      |
| **Presence of Chronic Disease**  |               |
| No                               | 909 (86.5)    |
| Yes                              | 142 (13.5)    |
| **HWS with caretaking responsibility for children less than 5 years or elderly more than 60 years** | | |
| No                               | 381 (36.2)    |
| Yes                              | 670 (63.7)    |

Ø Consists of the Ministry of Health and Population, the Department of Health Services, the Ministry of Social Development at the province level, Provincial health directorate, and health offices. § Consists of health posts, primary healthcare centers, community health units, and urban health centers at the local level. ⊗ Consists of metropolitan, sub-metropolitan, municipalities, and rural municipalities.

3.2. Health Workers’ Knowledge of COVID-19

Table 2 shows the frontline health workers’ knowledge and their associates. Of the total 1051 FHWs, 17.2% were found to have inadequate knowledge on COVID-19. The final adjusted multivariable logistic regression analyses demonstrated that FHWs at local public health facilities (AOR: 0.35; 95% CI: 0.17–0.68) were less likely to have adequate knowledge of COVID-19 compared to Federal
and Provincial Managerial Agencies, as were other types of FHWs (pharmacists and Ayurvedic HWs) (AOR: 0.33; 95% CI: 0.14–0.80) compared to doctors. Those with chronic diseases (AOR: 0.58; 95% CI: 0.37–0.91) were less likely compared to those without, and male FHWs (AOR: 1.60; 95% CI: 1.02–2.47) were more likely to have an adequate knowledge of COVID-19.

3.3. Health Workers’ Reactions to Government Response to COVID-19 Pandemic

The majority of FHWs (63.6%) perceived the government response to COVID-19 management as unsatisfactory. Our adjusted multivariable logistic regression analysis revealed that nurses/midwives (AOR: 2.10; 95% CI: 1.38–3.18) and public health workers (AOR: 1.83; 95% CI: 1.07–3.11) were found to have higher odds of having a satisfactory perception towards the government response compared to doctors, as were FHWs from Karnali Province (AOR: 2.62; 95% CI: 1.52–4.53), and Far-West Province (AOR: 1.72; 95% CI: 1.06–2.80) compared to Bagmati Province, as well as those who had adequate knowledge of COVID-19 (AOR: 3.86; 95% CI: 2.51–6.16) (Table 3).

3.4. Health Workers’ Willingness to Work during the COVID-19 Pandemic

Table 4 shows that about 64% of FHWs reported a willingness to work under the challenging conditions created during the COVID-19 pandemic. Further, in accordance with the adjusted model, FHWs such as paramedics (AOR: 2.52; 95% CI: 1.79–3.58), nurses/midwives (AOR: 2.09; 95% CI: 1.40–3.17), public health workers (AOR: 2.40; 95% CI: 1.47–4.01), laboratory workers (AOR: 3.54; 95% CI: 1.77–7.61), were found to have increased willingness to work during the COVID-19 pandemic when compared to doctors, as were health workers from Karnali Province (AOR: 2.96; 95% CI: 1.62–5.64) and Far-West Province (AOR: 2.10; 95% CI: 1.28–3.48) compared to others. Those who perceived the government’s response to COVID-19 as satisfactory (AOR: 2.52; 95% CI: 1.79–3.58) were also found to have increased willingness to work compared to their counterparts.
Table 2. Factors associated with knowledge of COVID-19.

