Prevalence and correlates of knowledge and practices regarding infection prevention and control, and triage in primary healthcare settings: A cross-sectional study in Bangladesh

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\textbf{SUMMARY}

\textbf{Background:} Despite the high prevalence of healthcare-acquired infection in resource-limited settings, healthcare workers' (HCWs') knowledge and practices of infection prevention and control (IPC) and triage are not well-researched. We examined this in Bangladesh's primary healthcare facilities (HCFs) during the COVID-19 pandemic.

\textbf{Methods:} We surveyed 312 HCWs in 94 community clinics (CCs) and 90 family welfare centres (FWCs) in six districts from February to April 2021. We assessed HCWs' self-reported knowledge and observed practices in four domains: personal hygiene, medical instrument processing, waste management, and triage. We constructed a weighted composite knowledge score and estimated the association between knowledge and background characteristics using a generalised linear mixed effects model. Practices were described through univariate analysis.

\textbf{Findings:} On a scale of 100, the mean composite knowledge score was 38.3 (SD: 13.3) overall and 44.0 (SD: 13.1) and 33.8 (SD: 11.6) for FWCs and CCs, respectively. The HCWs of FWCs were more aged, experienced, and educated than those of CCs. Knowledge score was the highest in personal hygiene and the lowest in medical waste segregation. Knowledge was significantly associated with HCWs' designation and education. Concerning practices, not more than one-third of the HCWs or HCFs, on average, followed the recommended protocols, except for wearing face masks while on duty (87.1%) and referring potential COVID-19 patients to higher-level facilities (68.3%).
Introduction

Infection prevention and control (IPC) is an evidence-based approach to pre-empt avoidable infections among patients and healthcare workers (HCWs) in healthcare facilities (HCFs) [1]. Triage, on the other hand, prioritises care according to the severity of the illness to identify the individuals who need immediate care [2]. IPC and triage substantially contribute to preventing healthcare-acquired infections (HAIs), thereby reducing hospital-acquired morbidity and mortality [3,4], shortening hospital stay, and trimming healthcare-related expenditures [5,6].

Prevalence of HAIs is considerably higher in developing countries than in developed countries. For instance, a systematic review of records between 1995 and 2008 in developing countries reported an HAI incidence of almost 48 per 1000 patient-days in adult intensive care units—three times as high as that of the USA [7]. Insufficient water, sanitation, and waste management systems, insufficient environmental cleaning, inadequate equipment, understaffing, overcrowding, poor knowledge of IPC measures, and the absence of proper IPC guidelines, policies, and programmes contribute to the disproportionate breakout of HAIs in resource-poor settings [1,8].

COVID-19 compounded the existing HAI burden. On the one hand, it interrupted the routine healthcare services due to the relocation of the healthcare workforce, supplies, and services to primarily deal with COVID-19 patient influx [9]; on the other hand, HAIs induced by SARS-CoV-2 transmission depleted HCW volume and increased workload, leading to physical and psychological burnout [10]. As of September 2022, COVID-19 gave rise to over five million cases and about 9000 deaths among HCWs [11]; among patients, the prevalence of COVID-19-associated HAIs ranged from 0-41% [12-15].

Proper knowledge of IPC and triage with efficient implementation of guidelines is crucial to achieving a quality healthcare delivery. Effective IPC programmes can lower HAI rates by more than 30%; improving hand hygiene practice reduces pathogen transmission in HCFs by 50% [1]. For example, resource-poor HCFs in Africa experienced a 44% reduction in surgical site infections when safety culture and prevention programmes were introduced [1]. Besides, prompt identification and effective triage of potential COVID-19 cases could prevent HAIs among patients, HCWs, and visitors [16].

Overall, the studies conducted in low-resource settings found adequate knowledge but relatively poor practices of IPC and triage among HCWs [17-20]. In those contexts, the reported correlates of knowledge and practice regarding IPC and triage are training on IPC, access to IPC materials at the workstation, facility infrastructure [19,20], work experience as an HCW, and availability of PPE [17,19]. Despite our HCFs’ resource constraints and IPC and triage standards not being satisfactory [21,22], there is a dearth of research on their knowledge and practices. Since COVID-19 fatality is more significant among patients with existing co-morbidities [23,24], to minimise patient-to-patient and patient-to-HCW transmission of COVID-19, an optimum level of knowledge and practice regarding IPC and triage is warranted [25].

As a part of Bangladesh’s National Preparation and Response Plan to contain the pandemic’s impact, an IPC and triage guideline was adopted for primary HCFs (i.e., community clinics [CCs] and family welfare centres [FWCs]) by the Directorate General of Health Services (DGHS) in collaboration with the WHO, the CDC, and local healthcare experts [26]. As per that guideline, BRAC (world’s largest non-governmental organisation) and DGHS trained the HCWs of the primary HCFs on IPC and triage management. We conducted this study to determine the knowledge and practices regarding IPC and triage in Bangladesh’s primary HCFs during the pandemic. Evidence from this study can inform policies in strategising post-pandemic healthcare preparedness in low-resource settings.

Methods

Sampling

The population of interest was the HCWs of primary HCFs, i.e., CCs and FWCs, based in the peri-urban and rural parts of Bangladesh. We carried out a cross-sectional study in two phases: phase 1 in February 2021 and phase 2 in April 2021, as part of a BRAC programme effectiveness evaluation in six districts of Bangladesh, namely Narayanganj, Kishoreganj, Sherpur, Bogura, Bagerhat, and Bhola. We adapted the multi-stage sampling technique of the baseline survey of that evaluation [27]. The required number of clusters (i.e., village) for that survey was selected according to the probability-proportional-to-size of the district’s population. For this study, from each union within which villages are nested, two HCFs (i.e., one CC and one FWC) were selected. In total, we visited 198 HCFs (i.e., 101 CCs and 97 FWCs) in two phases, of which we could survey 184 HCFs (i.e., 94 CCs and 90 FWCs), the response rate being 93/100. In 184 HCFs, we approached 462 HCWs for interview, of whom 312 HCWs (67.5%) completed it.

