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Headache in healthcare workers related to personal protective equipment use in COVID-19 referral hospital

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ABSTRACT

BACKGROUND

Studies show that wearing personal protective equipment (PPE) for long periods of time can lead to discomfort such as headaches, which could affect the performance of healthcare workers. The aim of this study was to determine the prevalence and risk factors of headaches related to PPE in healthcare workers at a COVID-19 referral hospital.

METHODS

A cross-sectional study was conducted involving 174 healthcare workers in a COVID-19 referral hospital in Bali. We conducted interviews using a questionnaire that consisted of three main parts: characteristics of the subjects, PPE usage, and PPE-associated headaches. A multiple logistic regression was used to analyze the data.

RESULTS

The analysis results showed that the PPE-associated headaches had a prevalence of 63.8% and were gradual in onset, pressure-like in quality (46%), and mild in intensity (80.1%). PPE level III-associated headache was the most common type. The majority of the participants had headaches up to 6 hours after using the protective gear, but improving within 15-30 minutes of removal and/or after pharmacotherapy. A Chi-squared analysis showed a statistically significant association between duration of PPE use, working units, and PPE levels ($p<0.05$). A logistic regression analysis found a significant relationship between PPE level and headache occurrence ($OR=4.826$; 95%CI: 2.433-9.572; $p<0.001$).

CONCLUSION

The frequency of PPE-associated headache was high and the PPE level was a risk factor of headache among healthcare workers. Better strategies are needed to reduce the duration of PPE exposure so that the work performance and quality of life of healthcare workers are not significantly affected.

Keywords: COVID-19, personal protective equipment, headaches, healthcare workers

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List of abbreviations

COVID-19: corona virus disease 2019; PPE: personal protective equipment; NRS: numeric rating scale; N-95 mask: non-oil 95 mask; VAS: visual analog scale



INTRODUCTION

The use of personal protective equipment (PPE) is obligatory for the entire community, specifically healthcare workers who are treating COVID-19 patients. Hospitals require their healthcare workers and visitors to always wear a mask when in the healthcare facility. Typically, healthcare personnel and visitors wear surgical masks, but while directly caring for COVID-19 patients, healthcare personnel wear N95 masks. Furthermore, the level of protection to be used is determined by the type of activity they carry out as well as the setting of their working units. They are advised to wear N95 aprons and masks instead of surgical masks while carrying out aerosol-generating procedures. High-risk areas include intensive care units, special isolation rooms for infectious patients, emergency units, and operating rooms.⁽¹⁾

Healthcare workers are people devoted to the health sector with knowledge and/or skills to provide healthcare services to patients. They are classified by law into several clusters and subgroups, namely medical staff, clinical psychologists, nursing staff, midwifery staff, pharmaceutical staff, public health workers, environmental workers, nutritionists, physiotherapists, medical technicians, biomedical engineering staff, traditional health workers and others.⁽²⁾

The impact of prolonged wear of PPE is physiologic and psychologic distress and reduced work efficiency, such as difficulty breathing, headache, rashes, acne, and the disequilibrium syndrome. PPE-associated headaches can be attributed to mechanical factors, hypercapnia, and hypoxemia. Tight straps and pressure on superficial facial and cervical nerves are mechanical factors capable of inflicting complications. Cervical neck pressure, sleep problems, abnormal mealtimes, and emotional distress are among the different sources of headache in healthcare workers during PPE usage.⁽³⁾

A previous study showed that PPE use by healthcare workers caused various complaints, such as skin damage, cognitive impairment, and headaches.⁽³⁾ This finding is consistent with 2 previous studies in Casablanca (Morocco) and Tehran (Iran), where 62% and 72.4% of the respective study samples experienced headaches.^(4,5) Furthermore, the use of masks, specifically N95, increased the incidence of the side effects, which was then aggravated in 81% of workers without a previous history of headaches. Discomfort around the ear accompanied by lack of hydration as well as conditions related to hypoxia/hypercapnia can cause headaches. The side effect is often experienced <60 minutes after use of PPE and improvement occurs within 30 minutes of removal.⁽⁶⁾ Previous studies showed that users can also feel pain due to external pressure in the neck (cervical) area, which then develops into a cervicogenic or tension-type headache.⁽⁶⁻⁹⁾