| Knowledge about COVID-19 | Inadequate Knowledge | Adequate Knowledge | OR (Univariable) | OR (Multivariable) |
|--------------------------|----------------------|--------------------|------------------|--------------------|
|                          | (n = 181)            | (n = 870)          | (95% CI; p-Value) | (95% CI; p-Value) |
| Gender                   |                      |                    |                  |                    |
| Female                   | 72 (22.1)            | 254 (77.9)         | -                | -                  |
| Male                     | 109 (15.0)           | 616 (85.0)         | 1.60 (1.15–2.23, p = 0.005) ** | 1.60 (1.02–2.47, p = 0.036) * |
| Professional Category    |                      |                    |                  |                    |
| Doctor                   | 60 (16.2)            | 311 (83.8)         | -                | -                  |
| Paramedics               | 57 (18.5)            | 251 (81.5)         | 0.85 (0.57–1.27, p = 0.423) | 1.06 (0.65–1.75, p = 0.809) |
| Nurse/Midwife            | 35 (20.2)            | 138 (79.8)         | 0.76 (0.48–1.22, p = 0.246) | 1.21 (0.67–2.18, p = 0.537) |
| Public Health Workers    | 11 (9.0)             | 111 (91.0)         | 1.95 (1.02–4.03, p = 0.054) | 1.65 (0.78–3.72, p = 0.203) |
| Lab Worker               | 8 (15.7)             | 43 (84.3)          | 1.04 (0.49–2.48, p = 0.929) | 0.92 (0.42–2.26, p = 0.851) |
| Other (Pharmacist, Ayurveda HW, etc.) | 10 (38.5) | 16 (61.5) | 0.31 (0.14–0.73, p = 0.006) ** | 0.33 (0.14–0.80, p = 0.012) * |
| Type of Health Facility  |                      |                    |                  |                    |
| Federal and Provincial managerial agencies | 12 (9.0) | 122 (91.0) | - | - |
| Teaching Hospital        | 38 (19.9)            | 153 (80.1)         | 0.40 (0.19–0.77, p = 0.009) ** | 0.51 (0.23–1.09, p = 0.090) |
| Public Hospital          | 38 (15.8)            | 202 (84.2)         | 0.52 (0.25–1.01, p = 0.064) | 0.66 (0.30–1.37, p = 0.284) |
| Private Hospital         | 15 (11.4)            | 117 (88.6)         | 0.77 (0.34–1.70, p = 0.516) | 0.95 (0.40–2.24, p = 0.915) |
| Local public health facilities | 72 (24.7)     | 220 (75.3)         | 0.30 (0.15–0.56, p < 0.001) *** | 0.35 (0.17–0.68, p = 0.003) ** |
| Local-level managerial agencies | 56 (90.3) | 0.92 (0.34–2.75, p = 0.871) | 0.96 (0.34–2.95, p = 0.936) |
| Presence of Chronic Disease |                      |                    |                  |                    |
| No                       | 148 (16.3)           | 761 (83.7)         | -                | -                  |
| Yes                      | 33 (23.2)            | 109 (76.8)         | 0.64 (0.42–1.00, p = 0.042) * | 0.58 (0.37–0.91, p = 0.015) * |

