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RESEARCH ARTICLE

Mask and Personal Protective Equipment (PPE) Associated Headache: A Cross-Sectional Study among the COVID-Time Physicians in Bangladesh

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ABSTRACT

We investigated the prevalence of mask/PPE associated headache among Bangladeshi physicians during COVID 19 pandemic along with the risk factors and headache characteristics. Headache severity was assessed by the Headache Impact Test (HIT-6). This is a cross-sectional, online Google form based study among 200 physicians from different hospitals in Dhaka conducted from December 2020 to April 2021. We compared characteristics of 'mask associated headache' and 'no headache' groups as well as of groups with and without previous headache. Independent factors associated with headache occurrence and severity were identified. Majority participants were male (129, 64.5%) with mean (SD) age of 35.4(7.5) years. Filter masks (146, 73%) were mostly used along with other PPE (139, 69.5%). Headache prevalence was 71% and 59.9% developed new onset headache. Doctors with a pre-existing primary headache disorder [OR: 5.40, 95% CI: 2.03-14.41; P=0.001] had the highest risk of developing headache. Headache occurrence was independently associated with working in the COVID unit [OR: 2.47, 95% CI: 1.18-5.18; P=0.017] and combined mask & other PPE usage [OR: 2.35, 95% CI: 1.13-4.84;P=0.021] for $\geq$ 6months [OR:2.06, 95%CI:1.05-3.99; P=0.036]. Most headaches were dull aching (33.8%), lasted for 1-4 hours (58.5%) & relieved within 1 hour of mask removal (43.6%). Headache Impact Test (HIT-6) score was substantial too severe among the doctors with previous headaches [OR: 2.91, 95%CI: 1.43-5.92; P=0.003] and those having moderate to severe stress levels [OR: 2.56, 95%CI: 1.19-5.55; P=0.017]. Most physicians with previous primary headache develop mask/PPE associated headache with considerable impacts on daily life.

Keywords: Headache; Mask; COVID19; Doctors

1 INTRODUCTION

The current Corona virus Disease (COVID-19) pandemic, after starting as an outbreak in Wuhan, China in December 2019, shattered the present world with its high infectivity, diverse and mysterious clinical presentations and alarming mortality[1,2]. Up to 1 September 2021, there have been 217,558,771 confirmed cases of COVID-19, including 4,517,240 deaths[3]. Healthcare workers have been identified as one of the groups most affected by this disease. In January 2021, WHO reported of 1.29 million health care workers affected by COVID-19[4]. In order to protect themselves, doctors all over the world needed to wear a tightly fitted face mask or respirator along with other parts of Personal Protective Equipment (PPE) while serving the infected patients. The corona-virus was confirmed to have spread to Bangladesh in March 2020 after which the number of cases were increasing day by day and 15,03,680 cases were officially reported till 1st September 2021 with 26,274 deaths[5]. Bangladeshi doctors hold the highest mortality rate from COVID-19 among the front liners[6]; nearly 200 of them died after contracting the infection[7]. Still doctors of all levels in the country are serving their best during this deadly pandemic. Their works are more stressful and troublesome than those of their counterparts in other countries due to long duty hours in the hot and humid environments of Bangladeshi hospitals. Lack of enough physicians, high population and patient density with poor hygiene and insufficient vaccination also compelled the physicians to wear protective masks for an

uncertain period of time. Headache, either new onset or exacerbation of previous ones, is one of the most frequent neurological complications after using different typea of masks[8,9]. Although headaches arising from using hat, helmet, goggles etc. worn during swimming or diving were previously reported[10–16], scientific literature related to the PPE-associated headaches in tropical countries is scarce. During the 2003 severe acute respiratory distress syndrome (SARS) epidemic in Singapore, new onset face mask-associated headaches with a prevalence rate of 37.3% was reported among healthcare workers[8]. Headache is one of the main reasons of poor N95 face mask compliance[17] & can cause considerable impairment of a doctor's daily activities. Further, studies on mask/PPE related headache are required for getting better services from this community. This study was done for the first time in Bangladesh where we investigated the prevalence of mask/PPE associated headache disorders among Bangladeshi physicians along with the risk factors and headache characteristics. We also assessed the headache severity by means of the Headache Impact Test (HIT-6).

2 METHODS

2.1 Study Design

This is a cross-sectional study carried out in the Neurology Department of Shaheed Suhrawardy Medical College Hospital (ShSMCH) conducted from December 2020 to April 2021. The study was approved by the Institutional Ethical Review Committee of Shaheed Suhrawardy Medical College (No-ShSMCH/Ethical/2020/21) and all the participants gave informed written consent.