A study among 268 healthcare workers from a COVID-19 referral center in Mexico, showed that 78.4% of participants were found to have PPE-associated headaches, and that the majority reported using mixed PPE, with stress as predictive risk factor for its conversion into chronic headache.⁽¹⁰⁾ In contrast, the aforementioned study in Tehran (Iran), which was a cross-sectional study involving 243 medical staff at four referral hospitals for COVID-19, showed no relationship of PPE headache with BMI, marital status, age, blood pressure, or history of systemic or psychiatric disorders.⁽⁵⁾ The 'de novo' headache occurrence, related to filter masks common among certain healthcare workers, has greater professional, familial, personal and social impact.^(1,6) Because of the need for PPE use by healthcare worker, especially during the COVID-19 pandemic, it is necessary to identify and eliminate the factors that lead to intolerance for these devices to help improve the performance of the healthcare workers. Our objective in this study was to determine the prevalence and risk factors of PPE-associated headache in healthcare workers.

METHODS

Research design

A cross-sectional study was conducted in Udayana University Hospital, which was used as a COVID-19 Referral Hospital in Bali, Indonesia, from January to February 2022.

Research subjects

A total of 174 participants in this study were recruited among healthcare workers providing healthcare services directly and indirectly to the patients in the hospital. They included doctors, nurses, pharmacists, midwives, radiology officers, and laboratory, and nutrition workers. Healthcare workers who reported having regular usage of PPE during the COVID-19 pandemic in their shift work, age between 20-40 years old, and able and willing to provide written informed consent, were included in this study.

Data collection

Demographic and headache characteristics of the participants were collected using a structured questionnaire. The questionnaire was written in the Indonesian language and consisted of three main parts, namely: 1) characteristics of the participants, such as age, gender, working unit, working time, history and types of previous headaches; 2) characteristics of PPE usage including level, duration, location, type of PPE, and intensity; 3) characteristics of the headache experienced, such as onset, duration, type, persistence after PPE removal, reducing factors, and management. In this section, we used open-ended questions for participants to describe any headaches they might have. Headache was classified according to the International Classification of Headache Disorders (ICHD-3).⁽¹¹⁾ Headache severity was expressed in the numeric rating scale (NRS), which was used to assess transient pain severity using a 0-10 scale, with zero meaning "no pain" and 10 meaning "the worst pain imaginable". The scale is more practical than a VAS and easier to understand for most people.⁽¹²⁾ Validation of the screening

questionnaire was carried out in the Neurology Department, Udayana University Hospital. We used 8 hours as the cut-off point for the working time in accordance with the time regulation of work shifts in the hospitals that divides a working day into two or three work shifts.

Statistical analysis

Descriptive analysis was used to study baseline subject characteristics. Categorical data were reported in frequencies and percentages. Continuous data were reported as mean \pm standard deviation if normally distributed and as median (interquartile range) if not normally distributed. The data were analyzed using the chi-square test, for differences in proportions and crude odds ratio. A multivariate logistic regression analysis was used to assess the main determinant associated with headache in healthcare workers after controlling for other determinants and calculating the adjusted odds ratio. A p-value of less than 0.05 was considered statistically significant. The data analysis was performed using the Statistical Package for Social Sciences (IBM SPSS Statistics) for Windows, version 22.0 (IBM Corp., Armonk, NY, USA).

Ethical approval

This study was approved by the Ethics Commission of the Faculty of Medicine, Udayana University, under reference number 71/UN14.2.2.VII.14/LT/2022. The study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

This study included 174 healthcare workers as the participants, whose mean age was 28.18 years. Eighty-four (48.3%) of the participants were male and 90 (51.7%) of them were female. The working time was up to 8 hours in 107 (61.49%) of the study participants. A total of 143 (82.18%) of them were working in a medical unit (isolation room, emergency room, outpatient clinic, maternity ward), whereas 31 (17.82%)

Table 1. Characteristics demographics of healthcare workers, PPE usage and headaches (n=174)

