Healthcare workers’ preparedness and response during COVID-19 pandemic

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Abstract

Background: Healthcare workers (HCWs) are most at risk of contracting SARS-CoV-2 and COVID-19 infection. Their preparedness, as a result of provision and access to personal protective equipment (PPE), training programmes and awareness and practices on infection prevention and control measures, is integral for the prevention of infectious disease transmission.

Objectives: This study was conducted to assess the preparedness and practices of HCWs during COVID-19 first wave outbreak in Brunei Darussalam.

Methods: A cross-sectional study using a pre-designed and self-administered web-based questionnaire was conducted among HCWs from government and private health sectors ranging from primary to tertiary health facilities in Brunei Darussalam. Data were analysed using descriptive statistics, and chi-square test was used for statistical significance.

Results: A total of 511 HCWs participated in the study. Nurses (64%) and HCWs based at hospitals (66%) made up the majority of the study participants, with 74% having occupational exposure to COVID-19 cases. More than 99% of HCWs used respiratory PPE, and 94% used gloves. 74% had undergone respirator fit testing and 65% had received PPE awareness session within the last one year. Coverage in training programmes was found to be low among HCWs from private health facilities.

Conclusions: Majority of HCWs who had received updated training programmes and therefore were better prepared came from government health facilities. HCWs from private health facilities lacked preparedness training programmes and as such, there needs to be improvement to enhance preparedness measures in light of the ongoing COVID-19 pandemic and for future infectious disease outbreaks.

Keywords

Healthcare workers, COVID-19, personal protective equipment, respirator fit testing

Introduction

Since the start of the global pandemic of COVID-19 in early 2020, frontline occupational groups such as healthcare workers (HCWs) have been identified to be most at risk of SARS-CoV-2 and COVID-19 infection.1,2 By April 2020, more than 22,000 confirmed cases of SARS-CoV-2 in HCWs had been reported to the World Health Organization (WHO). It is likely that many such cases still go unreported due to lack of a systematic reporting system particularly in countries that are currently experiencing high rates of infection where the healthcare system is already under strain.3 A scoping review of data from 130 countries reported that by May 2020 there were more than 152,000 infections and 1413 deaths among HCWs due to COVID-19. Infection was highest among

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nurses (39%), while deaths were observed to be highest among doctors (51%). A WHO publication on World Patient Safety Day in September 2020 reported that 14% of all reported cases of COVID-19 were among HCWs. An Australian study reported that 73% of 3574 reported cases of infected HCWs had acquired the infection from their workplace and almost 31% of these were among hospital based HCWs.

Since early 2020, WHO and Center for Disease Control and Prevention (CDC), USA, had published infection prevention and control (IPC) guidelines for HCW preparedness in healthcare settings. In general, these guidelines outlined five main strategies: early case detection and isolation of cases, application of standard IPC precautions, additional precautions for contact and airborne transmissions, administrative control measures and engineering control measures. These guidelines also emphasize on HCWs’ training on appropriate personal protective equipment (PPE) including proper selection, donning, doffing and disposal. Additionally, respirator fit testing (RFT) is recognized as an important component of a respiratory protection programme for HCWs for which Occupational Health and Safety Administration (OSHA), USA, recommends annual respirator fit testing to ensure proper fit and effectiveness for health protection. According to a recent Cochrane review update, selection of proper PPE, practising recommended donning and doffing procedures and computer-based or face-to-face training, provides better protection, fewer errors as well as improves compliance to PPE among HCWs. Recent studies in different countries purported that inadequate supply and improper PPE usage were among the determinants of SARS-CoV-2 infections among HCWs, while PPE and IPC training of HCWs were associated with lower infection rates. As a result, preparatory measures by various countries to mitigate COVID-19 threat included HCWs’ training on IPC, PPE and RFT. Brunei Darussalam is a country in South East Asia with a population of 459,500. Public healthcare in Brunei Darussalam, particularly for communicable diseases of epidemic and pandemic scales, is fully subsidized by the government through the Ministry of Health (MOH). Healthcare services are provided by four government hospitals, several government primary health centres, two private hospitals and private clinics. Brunei Darussalam reported its first case of COVID-19 on 9 March 2020, and as of 8 June 2021 (the time of writing), there have been 246 confirmed cases and 3 deaths, with the last locally transmitted case reported 398 days ago. Since the first reported case of COVID-19 and WHO’s declaration of the infectious disease as a public health emergency of international concern on 30 January 2020, MOH Brunei had implemented public health measures to delay the introduction as well as limit and control the spread of COVID-19 in the country. These measures include travel and mass gathering restrictions, encouraging social distancing, awareness on and instituting hygiene measures and enforcing provisions under the Infectious Disease Act 2010 including screening and isolation/quarantine measures. Guidelines on surveillance and management of HCWs exposed to and infected with COVID-19 were also drawn up. HCW preparedness and awareness were enhanced by providing training and awareness on COVID-19 infection and PPE. Additionally, since January 2020, the Occupational Health Division (OHD) under the Ministry of Health conducted an intensive drive of RFT sessions among HCWs in government healthcare facilities.

