

# A nationwide, multihospital, cross-sectional, self-reported study: Knowledge, attitude and behaviour concerning the use of personal protective equipment among healthcare workers during the COVID-19 pandemic in Malaysia

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## ABSTRACT

**Introduction:** Personal protective equipment (PPE) is crucial in reducing the risk of hospital-acquired COVID-19 as health care workers (HCW)s are highly exposed to the virus during the management of patients with COVID-19. This study assesses the knowledge, attitude and behaviour of the HCWs towards the use of PPE during the COVID-19 pandemic in Malaysia.

**Materials and Methods:** This is a nationwide, online-based cross-sectional study utilising a self-administered questionnaire that was distributed to tertiary hospital HCWs in Malaysia, conducted between June and August 2020.

**Results:** Forty-eight physicians, 66 nurses and 79 medical assistants participated in this study. 73.6% correctly recognised PPE components while 40.4% revealed correct hand hygiene practices and approximately 20% had misconceptions about the proper usage of PPE. Although 78.8% disclosed high compliance, 37.3% perceived that PPE protocol interferes with patient care. HCWs have suboptimal knowledge levels of hand hygiene. Age and poor behaviour were the independent predictors of good compliance with PPE.

**Conclusion:** This study highlights the necessity to analyse discrepancies in PPE practice among HCWs and its contributing elements. Recognised barriers should be addressed to narrow the gap between knowledge, attitude and behaviour to improve compliance. The study findings would assist in developing an improved disease transmission control and prevention training protocols for HCWs as a preparation for possible infectious outbreaks in the future.

## KEYWORDS:

COVID-19; personal protective equipment; health care worker; infection prevention; knowledge, attitude, and behavior

## INTRODUCTION

In December 2019, the first case of a highly infectious pneumonia caused by coronavirus was confirmed in Wuhan, Hubei province, China. The disease was later named the

Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2). Subsequently, the virus spread to over 200 countries. The World Health Organization (WHO) declared it as a pandemic in March 2020.

The initial cases were discovered in Malaysia in January 2020.<sup>1</sup> From January 2020 to May 2021, fatalities due to COVID-19 among health care workers (HCW)s continued to increase with an estimated 80,000–180,000 deaths recorded by the WHO.<sup>2</sup> In a study conducted at a Malaysian teaching medical centre in 2020, the prevalence of COVID-19 infection among HCWs was 0.3%.<sup>3</sup> However, as of 31 August 2021, nearly 20,000 HCWs in Malaysia had been infected, with a fatality of 0.09%.<sup>4</sup> Hospital-acquired infections constituted 40% of cases among the health work force with 20% from HCW interaction, 10% transmission from patients and 10% from various unidentified causes.<sup>5</sup>

The complex network of disease transmission between HCWs, patients and the community is a major threat to the healthcare systems due to the highly transmissible nature of the virus. The surge in HCW infections results in the reduction of hospital resources that can potentially incapacitate the healthcare system. To prevent the catastrophic collapse of the health care system, it is essential to protect HCWs from contracting nosocomial infection.<sup>6,7</sup> Consequently, HCWs are required to wear proper personal protective equipment (PPE) to protect themselves and their patients. Evidence has clearly demonstrated the importance of PPE in a study undertaken by Liu et al. where HCWs who used proper PPE did not contract the infection despite being highly exposed to COVID-19.<sup>8</sup> This corresponds with research conducted by Burke et al. who discovered that when proper PPE was used, the risk of contracting infections during patient care among HCWs was significantly lower compared to those who did not wear PPE.<sup>9</sup> The CDC, the WHO, as well as the Ministry of Health Malaysia have outlined clear and easily accessible guidelines on the appropriate levels of PPE for various activities and procedures during the management of COVID-19.<sup>10-12</sup> Proper PPE usage is essential in preventing the spread of COVID-19, thus the need to study the knowledge, attitude and behaviour towards the use of PPE among HCWs at tertiary hospitals in Malaysia.

This article was accepted: 26 February 2023

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## MATERIALS AND METHODS

### *Study Design and Setting*

This is a cross-sectional study designed to cumulate the information on knowledge, attitude and behaviour of PPE use among HCWs in Malaysia. HCWs from tertiary public hospitals under the Ministry of Health who provided consent were included in this study. At the time of study, there were 37 tertiary hospitals under the Ministry of Health Malaysia.