2.2 Participants and Procedure

We coined the term as "COVID-time Physicians" referring to the doctors of either sex having MBBS (and or above) qualifications and were registered with the Bangladesh Medical & Dental Council (BMDC) who served in different institutions of Dhaka city and used any type of medical mask at work during the time of COVID-19 pandemic irrespective of his/her activity in COVID unit. It was practically assumed that all doctors must have used any form of medical mask, if not using any other part of PPE, depending on their workspace and workload. For example, N95 mask with full PPE set was mandatory in COVID unit whereas only surgical masks were used by some doctors in personal chambers. Those who did not use the mask/respirators due to medical contraindications or duty exemptions for age and other co-morbidities were not included in the study. We estimated sample size by the formula $\frac{z^2pq}{d^2}$, where z=1.96 (at 95% confidence level), p=50% and d, allowable error/precision =7%. We finally arrived at an estimated sample size of 250, after considering a 10% non-response rate. A cluster sampling method was applied for data collection. Due to high infection rate among doctors, social distancing, lockdown and roster duty schedule, we avoided any physical interview and used digital media to collect data for safety of both investigators and respondents. Initially doctors were randomly selected from a primary list containing their email and Messenger/WhatsApp/Viber IDs. A structured Google form was sent to these doctors via through these digital platform's whichever suitable with request for completion and also for circulating the digital form among their respective units/wards/workplaces/colleagues to attain maximum number of responses from those clusters. These responses were automatically saved in the principal investigator's Google account for printing and further analysis.

The Google form was specifically designed with multiple choice options in different parts that a doctor needed to fill up. Initial portion of the form had an informed consent agreement from the respondent and demographic particulars including his/her age, discipline, work level (interns/ trainee juniors up to professor/GP) and information of his/her workplace (whether the doctor was directly involved in COVID duty or not/Government facility or not/Primary, secondary or tertiary care hospital etc). Information about an individual doctor's co-morbidities (like Diabetes, Hypertension, Asthma etc) and COVID-19 infection status was also acquired. The second portion contained mask/PPE related information including the types of masks/PPE used by the doctor, for how long it was being used, its usage time per day, frequency per week and the individual doctor's duty hours. Whether a mask was used in isolation or with other parts of PPE along with their frequency (occasionally or frequently) was also recorded. "Mask" was referred to any medical mask used for personal protection of doctors against SARS-CoV-2 which included N95 (3M) models like 8210/1860 or 3M Full face/half face respirators or a three layered surgical mask. We did not include fabric mask as it was not fully protective for the doctors to use in the hospitals. We expressed "Personal Protective Equipment (PPE)" as protective instruments other than masks to cover head area which included face shield, goggles and coverall, used in isolation or combined, that might have caused the development of headache. Assuming the fact that a same physician might have used different masks in different areas depending on the risk of workplaces, the type & pattern of mask or PPE used for "most of the work time" were specifically asked to be mentioned in the form.

If any respondent developed headache in relation to donning or doffing of mask/PPE, it was recorded in the headache information portion along with the headache characteristics in terms of nature, frequency, duration, relieving factors and other associated features. Headache was defined as pain or discomfort in any area of head including upper part of neck and excluding lower part of face (i.e. above the orbito-meatal line). Facial pain was described as

pain or discomfort in any area of face below the orbito-meatal line. We also included whether any previous primary headache disorder was present with any changes of its quality by frequency, duration or severity after mask/PPE usage. We described primary headache disorders as Migraine (ICHD1), Tension type Headache (TTH, ICHD 2) and Trigeminal Autonomic Cephalalgia (ICHD 3), including Cluster Headaches and others or any combinations of these. We also evaluated the personal stress level of individual physician during their work time by an arbitrary scale of four categories labeled as "severely stressed", "moderately stressed", "mildly stressed" and "not stressed at all". Finally we recorded the impact of this headache on individual doctor's quality of life with the HIT-6^{TM}/Headache Impact Test; a tool which included six standard questions to assess the ability to function on the job, at home and in social situations[18]. The responses were marked as "little/no", "moderate", "severe" and "substantial" impact. The "Google Form" was easily understandable for any level of physician and took 15-20 minutes to fill up.

2.3 *Statistical Analysis*

Descriptive analyses were applied for studying baseline characteristics. We expressed the qualitative data in number and percentage, quantitative data with normal distribution as mean (SD), and non-normal data as median (IQR). Unpaired t-test was used for testing quantitative data with normal distribution. We compared the categorical variables from baseline demographic characteristics and other co morbidities including previous primary headache disorders by chi-square test (χ^2) between groups having headache and no headache after using mask/PPE. Similarly comparisons were done for headache characteristics between previous primary headache and no previous headache groups. A binary logistic regression analysis was used to determine the risk factors for development of mask/PPE associated headache and predictive factors responsible for severe to substantial headache impact on daily life. To measure the relationship between the different variables in the study, statistical tests with a 95% significance level, i.e. a p-value of 0.05, were used. All statistical analyses were performed using the SPSS version 20.0 statistical package program for Windows.