This study was conducted to assess the practices and preparedness of HCWs in healthcare facilities in Brunei Darussalam on COVID-19, focussing on PPE use, participation in awareness and training programmes, respirator fit testing, as well as HCWs’ perceived effectiveness of control measures for COVID-19. Uptake of annual influenza vaccination was also assessed in view of MOH’s strategy to ensure a resilient healthcare system amidst the potential of double burden of COVID-19 and Influenza cases in the country.

Methods

Research design
A cross-sectional study among HCWs from government and private health facilities, including the National Isolation Centre (NIC), was conducted using a pre-designed, pre-tested, self-administered and anonymous questionnaire covering demographic profile, training details, PPE practice and HCWs’ perception to effectiveness of common control measures (measured on a 5-point Likert scale consisting of strongly disagree, disagree, not sure, agree and strongly agree). Information on uptake of annual influenza vaccination was also included. For this study, HCWs are defined as those in healthcare settings who were engaged in tasks with the primary intent of enhancing health such as doctors, nurses, allied health professionals (AHPs), support staff, cleaners and voluntary health workers.

Participant recruitment and data collection

Recruitment of participants and distribution of the questionnaire were carried out from 1 July to 3 August 2020. Using convenience sampling, the questionnaire link which also contained a participant information sheet and consent form, was distributed via social media platform to HCWs who had been screened at the Occupational Health Clinic for influenza-like illness (ILI) symptoms during the outbreak period, HCWs who had returned from overseas travel during the outbreak period, HCWs with occupational or non-occupational contact with suspect or confirmed COVID-19 case, HCWs who had undergone COVID-19 surveillance screening at MOH designated flu and swab centres, and HCWs working in NIC. Designated flu and swab centres are health facilities that are dedicated to receiving patients with symptoms of ILI or those who were close contacts of confirmed or suspect cases of COVID-19.

Data analysis

Data were analysed using SPSS 20.0, with descriptive statistics using percentage for categorical data, range and mean (± SD) for continuous data, and Pearson chi-square test for comparison of categorical variables.

Results

Study participants, frequency of exposure and PPE usage

A total of 511 HCWs responded to the study survey. Findings showed that the mean age of respondents was 38 (± 9.5) years.
Table 1. Sociodemographic and work characteristics of healthcare workers.