Data collection

In a CC, our study participants were: (a) community healthcare providers (CHCPs), (b) health assistants (HAs), and (c) family welfare assistants (FWAs); whereas in FWCs, we interviewed (a) sub-assistant community medical officers (SACMOs), (b) family welfare visitors (FWVs), and (c) pharmacists. The HCWs’ job responsibilities are broadly aligned with the nature of the services provided in CCs and FWCs. The HCWs in a CC are generally involved in providing primary care services that include routine health check-ups (e.g., measuring blood pressure and blood sugar), normal vaginal delivery, counselling...
on MNCH and family planning, conducting immunisation, and dispensing routine medications. Routine immunisation is performed by HAs, whereas FWAs conduct the MNCH and family planning counselling services. The HCWs in an FWC, on the other hand, offer more exhaustive pregnancy care and MNCH health services including assisted deliveries, growth monitoring, and nutrition counselling, with FWVs carrying out the MNCH services. CHCPs and SACMOs are the administrators of CCs and FWCs, respectively, who oversee service provision, referrals, and logistics of their respective HCFs. We used a pre-tested structured questionnaire to assess their knowledge of IPC and triage and their demographic and socioeconomic characteristics. Additionally, we utilised a structured observation checklist to assess their practices and HCWs’ structures concerning IPC and triage. We acquired knowledge and practice information on four domains: personal hygiene (Domain 1), medical instrument processing (Domain 2), waste management (Domain 3), and triage for identifying possible COVID-19 cases (Domain 4) [26].

Of the 184 HCFs we visited, we assessed knowledge in all of those; however, all could not be observed for the practices because [1]: some observations needed HCW’s assistance; hence those could not be performed in their absence, and [2] the HCWs could not exhibit certain practices as no care seeker visited during the observation period. A team of trained surveyors conducted the data using SurveyCTO version 2.70. To ensure data quality, randomly selected 5% of HCFs were revisited at regular intervals.

**Data analysis**

To assess knowledge, we asked 30 questions (Table S1) of both single- and multiple-choice types, containing a total of 113 correct choices. Since the number of questions across knowledge domains and the number of correct choices across different questions varied considerably, we balanced the knowledge scores by scaling the choices to weigh the domains equally. However, as all the HCFs could not be observed equally for all the indicators considered, the practices were not scored or indexed. In addition, an insufficient number of observations did not allow for multivariable analyses of the findings related to practices. Hence, the practice component is described only through frequency and percentage (Table IV and Table V).

To determine the correlates of knowledge, we applied a generalised linear mixed effects model [28]. For each of the 30 questions, the number of correct responses was assumed to follow a binomial distribution. The odds of correct responses were modelled using a logit-link function, where age, sex, education, HCW’s designation, type of HCF (CC or FWC), and district are considered covariates. Besides, the main effects of the selected covariates and interactions between domains and designation of the HCWs are also considered in the model. Since we collected the data in two phases, we checked for the possible difference in knowledge between those phases (Table III). Furthermore, to check the robustness of the findings, we repeated the analyses (Table S3) using only the key IPC and triage indicators, i.e., etiquettes of handwashing and wearing a face mask, medical instrument processing steps, sharp medical waste management, and suspected and confirmed COVID-19 case detection criteria (Table S2). The regression estimates are presented in adjusted odds ratios (aORs) with corresponding P-values and 95% confidence intervals (CI). The analyses were carried out in R version 4.1.1 [29].

**Findings**

**Profile of the sample**

Table I presents the demographic and socioeconomic characteristics of the HCWs. The mean age of the HCWs was around 40 (SD: 10.55, range: 23–59) years. Overall, HCWs of CCs were younger (mean: 36.18, SD: 8.5; range: 23–55) than that of FWCs (mean: 43.24, SD: 11.52; range: 27–59) (P < .001). CHCPs being the youngest of all. HCWs were predominantly female (61.2%). About two-thirds of HCWs (64.7%) were educated beyond the higher secondary level, with CHCPs in CCs and pharmacists and SACMOs in FWCs being the most educated of all. Overall, the HCWs of CCs had higher educational attainment compared to those of FWCs (P < .001). However, the HCWs of FWCs were more experienced compared to CCs, with a mean service duration of about 20 years (SD: 13.92 years) as opposed to 12.47 years (SD: 8.68 years) among those of FWCs (P < .001).

**Knowledge regarding IPC and triage**

Table II presents weighted knowledge scores. The mean overall knowledge score was 38.3 (SD: 13.3) on a scale of 100; this was 33.8 (SD: 11.6) for CCs and 44.0 (SD: 13.1) for FWCs. Standardisation of the score yielded a slightly skewed distribution towards the left for CCs and the right for FWCs. Roughly one-fifth of HCWs of CCs scored between -2 and -1 SD (mean: 10.6–22.2) as opposed to only 5% in FWCs. On the other hand, between +1 and +2 SD (i.e., a score between 45.4 and 57), the percentages were 6.9% for CCs as opposed to 28.8% for FWCs. This pattern was also reflected in the domain-specific knowledge, wherein HCWs of FWCs outscored those of CCs. Overall, the highest score was attained in personal hygiene, followed by triage, whereas the medical instrument processing domain yielded the lowest score for CCs; for FWCs, this was the domain of medical waste management.

More than 50% recalled the second and the third steps of processing instruments (Domain 2; K7–K17), i.e., cleaning and sterilisation; fewer recalled the other three steps, i.e., decontamination (31.7%), disinfection (18.9%), and preservation and reuse (23.7%). Less than 10% in CCs and half in FWCs recalled the recommended decontaminant, i.e., chlorine. However, 77.7% of HCWs in FWCs and 30.1% in CCs correctly identified the optimum duration for decontamination, i.e., 10 minutes. Most HCWs of FWCs identified the recommended options for sterilisation, i.e., autoclave (69.8%) and boiling (70.5%), as opposed to CCs (boiling: 40.5%, autoclave: 10.4%). Most HCWs suggested boiling for disinfection; however, very few identified the recommended disinfectants, i.e., glutaraldehyde (2.2%) and 0.5% chlorine solution (18.9%).