3 RESULTS

We approached 305 physicians during the study time of whom 213 responded by submitting the Google form. After careful scrutiny, forms with no consent agreement and with incomplete responses were excluded and finally 200 responses were selected. Majority participants were male (129, 64.5%) with mean (SD) age of 35.4(7.5) years. Participating doctors were mostly from Internal Medicine discipline (60,30%) & worked in tertiary government medical institutions (107,53%). Most of the physicians of medical officer rank (49, 84.5%) developed headache after using mask/PPE, followed by residents (34, 82.9%) and assistant professors (34,73.9%), (p<0.001).113(56.5%) doctors worked in COVID dedicated units and 92(81.4%) of them developed headache after mask/PPE usage in comparison with those who did not work in COVID unit, the difference was statistically significant (p<0.001). RT-PCR for COVID 19 became positive in 63(31.5%) cases in the last 6-month period (Table 1). Among the doctors who developed mask headache, severe & moderate level of personal stress were reported by 26(18.3%) and 79(55.6%) doctors respectively (Figure 1).

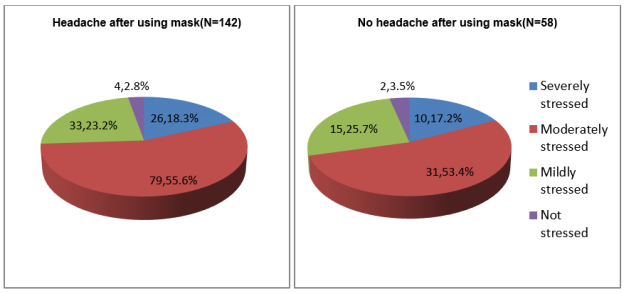

Fig. 1: Personal stress level among physicians

Out of 200 participants, 142 (71%) developed mask/PPE associated headache. 85(59.9%) mask/PPE associated headaches were of new onset. Previous primary headache disorders were present in 63(31.5%) physicians of whom 57(90.5%) developed headache after wearing mask/PPE (p<0.001). Headache subtypes included migraine in 24(38.1%), TTH in 35(55.5%) and both Migraine and TTH diagnosis in 4(6.3%) respondents, of which mask/PPE associated headache occurred in 23(95.8%), 30(85.7%) and 4(100%) cases, respectively. Other than previous headaches, doctors had several other co-morbidities which included asthma (31,15.5%), hypertension (24,12%), diabetes mellitus(19,9.5%), Crohn's disease(2,1%), iron deficiency anaemia (1,05%), chronic kidney disease (1,05%), obesity (1,05%), hyperthyroidism (1,05%), sarcoidosis (1,05%) & supraventricular tachycardia (1,05%). Mask/PPE associated headache developed in 26(83.9%) asthmatic, 18(75.0%) hypertensive and 15(78.9%) diabetic doctors (Table 2).

Majority of the doctors used filter masks (146, 73%) for most of the time, of which 138(69%) were N95 masks and 8(4%) were 3M half face respirators. Headache was mostly observed in N95 users (101, 73.2%) followed by surgical mask users (54, 27%).149(74.5%) doctors had a shifting roster duty (6 hours morning/evening or12 hours night) while 45(22.5%) had a fixed 8 hour (mornings only/evening chambers only) duty pattern. Headache after wearing mask was mostly observed in shifting roster pattern (110, 73.8%).Most of the respondents used masks for more than or equal to last 6 months (136, 68%). Maximum mask

Table 1: Baseline Characteristics of Participating Physicians (N=200)

Characteristics	Total (N=200)	Headache after using mask (n=142)	No headache after using mask (n=58)	p-value*
Age (years) Mean(SD)	35.4(7.5)	36.0(6.9)	34.1(8.7)	0.098
Sex (male), n (%)	129(64.5)	86(66.7)	43(33.3)	0.069
PHYSICIAN LEVEL				0.000
Intern	32(16.0)	12(37.5)	20(62.5)	
Medical officer	58(29.0)	49(84.5)	09(15.5)	
Resident	41(20.5)	34(82.9)	7(17.1)	
Assistant professor	46(23.0)	34(73.9)	12(26.1)	
Associate professor	12(6.0)	8(66.7)	4(33.3)	
Others (GP, Dentist, Lecturer, Research assistant, Professor, Civil surgeon)	11(5.5)	5(45.5)	6(54.5)	
DISCIPLINE				0.136
Internal Medicine	60(30)	43(71.7)	17(28.3)	
Gynae & Obstetrics	14(7)	7(50.0)	7(50.0)	
Neurology	22(11)	18(81.8)	4(18.2)	
Paediatrics	16(8)	13(81.2)	3(18.8)	
General Surgery	9(4.5)	6(66.7)	3(33.3)	
Otolaryngology	6(3.0)	3(50.0)	3(50.0)	
Nephrology	6(3.0)	5(83.3)	1(16.7)	
Psychiatry	6(3.0)	4(66.7)	2(33.3)	
General Physician	8(4.0)	6(75)	2(25)	
Others (clinical)	26(13)	15(57.7)	11(42.3)	
Other (para-clinical/basic)	21(10.5)	16(76.2)	5(23.8)	
WORK SETTING				0.369
Tertiary Government hospitals	107(53.5)	74(69.2)	33(30.8)	
Tertiary Non Gov. Hospitals & clinics	22(11.0)	13(59.1)	9(41.0)	
Gov. Office & Evening Consultation	63(31.5)	48(76.2)	15(23.8)	
Others (District hospital/Primary health care)	8(4.0)	7(87.5)	1(12.5)	
Works in COVID unit				0.000
YES	113(56.5)	92(81.4)	21(18.6)	
NO	87(43.5)	50(57.5)	37(42.5)	
COVID Positiveness (last 6 months)				0.273
Yes	63(31.5)	48(76.2)	15(23.8)	
No	137(68.5)	94(68.6)	43(31.4)	