| Demographic characteristic | Number (n = 511) | Percentage (%) (95% confidence interval) |
|----------------------------|------------------|----------------------------------------|
| **Age group**              |                  |                                        |
| ≤25 years                  | 66               | 12.9 (10.0–15.8)                        |
| 26–35 years                | 149              | 29.2 (25.2–33.1)                        |
| 36–45 years                | 170              | 33.3 (29.4–37.4)                        |
| 46–55 years                | 106              | 20.7 (17.3–24.5)                        |
| >55 years                  | 20               | 3.9 (2.4–5.9)                           |
| **Gender**                 |                  |                                        |
| Male                       | 116              | 22.7 (19.1–26.6)                        |
| Female                     | 394              | 77.1 (73.2–80.1)                        |
| Unknown                    | 001              | 0.2                                    |
| **Education**              |                  |                                        |
| Primary                    | 02               | 0.4 (0.05–1.4)                          |
| Secondary                  | 62               | 12.1 (9.4–15.2)                         |
| Diploma                    | 283              | 55.4 (51.0–59.8)                        |
| Degree and above           | 144              | 28.2 (24.3–32.3)                        |
| Unknown                    | 20               | 3.9 (2.4–6.0)                           |
| **Nationality**            |                  |                                        |
| Brunei                     | 442              | 86.5 (83.2–89.3)                        |
| Philippines                | 22               | 4.3 (2. – 6.5)                          |
| Pakistan                   | 14               | 2.7 (1.5–4.6)                           |
| Malaysia                   | 11               | 2.2 (1.3–3.8)                           |
| Myanmar                    | 10               | 2.0 (0.9–3.6)                           |
| Others                     | 12               | 2.3 (1.2–4.1)                           |
| **Marital status**         |                  |                                        |
| Married                    | 371              | 72.6 (68.5–76.4)                        |
| Single/divorced/separated/widowed | 140       | 27.4 (23.6–31.5)                        |
| **Healthcare workers**     |                  |                                        |
| Doctor                     | 87               | 17 (13.9–20.5)                          |
| Nurse                      | 327              | 64 (59.7–68.2)                          |
| Allied health professional | 40               | 7.8 (5.7–10.5)                          |
| Others                     | 57               | 11.2 (8.6–14.2)                         |
| **Workplace**              |                  |                                        |
| Hospital                   | 338              | 66.1 (61.9–70.2)                        |
| Health centre/clinic       | 107              | 21 (17.5–24.7)                          |
| Flu/swab centre            | 12               | 2.3 (1.2–4.1)                           |
| National isolation centre  | 20               | 3.9 (2.4–6.0)                           |
| Others                     | 34               | 6.7 (4.7–9.2)                           |
| **Work sector**            |                  |                                        |
| Government                 | 494              | 96.7 (94.798.1)                         |
| Private                    | 17               | 3.3 (1.6–5.3)                           |

Table 2. Work characteristics of healthcare workers during COVID-19 outbreak.

| Work characteristics                                    | Number (n = 511) | % (95% Confidence interval) |
|---------------------------------------------------------|------------------|------------------------------|
| Exposure to COVID-19 confirmed cases and frequency of exposure |                  |                              |
| Yes                                                      | 376              | 73.6 (69.5–77.4)             |
| Daily                                                   | 168              | 44.7 (39.6–49.9)             |
| Few times a week                                        | 71               | 18.9 (15.1–23.2)             |
| Once a week                                             | 20               | 5.3 (3.3–8.1)                |
| Rare                                                    | 117              | 31.1 (26.5–36.1)             |
| No                                                       | 87               | 17 (13.9–20.6)               |
| Not sure                                                | 48               | 9.4 (7.0–12.3)               |
| Involvement in Aerosol generating procedure             |                  |                              |
| Yes                                                      | 253              | 49.5 (45.2–53.9)             |
| No                                                      | 258              | 50.5 (46.2–54.8)             |

(age range 19–64), with majority (33%) in the 36–45 age group. 77.1% of HCWs were women, and 86.5% were Bruneian. 83.6% had post-secondary level of education (diploma level and above). The majority of participants were nurses (64%), followed by doctors (17%), and allied healthcare professionals (e.g. physiotherapists and laboratory staff) (7.8%), while the remaining 11.2% were from other occupations (e.g. security personnel and cleaners). There was an overwhelming majority of respondents from government health facilities (96.7%). 66.1% of HCWs were based at tertiary health facilities, 21% at health centres or clinics, 3.9% at NIC, and 2.3% at designated flu and swab centres (Table 1).

As per Table 2, 73.6% of HCWs had varying degrees of exposure to COVID-19 cases as a result of their workplace exposure. The frequency of exposure was reported to be daily for 44.7% of HCWs, 18.9% for exposure of few times a week, 5.3% for once a week exposure, and 31.1% for rare exposure. Almost 50% of participants reported that their work tasks involved aerosol generating procedures (AGP).
Respiratory protection in the form of either surgical mask or N95 respirator was the commonest type of PPE used by 99.6% of HCWs, followed by gloves (94.7%) (Table 3).