* Odds Ratios were obtained by multivariate logistic regression adjusted for gender, professional categories, health facility types, and presence of chronic disease. ** p-value < 0.05 at the 5% level of significance *** p-value < 0.01 at the 5% level of significance **** p-value < 0.001 at the 5% level of significance.
| Table 3. Factors associated with self-reported perception of government response to COVID-19 pandemic. |
|---------------------------------------------------------------|
| **Self-Reported Perception of Government Response** | **Unsatisfactory Government Response** | **Satisfactory Government Response** | **OR (Univariable)** | **OR (Multivariable)** *
| | (n = 668) | (n = 383) |  |  |
| Caste/ethnicity | | |  |  |
| Brahmin/Chhetri | 367 (60.9) | 236 (39.1) | - | - |
| Madhesi/Muslim | 145 (69.4) | 64 (30.6) | 0.69 (0.49–0.96, p = 0.028) * | 1.15 (0.70–1.99, p = 0.586) |
| Janajati | 115 (66.1) | 59 (33.9) | 0.80 (0.56–1.13, p = 0.211) | 0.96 (0.65–1.42, p = 0.846) |
| Dalit | 24 (70.6) | 10 (29.4) | 0.65 (0.29–1.34, p = 0.260) | 0.67 (0.29–1.46, p = 0.322) |
| Sanyasi, Bharati | 17 (54.8) | 14 (45.2) | 1.28 (0.61–2.64, p = 0.504) | 1.13 (0.50–2.49, p = 0.770) |
| Professional Category | | |  |  |
| Doctor | 274 (73.9) | 97 (26.1) | - | - |
| Paramedics | 198 (64.3) | 110 (35.7) | 1.57 (1.13–2.18, p = 0.007) | 1.38 (0.78–2.49, p = 0.393) |
| Nurse/Midwife | 96 (55.5) | 77 (44.5) | 2.27 (1.55–3.31, p < 0.001) *** | 2.10 (1.38–3.18, p < 0.001) *** |
| Public Health Workers | 52 (42.6) | 70 (57.4) | 3.80 (2.49–5.85, p < 0.001) *** | 1.83 (1.07–3.11, p = 0.027) * |
| Lab Worker | 30 (56.8) | 21 (41.2) | 1.98 (1.07–3.60, p = 0.027) | 1.52 (0.79–2.90, p = 0.207) |
| Other (Pharmacist, Ayurveda HW etc.) | 18 (69.2) | 8 (30.8) | 1.26 (0.50–2.89, p = 0.606) | 1.37 (0.52–3.83, p = 0.506) |
| Province | | |  |  |
| Bagmati Province | 147 (72.1) | 57 (27.9) | - | - |
| Province 1 | 136 (70.5) | 57 (29.5) | 1.08 (0.70–1.67, p = 0.726) | 0.99 (0.62–1.59, p = 0.976) |
| Province 2 | 113 (72.4) | 43 (27.6) | 0.98 (0.61–1.56, p = 0.937) | 0.88 (0.48–1.61, p = 0.680) |
| Gandaki Province | 42 (60.9) | 27 (39.1) | 1.66 (0.93–2.93, p = 0.083) | 1.69 (0.92–3.11, p = 0.090) |
| Province 5 | 96 (62.7) | 57 (37.3) | 1.53 (0.98–2.40, p = 0.062) | 1.48 (0.93–2.40, p = 0.105) |
| Karnali Province | 46 (41.4) | 65 (58.6) | 3.64 (2.25–5.96, p < 0.001) *** | 2.62 (1.52–4.53, p = 0.001) ** |
| Far-West Province | 88 (53.3) | 77 (46.7) | 2.26 (1.47–3.49, p < 0.001) *** | 1.72 (1.06–2.80, p = 0.030) * |
| Type of Health Facility | | |  |  |
| Federal and Provincial managerial agencies | 53 (39.6) | 81 (60.4) | - | - |
| Teaching Hospitals | 135 (70.7) | 56 (29.3) | 0.27 (0.17–0.43, p < 0.001) *** | 0.52 (0.29–0.93, p = 0.027) * |
| Public Hospitals | 168 (70.0) | 72 (30.0) | 0.28 (0.18–0.43, p < 0.001) *** | 0.41 (0.24–0.70, p = 0.001) ** |
| Private Hospitals | 90 (68.2) | 42 (31.8) | 0.31 (0.18–0.50, p < 0.001) *** | 0.52 (0.28–0.94, p = 0.032) |
| Local public health facilities | 196 (67.1) | 96 (32.9) | 0.32 (0.21–0.49, p < 0.001) *** | 0.49 (0.30–0.81, p = 0.005) ** |
| Local-level managerial agencies | 26 (41.9) | 36 (58.1) | 0.91 (0.49–1.68, p = 0.752) | 1.12 (0.58–2.20, p = 0.742) |
| Knowledge about COVID-19 | | |  |  |
| Inadequate | 154 (85.1) | 27 (14.9) | - | - |
| Adequate | 514 (59.1) | 356 (40.9) | 3.95 (2.61–6.20, p < 0.001) *** | 3.86 (2.51–6.16, p < 0.001) *** |

* Odds Ratios were obtained by multivariate logistic regression adjusted for caste/ethnicity, Professional category, Province, type of health facility, and health worker perceived knowledge of COVID-19. * p-value < 0.05 at the 5% level of significance ** p-value < 0.01 at the 5% level of significance *** p-value < 0.001 at the 5% level of significance.
Table 4. Factors associated with self-reported willingness to work during the COVID-19 pandemic.