* chi-square test

usage duration in a day was for 8-12 hours in 71(35.5%) and 6-8 hours in 71(35.5%) cases; 49(69%) and 52(73.2%) of which had headache occurrence respectively. Most of the doctors (170, 85%) used masks for more than or equal to four days per week. Headache occurrence was significantly higher in doctors who used other PPEs for most of the times (60, 81.1%) along with masks (p=0.010) (Table 3).In respect to other PPEs, 60(75.9%) of isolated face shield users, 28(77.8%) of isolated goggles users and 19(79.2%) of combined face shield-goggles users experienced headache (Figure 2).

The time interval between wearing of mask/PPE to the onset of headache was 3-4 hours in majority of the doctors 82(57.7%). Forty three cases(30.3%) developed it one hour after wearing mask, 15(10.6%) after 6 hours and some (21.4%) developed it after removal of the mask. The headache duration in a day was 1-4 hours in 83(58.5%) respondents, 4-8 hours in 42(29.6%), 8-12 hours in 7(4.9%) and more than 12 hours in 10(7%). Headache duration was significantly higher in physicians with new onset headache (p=0.014). The mean (SD) headache days per week was 2.3(1.7) and mean (SD) headache days per month was 9.7(6.6). The nature of headache was compressive in 46(32.4%), dull aching in 48(33.8%), throbbing in 20(14.1%) and combination of throbbing and compressive in 28(19.7%) subjects. New onset headaches were significantly more compressive, throbbing

Table 2: Pre-existing Primary Headaches & other co-morbidities of participating physicians (N=200)

Characteristics	Total (N=200)	Headache after using mask (n=142)	No headache after using mask (n=58)	p-value*
Previous Primary Headache				
YES	63(31.5)	57(90.5)	6(9.5)	0.000
NO	137(68.5)	85(62.0)	52(38.0)	
Headache Subtypes				
Migraine	24(38.1)	23(95.8)	1(4.2)	
Tension Type Headache	35(55.6)	30(85.7)	5(14.3)	
Both migraine and Tension Type Headache	4(6.3)	4(100)	0(0)	0.343
Other co-morbidities				
Asthma	31(15.5)	26(83.9)	5(16.1)	0.086
Diabetes Mellitus	14(7)	11(78.6)	3(21.4)	0.517
Hypertension	24(12)	18(75.0)	6(25.0)	0.645
Anaemia	1(0.5)	1(100)	0(0)	0.522
Impaired Glucose Tolerance	5(2.5)	4(80.0)	1(20.0)	0.653
Chronic Kidney Disease	1(0.5)	1(100)	0(0)	0.522
Chrohn's Disease	2(1)	2(100)	0(0)	0.368
Supraventricular Tachycardia	1(0.5)	1(100)	0(0)	0.522
Sarcoidosis	1(0.5)	0(0)	1(100)	0.117
Hyperthyroidism	1(0.5)	1(100)	0(0)	0.522
Obesity	1(0.5)	0(0)	1(100)	0.117