Training and awareness programme

This study showed that 73.6% of HCWs underwent respiratory fit testing (RFT) within the last one year, with a high proportion of participation seen in doctors (95.4%, \( p < .001 \)) compared to other clinical staff. There was a significantly high proportion of RFT participation among HCWs from NIC (95%, \( p < .001 \)) compared to other health facilities such as hospitals (76%) or flu and swab centres (75%). 64.8% of HCWs reported that they had received PPE training within the last one year, with the majority of participation among nurses (75.8%) and among HCWs from NIC (95%) (\( p < .001 \)) (Table 4).

Only 40.5% of HCWs had attended a COVID-19 awareness session. Within this group, attendance was mostly by doctors (67.8%), followed by HCWs from NIC (55%) and health centres/clinics (47.6%) (\( p < .001 \)).

Influenza vaccination uptake

For annual influenza vaccination uptake among HCWs, 67.3% reported having had their influenza vaccination within the last one year. Uptake was seen to be significantly high among doctors (87.4%) and AHP (80%) compared to nurses and other categories (63.3% and 50.8% respectively) (\( p < .001 \)). In terms of work location, the highest proportion for vaccination uptake was seen in HCWs from NIC (75%), followed by health centres/clinics (73.8%), hospitals (66.2%) and flu and swab centres (58.3%) (\( p < .01 \)).

Perceived effectiveness of workplace control measures

Figure 1 shows HCWs’ perceived effectiveness of workplace control measures in protecting them from COVID-19 infection. Almost 92% agreed that providing an isolated area or special room for suspect or confirmed cases was an effective control measure, while 91% agreed that having prominent information displayed or disseminated to advise patients and visitors was equally effective. The proportions of agreement were similar among the different categories of HCWs. 96.8% HCWs agreed that regular and proper hand hygiene practice was an effective control measure for COVID-19 transmission, with majority of nurses (98.4%) agreeing with this more than other HCWs (\( p = .04 \)). 89.4% of HCWs agreed with limiting the number of visitors at the workplace. 77.8% of HCWs agreed that temperature screening at entrances for staff and visitors was effective; however, doctors agreed with this measure (57%) the least compared to other HCWs (\( p < .001 \)).

Discussion

After the first reported cluster of COVID-19 cases in Wuhan, China in December 2019, MOH Brunei had stepped up measures in reviewing and updating national health guidelines and standard operating procedures for national level preparedness and instituted preventive measures in preparation for the first COVID-19 case in the country. The time period between then and Brunei’s first confirmed case (9 March 2020) was crucial for national preparedness measures to be strengthened in view of the rapid global spread of infection.

The proportion of HCW respondents by occupational group in this study (17% doctors; 64% nurses; 8% AHP; 11% others) is comparable to that of the health workforce in the country, that is, 19% for doctors and dentists, 72% for nurses and midwives and 9% for AHPs. This was similarly observed for gender whereby 77% of respondents were women (comparable with 75% women in the total health workforce of the country). Participation was highest among Bruneians (86%) (compared with 77% Bruneian of total health workforce). 66% of respondents were from tertiary health facilities (including three district hospitals and one private hospital), 21% were from health centres and clinics and 4% were from NIC. As healthcare services in the country are mainly provided by government health facilities and in particular for health response to national level threats, it is not surprising to observe that 97% of respondents were from government health facilities. 74% of HCWs reported having had occupational exposure to either a confirmed or suspect COVID-19 case, with 45% of them reporting daily occupational exposure. Almost 50% of HCWs were involved in aerosol generating procedures.

This study showed that more than 99% of HCWs used respiratory protection at work, with 84% wearing either a surgical or medical mask and 79% wearing N95 respirator. 95% wore gloves, while 77% used either a face shield or visor. PPE usage was found to be higher in our study compared to a study from Latin America where PPE practice was 91% for gloves, 84% for mask, 56% for N95 respirator and 33% for face shield. As presented in Figure 2, further analysis of PPE practice in our study showed that 90% of HCWs in NIC and 83% of HCWs in hospitals used the appropriate PPE as recommended by WHO for airborne and contact precautions. All HCWs from NIC and 92% of HCWs involved in AGP wore N95 respirator. As per Occupational Safety and Health Administration (OSHA) recommendation, annual respirator fit testing (RFT) is an important component of a respiratory protection programme for HCWs. In this study, 74% of HCWs underwent RFT within the last one year. This is higher than a study from Australia which found that only 36% of HCWs had RFT.