| Perceived Willingness to Work | Unwilling to Work (n = 377) | Willing to Work (n = 674) | OR (Univariable) (95% CI, p-Value) | OR (Multivariable) (95% CI, p-Value)* |
|-------------------------------|-----------------------------|---------------------------|-----------------------------------|--------------------------------------|
| **Caste/ethnicity**           |                             |                           |                                   |                                      |
| Brahmin/Chhetri               | 203 (33.7)                  | 400 (66.3)                | -                                 | -                                    |
| Madhesi/Muslim               | 89 (42.6)                   | 120 (57.4)                | 0.68 (0.50–0.95, p = 0.021)        | 1.11 (0.69–1.80, p = 0.659)          |
| Janajati                      | 69 (39.7)                   | 105 (60.3)                | 0.77 (0.55–1.10, p = 0.145)        | 0.90 (0.62–1.31, p = 0.575)          |
| Dalit                         | 7 (20.6)                    | 27 (79.4)                 | 1.96 (0.88–4.95, p = 0.121)        | 1.74 (0.76–4.53, p = 0.215)          |
| Other (Sanyasi, Giri, etc.)   | 9 (29.0)                    | 22 (71.0)                 | 1.24 (0.58–2.89, p = 0.595)        | 0.97 (0.43–2.36, p = 0.945)          |
| **Professional Category**     |                             |                           |                                   |                                      |
| Doctor                        | 191 (51.5)                  | 180 (48.5)                | -                                 | -                                    |
| Paramedics                    | 83 (26.9)                   | 225 (73.1)                | 2.88 (2.09–3.99, p < 0.001) ***    | 2.52 (1.79–3.58, p < 0.001) ***      |
| Nurse/Midwife                 | 52 (30.1)                   | 121 (69.9)                | 2.47 (1.69–3.64, p < 0.001) ***    | 2.09 (1.40–3.17, p < 0.001) ***      |
| Public Health Workers         | 28 (23.0)                   | 94 (77.0)                 | 3.56 (2.26–5.77, p < 0.001) ***    | 2.40 (1.47–4.01, p = 0.001) **       |
| Lab Worker                    | 11 (21.6)                   | 40 (78.4)                 | 3.86 (1.98–8.11, p < 0.001) ***    | 3.54 (1.77–7.61, p = 0.001) **       |
| Other (Pharmacist, Ayurveda HW etc.) | 12 (46.2)                  | 14 (53.8)                 | 1.24 (0.56–2.79, p = 0.600)        | 1.24 (0.54–2.89, p = 0.609)          |
| **Province**                  |                             |                           |                                   |                                      |
| Bagmati Province              | 90 (44.1)                   | 114 (55.9)                | -                                 | -                                    |
| Province 1                    | 72 (37.3)                   | 121 (62.7)                | 1.33 (0.89–1.99, p = 0.168)        | 1.18 (0.77–1.81, p = 0.446)          |
| Province 2                    | 71 (45.5)                   | 85 (54.5)                 | 0.95 (0.62–1.44, p = 0.792)        | 0.83 (0.47–1.45, p = 0.510)          |
| Gandaki Province              | 29 (42.0)                   | 40 (58.0)                 | 1.09 (0.63–1.90, p = 0.762)        | 1.24 (0.69–2.22, p = 0.473)          |
| Province 5                    | 64 (41.8)                   | 89 (58.2)                 | 1.10 (0.72–1.68, p = 0.666)        | 0.87 (0.56–1.37, p = 0.554)          |
| Karnali Province              | 17 (15.3)                   | 94 (84.7)                 | 4.37 (2.48–8.06, p < 0.001) ***    | 2.96 (1.62–5.64, p = 0.001) **       |
| Far-West Province             | 34 (20.6)                   | 131 (79.4)                | 3.04 (1.92–4.90, p < 0.001) ***    | 2.10 (1.28–3.48, p = 0.004) **       |
| **Presence of Chronic Disease**|                             |                           |                                   |                                      |
| No                            | 313 (34.4)                  | 596 (65.6)                | -                                 | -                                    |
| Yes                           | 64 (45.3)                   | 78 (54.9)                 | 0.64 (0.45–0.92, p = 0.015)        | 0.67 (0.46–0.99, p = 0.043)          |
| **HWs having family members who need care** |                         |                           |                                   |                                      |
| No                            | 120 (31.5)                  | 261 (68.5)                | -                                 | -                                    |
| Yes                           | 257 (38.4)                  | 413 (61.6)                | 0.74 (0.57–0.96, p = 0.026)        | 0.72 (0.54–0.95, p = 0.021)          |
| **Perceived Knowledge about COVID-19** |                         |                           |                                   |                                      |
| Inadequate                    | 86 (47.5)                   | 95 (52.5)                 | -                                 | -                                    |
| Adequate                      | 291 (33.4)                  | 579 (66.6)                | 1.80 (1.30–2.49, p < 0.001) ***    | 1.81 (1.27–2.58, p = 0.001) **       |
| **Perception of government response** |                           |                           |                                   |                                      |
| Unsatisfactory perception     | 264 (39.5)                  | 404 (60.5)                | -                                 | -                                    |
| Satisfactory Perception       | 113 (29.5)                  | 270 (70.5)                | 1.56 (1.20–2.05, p = 0.001) **     | 1.12 (0.83–1.51, p = 0.448)          |