Variable	n	%	Mean
Age (years)			28.18 ± 3.86
Gender			
Male	84	48.3	
Female	90	51.7	
Working unit*			
Medical	143	82.18	
Non-medical	31	17.82	
Working time (hours)			
Up to 8 hours	107	61.49	
More than 8 hours	67	38.51	
Previous headaches			
Yes	25	14.4	
No	149	85.6	
Type of the previous headaches			
Migraine	15	60.0	
Tension-type headache	6	24.0	
Others	4	16.0	
PPE level			
PPE levels I and II	89	51.1	
PPE level III	85	48.9	
PPE usage time (hours)			6.02 ± 3.83
Headache during PPE usage			
Yes	111	63.8	
No	63	36.2	
Location of headache			
Forehead	49	23.0	
Temple area	27	12.7	
Behind the eyes	14	6.6	
Back of the head	34	16.0	
Right side	36	16.9	
Left side	34	16.0	
Neck	19	8.9	
Type of headaches [‡]			
Pressure	51	46.0	
Stabbing	7	6.3	
Pulsating	29	26.1	
Rebound	19	17.1	
Achy	5	4.5	
Intensity of headaches			
Mild	89	80.1	
Moderate	21	18.9	
Severe	1	0.9	
Type of headaches during PPE usage			
Migraine	3	2.7	
Tension-type headaches	108	97.3	
Onset of headaches			
Gradually	59	53.2	
Suddenly	11	9.9	
Mixed onset type	41	36.9	
Duration onset of headaches while PPE usage			
Up to 6 hours	87	78.38	
More than 6 hours	24	21.62	
Improving headaches after removed			

Data presented as n (%), except for age and PPE usage time; *Medical Unit = isolation room, emergency room, outpatient clinic, maternity ward; Nonmedical unit = laboratory, radiology, laundry, pharmacy, nutrition; [‡] more than one answer; PPE: Personal Protective Equipment

participants were working in a non-medical unit (laboratory, radiology, laundry, pharmacy, nutrition). Pre-existing headache diagnosis was recorded in 25 (14.4%) participants, with the predominant type of previous headache being migraine in 15 (60%) of participants as shown in Table 1. Eighty-five (48.9%) of participants used PPE at level III, 89 (51.1%) used PPE at levels II and I, while mean PPE use by participants was 6 hours per working shift. The present study focuses on participants' experience of headaches when using PPE while working in a hospital in the COVID-19 period. A total of 111 (63.8%) participants experienced headaches and predominantly had tension-type headache (97.3%). The majority described the headache as being in the forehead (23%), with pressure-like quality (46%), mild in intensity (80.1%), gradual in onset (53.2%), and up to 6 hours in duration (78.38%), while lying down or sleeping reduced the headache (51.4%). Table 1 summarizes the demographic characteristics of the healthcare workers and the headache characteristics during PPE usage.

From bivariate analysis (Table 2) it was found that participants were divided into two groups, namely the group with headache and PPE usage that had 111 (63.8%) participants and the group without headache with 63 (36.2%) participants. The chi-square analysis showed that the working units, PPE levels, and duration of PPE use were significantly different between the two groups of participants, as shown in Table 2. There were more subjects in the group who experienced headaches while wearing PPE who were working in medical units ($p=0.01$), had PPE level III usage ($p=0.001$), and were using PPE for up to 6 hours per day ($p=0.001$).

A logistic regression analysis was used to examine the association of the PPE levels, working units, and duration of PPE use with the headaches (Table 3). The analysis found a significant relationship between the PPE level and headache occurrence ($OR=4.83; 95\% CI: 2.43-9.57; p<0.001$). These results indicate that when healthcare workers use PPE at level III, they were four times more likely to experience headaches than those using PPE at lower levels.

Table 2. Bivariate Analysis of several risk factors of headache

Variables	Headaches (+)		Headaches (-)		OR (95% CI)	p value
Age					1.07 (0.57- 2.01)	0.833
Up to 28 years old	67	64.4	37	35.6		
>28 years old	44	62.9	26	37.1		
Gender					1.04 (8.36-56.66)	0.891
Male	54	64.3	30	35.7		
Female	57	63.3	33	36.7		
Working unit**					4.0 (1.30- 12.30)	0.001*
Medical	106	66.7	53	33.3		
Non-medical	5	33.3	10	66.7		
Shift duration					1.08 (0.57- 2.04)	0.810
Up to 8 hours	69	64.5	38	35.5		
>8 hours	42	62.7	25	37.3		
PPE level**					0.21 (0.10 - 0.41)	0.001*
PPE levels I&II	42	47.2	47	52.8		
PPE level III	69	81.2	16	18.8		
PPE duration**					3.09 (1.58- 6.05)	0.001*
Up to 6 hours	87	71.9	34	28.1		
>6 hours	24	45.3	29	54.7		
Previous headaches					1.55 (0.61- 3.94)	0.356
Yes	18	72.0	7	28.0		
No	93	62.4	56	37.6		