### *Data Collection Instruments and Procedure*

This study was conducted between the second and third wave of COVID-19 in Malaysia, prior to the availability of vaccination. Data were collected using a self-administered online questionnaire (Google form) in English from June 2020 to August 2020. The link to the questionnaire was shared via email and WhatsApp to physicians, nurses and medical assistants through hospital administration offices of the 37 tertiary centres following the approval of the Medical Research and Ethics Committee, Ministry of Health Malaysia. Minimum sample size of 196 was calculated according to the formula  $n = Z^2 P(1-P)/d^2$  with the assumption of a total population estimate of 10,000 HCWs employed at tertiary hospitals, 95% confidence interval ( $Z=1.96$ ), expected prevalence ( $P$ ) of 0.5 and  $d=0.05$ .<sup>13</sup>

The questionnaire was adapted from a study conducted by Daugherty et al. (2009)<sup>14</sup>, comprising a section on demographic information, six items on knowledge, eight items on attitude and three items on behaviour.<sup>13</sup> In the knowledge section, we classified good and poor knowledge levels based on Bloom's cut-off point of 80%–100%. One point was awarded to each correct answer, while incorrect response was scored as zero. A score of  $\geq 5$  was set as good PPE knowledge. Attitude and behavioural aspects of PPE were elicited by a 5-point Likert scale (e.g., completely agree, agree, neither agree nor disagree, disagree, completely disagree). Good attitude and behaviour were defined as responses that indicate agreement or complete agreement in all questions. For the level of compliance to PPE, we considered responses with self-reported compliance of  $> 80\%$  as high (good) compliance. In a work by Berhe et al.<sup>15</sup> on the control of nosocomial infections, 'high compliance' was specified as  $> 80\%$ .

### *Data Analysis*

A statistical analysis was performed using IBM Statistical Package for the Social Sciences (SPSS) Statistics for Windows version 25.0. All five-point Likert-scale responses were then categorised into completely agree/agree versus neither agree nor disagree/disagree/completely disagree. A further statistical test was performed to analyse the relationship between the variables. The statistical significance level was set at  $p < 0.05$ . Categorical variables were compared with Chi-square test. Pearson correlation test was done to determine the relationship between continuous variables. The odds ratio (OR) was estimated based on both univariate analysis and multivariate logistic regression analysis for the determination of independent predictors for high compliance with the PPE used during patient care. Variables such as characteristics of HCWs, knowledge, attitudes and behaviours were included in the model using stepwise conditional forward and backward entry, if  $p < 0.1$  in a univariate analysis. An OR less than 1

indicated low compliance towards the use of PPE, while an OR greater than 1 indicated high compliance with PPE during patient care.

## RESULTS

### *Respondent Characteristics*

Table I illustrates the characteristics of the respondents. A total of 193 respondents participated in this study with 46.1% males and 53.9% females. The mean age of the respondents was 30.6 with a standard deviation of 5.85 years. Physicians comprised 25.7% of the respondents, while 34.2% were nurses and 40.9% were assistant medical officers. Most respondents were emergency and trauma department (ETD) personnel (67.9%), 11.9% were from the infectious disease unit and 20.2% were from other departments. Slightly over three-quarters (79.3%) were directly involved in the care of patients with COVID-19.

### *Knowledge*

The majority of the respondents (73.6%) managed to correctly identify the appropriate PPE (Table II). Good knowledge in the usage of the suitable face mask, and proper protective eyewear and gown was demonstrated in 79.8% and 80.3% of HCWs, respectively. In addition, only 40.4% possessed adequate knowledge and understanding of hand hygiene with a significantly lower percentage of nurses and medical assistants scoring correct responses for the mentioned item questions ( $p < 0.001$ ). No significant difference in the total knowledge scores was found between physicians, nurses and medical assistants.