* Odds Ratios were obtained by multivariate logistic regression adjusted for caste/ethnicity, Professional category, Province, Presence of Chronic Disease, health workers with family members requiring care, perceived knowledge of COVID-19, and perception of government response. * p-value < 0.05 at the 5% level of significance ** p-value < 0.01 at the 5% level of significance *** p-value < 0.001 at the 5% level of significance.
4. Discussion

This is the first nationwide study on knowledge and perception of COVID-19 among FHWs, and their willingness to work during the COVID-19 pandemic situation in Nepal despite several other studies have been conducted in Nepal related to COVID-19. Approximately two in ten FHWs had inadequate knowledge of COVID-19, which is higher than that reported in a Chinese study, in which ≈11% demonstrated insufficient knowledge [22]. On the other hand, a study conducted by Bhagavathula et al. reported that 61% of health workers had poor knowledge about COVID-19 transmission [23]. These differences between rates may have been due to variations in the contents and criteria used for assessing the knowledge, and study subject attributes. Furthermore, the latter study was conducted in the first week of March 2020, and the Chinese study was conducted in the third week of May, when more information regarding COVID 19 was available and disseminated through different media.

Knowledge is crucial for establishing perceptions and preventive behaviors, affecting coping interventions to some degree [24]. We also found that male health workers were more likely to report adequate knowledge, which is consistent with the findings of another study conducted in Nepal [25]. This finding may be due to greater interaction and socialization by men, and gendered norms, which means men are more likely to overestimate, and women are likely to underestimate personal knowledge [26–29]. Our study also showed that pharmacists and Ayurvedic HWs had inadequate knowledge of COVID-19 as compared with doctors which is similar to a previous local area study conducted in Nepal [25]. This could obviously be a matter of content-specific higher educational achievement, and direct and higher levels of work exposure of medical doctors than those of pharmacists and Ayurvedic HWs. We found that FHWs in the local health facilities were less likely to have adequate knowledge than the FHWs in federal or provincial agencies. This could possibly be due to weaker implementation of COVID-19-related governmental interventions at the local level than at provincial or federal levels, and the provincial or federal level FHWs in Nepal are obviously more qualified than at local levels. In addition, FHWs with chronic diseases had inadequate knowledge of COVID-19, perhaps because of time limitations imposed by pre-existing conditions restricting studies on COVID-19. Therefore, these factors should be considered while disseminating available knowledge updating ongoing and the latest available information, education, and communication materials.

Our observation demonstrated that nearly two-thirds (63.6%) of FHWs perceived the government response to COVID-19 management as unsatisfactory. A slightly higher level of satisfaction with government response was reported in a survey conducted on the Nepalese general public in April 2020 (71.4%) [30]. The present study also showed that most FHWs (86%) experienced logistical shortcomings and reported inadequate supports from administrative (60%) and elected representatives (67.5%) (data not presented in the Table), which concurs with findings of a previous study [31]. Our observation additionally found that the professional category, province, type of health facility, and knowledge of COVID-19 were significantly associated with frontline health workers’ satisfaction with government response to the pandemic. Accordingly, nurses were found to be more likely to be satisfied with government response than frontline doctors. This perception difference might have been due to the differences in technical knowledge levels among doctors, nurses, and public health workers. Similarly, FHWs from Karnali and Far-West provinces were more likely to be satisfied with the government response than FHWs from Bagmati Province. However, the reasons for these provincial variations were not determined. In addition, FHWs from local public health facilities, teaching hospitals, and private hospitals had unsatisfactory perceptions compared to managerial level FHWs at the ministry level, which we attribute to different work experiences, as FHWs at health service outlets are directly exposed to risks and better understand the risks posed by logistical shortfalls than managerial-level FHWs. Interestingly, FHWs with adequate knowledge of COVID-19 had higher odds of satisfaction with government response than those with inadequate knowledge. Based on this evidence, prompt promotive actions such as provision of necessary medicaments, logistics,
and empowerments in health workers’ knowledge are necessary from the Health Ministry of Nepal to create a favorable work environment during the pandemic.