Domain 3 included questions on waste management (K18–K22). Most HCWs identified the correct bin (i.e., red) for disposing of sharp medical waste (54.3% in CCs and 71.9% in FWCs). However, knowledge of the other forms of waste management was poor, especially about liquid waste (9.2% in CCs and 15.8% in FWCs) that is to be disposed of in blue-coloured bins.
Domain 4 consisted of questions on triage in COVID-19's context (K23 – K30). Most HCWs (81.1%) recognised 'acute onset of fever or cough' as the clinical criterion to identify a suspected case, while only 45.2% stated the other criterion, i.e., 'acute onset of three or more signs and symptoms'. By contrast, most HCWs (87.5%) correctly stated the criterion to detect a confirmed case.

### Association of knowledge with background characteristics

A generalised linear mixed effects model was considered to model the log-odds of correct responses, and the corresponding estimates of the association between HCWs' background features and their knowledge are presented in Table III. In

| Background characteristics of HCWs | All HCWs | HCWs in CC | HCWs in FWC | P-value |
|------------------------------------|----------|------------|-------------|---------|
| **Age (in years), Mean (SD)**      | 39.32 (10.55) | 36.18 (8.50) | 43.24 (11.52) | <.001 |
| **Sex**                            |          |            |             |         |
| Female                             | 191 (61.2) | 104 (60.1) | 87 (62.6)   | .656   |
| **Education**                      |          |            |             |         |
| Above primary, up to SSC           | 41 (13.1) | 17 (9.8)   | 24 (17.3)   | <.001 |
| HSC                                | 69 (22.1) | 36 (20.8)  | 33 (23.7)   |         |
| Vocational                         | 47 (15.1) | -          | 47 (33.8)   |         |
| Graduation                         | 77 (24.7) | 54 (31.2)  | 23 (16.5)   |         |
| Masters                            | 78 (25.0) | 66 (38.2)  | 12 (8.6)    |         |
| **District**                       |          |            |             |         |
| Bagerhat                           | 58 (18.6) | 31 (17.9)  | 27 (19.4)   | .947   |
| Bhola                              | 38 (12.2) | 24 (13.9)  | 14 (10.1)   |         |
| Bogura                             | 49 (15.7) | 27 (15.6)  | 22 (15.8)   |         |
| Kishoreganj                        | 62 (19.9) | 33 (19.1)  | 29 (20.9)   |         |
| Narayanganj                        | 57 (18.3) | 31 (17.9)  | 26 (18.7)   |         |
| Sherpur                            | 48 (15.4) | 27 (15.6)  | 21 (15.1)   |         |
| **Designation (CC)**               |          |            |             |         |
| CHCP                               | 89 (28.5) | 89 (51.4)  | -           | -       |
| HA                                 | 41 (13.1) | 41 (23.7)  | -           | -       |
| FWA                                | 43 (13.8) | 43 (24.9)  | -           | -       |
| **Designation (FWC)**              |          |            |             |         |
| SACMO                              | 60 (19.2) | -          | 60 (43.2)   | -       |
| FWV                                | 70 (22.4) | -          | 70 (50.4)   | -       |
| Pharmacist                         | 9 (2.9)   | -          | 9 (6.5)     | -       |
| **Service duration (in years), Mean (SD)** | 15.61 (11.83) | 12.47 (8.68) | 19.51 (13.92) | <.001 |

Notes: HCW: Healthcare Worker; CC: Community Clinic; FWC; Family Welfare Centre; SSC: Secondary School Certificate; HSC: Higher Secondary School Certificate; CHCP: Community Healthcare Provider; HA: Health Assistant; FWA: Family Welfare Assistant; SACMO: Sub-Assistant Community Medical Officer; FWV: Family Welfare Visitor.

### Table I

#### Background characteristics of HCWs

| Age (in years), Mean (SD) | All HCWs | 312 | HCWs in CC | 173 | HCWs in FWC | 139 | P-value |
|--------------------------|----------|-----|------------|-----|-------------|-----|---------|
| 39.32 (10.55)            |          |     |            |     |             |     |         |
| Sex                      |          |     |            |     |             |     |         |
| Female                   | 191 (61.2)| 104 (60.1)| 87 (62.6) |     |             |     | .656   |
| Education                |          |     |            |     |             |     |         |
| Above primary, up to SSC | 41 (13.1) | 17 (9.8) | 24 (17.3) |     |             |     | <.001 |
| HSC                      | 69 (22.1) | 36 (20.8) | 33 (23.7) |     |             |     |         |
| Vocational               | 47 (15.1) | -    | 47 (33.8)  |     |             |     |         |
| Graduation               | 77 (24.7) | 54 (31.2)| 23 (16.5) |     |             |     |         |
| Masters                  | 78 (25.0) | 66 (38.2)| 12 (8.6)  |     |             |     |         |
| District                 |          |     |            |     |             |     |         |
| Bagerhat                 | 58 (18.6) | 31 (17.9)| 27 (19.4) |     |             |     | .947   |
| Bhola                    | 38 (12.2) | 24 (13.9)| 14 (10.1) |     |             |     |         |
| Bogura                   | 49 (15.7) | 27 (15.6)| 22 (15.8) |     |             |     |         |
| Kishoreganj              | 62 (19.9) | 33 (19.1)| 29 (20.9) |     |             |     |         |
| Narayanganj              | 57 (18.3) | 31 (17.9)| 26 (18.7) |     |             |     |         |
| Sherpur                  | 48 (15.4) | 27 (15.6)| 21 (15.1) |     |             |     |         |
| Designation (CC)         |          |     |            |     |             |     |         |
| CHCP                     | 89 (28.5) | 89 (51.4)| -         |     |             |     | -       |
| HA                       | 41 (13.1) | 41 (23.7)| -         |     |             |     | -       |
| FWA                      | 43 (13.8) | 43 (24.9)| -         |     |             |     | -       |
| Designation (FWC)        |          |     |            |     |             |     |         |
| SACMO                    | 60 (19.2) | -    | 60 (43.2)  |     |             |     | -       |
| FWV                      | 70 (22.4) | -    | 70 (50.4)  |     |             |     | -       |
| Pharmacist               | 9 (2.9)   | -    | 9 (6.5)    |     |             |     | -       |
| Service duration (in years), Mean (SD) | 15.61 (11.83) | 12.47 (8.68) | 19.51 (13.92) | <.001 |