* chi-square test

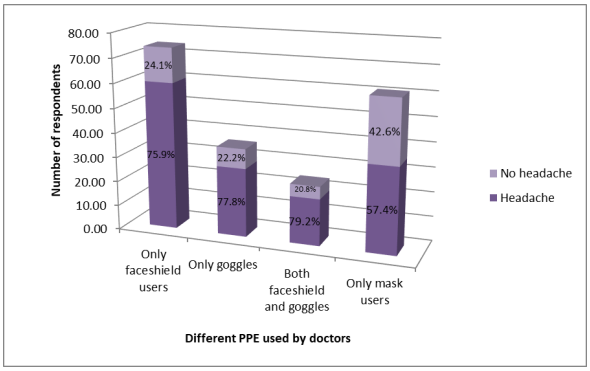

Fig. 2: Headache occurrence in different types of PPE used by doctors

and dull aching in nature (p=0.024). The commonest site of headache location was forehead (66,46.5%), followed by global (29,20.4%), temporal (24,16.9%), occipital (12,8.5%), periorbital (12,8.5%), upper part of neck(9,6.3%), hemi cranial (8,5.6%) and face(2,1.4%). In most of the doctors (62, 43.6%), headache was relived within one hour of removal of the mask/PPE. In 37(26.1%), headache remission occurred within 4 hours of mask/PPE removal, in 7(4.9%) within 6 hours and in 36(25.4%), analgesics were required in addition to mask removal. Maximum new onset headaches were relieved within one hour and within 4 hours of mask/PPE removal while analgesics were mostly required for previous primary headaches (p=0.001). Paracetamol was the mostly used analgesic (80,80.8%); naproxen (8,8.1%) and tolfenamic acid(6,6.1%)were also used (Table **??**). Of the respondents having previous primary headaches, majority of migraine(13,22.8%), TTH (20,35.1%) and combined migraine and TTH (3,5.3%) sufferers reported that their mask associated headaches were more severe or more frequent or longer in duration or had these features in combinations, in contrast to their previous headache nature (Figure 3). The attributed headache had a severe impact on daily life style of majority physicians (44, 31%). In 34(23.9%) cases a substantial headache impact, in 32(22.5%) moderate and in 32(22.5%) no impact on daily life was observed. Headache impact was significantly severe in doctors having a preexisting primary headache disorder (p=0.001)(Table **??**).

In binary logistic regression analysis, doctors with pre-existing primary headache disorders [OR: 5.40, 95% CI: 2.03-14.41; P=0.001] had the highest risk of developing mask/PPE associated headache. Headache occurrence was independently associated with working in the COVID unit [OR: 2.47, 95% CI: 1.18-5.18; P=0.017]. Those who used mask & other PPE in combination had a higher chance of developing headache [OR: 2.35, 95% CI: 1.13-4.84; P=0.021] than those who used mask alone. Mask usage duration for $\geq$ 6months was associated with higher risk of developing headache [OR:2.05, 95%CI:1.05-3.99; P=0.036]. Previous

Table 3: Pattern of mask & PPE use among participating physicians (N=200)

Characteristics	Total (N=200)	Headache after using mask (n=142)	No headache after using mask (n=58)	p-value*
MASK TYPE				
N95/FFP3/FFP2	138(69)	101(73.2)	37(26.8)	
Half/Full Respirator	8(4)	5(62.5)	3(37.5)	0.579
Surgical Mask	54(27)	36(66.7)	18(33.3)	
DURATION OF MASK USE (MONTHS)				
<3 months	22(11)	13(59.1)	9(40.9)	
3-6 months	42(21)	27(64.3)	15(35.7)	0.176
≥6 months	136(68)	102(75.0)	34(25.0)	
DUTY PATTERN				
Shifting roster	149(74.5)	110(73.8)	39(24.2)	0.077
8 hours/day (Mornings only/ Evening chamber only)	45(22.5)	30(66.7)	15(33.3)	
>12 hours/day	6(3)	2(33.3)	4(66.7)	
DURATION OF MASK USE (in a day)				
<6 hours	39(19.5)	28(71.8)	11(28.2)	
6-8 hours	71(35.5)	49(69.0)	22(31.0)	0.984
8-12 hours	71(35.5)	52(73.2)	19(26.8)	
>12 hours	19(9.5)	13(68.4)	6(31.6)	
FREQUENCY OF MASK USE(IN A WEEK)				
<4 DAYS	30(15)	23(76.7)	7(23.3)	0.866
≥4 DAYS	170(85)	119(70.0)	51(30.0)	
FREQUENCY OF PPE USE WITH MASK				
Most of the time	74(37)	60(81.1)	14(18.9)	0.010
Occasionally	65(32.5)	47(72.3)	18(27.7)	

* chi-square test

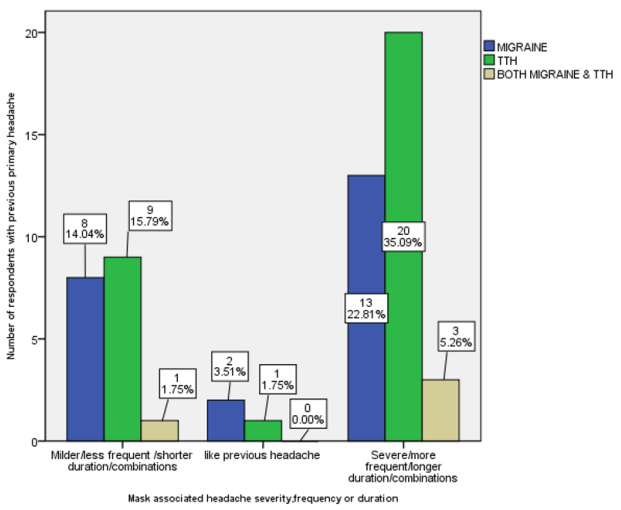

Fig. 3: Headache changes in patients of pre-existing primary headache disorders after using mask/PPE

primary headaches [OR: 2.91, 95%CI: 1.43-5.92; P=0.003] and moderate to severe stress levels [OR: 2.56, 95%CI: 1.19-5.55; P=0.017] were predictive factors associated with substantial to severe headache impact on daily life (Table 5 and Table 6).