Table 3. Type of PPE used by healthcare workers during COVID-19 outbreak.

| PPE                          | Number | % (95% CI)  |
|------------------------------|--------|-------------|
| Respiratory PPE              | 509    | 99.6 (98.6–99.9) |
| Surgical mask                | 431    | 84.3 (80.9–87.4) |
| N95 respirator (or equivalent)| 401    | 78.5 (74.7–82) |
| Gloves                       | 484    | 94.7 (92.4–96.5) |
| Face shield                  | 395    | 77.3 (73.4–80.9) |
| Hair cover                   | 361    | 70.7 (66.5–74.6) |
| Shoe cover                   | 353    | 69.1 (64.9–73.1) |
| Enhanced (jupiter suit)      | 257    | 50.3 (45.9–54.7) |
| Other PPE                    | 281    | 55 (50.7–59.3)  |

CI: confidence interval; PPE: personal protective equipment.
Table 4. Preparedness training and Influenza vaccination coverage among HCWs within the last one year.

Respirator fit testing

| Type of HCW | Healthcare facility | Work sector | Total |
|-------------|---------------------|-------------|-------|
|             | No (%)              | No (%)      | No (%)|
| Doctor      | 83 (95.4)           | 257 (76)    | 337 (74.8) |
| Nurse       | 256 (78.2)          | 75 (70)     | 331 (64.8) |
| AHP         | 20 (50)             | 9 (75)      | 494 (97) |
| Other       | 17 (29.8)           | 19 (95)     | 1 (5) |
| Hospital    | 257 (76)            | 9 (75)      | 16 (47) |
| HC          | 75 (70)             | 19 (95)     | 1 (5) |
| FC          | 3 (25)              | 1 (5)       | 2 (11.7) |
| NIC         | 1 (5)               | 1 (5)       | 2 (11.7) |
| Other       | 10 (18)             | 20 (20)     | 87 (32.2) |
| Govt        | 79 (76)             | 18 (35.2)   | 180 (35.2) |
| Private     | 14 (47)             | 6 (35.2)    | 11 (64.8) |

$p$-value: $X^2 = 92.61, p < .001$

PPE training

| Type of HCW | Healthcare facility | Work sector | Total |
|-------------|---------------------|-------------|-------|
|             | No (%)              | No (%)      | No (%)|
| Doctor      | 54 (62)             | 248 (73.3)  | 323 (65.3) |
| Nurse       | 248 (75.8)          | 43 (40.1)   | 171 (34.7) |
| AHP         | 12 (30)             | 6 (50)      | 11 (21.7) |
| Other       | 28 (70)             | 6 (50)      | 11 (21.7) |
| Hospital    | 248 (73.3)          | 19 (95)     | 15 (44.1) |
| HC          | 90 (26.7)           | 15 (55.9)   | 18 (44.1) |
| FC          | 64 (59.9)           | 6 (50)      | 19 (55.9) |
| NIC         | 6 (50)              | 1 (5)       | 2 (11.7) |
| Other       | 207 (63.3)          | 25 (7.6)    | 207 (40.5) |
| Govt        | 134 (40.9)          | 11 (64.8)   | 180 (35.2) |
| Private     | 193 (59.1)          | 293 (59.4)  | 304 (59.5) |