Notes: n (%) is presented unless specified otherwise; HCW: Healthcare Worker; CC: Community Clinic; FWC: Family Welfare Centre; SSC: Secondary School Certificate; HSC: Higher Secondary School Certificate; CHCP: Community Healthcare Provider; HA: Health Assistant; FWA: Family Welfare Assistant; SACMO: Sub-Assistant Community Medical Officer; FWV: Family Welfare Visitor.

### Table II

#### Weighted knowledge scores

| Knowledge score, Mean (SD) | N = 312 | N = 173 | N = 139 |
|---------------------------|---------|---------|---------|
| 30                        | 38.3 (13.3) | 33.8 (11.6) | 44.0 (13.1) |
| Domain 1: Personal Hygiene| 6       | 13.3 (4.3) | 12.3 (4.0) | 14.6 (4.2) |
| Domain 2: Medical Instrument Processing | 11     | 7.2 (3.7)  | 5.3 (2.9)  | 9.6 (3.1)  |
| Domain 3: Medical Waste Management | 5       | 8.4 (6.4)  | 7.7 (6.4)  | 9.3 (6.3)  |
| Domain 4: Triage          | 8       | 9.5 (5.3)  | 8.5 (5.2)  | 10.6 (5.4) |
| Distribution of knowledge score, Percentage |         |         |         |
| -2 SD or less             |         | -       | -       | 1.6       | 2.3 | 0.7 |
| >-2 to -1 SD              |         | -       | -       | 14.1      | 21.4 | 5.0 |
| >-1 to 1 SD               |         | -       | -       | 66.0      | 69.4 | 61.9 |
| 1 to <2 SD                |         | -       | -       | 16.7      | 6.9  | 28.8 |
| 2 SD or above             |         | -       | -       | 1.6       | -    | 3.6 |

Notes: HCW: Healthcare Worker; CC: Community Clinic; FWC: Family Welfare Centre.
Concerning geographical location, there is no significant difference among districts in terms of providing correct responses. Having a master’s degree had almost 18% higher odds of providing correct responses than education below the higher secondary (HSC) level (aOR: 1.177, CI: 1.029–1.347; P = .018).

The interaction between 'knowledge domain' and 'designation' compares the odds of correct responses to questions of each domain for different designations of the HCWs. Compared to HAs and FWAs of CCs, all other HCWs possessed a greater level of knowledge in all IPC domains except for CHCPs in domain 1. The difference in performance was more prominent in domain 2, where FWVs and pharmacists revealed the highest

| Interaction terms | Domain 1 × HA & FWA | Domain 1 × CHCP | Domain 1 × FWV & Pharmacist | Domain 1 × SACMO | Domain 2 × HA & FWA | Domain 2 × CHCP | Domain 2 × FWV & Pharmacist | Domain 2 × SACMO | Domain 3 × HA & FWA | Domain 3 × CHCP | Domain 3 × FWV & Pharmacist | Domain 3 × SACMO | Domain 4 × HA & FWA | Domain 4 × CHCP | Domain 4 × FWV & Pharmacist | Domain 4 × SACMO |
|-------------------|---------------------|----------------|-----------------------------|----------------|--------------------|----------------|-----------------------------|----------------|---------------------|----------------|-----------------------------|----------------|---------------------|----------------|-----------------------------|----------------|
| Age (in years)    | 0.998               | 0.248          | 0.994                       | 1.002          | Sex                | Male           | 0.955                       | 0.246          | 0.884               | 1.032          | District           | Bagerhat       | Bhola                | 0.921                       | 0.252          | 0.801               | 1.060          | Bogura                | 0.863                       | 0.028          | 0.756               | 0.984          | Kishoreganj          | 0.945                       | 0.373          | 0.833               | 1.071          | Narayanganj          | 1.018                       | 0.790          | 0.895               | 1.157          | Sherpur               | 0.986                       | 0.828          | 0.864               | 1.124          | Education           | Below HSC       | HSC                  | 1.029                       | 0.628          | 0.916               | 1.156          | Vocational           | 0.975                       | 0.748          | 0.834               | 1.139          | Graduation           | 1.096                       | 0.163          | 0.963               | 1.247          | Master’s degree       | 1.177                       | 0.017          | 1.029               | 1.347          |