### *Attitude*

In this study, 90.2% believed that proper PPE use conferred sufficient protection against COVID-19 infection among HCWs, with significantly more nurses possessing this impression compared to physicians and medical assistants ( $p < 0.05$ ) (Table II). On the contrary, only 59.1% felt that the use of PPE will protect patients from contracting COVID-19. 46.6% of the respondents regarded PPE use as cumbersome, with 37.3% believed that it interferes with the care of patients with COVID-19. Significantly more physicians perceived PPE use as an impediment to providing care to patients ( $p < 0.001$ ). A great majority of 98.4% were confident that they understood the risk of COVID-19 to the patients and HCWs. Of the HCWs surveyed in this study, 93.8% felt that they could improve the compliance with the recommended PPE. A significantly higher extent of negative attitude was found among physicians than non-physicians towards PPE.

### *Behaviour and Organisational Factors*

While 73.6% of the respondents exposed that their colleagues frequently failed to use the recommended PPE, 79.8% admitted to forgetting to change PPE between patients. Significant difference in the aforementioned behaviours was seen across the three different professional groups with the former  $p < 0.001$  and the latter  $p < 0.01$ . In both behavioural aspects, physicians held the most negative behaviour towards PPE. In addition, 93.3% noted that they removed their PPE immediately after leaving the patients' room. Behaviour scores were generally poor and significantly associated with different professional roles.

Table I: Characteristics of the respondents

Category	n (%)	Mean (SD)
Age		30.57 (5.84)
20–29	108 (56.0)	
30–39	66 (34.2)	
40–49	19 (9.8)	
Gender		
Male	89 (46.1)	
Female	104 (53.9)	
Profession		
Physician	48 (25.7)	
Nurse	66 (34.2)	
Assistant medical officer	79 (40.9)	
Area of work		
ETD	131 (67.9)	
Infectious disease unit	23 (11.9)	
Others <sup>1</sup>	39 (20.2)	
Work with patients with COVID-19		
Yes	153 (79.3)	
No	40 (20.7)	

ETD (emergency and trauma department).

<sup>1</sup>Among the 39 other areas of work, 10 were intensive care unit staff, 12 were from the medical department, 10 personnel were from the orthopaedic department, 3 were otorhinolaryngology department staff, 1 each from the radiology and psychiatric departments, respectively and 2 were from step-down COVID centres.

Table II: Use of PPE during the COVID-19 pandemic: Knowledge, attitude and behaviour and organisational factors

	Physician (n = 48)	Nurse (n = 66)	Medical assistant (n = 79)	Total (n = 193)
<b>Knowledge</b>				
• Correct recognition of PPE	70.8% (34)	75.8% (50)	73.4% (58)	73.6% (142)
• Proper use of protective eyewear and gown upon patient care	72.9% (35)	78.8% (52)	84.8% (67)	79.8% (154)
• Correct use of mask during patient care	77.1% (37)	80.3% (53)	82.3% (65)	80.3% (155)
• Proper understanding on hand hygiene***	79.2% (38)	31.8% (21)	24.1% (19)	40.4% (78)
<b>Attitude</b>				
• Use of PPE will protect HCWs from contracting COVID-19*	83.3% (40)	97.0% (64)	88.6% (70)	90.2% (174)
• Use of PPE will prevent patients from contracting COVID-19	59.3% (27)	54.5% (36)	64.6% (51)	59.1% (114)
• PPE use does not cause inconvenience	50.0% (24)	48.5% (32)	59.5% (47)	53.4% (103)
• Use of PPE does not interfere with patient care***	25.0% (12)	65.2% (43)	83.5% (66)	62.7% (121)
• I have the knowledge of COVID-19	97.9% (47)	95.5% (63)	98.7% (78)	97.4% (188)
• I am certain that I comprehend the risks of a pandemic for patients and HCWs	97.9% (47)	97.0% (64)	100% (79)	98.4% (190)
• I am sure that I can increase compliance with PPE	97.9% (47)	94.5% (63)	89.9% (71)	93.8% (181)
• High compliance (>80%) with PPE during patient care	89.6% (43)	77.2% (51)	73.4% (58)	78.8% (152)
<b>Behaviour</b>				
• My colleagues often failed to don PPE during patient care***	93.6% (45)	72.7% (48)	62.0% (49)	73.6% (142)
• I will doff my PPE straight after leaving the patient room	87.5% (42)	93.9% (62)	97.5% (77)	93.3% (181)
• I forget to switch PPE between patient upon patient care**	91.7% (44)	83.3% (55)	69.6% (55)	79.8% (154)
<b>Organisation</b>				
• PPE is easily accessible in the department	79.2% (38)	87.9% (58)	92.4% (73)	87.6% (169)
• I will be reprimanded by my supervisor	93.8% (45)	94.0% (62)	97.5% (77)	95.3% (184)
• I know when my patients are on COVID-19 precautions	91.7% (44)	89.4% (59)	86.1% (68)	88.6% (171)
<b>Knowledge scores</b>				
• Good knowledge	35.4% (17)	50.0% (33)	43% (34)	43.5% (84)
• Poor knowledge	64.6% (31)	50.0% (33)	57.0% (45)	56.5% (109)
<b>Attitude scores**</b>				
• Good attitude	33.3% (16)	43.9% (37)	65.8% (52)	54.4% (105)
• Poor attitude	66.7% (32)	56.1% (29)	34.2% (27)	45.6% (88)
<b>Behavior scores*</b>				
• Good behavior	4.2% (2)	13.6% (9)	22.8% (18)	15.5% (29)
• Poor behavior	95.8% (46)	86.4% (57)	77.2% (61)	85.0% (164)