In addition to developing headache, physicians also developed other medical conditions after using mask/PPE. In order of frequency, those were irritability (78,39%), inability to concentrate (73,36.5%), fatigue (63,31.5%), dizziness/vertigo (57,28.5%), sleep disturbance(52,26%), nasal stuffiness (40,20%), exertional dyspnoea (40,20%), nausea (31,15.5%), lacrimation (24,12%), photophobia (20,10%), visual disturbance (19,9.5%), resting dyspnoea (10,5%), eye congestion (10,5%), phonophobia (3,1.5%), itching (1,0.5%), sore throat (1,0.5%), excessive facial sweating (1,0.5%) and temporomandibular joint pain(1,0.5%). Headache was significantly accompanied by inability to concentrate in 59 (80.8%) and with nasal stuffiness in 34(85%) doctors (p=0.020 and p=0.029, respectively) (Table 7).

Table 4: Characteristics of headache among mask and PPE users (N=142)

Characteristics	All physicians (N=142)	Physicians with Previous Primary headaches (n=57)	Physicians with new onset headache (n=85)	p-value*
Onset of headache				
Within 1 hour of wearing mask	43(30.3)	19(44.2)	24(55.8)	
After 3-4 hours of wearing mask	82(57.7)	31(37.8)	51(62.2)	0.709
After 6 hours of wearing mask	15(10.6)	7(46.7)	8(53.3)	
After removing the mask	2(1.4)	0(0)	2(100)	
Headache Duration/day				
1-4 hours	83(58.5)	26(31.3)	57(68.7)	
4-8 hours	42(29.6)	19(45.2)	23(54.8)	0.014
8-12 hours	7(4.9)	4(57.1)	3(42.9)	
>12 hours	10(7)	8(80.0)	2(20.0)	
Headache days per week (mean± SD)	2.3(1.7)	2.5(1.8)	2.2(1.5)	0.289
Headache days per month (mean± SD)	9.7(6.6)	10.4(7.3)	9.2(6.2)	0.279
Headache Nature				
Throbbing	20(14.1)	8(40.0)	12(60.0)	
Compressive	46(32.4)	17(37.0)	29(63.0)	0.024
Combined throbbing & compressive	28(19.7)	18(64.3)	10(35.7)	
Dull aching	48(33.8)	14(29.2)	34(70.8)	
Headache Location				
Forehead	66(46.5)	24(36.4)	42(63.6)	0.392
Occipital	12(8.5)	8(66.7)	4(33.3)	0.050
Temporal	24(16.9)	9(37.5)	15(62.5)	0.772
Face	2(1.4)	0(0)	2(100)	0.243
Periorbital	12(8.5)	7(58.3)	5(41.7)	0.179
Upper part of neck	9(6.3)	4(44.4)	5(55.6)	0.786
Hemicranial	8(5.6)	7(87.5)	1(12.5)	0.005
Global	29(20.4)	9(31.0)	20(69.0)	0.262
Relieving Factor				
Within 1 hour of mask removal	62(43.6)	20(32.4)	42(67.7)	
Within 4 hours of mask removal	37(26.1)	11(29.7)	26(70.3)	0.001
After 6 hours of mask removal	7(4.9)	1(14.3)	6(65.7)	
Analgesic Required	36(25.4)	25(69.4)	11(30.6)	
Analgesic Usage				
Paracetamol	80(56.3)	37(64.9)	43(50.6)	
Paracetamol and caffeine	1(0.7)	0(0)	1(1.2)	
Naproxen	8(8.08)	2(3.5)	6(7.1)	
Tolfenamic acid	6(6.06)	6(10.5)	0(0)	0.001
Ketorolac	1(0.7)	1(1.8)	0(0)	
Imipramine	1(0.7)	1(1.8)	0(0)	
Etoricoxib	1(0.7)	1(1.8)	0(0)	
Rizatriptan	1(0.7)	1(1.8)	0(0)	
No analgesics used	43(21.5)	8(18.6)	35(81.4)	
HEADACHE IMPACT SCORE (HIT-6)				
No Impact	32(22.5)	5(15.6)	27(84.4)	0.001
Moderate Impact	32(22.5)	12(37.5)	20(62.5)	
Substantial Impact	34(23.9)	13(38.2)	21(61.8)	
Severe Impact	44(31)	27(61.3)	17(38.7)	