Notes: aOR: Adjusted Odds ratio; CI: Confidence interval; CC: Community Clinic; FWC: Family Welfare Centre; CHCP: Community Healthcare Provider; HA: Health Assistant; FWA: Family Welfare Assistant; SACMO: Sub-Assistant Community Medical Officer; FWV: Family Welfare Visitor; HSC: Higher Secondary School Certificate.
| Sl. No. | Questions                                                                 | Overall       | CC            | FWC            |
|--------|---------------------------------------------------------------------------|---------------|---------------|----------------|
| P1     | Is there a dedicated IPC unit/corner?                                     | N = 184       | N = 94        | N = 90         |
|        | No                                                                        | 180 (97.8)    | 92 (97.9)     | 88 (97.8)      |
|        | Yes                                                                       | 4 (2.2)       | 2 (2.1)       | 2 (2.2)        |
| P2     | Is there a national IPC guideline at the facility?                         | N = 176       | N = 90        | N = 86         |
|        | No                                                                        | 167 (94.9)    | 88 (97.8)     | 79 (91.9)      |
|        | Yes                                                                       | 9 (5.1)       | 2 (2.2)       | 7 (8.1)        |
| P3     | Is there an IPC guideline for COVID-19 at the facility?                    | N = 174       | N = 89        | N = 85         |
|        | No                                                                        | 164 (94.3)    | 87 (97.8)     | 77 (90.6)      |
|        | Yes                                                                       | 10 (5.7)      | 2 (2.2)       | 8 (9.4)        |
| P4     | Is there any triage/fever or COVID-19 unit/corner in the facility?         | N = 184       | N = 94        | N = 90         |
|        | No                                                                        | 184 (100.0)   | 94 (100.0)    | 90 (100.0)     |
|        | Yes                                                                       | -             | -             | -              |
| P5     | Is there an isolation facility for COVID-19 patients at the centre?        | N = 184       | N = 94        | N = 90         |
|        | No                                                                        | 184 (100.0)   | 94 (100.0)    | 90 (100.0)     |
|        | Yes                                                                       | -             | -             | -              |
| P6     | Are there hand hygiene (running water, basin, soap, etc.) facilities at   | N = 184       | N = 94        | N = 90         |
|        | all points of care?                                                        | No            | 127 (69.0)    | 73 (77.7)      | 54 (60.0)      |
|        | Yes                                                                       | 57 (31.0)     | 21 (22.3)     | 36 (40.0)      |
| P7     | Is there hand hygiene poster at the hand washing sites?                    | N = 184       | N = 94        | N = 90         |
|        | No                                                                        | 151 (82.1)    | 81 (86.2)     | 70 (77.8)      |
|        | Yes                                                                       | 33 (17.9)     | 13 (13.8)     | 20 (22.2)      |
| P8     | Are there separate hand hygiene facilities for the visitors?              | N = 184       | N = 94        | N = 90         |
|        | No                                                                        | 113 (61.4)    | 67 (71.3)     | 46 (51.1)      |
|        | Yes                                                                       | 71 (38.6)     | 27 (28.7)     | 44 (48.9)      |
| P9     | The materials and equipment essential for decontamination are in place     | N = 145       | N = 75        | N = 70         |
|        | (e.g., goggles, mask, gloves, cap, mackintosh, bleach, strainer, stirrer, | No            | 102 (70.3)    | 68 (90.7)      | 34 (48.6)      |
|        | and bucket)                                                               | Yes           | 43 (29.7)     | 7 (9.3)        | 36 (40.0)      |
| P10    | Bleaching powder is kept in plastic container with coloured lid           | N = 148       | N = 72        | N = 76         |
|        | No                                                                        | 106 (71.6)    | 64 (88.9)     | 42 (55.3)      |
|        | Yes                                                                       | 42 (28.4)     | 8 (11.1)      | 34 (44.7)      |
| P11    | After decontamination and before sterilisation/disinfection,              | N = 31        | N = 20        | N = 11         |
|        | instruments are cleaned in detergent solution                              | No            | 19 (61.3)     | 17 (85.0)      | 2 (18.2)       |
|        | Yes                                                                       | 12 (38.7)     | 3 (15.0)      | 9 (18.8)       |
| P12    | Instruments are cleaned in running water                                  | N = 37        | N = 23        | N = 14         |
|        | No                                                                        | 25 (67.6)     | 21 (91.3)     | 4 (28.6)       |
|        | Yes                                                                       | 12 (32.4)     | 2 (8.7)       | 10 (71.4)      |
| P13    | Does the facility have functioning autoclave(s) for sterilisation?         | N = 151       | N = 75        | N = 76         |
|        | No                                                                        | 105 (69.5)    | 72 (96.0)     | 33 (43.4)      |
|        | Yes                                                                       | 46 (30.5)     | 3 (4.0)       | 43 (56.6)      |
| P14    | (If P13 is 'Yes') The pressure gauge and valve of the autoclave work     | N = 32        | N = 1         | N = 31         |
|        | properly                                                                  | No            | 6 (18.8)      | -              | 6 (19.4)       |
|        | Yes                                                                       | 26 (81.3)     | 1 (100.0)     | 25 (80.6)      |
| P15    | In the absence of an autoclave, instruments are boiled for 30 minutes      | N = 40        | N = 24        | N = 16         |
|        | No                                                                        | 28 (70.0)     | 21 (87.5)     | 7 (43.8)       |
|        | Yes                                                                       | 12 (30.0)     | 3 (12.5)      | 9 (56.3)       |
| P16    | The expiration date for use of the instruments is clearly written down    | N = 111       | N = 56        | N = 55         |
|        | on the instrument storage containers                                       | No            | 100 (90.1)    | 52 (92.9)      | 48 (87.3)      |
|        | Yes                                                                       | 11 (9.9)      | 4 (7.1)       | 7 (12.7)       |
| P17    | Separated utility gloves are worn during the waste management process     | N = 42        | N = 27        | N = 15         |
|        | No                                                                        | 32 (76.2)     | 21 (77.8)     | 11 (73.3)      |
|        | Yes                                                                       | 10 (23.8)     | 6 (22.2)      | 4 (26.7)       |
| Sl. No. | Questions                                                                 | Overall | CC     | FWC     |
|--------|---------------------------------------------------------------------------|---------|--------|---------|
| P18    | Does the facility have sufficient waste bins? (at least 3 colours, i.e., black, yellow, red) | N = 176 | N = 89 | N = 87  |
|        | No                                                                        | 122 (69.3) | 73 (82.0) | 49 (56.3) |
|        | Yes                                                                       | 54 (30.7)  | 16 (18.0)  | 38 (43.7) |
| P19    | Waste disposal bins are decontaminated in chlorine solutions after use     | N = 50  | N = 29  | N = 21  |
|        | No                                                                        | 41 (82.0)  | 27 (93.1)  | 14 (46.7) |
|        | Yes                                                                       | 9 (18.0)   | 2 (6.9)    | 7 (33.3) |
| P20    | Non-combustible wastes are sorted for further management                  | N = 51  | N = 29  | N = 22  |
|        | No                                                                        | 37 (72.5)  | 25 (86.2)  | 12 (54.5) |
|        | Yes                                                                       | 14 (27.5)  | 4 (13.8)   | 10 (45.5) |
| P21    | (If P20 is 'Yes') How are the non-combustible wastes managed?             | N = 12  | N = 3   | N = 9   |
|        | Buried in the ground                                                      | 8 (66.7)  | -       | 8 (88.9) |
|        | Left in open place                                                        | 3 (25.0)  | 2 (66.7)  | 1 (11.1) |
|        | Others                                                                    | 1 (8.3)   | 1 (33.3)  | -       |
| P22    | Incinerator is present for burning waste                                  | N = 139 | N = 69  | N = 70  |
|        | No                                                                        | 128 (92.1)| 69 (100.0)| 59 (84.3)|
|        | Yes                                                                       | 11 (7.9)  | -       | 11 (15.7)|
| P23    | Following equipment are present                                           | N = 173 | N = 88  | N = 85  |
|        | Thermometer                                                               | 53 (30.6)| 25 (28.4)| 28 (32.9)|
|        | Masks for all cases                                                       | N = 168 | N = 86  | N = 82  |
|        | Disposable towels                                                         | 40 (23.8)| 20 (23.3)| 20 (24.4)|
|        | Biohazard bags with bin                                                   | N = 171 | N = 87  | N = 84  |
|        | Personal protective equipment for health care staffs (gloves, masks and/or respirators, gowns) | N = 164 | N = 84  | N = 80  |
|        | Hand hygiene supplies (Soap-water or hand sanitiser)                      | N = 165 | N = 85  | N = 80  |
|        |                                                                            | 61 (37.0)| 32 (37.6)| 29 (36.3)|
| P24    | All visitors (including you) are screened with infrared thermometer at the entry point of the facility | N = 79  | N = 41  | N = 38  |
|        | No                                                                        | 69 (87.3)| 35 (85.4)| 34 (89.5)|
|        | Yes                                                                       | 10 (12.7)| 6 (14.6) | 4 (10.5) |
| P25    | Signboards on triaging instructions are present                           | N = 79  | N = 41  | N = 38  |
|        | No                                                                        | 67 (84.8)| 35 (85.4)| 32 (84.2)|
|        | Yes                                                                       | 12 (15.2)| 6 (14.6) | 16 (15.8)|
| P26    | Patients are asked about history of novel coronavirus exposure            | N = 63  | N = 31  | N = 32  |
|        | No                                                                        | 38 (60.3)| 22 (71.0)| 16 (50.0)|
|        | Yes                                                                       | 25 (39.7)| 9 (29.0) | 16 (50.0)|
| P27    | Patients are asked and advised about the illness due to COVID-19          | N = 63  | N = 32  | N = 31  |
|        | No                                                                        | 36 (57.1)| 21 (65.6)| 15 (48.4)|
|        | Yes                                                                       | 27 (42.9)| 11 (34.4)| 16 (51.6)|
| P28    | Potential cases with novel coronavirus infection are documented          | N = 79  | N = 41  | N = 38  |
|        | No                                                                        | 71 (89.9)| 38 (92.7)| 33 (86.8)|
|        | Yes                                                                       | 8 (10.1) | 3 (7.3)  | 5 (13.2) |
| P29    | Potential cases with novel coronavirus infection are referred to higher facilities | N = 79  | N = 41  | N = 38  |
|        | No                                                                        | 25 (31.6)| 13 (31.7)| 12 (31.6)|
|        | Yes                                                                       | 54 (68.4)| 28 (68.3)| 26 (68.4)|
| P30    | (If P29 is 'Yes') Referrals are documented                                | N = 54  | N = 28  | N = 26  |
|        | No                                                                        | 37 (68.5)| 17 (60.7)| 20 (76.9)|
|        | Yes                                                                       | 17 (31.5)| 11 (39.3)| 6 (23.1)|