*p-values <0.05 considered statistically significant; data presented as n (%); OR: odds ratio; PPE: Personal Protective Equipment

Table 3. Multivariable logistic regression analysis of independent factors and PPE usage patterns associated with the development of de novo headache



Note: CI: Confidence interval; OR: odds ratio; PPE: personal protective equipment; *p<0.05 considered significant

DISCUSSION

Nearly 65% of the participants reported the occurrence of headache with the use of PPE at all levels (I, II or III). The PPE level I protection consists of the use of a mask (3-ply cotton cloth mask) with or without disposable gloves. The types of PPE used in level II protection consist of a 3-ply surgical mask, gown, disposable rubber gloves, eye protection/face shield, and headcap. A radiographer's coat is used for healthcare workers who work in the radiology department. The PPE level III protection consists of a 3-ply surgical mask, gown (when at risk of splashing body fluids), disposable rubber gloves, eye protection/face shield (when at risk of splashing body fluids) and head cap.^(1, 13,14) The present study was based on the previous studies conducted by Hajjij et al.⁽⁴⁾ and Ong et al.⁽⁶⁾ Both studies found that increased use of PPE during the COVID-19 pandemic is responsible for generating headaches in frontline healthcare workers, whereas in our study, only individuals without a previous history of pre-existing headaches were found to be more susceptible to 'de novo' PPE-induced headaches.

Furthermore, the majority of healthcare workers were female, and this is consistent with Indonesian 2019 and 2017 data on the distribution of the nurses' population, which is dominated by women.⁽²⁾ Similar studies in Spain, Korea, Mexico and Italy also reported that the majority of healthcare workers are females.^(1,10,13,15)

Progesterone and estrogen affect neurotransmitter systems and have been suggested to be directly involved in the pathophysiology of some primary headaches. This could be an important mechanism explaining why women are more susceptible than men.⁽¹⁰⁾

The participants were grouped according to their work area, and this is in line with a previous study that the risk attached to their working unit determines the type of personal protective equipment. High-risk areas include intensive care units, special isolation rooms for infectious patients, emergency units, and operating rooms.⁽¹⁾ Current guidelines require that those caring for patients, regardless of the patients' status, should wear PPE, resulting in an additional amount of time during which healthcare workers must wear protective equipment and obey the WHO protocols in work settings.⁽¹⁴⁾

This study describes 'de novo' PPE-associated headaches amongst frontline healthcare workers throughout the current COVID-19 outbreak. Following PPE use, nearly 63.8% of the participants experienced headaches with different characteristics, pressure-like in quality (46%) and mild in intensity (80.1%), which were related to tension-type headache (97.3%). A similar result was obtained by a previous study of Hajjij et al.⁽⁴⁾ in Morocco showing that 62% of healthcare workers suffered from headache associated with the use of PPE. In the study of Jafari et al.⁽⁵⁾ in Iran, a prevalence rate of 72.4% was recorded among healthcare workers after the use of masks. The type of mask most commonly associated with headache was the N95 type. Other studies revealed that facial pain or discomfort around the ear, lack of hydration as well as conditions related to hypoxia/hypercapnia can cause headaches. Our study associated the incidence of headache with PPE usage, based on the prevailing PPE level in the hospital. We found that the use of PPE at level III (81.2%) was associated with the occurrence of PPE-related headaches and this was the type of protection used by 48.9% of the participants in our hospital. The distribution of protection levels

in this study was based on the type of health service and the actions taken by the workers. The N95 mask was used by healthcare and supporting personnel on duty in hospital. It was also used while performing aerosol-generating activities and respiratory sampling for suspected and confirmed COVID-19 patients.⁽¹⁶⁾ The abovementioned study by Jafari et al.⁽⁵⁾ in Iran reported that 41% of all headaches experienced were related to the use of N95 masks.