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

$p$  value achieved from Chi-square test

Table III: Relationship between knowledge and attitude of the use of PPE towards behaviour

	r value	p value
Knowledge	0.111	0.124
Attitude	0.313	0.000

$p < 0.05$

Table IV: Predictors of high compliance to PPE use among the healthcare workers

	Univariate analysis OR (95% CI)	Multivariate analysis OR (95% CI)
<b>Age</b>		
20–29	Ref.	
30–39	*2.55 (1.126, 5.714)	*2.150 (1.087, 4.253)
40–49	7.247 (0.927, 56.652)	
<b>Gender</b>		
Male	Ref.	
Female	1.146 (0.574, 2.285)	
<b>Profession</b>		
Physician	Ref.	
Nurse	0.395 (0.133, 1.176)	
Others	0.321 (0.112, 0.920)	
<b>Area of work</b>		
ETD	Ref.	
Infectious Disease	1.535 (0.486, 4.847)	
Others	2.198 (0.793, 6.095)	
<b>Knowledge</b>		
• Correct recognition of PPE	1.393 (0.656, 2.958)	
• Proper use of protective eyewear and gown during patient care	1.156 (0.578, 2.311)	
• Correct use of mask during patient care	1.984 (0.975, 4.038)	
• Proper understanding of hand hygiene	1.227 (0.602, 2.502)	
<b>Attitude</b>		
• I have knowledge of COVID-19	0.393 (0.063, 2.432)	
• Use of PPE will protect HCWs from contracting COVID-19	2.000 (0.702, 5.702)	
• Use of PPE will prevent patient from contracting COVID-19	0.981 (0.484, 1.990)	
• PPE use cause inconvenience during patient care	0.870 (0.434, 1.741)	
• Use of PPE interfere with patient care	**0.276 (0.450, 0.661)	0.395 (0.125, 1.242)
• I am sure that I can increase compliance toward PPE use	0.923 (0.188, 4.524)	
<b>Behavior</b>		
• My colleague forget to don PPE during patient care	***0.234 (0.113, 0.487)	*0.281 (0.133, 0.595)
• I will doff PPE straight after leaving the patient room	0.320 (0.040, 2.557)	
• I failed to switch PPE between patient upon patient care	**0.325 (0.150, 0.702)	0.758 (0.253, 2.272)
<b>Organisational factors</b>		
• PPE is easily attained in the department	0.492 (0.139, 1.740)	
• I will be reprimanded by my supervisor if I fail to adhere to PPE protocol	1.921 (0.459, 8.037)	
• I am aware of patients who are on COVID-19 precautions	1.181 (0.405, 3.439)	

\* $p < 0.05$ , \*\* $p < 0.005$ , \*\*\* $p < 0.001$

Out of the 193 respondents, 87.6% agreed that the recommended PPE was readily available in their department (Table II), 95.3% perceived some form of disciplinary action from their superiors in the event of compromised PPE practice, and 88.6% were aware that their patient was on COVID-19 precautions.

Attitude on the use of PPE showed statistically significant, moderate positive correlation with behaviour (Pearson correlation coefficient,  $r=0.313$ ;  $p<0.001$ ), whereas knowledge level did not influence behaviour (Table III).