Notes: n (%) is reported; HCF: Healthcare Facility; CC: Community Clinic; FWC: Family Welfare Centre.
level of knowledge among all the HCWs (aOR: 2.55, CI: 1.963–2.950; \( P < .001 \)), followed by SACMOs (aOR: 2.173, CI: 1.837–2.571; \( P < .001 \)), and CHCP (aOR: 2.223, CI: 1.065–2.404; \( P = .004 \)). In the other three domains, SACMOs performed better than the HCWs of other designations.

Comparison between the two phases of collections revealed no significant differences except for a slightly greater level of knowledge in domain 2 in the second phase (aOR: 1.287, CI: 1.177–1.408; \( P < .001 \)). Besides, the robustness analysis (Table S3) revealed similar effect sizes and statistical significance to the original regression analysis.

**Practices related to IPC and triage**

The descriptive statistics for practices regarding IPC and triage are outlined in Table IV and Table V. The HCFs were observed for certain structural factors concerning IPC, such as a dedicated IPC unit, COVID-19 corners, and hard copies of IPC and triage guidelines (Table IV). Almost no HCF possessed these features. Concerning hand hygiene, less than 30% of CCs possessed the relevant amenities (i.e., handwashing stations at all points of care, separate stations for visitors, and handwashing posters near the stations); for FWCs, this was higher than 40% except for hand hygiene posters that were present in 20% of HCFs.