In terms of unwillingness to work during the pandemic, our study revealed that more than one in three FHWs (35.8%) reported their willingness, which is a considerable issue because the health system’s workload during the pandemic is usually presumed to higher, and all available health resources are required to combat emergencies. The unwillingness rate to work during the pandemic observed in our study was higher than those reported in several other studies among health workers during public health emergencies [12–14,32,33]. In the present study, these high rates may be due to inadequate knowledge (17%) and pre-existing chronic disease (13.5%), and shortage of PPE (86%) (data not presented in the table), and other factors such as unknown risks, and emergency preparedness competencies [33,34]. The high rates of unwillingness to work during the pandemic revealed by our study demand that additional efforts be made to rectify the situation. Interestingly, health workers by professional category, province, presence of chronic disease, dependent family members, and knowledge about COVID-19 were associated with a willingness to work during the pandemic. We observed that nurses, paramedics, public health workers, and laboratory staff were more willing to work than clinicians, which contradicts the results of a systematic review conducted by Aoyagi et al. [35], who reported healthcare workers’ willingness to work during an influenza pandemic was moderately high, albeit highly variable. We also found that FHWs from Karnali and Far-West provinces were more willing to work than their counterparts from Bagmati Province. These provincial differences could be due to virtually no cases of COVID-19 during the study, and that the FHWs were willing to work in a humane way. Furthermore, FHWs with adequate knowledge about COVID-19 were more willing to work, which concurs with a study performed on the 2007 influenza pandemic [36]. Our result shows that FHWs with a chronic disease and those that cared for family members were less willing to work, which is also in line with previous studies [13,35]. It may be caring for family members and coping with personal chronic health problems might diminish work-willingness.

We believe that the findings of this study could be meaningful to inform various stakeholders and policymakers at national and provincial level health departments who are involved in the drafting of future interventions to improve the effectiveness of the health sector during public health crises. However, despite our efforts, this study has some notable methodological limitations. First, data were obtained using a questionnaire over the web, and healthcare workers were enrolled using their networks. Therefore, our results should not be extended to healthcare workers who do not use the internet. Second, the data used were self-reported, which makes the study prone to desirability bias and inaccuracies. Third, participants were asked to consider their willingness to work under hypothetical conditions that did not exist when Nepal comparatively observed fewer cases and fatalities during the study period. Fourth, we used the five-point Likert scale for outcome assessment which might not be specifically used for assessing related knowledge-specific variables. We recommend studies of the impacts of FHWs’ knowledge, perception, and willingness to work on health sector efficiency in public health emergencies.

5. Conclusions

We concluded that Nepalese health workers have some gaps in knowledge related to COVID-19, the majority have a negative perception of the government’s COVID-19 response, and nearly one-third of them were unwilling to work during the COVID-19 pandemic. Our study also revealed that FHWs at local public health facilities, pharmacists and Ayurvedic FHWs, those with chronic diseases were less likely, and male FHWs were more likely to have adequate knowledge of COVID-19. In contrast, nurses/midwives, public health workers, FHWs from Karnali Province and Far-West Province, and those who had adequate knowledge of COVID-19 were found to have higher odds of having satisfactory perceptions towards government response to COVID-19 management. In addition, FHWs such as paramedics, public health workers, laboratory workers, FHWs from Karnali Province and Far-West Province, and those having perceived the government’s response to COVID-19 as
satisfactory compared to their counterparts were found to have incremental willingness to work during the COVID-19 pandemic. Our study suggests that prompt actions are required to improve health workers’ knowledge of COVID-19, address negative perceptions to government responses, and motivate them through monetary, non-monetary, and other likely specific measures to provide effective and efficient healthcare services during the pandemic. Additional studies on the impacts of frontline health workers’ knowledge, perception, and willingness to work on health sector efficiency in the context of public health emergencies should be undertaken.