$p$-value: $X^2 = 69.5, p < .001$

COVID-19 awareness session

| Type of HCW | Healthcare facility | Work sector | Total |
|-------------|---------------------|-------------|-------|
|             | No (%)              | No (%)      | No (%)|
| Doctor      | 59 (67.8)           | 131 (38.8)  | 201 (40.6) |
| Nurse       | 134 (40.9)          | 51 (47.6)   | 171 (34.7) |
| AHP         | 6 (15)              | 5 (41.6)    | 11 (21.7) |
| Other       | 8 (14)              | 11 (45)     | 49 (86) |
| Hospital    | 131 (38.8)          | 11 (55)     | 7 (16.6) |
| HC          | 197 (61.2)          | 25 (73.6)   | 18 (44.1) |
| FC          | 56 (52.4)           | 9 (45)      | 6 (50) |
| NIC         | 7 (58.4)            | 25 (73.6)   | 6 (50) |
| Other       | 207 (63.3)          | 25 (7.6)    | 207 (40.5) |
| Govt        | 13 (40.9)           | 6 (35.2)    | 18 (35.2) |
| Private     | 193 (59.1)          | 293 (59.4)  | 304 (59.5) |

$p$-value: $X^2 = 54.3, p < .001$

Influenza vaccination

| Type of HCW | Healthcare facility | Work sector | Total |
|-------------|---------------------|-------------|-------|
|             | No (%)              | No (%)      | No (%)|
| Doctor      | 76 (87.40)          | 224 (66.2)  | 198 (59.6) |
| Nurse       | 207 (63.3)          | 79 (73.8)   | 286 (85.2) |
| AHP         | 32 (80)             | 7 (58.3)    | 12 (36.3) |
| Other       | 29 (50.8)           | 15 (75)     | 18 (54.5) |
| Hospital    | 224 (66.2)          | 15 (75)     | 18 (54.5) |
| HC          | 79 (73.8)           | 15 (75)     | 18 (54.5) |
| FC          | 7 (58.3)            | 15 (75)     | 18 (54.5) |
| NIC         | 18 (58.3)           | 15 (75)     | 18 (54.5) |
| Other       | 18 (58.3)           | 15 (75)     | 18 (54.5) |
| Govt        | 335 (67.8)          | 9 (26.4)    | 344 (67.3) |
| Private     | 293 (65.3)          | 25 (7.6)    | 318 (67.3) |

$p$-value: $X^2 = 38.5, p<0.001$

HC: health centre; FC: flu/swab centre; NIC: National Isolation Centre; HCW: healthcare workers; AHP: allied health professional.
within the last few months. A study in Saudi Arabia reported higher coverage (95%) of HCWs for RFT within the last one year, which may be due to the selection of only hospital-based HCWs who were either directly or indirectly involved in the care of COVID-19 cases, and the exclusion of administrative or support staff. In our study, most of the RFT sessions were conducted since January 2020 as part of HCW preparedness for COVID-19. Majority of the study participants who had attended RFT comprised doctors and nurses. A good proportion was HCWs from hospitals (76%), health centres (70%), flu and swab centres (75%) and NIC (95%). A higher proportion of HCWs from government health facilities (75%) attended RFT, whereas only 35% from private health facilities attended RFT in the last one year. Regular PPE training also forms an important component of respiratory protection programme, and this entails ensuring proper use, donning and doffing technique and proper disposal. Our study results showed that 65% of HCWs underwent PPE training in the last one year, which is comparatively higher than a study from Libya that reported 50% of participating HCWs had PPE training, but lower to the findings from Australia where 80% of HCWs had PPE training over the period of a few months, although this study only included HCWs from critical care facilities involved in the direct care of COVID-19 cases. The proportion of PPE-trained HCWs in our study was highest among nurses (76%), and HCWs from NIC (95%) followed by hospitals (73%). However, the coverage of PPE-trained HCWs from private health facilities (47%) and those from other occupational categories (i.e. AHP and others) (30%) were comparatively low.

Healthcare workers’ possession of updated knowledge and awareness on COVID-19 has proven to be integral in clinical management, attitude and practices when managing positive and suspect cases. In addition to available online training courses including those from the WHO, MOH Brunei had held several continuous medical/nursing education (CME and CNE) programmes on COVID-19 at various healthcare facilities in early 2020 to ensure increased coverage of HCWs’ knowledge and appropriate training, and to share MOH’s preventive strategies and preparedness plans. Our study showed that 41% of HCWs had participated in a COVID-19 awareness session, with high participation seen among doctors and nurses, and among HCWs from health centres (48%) compared to hospitals (39%). This can be attributed to CME/CNE sessions that had high attendance from primary healthcare HCWs since they would be at the forefront to receive symptomatic cases. A similar participation of HCWs in COVID-19 training was also observed in a study in the Palestine region where 41.3% of HCWs received training. However, studies from Yemen (51%) and Jordan (60.3%) showed higher participation of HCWs on COVID-19 awareness or training sessions.