Approximately half of FWCs possessed the necessary equipment for decontamination as opposed to only 9.3% of CCs. Almost no CC possessed a functioning autoclave, whereas just more than 50% of FWCs did, even though one-fifth of those had defective valves and pressure gauges. In the absence of autoclaves, more than half of FWCs boiled their instruments compared with only 12.5% of CCs. Only 25% of HCWs were wearing utility gloves during waste disposal. The FWCs outperformed the CCs in waste management (e.g., provisioning a sufficient number of waste bins, decontaminating those after waste disposal, sorting non-combustible waste materials, and incinerating the combustible ones).

Only 20% of HCWs of CCs sanitised hands before/after attending patients, as opposed to approximately one-third in FWCs before examining patients and 43.5% after attending them (Table V). Barely one-fifth of HCWs wore surgical gloves before attending patients. Around one-third sanitised hands before donning, whereas 29.6% in CCs and about 50% in FWCs did so before and after doffing. However, most HCWs wore face masks at all times in their workstations.

Similar to IPC, almost no HCF possessed the structural features relevant to the triage system (Table IV). For example, only about 25% of HCFs possessed thermometers, face masks and PPE; one-third had hand hygiene stations and amenities; however, only 4.7% possessed disposable towels and biohazard bags with bins.

Most HCWs did not screen the visitors with an infrared thermometer at the entrance, nor did they possess signboards with triaging instructions. About 50% of HCWs of FWCs took the history of SARS-CoV-2 exposure and subsequent illness and advised patients accordingly, whereas about 33% of HCWs of CCs did so. Most HCWs did not have separate registers for COVID-19 cases. Although more than two-thirds reportedly referred possible cases to higher-level HCFs, they did not document the referrals.

### Table V

Questions related to IPC practices among the HCWs

| Sl. No. | Questions                                                                 | Overall | HCWs in CC | HCWs in FWC |
|--------|----------------------------------------------------------------------------|---------|------------|-------------|
| P31    | The provider washes hands with soap/sanitise hands before examining every patient | N = 123 | N = 59     | N = 64      |
| No     | 89 (72.4)                                                                  | 47 (79.7) | 42 (65.6)  |
| Yes    | 34 (27.6)                                                                  | 12 (20.3) | 22 (34.4)  |
| P32    | The provider washes hands with soap/sanitise hands after examining every patient | N = 131 | N = 62     | N = 69      |
| No     | 87 (66.4)                                                                  | 48 (77.4) | 39 (56.5)  |
| Yes    | 44 (33.6)                                                                  | 14 (22.6) | 30 (43.5)  |
| P33    | Gloves are worn in the proper (non-touch) technique before every examination | N = 91  | N = 45     | N = 46      |
| No     | 74 (78.7)                                                                  | 35 (77.8) | 39 (84.8)  |
| Yes    | 17 (18.1)                                                                  | 10 (22.2) | 7 (15.2)   |
| P34    | Hands are sanitised or washed with soap before putting the gloves on        | N = 59  | N = 31     | N = 28      |
| No     | 39 (66.1)                                                                  | 20 (64.5) | 19 (67.9)  |
| Yes    | 20 (33.9)                                                                  | 11 (35.5) | 9 (32.1)   |
| P35    | Hands are sanitised before taking the gloves off                            | N = 52  | N = 27     | N = 25      |
| No     | 33 (63.5)                                                                  | 19 (70.4) | 14 (56.0)  |
| Yes    | 19 (36.5)                                                                  | 8 (29.6)  | 11 (44.0)  |
| P36    | Hands are sanitised or washed with soap after taking the gloves off        | N = 52  | N = 27     | N = 25      |
| No     | 32 (61.5)                                                                  | 19 (70.4) | 13 (52.0)  |
| Yes    | 20 (38.5)                                                                  | 8 (29.6)  | 12 (48.0)  |
| P37    | The provider wears face mask at all times                                   | N = 254 | N = 124    | N = 130     |
| No     | 27 (10.6)                                                                  | 16 (12.9) | 11 (8.5)   |
| Yes    | 227 (89.4)                                                                 | 108 (87.1)| 119 (91.5) |

Notes: n (%) is reported; HCW: Healthcare Worker; CC: Community Clinic; FWC: Family Welfare Centre; CHCP: Community Healthcare Provider; HA: Health Assistant; FWA: Family Welfare Assistant; SACMO: Sub-Assistant Community Medical Officer; FWV: Family Welfare Visitor.
Discussion

Background characteristics

We conducted this study in 184 HCFs (94 CCs and 90 FWCs) in the peri-urban and rural parts of six districts in Bangladesh. We surveyed 312 HCWs, of whom 55.4% were from CCs. The mean age of the HCWs from CCs was less than their counterparts at FWCs (i.e., 36 years and 43 years, respectively). Similarly, the HCWs were more experienced in FWCs. Overall, 64.8% of HCWs had 12+ years of education. The HCWs were predominantly female, which is expected in the context of Bangladesh, where most community health workers are females; this has been possible through the collaborative contributions from the large NGOs like BRAC and Grameen Bank and initiatives from the government regarding women’s education and empowerment [30,31]. The differences amongst HCWs of CCs and FWCs concerning age, experience, and education can mainly be explained by the history of those HCFs in Bangladesh’s health system. The CC was a newer concept planned by the Government of Bangladesh (in 1996) to extend primary healthcare at the doorsteps of the villagers all over the country by establishing one CC for 6000 population [32–34]. However, the CC project started functioning fully more recently [35], whereas FWCs were established earlier and were functioning from the mid-80s [36]. Since FWCs have been established for a longer period, their HCWs are expected to be more aged and experienced than CCs and that is evident from our study. Interestingly, about 13% of HCWs did not attain higher secondary education — this is expected given that many HCWs are recruited for non-salaried positions from within the community irrespective of their educational qualifications and given need-based training and incentives to assist the HCFs.