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References
1. Huang, C.; Wang, Y.; Li, X.; Ren, L.; Zhao, J.; Hu, Y.; Zhang, L.; Fan, G.; Xu, J.; Gu, X.; et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020, 395, 497–506. [CrossRef]
2. World Health Organization. WHO Director-General’s Opening Remarks at the Media Briefing on COVID-19. Available online: https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020 (accessed on 10 June 2020).
3. Machhi, J.; Herskovitz, J.; Senan, A.M.; Dutta, D.; Nath, B.; Oleynikov, M.D.; Blomberg, W.R.; Meigs, D.D.; Hasan, M.; Patel, M.; et al. The natural history, pathobiology, and clinical manifestations of SARS-CoV-2 infections. J. Neuroimmune Pharm. 2020, 15, 359–386. [CrossRef] [PubMed]
4. Shrestha, R.; Shrestha, S.; Khanal, P.; Ke, B. Nepal’s first case of COVID-19 and public health response. J. Travel Med. 2020, 27. [CrossRef]
5. Ministry of Health and Population. Corona Info- Ministry of Health and Population, Nepal. Available online: https://covid19.mohp.gov.np/#files/268/covid19.mohp.gov.np.html (accessed on 19 October 2020).
6. Ministry of Health and Population. Health Emergency Operation Center-Health Emergency Operation Center; Ministry of Health and Population: Katmandu, Nepal, 2020.
7. Huynh, G.; Nguyen, T.N.H.; Tran, V.K.; Vo, K.N.; Vo, V.T.; Pham, L.A. 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. [CrossRef]
8. Olum, R.; Chekwech, G.; Wekha, G.; Nassozi, D.R.; Bongomin, F. Coronavirus Disease-2019: Knowledge, attitude, and practices of health care workers at makerere university teaching hospitals, Uganda. Front. Public Health 2020, 8. [CrossRef]
9. Deng, J.F.; Olowokure, B.; Kaydos-Daniels, S.C.; Chang, H.J.; Barwick, R.S.; Lee, M.L.; Deng, C.Y.; Factor, S.H.; Chiang, C.E.; Maloney, S.A.; et al. Severe acute respiratory syndrome (SARS): Knowledge, attitudes, practices and sources of information among physicians answering a SARS fever hotline service. Public Health 2006, 120, 15–19. [CrossRef]
10. Khan, M.U.; Shah, S.; Ahmad, A.; Fatokun, O. Knowledge and attitude of healthcare workers about middle east respiratory syndrome in multispecialty hospitals of Qassim, Saudi Arabia. BMC Public Health 2014, 14, 1281. [CrossRef]
11. Watt, K.; Tippett, V.C.; Raven, S.G.; Jamrozik, K.; Coory, M.; Archer, F.; Kelly, H.A. Attitudes to living and working in pandemic conditions among emergency prehospital medical care personnel. Prehospital Disaster Med. 2010, 25, 13–19. [CrossRef]
12. Hope, K.; Durrheim, D.; Barnett, D.; D’Este, C.; Kewley, C.; Dalton, C.; Manager, N.W.; Kohlhagen, J.; Links, J. Willingness of frontline health care workers to work during a public health emergency. Aust. J. Emerg. Manag. 2010, 25, 39–47.
13. Martin, S.D. Nurses’ ability and willingness to work during pandemic flu. J. Nurs. Manag. 2011, 19, 98–108. [CrossRef]

14. Qureshi, K.; Gershon, R.R.M.; Sherman, M.F.; Straub, T.; Gebbie, E.; McCollum, M.; Erwin, M.J.; Morse, S.S. Health care workers’ ability and willingness to report to duty during catastrophic disasters. J. Urban. Health 2005, 82, 378–388. [CrossRef] [PubMed]

15. Eysenbach, G. Improving the quality of web surveys: The checklist for reporting results of internet e-surveys (CHERRIES). J. Med. Internet Res. 2004, 6, e34. [CrossRef] [PubMed]

16. Ministry of Health and Population. Coronavirus Disease (COVID-19) Outbreak Updates & Resource Materials-Health Emergency Operation Center. Available online: https://heoc.mohp.gov.np/update-on-novel-corona-virus-covid-19/ (accessed on 10 July 2020).

17. World Health Organization. Technical Guidance Publications. Available online: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance-publications (accessed on 10 July 2020).

18. Goforth, C. Using and Interpreting Cronbach’s AlphaUniversity of Virginia Library Research Data Services + Sciences. Available online: https://data.library.virginia.edu/using-and-interpreting-cronbachs-alpha/ (accessed on 10 July 2020).

19. Google Forms. Available online: https://docs.google.com/forms/u/0/ (accessed on 15 March 2020).

20. Globalstats, S. Social Media Stats Nepal. Available online: https://gs.statcounter.com/social-media-stats/all/nepalfiles/280/nepal.html (accessed on 11 March 2020).