Ministry of Health Brunei, through the Occupational Health Division, conducts pre-employment and periodic medical examinations on HCWs and during these visits, HCWs are assessed and updated for their annual influenza vaccination. A previous local research in 2017 on influenza
vaccination uptake among nurses showed that only 33.5% had received their annual influenza vaccination. In this study, influenza vaccination uptake among HCWs in the last one year was found to have doubled (67%). More doctors (87%) and AHPs (80%) received their vaccination compared to nurses (63%). There was higher vaccination coverage among HCWs based in NIC (75%) and health centres (74%) compared to hospitals (66%). This increase in influenza vaccination uptake can be attributed to the influenza vaccination campaign carried out by MOH in January–March 2020 to ensure that HCWs were protected against serious complications of influenza so as not to overwhelm hospital services with influenza cases, over and above the threat and outbreak of COVID-19 in the country.

Our study results on HCWs’ perception on implemented preventive measures for COVID-19 showed that almost 90% agreed that providing an isolated area at health facilities for suspect or confirmed cases, having prominent information displayed at health facilities to increase awareness and limiting number of visitors to health facilities were effective. Similarly, a high proportion (97%) agreed that regular and proper hand hygiene practices, as recommended by WHO, were effective in curbing the spread of the virus. Only 78% of HCWs perceived that temperature screening at entrances of health facilities was an effective measure, and this finding was observed to be lowest among doctors (57%). Temperature screening at entry points of public places and workplaces is a widely adopted screening measure; however, various studies have shown its doubtful effectiveness in view of the limited ability to detect asymptomatic or pre-symptomatic cases.

Strengths and limitations
Data collection using a validated questionnaire and a considerable sample size of 511 HCWs are some of the strengths of this study; however, the use of convenience sampling and low participation of HCWs from private health facilities (3.3%) are limitations of this study. Further research in future could consider use of a more extensive sampling methodology to include other frontline participation (including health volunteers) from various occupational groups, facilities and sectors.

Conclusion
Our study highlights Brunei MOH’s health preparedness activities and public health control measures that were implemented for HCWs in Brunei Darussalam, with the aim of having HCWs well-prepared to manage and mitigate COVID-19. A high proportion of HCWs were equipped with updated and appropriate training to better prepare them to face COVID-19 cases; however, RFT and PPE training were found to be low among HCWs from private health facilities (35% and 47%, respectively), thereby highlighting preparedness disparity between government and private health sectors. The coverage of HCWs who had undergone a COVID-19 awareness session in the early days of the
outbreak was only 40%; thus indicating an area for future improvement as sound knowledge of the novel SARS-CoV-2 aetiology and transmission rate can further enhance existing practices of HCWs when providing care to COVID-19 cases. More than 99% of HCWs adhered to wearing respiratory protection, while more than 90% concurred with the effectiveness of infection and prevention control measures of isolating patients with influenza-like illnesses, limiting visitors at health facilities, prominent display of information, education and communication materials and proper hand hygiene practices. This reflects an excellent level of awareness among HCWs on COVID-19 infection and prevention control measures. This study also saw an increase in influenza vaccination coverage of 67% in the last one year compared to a previous coverage of 33% in 2017. Of note, it is highly encouraging to the nation that to date (at the time of writing), Brunei has recorded zero cases.

Authors’ contributions
AL and DK conceptualized the study, critically revised the manuscript and approved the final version of the manuscript. KNW and KI contributed to manuscript revision and approved the final version. AT, MF and NI contributed to protocol development, data collection, data analysis and preparation of the draft manuscript.

Declaration of conflicting interests
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Ethical Approval
This study was granted approval by the Medical and Health Research Ethics Committee, MOH, Brunei Darussalam [Ref. No. MHREC/MOH/2020/7 (1)].

Informed consent
Informed consent was obtained from all the study participants.

Availability of data and materials
The datasets generated and/or analysed during the current study are available from corresponding author.

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