#### Predictors of PPE Usage Compliance

High compliance (>80%) towards the use of PPE was proclaimed by 78.8% of respondents (Table II). Age group 30–39 years is a significant positive predictor to high compliance to PPE, whilst having the perception that PPE use interferes with patient care and behavioural factors such as failure to change PPE and reports of colleague forgetting to wear PPE

were found to be significant negative predictors to high compliance with PPE protocol in univariate logistic regression (Table IV).

Age and reports of fellow colleagues neglecting PPE use during patient care were significant predictors of PPE compliance in both simple and multivariate logistic regression model analyses (Table IV).

#### DISCUSSION

The influenza A (H1N1) pandemic (2009), Severe Acute Respiratory Syndrome (SARS) outbreak (2002 and 2003) and the Middle East Respiratory Syndrome outbreak (2012) have highlighted HCW vulnerability to workplace infection.<sup>16</sup> PPE protects against contamination by acting as a physical barrier between pathogens and personnel.<sup>17</sup> In 2020, Lockhart et al.<sup>18</sup> suggested the combination of modified PPE comprising a N95 respirator, eye protection (surgical mask

with visor), disposable surgical gown, double high-cuffed (surgical-type) gloves, surgical hood with ties (head and neck covering) and knee-high shoe covering for aerosol-generating procedures, which aligns with the WHO guidelines, sans the doublegloving.<sup>11,18</sup> A proper selection of PPE and correct practice and competency in donning and doffing is essential to protect HCWs from COVID-19 and to prevent further transmission of the disease.<sup>19,20</sup>

According to the Centres of Disease Control and Prevention (CDC), hand hygiene must be performed for extra protection to potentiate the effectiveness of PPE. It is recommended to perform the hand hygiene steps immediately after the removal of all PPE as the hands might be contaminated upon doffing.<sup>21</sup> We found a remarkable lack of proper understanding on hand hygiene among subjects (40.4%), with significant variability between the three professional groups. The considerably poorer hand hygiene knowledge among nurses and medical assistants implies that special attention to infection prevention in this group is required.

Most respondents were confident that using PPE ensures protection from COVID-19 exposure. Ironically, only 59.1% believed that wearing PPE will prevent patients from contracting COVID-19, contrary to what would be expected from the former belief. This conflicting finding corresponds with a survey conducted during the H1N1 influenza pandemic by Hu et al.<sup>22</sup> The counterintuitive perceptions of the role of PPE illustrate that some HCWs are unaware that they are inadvertently protecting themselves and the patients by wearing PPE. The particular emphasis on the importance of PPE in protecting HCWs from COVID-19 may have sidetracked the other functions of PPE that are equally paramount in preventing hospital-acquired infection.<sup>23</sup> Nevertheless, further research is required to explore this finding.

Interestingly, 46.6% confessed that wearing PPE during patient care is inconvenient. A corresponding 37.3% of respondents agreed that using PPE interferes with patient care, with significant differences in beliefs across professional groups. A complete set of PPEs routinely worn for protracted periods during the care of patients with COVID-19 may cause a multitude of problems. Increased breathing resistance and humidity from N95 masks, vision restrictions from face shields, ineffective communication from muffled speech, thermal stress from layers of impermeable PPE and impaired manual dexterity and tactile sensation (especially with layers of gloves) are physiological stressors that potentially reduce compliance and impair a clinician's performance. This may eventually result in mental fatigue and psychological stress.<sup>24,25</sup> This perceived inconvenience is a contributing factor to the poor adherence to PPE.<sup>22,26</sup> While technological advancement in the construct of PPE remains far from optimal, several counter-measure strategies to address the problems arising from PPE use can improve the ability to provide quality care to patients. These strategies include regular training, careful planning of critically demanding duties, adequate rest and nutrition, breathing exercises, facilitating visual awareness, effective communication skills, lowering the threshold for additional assistance, appropriate temperature adaptation, the introduction of mindfulness training programs<sup>25</sup> and the provision of vigorous psychological support.<sup>27,28</sup>

We discovered a positive correlation between attitude and behaviour indicating HCWs with positive attitude and showed positive behaviour. Nevertheless, the level of knowledge did not translate to good PPE practice. Generally, respondents with good knowledge have higher odds of reporting high compliance. Contrariwise, HCWs with poor attitude and behaviour scores are less likely to self-report high compliance. Similar studies or studies akin to this research with PPE practice as one of the subcomponents appraised have revealed diverse outcomes with some studies showing knowledge correlates with good attitude and practice and the other studies showing the opposite findings.<sup>14,22,29-33</sup> The diverse study outcome is possibly due to multiple factors including the variation in participant demographics, study designs, data collection tools, research settings, institutions and regions. This may complicate the accurate comparison between knowledge, attitude, behaviour and compliance across these studies.