21. Harrison, E.; Drake, T.; Ots, R. finalfit: Quickly Create Elegant Regression Results Tables and Plots when Modelling. Available online: https://finalfit.org/ (accessed on 10 February 2020).

22. Zhang, M.; Zhou, M.; Tang, F.; Wang, Y.; Nie, H.; Zhang, L.; You, G. Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. J. Hosp. Infect. 2020, 105, 183–187. [CrossRef] [PubMed]

23. Bhagavathula, A.S.; Aldhalee, W.A.; Rahmani, J.; Mahabadi, M.A.; Bandari, D.K. Knowledge and perceptions of COVID-19 among health care workers: Cross-sectional study. JMIR Public Health Surveill. 2020, 6, e19160. [CrossRef]

24. McEachan, R.; Taylor, N.; Harrison, R.; Lawton, R.; Gardner, P.; Conner, M. Meta-analysis of the reasoned action approach (RAA) to understanding health behaviors. Ann. Behav. Med. A Publ. Soc. Behav. Med. 2016, 50, 592–612. [CrossRef]

25. Nepal, R.; Sapkota, K.; Adhikari, K.; Paudel, P.; Adhikari, B.; Paudyal, N.; Sapkota, K.; Nepal, R. Knowledge, attitude and practice regarding COVID-19 among healthcare workers in Chitwan, Nepal. BMC Infect. Dis. 2020. [CrossRef]

26. Beyer, S. Gender differences in the accuracy of self-evaluations of performance. J. Personal. Soc. Psychol. 1990, 59, 960–970. [CrossRef]

27. Cooper, K.M.; Krieg, A.; Brownell, S.E. Who perceives they are smarter? Exploring the influence of student characteristics on student academic self-concept in physiology. Adv. Physiol. Educ. 2018, 42, 200–208. [CrossRef]

28. Ehrlinger, J.; Dunning, D. How chronic self-views influence (and potentially mislead) estimates of performance. J. Personal. Soc. Psychol. 2003, 84, 5–17. [CrossRef]

29. Indiana University. Female Medical Students Underestimate Their Abilities and Males Tend to Overestimate Theirs. Available online: https://www.sciencedaily.com/releases/2008/10/081003122713.htm (accessed on 10 July 2020).

30. Madhu, A.; Chapagain, B.; Adhikari, R.P. COVID 19, Citizen’s pulse (A National Survey on COVID 19-Nepal)—Participedia. Available online: https://participedia.net/case/6543 (accessed on 10 July 2020).

31. Sim, M.R. The COVID-19 pandemic: Major risks to healthcare and other workers on the front line. Occup. Environ. Med. 2020, 77, 281–282. [CrossRef]

32. Kaiser, H.E.; Barnett, D.J.; Hsu, E.B.; Kirsch, T.D.; James, J.J.; Subbarao, I. Perspectives of future physicians on disaster medicine and public health preparedness: Challenges of building a capable and sustainable auxiliary medical workforce. Disaster Med. Public Health Prep. 2009, 3, 210–216. [CrossRef] [PubMed]

33. Balicer, R.D.; Barnett, D.J.; Thompson, C.B.; Hsu, E.B.; Catlett, C.L.; Watson, C.M.; Semon, N.L.; Gwon, H.S.; Links, J.M. Characterizing hospital workers’ willingness to report to duty in an influenza pandemic through threat- and efficacy-based assessment. BMC Public Health 2010, 10, 436. [CrossRef] [PubMed]
34. Yonge, O.; Rosychuk, R.J.; Bailey, T.M.; Lake, R.; Marrie, T.J. Willingness of university nursing students to volunteer during a pandemic. *Public Health Nurs.* **2010**, *27*, 174–180. [CrossRef] [PubMed]

35. Aoyagi, Y.; Beck, C.R.; Dingwall, R.; Nguyen-Van-Tam, J.S. Healthcare workers’ willingness to work during an influenza pandemic: A systematic review and meta-analysis. *Influenza Respir. Viruses* **2015**, *9*, 120–130. [CrossRef]

36. Daugherty, E.L.; Perl, T.M.; Rubinson, L.; Bilderback, A.; Rand, C.S. Survey study of the knowledge, attitudes, and expected behaviors of critical care clinicians regarding an influenza pandemic. *Infect. Control. Hosp. Epidemiol.* **2009**, *30*, 1143–1149. [CrossRef]

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