* chi-square test

Table 5: Binary logistic regression analysis of factors in respondents associated with mask associated headache (N=200)

Characteristics	0R(95 % CI)	p-value
Age	1.04(0.98-1.10)	0.191
Male sex	0.53(0.25-1.13)	0.100
Discipline (Internal Medicine / Others)	1.92(0.82-4.46)	0.131
Working in COVID unit	2.47(1.18-5.18)	0.017
COVID positiveness	1.40(0.65-3.03)	0.393
Previous Primary Headache	5.40(2.03-14.41)	0.001
Mask Type [Filter masks (N95, Respirators) / Surgical Masks]	1.12(0.55-2.28)	0.748
Duration of mask Use (in month) (more than or equal to 6 months / less than 6 months)	2.05(1.05-3.99)	0.036
Duty Pattern (Shifting Roster / Other than shifting)	1.72(0.84-3.52)	0.136
PPE USAGE WITH MASK		
Mask with other PPE Only mask	2.35(1.13-4.84)	0.021
Mask with face shields only	1.50(0.80-2.85)	0.214
Mask with Goggles only	1.11(0.43-2.84)	0.830
Mask with both face shield and Goggles	1.20(0.40-3.66)	0.744

Table 6: Binary logistic regression analysis of factors associated with substantial to severe headache impact (N=142)

Characteristics	0R(95 % CI)	p-value
Male sex	0.88(0.19-4.08)	0.865
Previous Primary Headache	2.91(1.43-5.92)	0.003
Personal Stress Level (Moderate to severe stress / Mild or no stress)	2.56(1.19-5.55)	0.017
Duration of mask use/day (more than or equal to 8 hours / less than 8 hours)	1.31(0.47-3.62)	0.605

Table 7: Symptoms other than headache after using mask/PPE in participating physicians (N=200)

Characteristics	Total (N=200)	Headache after using mask (n=142)	No headache after using mask (n=58)	p-value*
Dizziness/vertigo	57(28.5)	46(80.7)	11(19.3)	0.056
Inability to concentrate	73(36.5)	59(80.8)	14(19.2)	0.020
Nausea	31(15.5)	25(80.6)	6(19.4)	0.198
Fatigue	63(31.5)	47(74.6)	16(25.4)	0.446
Irritability	78(39)	58(74.4)	20(25.6)	0.403
Sleep disturbance	52(26)	41(78.8)	11(21.2)	0.147
Photophobia	20(10)	16(80.0)	4(20.0)	0.350
Phonophobia	3(1.5)	3(100)	0(0)	0.265
Resting Dyspnoea	10(5)	7(70.0)	3(30.0)	0.943
Exertional dyspnoea	40(20)	31(77.5)	9(22.5)	0.311
Visual disturbance	19(9.5)	17(89.5)	2(10.5)	0.062
Eye congestion	10(5)	9(90.0)	1(10.0)	0.174
Nasal stuffiness	40(20)	34(85)	6(15)	0.029
Lacrimation	24(12)	20(83.3)	4(16.7)	0.156
Temporomandibular Joint Pain	1(0.5)	0(0)	1(100)	0.117
Sore throat	1(0.5)	1(100)	0(0)	0.522
Excess Sweating	1(0.5)	1(100)	0(0)	0.522
Itching	1(0.5)	0(0)	1(100)	0.117

* chi-square test

4 DISCUSSION

Our study demonstrated prevalence mask/PPE associated headaches among the front line physicians of Bangladesh during the COVID 19 pandemic. Majority of the respondents developed mask/PPE associated headache among which more than half was new onset. Doctors who worked in the COVID unit and used mask and PPE in combination for $\geq$ 6 months and those who had a preexisting primary headache disorder diagnosis had a greater likelihood of developing mask induced headache.

The International Headache Society (IHS) expressed the term External-compression headache (ICHD 4.6.1) as headache resulting from sustained compression of pericranial soft tissues; for example, by a tight band around the head, hat or helmet, or goggles worn during swimming or diving, without damage to the scalp, and had specific criteria for its diagnosis [10]. However, there is yet no specific criteria used for mask or PPE associated headaches. It seems that the world has been radically changed after emergence of SARS-CoV-2 and health workers are not readily getting rid of wearing masks/PPE in near future. From many parts of the world, studies are now being reported on mask induced headaches among the health professionals.