In our study, organisational factors, such as easy access to PPE has no significant association with high compliance to PPE although the majority agreed that PPE readily available. Conversely, Hu et al. and Daugherty et al. found a significant association between the availability of PPE and the level of compliance, affirming the importance of institutional-level interventions. Our survey showed that if respondents carried the perception of professional consequences from non-compliance to PPE protocol and awareness of patients under COVID-19 precautions, they were at higher odds to report high compliance. Compliance towards the usage of proper PPE could be enhanced with a concerted effort from all departments in the implementation of improved guidelines. This involves a dedicated team of safety managers created to monitor and enforce PPE adherence. This working party will also oversee the process of coaching and instilling safe PPE practice by coordinating regular workshops on the updated PPE recommendations, periodic simulated drills, and on-site trainings, as well as refresher courses to reinforce the proper practice of PPE. In addition, the incorporation of mindfulness-based cognitive training programs to improve resilience and manage burnout among HCWs should be considered.<sup>34</sup> A multiprong approach of regular and mandatory infection prevention and control training programmes for HCWs<sup>3,35</sup>, and the enforcement of PPE protocol adherence by a regulatory team has resulted in significantly more competent PPE practice among HCWs.<sup>30</sup>

We discovered that a negative attitude (notion of PPE use interferes with patients' care) and recalcitrant behaviour, such as the failure to don PPE during patient care and the failure to switch PPE between patients, were significant independent factors of low compliance towards PPE wear in the univariate analysis. The perceived obstruction in patient care was reported in previous studies by Daugherty, Hu and Seitz.<sup>14,22,29</sup> Failure to switch PPE might be challenging owing to time constraints and a large number of patients with the COVID-19 pandemic, as additional time and effort is required to ensure this is performed correctly before entering a patient's room (and subsequently removed meticulously in an appropriate sequence to prevent self-contamination).<sup>14,21,22</sup>

## LIMITATIONS

This study is a voluntary survey with feedback reflecting on the opinions and perceptions of the respondents instead of the actual situation. As this study relied on a self-reported questionnaire, there is an inclination to overrate favourable attitudes and behaviours. A comprehensive instrument validation and reliability assessment would have increased the virtue of the tool. The sample size of the study may be under-representing the actual number of HCWs in Malaysia. Therefore, an extension of the study to include university hospitals, district hospitals and hospital laboratories would be ideal to provide a more comprehensive picture. Finally, language may have been a barrier to several HCWs as the survey was only offered in English.

## CONCLUSION

HCWs in Malaysia have suboptimal knowledge levels of hand hygiene. There was a significant positive correlation between attitude and the behaviour of HCWs. Age and negative behaviour towards PPE use have been recognised as predictors of compliance towards PPE use. Our study highlights the necessity to analyse discrepancies in PPE practice and the contributing elements to the disparities among HCWs. Understanding the perceptions and obstacles of PPE use provides an insight into the factors that may influence compliance with PPE during the pandemic. Furthermore, the imperative exploration of PPE practice among HCWs would assist in the development of a more comprehensive control and preventative strategy as part of health emergency preparedness and response to possible infectious threats in the future.

## ETHICAL APPROVAL

This study received approval from the ethics committee of Medical Research Ethics Committee, Ministry of Health, Malaysia (NMRR-20-878-54908 [IIR]).

## ACKNOWLEDGMENTS

We would like to extend our gratitude to the Director-General of Health, Ministry of Health Malaysia, for permitting us to publish this article. We would also like to extend special thanks to Datuk Dr. Mohamed Alwi Abdul Rahman and Professor Dr. Md Mizanur Rahman for their guidance.

## CONFLICT OF INTEREST

The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this paper.

## FUNDING

No specific funding was received for this work.

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