Discomfort or pain is caused by the strong pressure exerted by the mask straps, specifically while using KN95 masks for a long time.^(16,17) Similar results were obtained by previous studies, namely that headaches can be caused by the external pressure from the PPE used.^(9,10,18,19) Another study also reported that external pressure was responsible for 25.1% of side effects related to the use of protective gear by healthcare workers.⁽⁵⁾ Pressure in the cervical area while using PPE causes pain, which leads to cervicogenic or tension-type headaches.^(7,8,13,20) Furthermore, mask straps can cause local tissue damage as well as superficial nerve irritation in the face, head, and cervical region and an abnormal scalp sensitivity or discomfort during headache attacks elicited by non-noxious stimuli (allodynia), including the elastic head straps.^(9,13)

A mean PPE usage duration of 6 hours per working shift was obtained along with a mean working time of 12.46 ± 8.82 hours. A previous study reported that healthcare workers on duty for >12 hours per day are more susceptible to severe headaches.⁽⁴⁾ The several research studies about PPE usage for >4 hours per day and those who had pre-existing headache analysis had a greater probability of developing such headaches.⁽⁶⁾ The ratio of working time and usage duration in each study has a relationship with the emergence of headaches that are experienced after the use of PPE. About 24.3% of the respondents stated that the side effects appeared >120 minutes after they used the protective gear, while 28.8% revealed that the headache improved 15-30 minutes after PPE removal. A similar study reported that most of the headaches were felt

<60 minutes after using PPE and pain relief occurred within 30 minutes of removal.⁽⁶⁾ The differences in the results obtained were caused by the patients' condition as well as the type of PPE used. This study found a significant difference between the occurrence of headache related to PPE usage on the one hand, and the PPE levels, working units, and duration of PPE usage on the other. The problem of PPE-usage-related headaches may also worsen if the COVID-19 outbreak continues for a longer time. Shorter duty shifts and the resultant shorter duration of PPE use is probably a better approach to avoid the adverse effects of PPE usage.

Various activities were carried out by the participants to reduce the headaches while using PPE, such as lying down or sleeping, massaging the head, continue with their duties, and applying cold or warm compresses to the head. Meanwhile, some healthcare workers did not take analgesics to relieve the adverse effects, although a previous study reported that 61.4% of the subjects who experienced headaches responded positively to the pain relief.⁽¹⁾

This study is not without limitations. The retrospective assessment of previous headaches and headaches while using PPE can lead to a recall bias and although a similar study in Singapore⁽²¹⁾ reported that an increase in the frequency and duration of severe headaches after using PPE was also associated with sleep deprivation, physical stress, emotional stress, late eating, and inadequate intake of water, these factors were not assessed in the present study. However, our study has its strengths, since it was conducted by filling out the questionnaire directly between doctor and participants, which ensures a good understanding of the questions and the correct interpretation of data results. Our study was performed in a special hospital for COVID-19 isolation, where almost all healthcare workers on duty are involved in treating COVID-19 patients and adapting to the PPE level. The results from this study are expected to serve as basic data for future studies with a broader sample population, considering that healthcare workers

in COVID-19 referral hospitals have different workloads and stress levels.

CONCLUSION

The frequency of PPE-related headache in COVID-19 healthcare workers is high, with the healthcare workers being at risk to evolve to chronic and medication overuse headaches. The magnitude of this condition is clinically significant and might worsen if the current outbreak spreads widely and stays for a longer time, affecting the work performance of healthcare workers. Better strategies are needed to reduce the duration of PPE exposure so that the work performance and quality of life of healthcare workers are not significantly affected.

COMPETING INTERESTS

No relevant disclosures.

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CONTRIBUTORS

IASW conceived the original idea of this research and proof outline. IASW wrote the manuscript with support, help and input from NPAPM, IPGS, KM, NMS and IMOA. IASW, NPAPM, and KM collected the samples and input the data. IASW with help from IPGS, NMS, and NPAPM analyzed the data. IASW, IMOA, NPAPM and IPGS also did the copyediting, proofreading and revised the final manuscript. All authors were involved in drafting the article or revising it critically for important intellectual content. All authors have read and approved the final manuscript to be published.



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