Knowledge regarding IPC and triage

On a scale of 100, the mean knowledge score was only 38.3. The score was higher among the HCWs of FWCs (44.0) than those of CCs (33.8). Among the four knowledge domains, the score (13.3) exceeded 50% only for personal hygiene. All the other components’ scores were around 33%. We found that knowledge of IPC and triage is significantly associated with the domains of knowledge, HCWs designation, and education. No difference was found in knowledge between the two data collection phases. The robustness analysis also revealed similar results. The overall knowledge score related to infection prevention for COVID-19 was poor among the HCWs, irrespective of their work setting. Our results correspond to the findings of many other studies conducted in similar settings of low- and middle-income countries (LMICs) [37–40]. Similar findings were reported in other countries like Turkey and Egypt [41,42]. Poor knowledge concerning the triage of COVID-19 cases could be explained by the novelty of the pandemic and a lack of preparedness for the neo-normal era [37,43]. However, among the knowledge domains, the score was comparatively better for personal hygiene, which might be due to their practice of the same in their day-to-day lives. Most campaigns regarding COVID-19 prevention in Bangladesh emphasise personal hygiene practices, including handwashing, using sanitiser, wearing masks and social distancing [44]. Nevertheless, improving the knowledge regarding medical instrument processing, waste management, or triage has remained a challenge, especially among the HCWs serving distant rural populations. The HCWs of FWCs documented better knowledge than those of CCs, possibly due to their higher education, experience, and exposure in the FWCs compared to CCs, as found in a KAP study in Pakistan [45]. We did not find any difference in knowledge between the two phases, which might reflect the overall underprepared coordination of COVID-19 response in Bangladesh [46]. However, we found that being a SACMO and assuming any other position in FWCs was associated with greater odds of responding correctly, compared to the FWCs of CCs. Again, this can be explained by the higher education, experience, and patient exposure among HCWs of FWCs [33]. In our study, having a master’s degree had almost 18% greater odds of providing correct responses than education below the HSC level, which corresponds to the findings from many studies conducted in Bangladesh and countries with similar settings [47–49].

Practices related to IPC and triage

Less than one-fourth of the 94 CCs had hand hygiene facilities at all points of care, whereas the proportion was 60% for FWCs. The poor condition of hand hygiene initiatives is expected in resource-poor countries like Bangladesh, as evident in the WHO hand hygiene self-assessment framework global survey of 2019 [50]. Regarding practices related to disinfection or sterilisation of the equipment, FWCs showed more functionality than CCs. Similarly, only 18% of the CCs had sufficient waste bins, as opposed to 43.7% of FWCs. Such contrasts between CCs and FWCs with regard to instrument processing and waste management are expected since no surgical procedure is conducted in CCs, whereas FWCs are designed to perform normal vaginal deliveries and first-aid treatments [3,51,52]. However, poor practices were documented for both types of HCFs regarding screening the visitors with infrared thermometers, having signboards for triaging indications, documentation of COVID-19 infection, and documentation of referrals. This is possibly due to a lack of training regarding COVID-19 among the HCWs [53], which is also evident in our study as more than two-thirds of the suspected COVID-19 cases were reportedly referred to higher facilities. In CCs, HAs performed better where practices of IPC are concerned. Since HAs receive greater patient exposure and in-service training than CHCPs and FWAs [54], better performance is expected from them. Conversely, in FWCs, FWVs showed better practices regarding IPC compared to the SACMOs. However, this is also expected since SACMOs handle the bulk of patients in FWCs [55] and usually cannot allocate time for frequent handwashing and using gloves because of the patient load. Notwithstanding the poor handwashing and gloves-use etiquettes, the facemask-use proportion among SACMOs and FWVs is more than 90%, which also indicates that the SACMOs cannot practise the other IPC indicators primarily due to the time constraint.

Limitations and strengths

Much as this study provides useful insights into the knowledge and practices regarding IPC and triage in low-resource healthcare, it also highlights the need to interpret findings in light of the following potential limitations. First, the observational nature of this study prevents drawing any causal
conclusions. Second, information was mainly collected through self-reports, which could result in information bias. Third, a more in-depth assessment of specific IPC and triage components is required to better understand the reasons for discrepancies between the reported knowledge and observed practices. Notwithstanding the aforementioned limitations, the study sample was chosen through a probability sampling technique, ensuring adequate representation of the source population. Nevertheless, generalising the findings to a different context may prevent drawing similar inferences. Finally, the findings were further validated through the robustness analysis.

Conclusions

HCWs reveal poor knowledge about IPC and triage except for the personal hygiene domain; this may be the result of extensive hand-hygiene campaigns to prevent SARS-CoV-2 transmission. Overall, the HCWs of FWCs manifest better knowledge and practices than those of CCs. Education and designation of HCWs are positively associated with knowledge. The HCWs of FWCs are more experienced and assume higher designations and education than those of CC as they have to perform more sophisticated MNCH-related procedures that warrant rigorous IPC management. This suggests the need to follow a more formal education and training approach to build HCW’s capacity in instrument processing, waste management, and triage, in particular, which revealed a noticeable dearth of knowledge. Our study can contribute to this region’s evidence base regarding IPC and triage knowledge and practices, more so in the context of COVID-19, given that not much research has been conducted in that regard.

Data availability statement

The data sets can be made available upon request.

Ethical approval

The BRAC James P Grant School of Public Health (JPGSPH) ethical review committee approved the study protocol at BRAC University, Bangladesh. The reference number is IRB-20-November’20–049. Before starting any data collection activity, authorisations were collected from the respective local administrative bodies of the selected sub-districts. Informed written consents were also obtained from the participants of this study. All procedures performed in this study involving human participants were per the ethical standards of JPGSPH, BRAC University and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Moreover, since the survey was conducted during the COVID-19 pandemic, all the recommended protective measures (e.g., wearing face masks and maintaining a physical distance of at least 2 meters) were taken while interviewing the participants.

Conflict of interest

The authors have no conflict of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.infpip.2022.100258.

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