Our study findings are in close agreement with the study of Ramirez-Moreno JM et al. who reported 51.6% PPE associated "de novo" headache in Spain in 2020 [19]. In the study of Ong JJY et al., newly developed headache occurrence after using PPE was 82% [9]. Both of the studies however incorporated all level of healthcare professionals including nurses and office staffs. We considered that the job descriptions & level of exposure to mask/PPE might not be equal for all type of health staffs and hence we included only physicians in this study. In our study, younger male doctors mostly developed mask induced headache. The bulk of physician workforce who directly dealt with COVID patients for longer period of time were mostly of medical officer ranks for which they might have had a higher occurrence of headache in our study. Understandably, working in COVID unit is very stressful and laborious, especially for wearing air tight mask/PPE in the non-air conditioned environment, and thus we found it as a predisposing factor for development of mask/PPE induced headache. Lim ECH et al. in his study also reported of high prevalence of mask headache in health workers working in high risk areas during SARS epidemic of 2003 [8].

N95 masks, which was the most used mask in our study, was associated with higher development of headaches, even though the association was not statistically significant. Ong JJY et al. observed N95 mask was the "likely" cause of headache in 51.6% respondents in his cohort [9] while another cohort reported 57.2% headache occurrence with surgical masks [20]. In their study, Ipek et al. revealed that headache was present 59% cases of N95 users along with respiratory alkalosis and hypocarbia [20]. The aetiopathogenesis of development of headaches after using masks is definitely complex and multifactorial. The main contributing factors could be mechanical compression, biochemical (mostly hypoxemia with hypercarbia) and anxiety of wearing the device as well as psychological stress [9,19,20]. In a tropical country, other stressors like dehydration and long duration of use of masks may be additive factors.

Mask and protective eyewear used by the physicians have elastic head straps to ensure a tight-fit in order to prevent viral entry. Continued compression and traction forces from these structures may cause irritation to the underlying superficial sensory nerves, specially trigeminal or occipital nerve branches which innervate the face, head, and cervical region, which might have triggered headache or facial pains or ear lobe discomfort [9]. Our study findings, in respective to location of headaches observed, support this theory as most headaches were located in forehead, temporal and occipital regions, the points of contact with bands/straps. The air-tight mask/PPE also causes moist warm air inside the mask which can lead to thermal discomfort over face [9].

Previous studies have suggested that the use of filtering masks may lead to hypoxia and CO_2 retention which were thought to be possible chemical factors behind developing headache [21,22]; in contrast to which hypocarbia along with respiratory alkalosis, documented by İpek S et al. in 2021, which was proposed to cause not only mask headaches by cerebral vasoconstriction but also attention deficit and concentration problems in health care staffs [20]. The biochemical analysis was beyond scope of our study as it was online based.

Stress and anxiety have always has been a trigger for all sorts of headaches. Majority doctors of our study reported moderate to severe stress during their work time for several reasons which might have caused new mask headaches or aggravated previous ones. Stress factors included tremendous work pressure, dealing with tragic deaths or respiratory distress of the patients as well as of co-workers and family members from COVID-19, apprehension of getting infected by SARS-CoV-2 and different socio-political pressurization. Ramirez-Moreno JM et al. in their work found that the level of stress in headache subjects was significantly worse in all aspects measured by Psychosomatic Problems Questionnaire(PPQ) [23]. A multinational, multicentre study done in Singapore and India on the psychological outcomes and associated physical symptoms amongst healthcare workers during COVID-19 outbreak showed that depression, anxiety and stress were significantly associated with the presence of multiple physical symptoms of which headache was commonest [17]. In agreement with this, we also found "moderate to severe" personal stress level as a significant predisposing factor for causing "severe to substantial impact" on daily life of physicians in our study.

Ong JJY et al. demonstrated pre-existing primary headache to be independently associated with development of new onset headaches [9]. We have identical observation in our study. There were no significant associations between any previous headache sub-types with mask associated headaches. In previous headaches, particularly in chronic forms, the peripheral nociceptors in head or face regions might have already been sensitized. Donning of mask/PPE exerts compression which might stimulate the trigemino-cervical complex through different branches of the trigeminal nerve. Ultimately the transmitted nociception travels through trigeminal ganglia and brain stem and ends in higher cortical areas to cause headache [9]. Previous primary headaches is also a significant predisposing factor in our study for "severe to substantial impact" on daily life of physicians which was not reported by any literature previously. Physicians are known to be 'bad patients' and we believe that doctors should achieve good control of previous primary headaches to prevent worst headache attacks while working with masks during this pandemic.

It has been shown that N95 face mask, protective eyewear or using them together for >4 hours per day had a higher chance of developing headache [9]. In contrast to that, we found that combined use of any mask with other PPE, including face shield and goggles, for a duration of more than or equal to 6 months is significantly associated with mask induced headache onset. We also found that doctors who used other PPEs like face shield/goggles/coveralls along with mask for most of the times, rather than occasionally, had significantly higher headache occurrence. Possibly the frequent and combined use of structures like straps/holders of face shield, goggles, or head coverings initiate headache or potentiate already developed headache by their pressure effects.

The study findings of Ong JJY et al. was in accordance with the International Headache Society definition of External-compression headache (ICHD 4.6.1) in terms of headache onset (brought on by and occurring within one hour during sustained external compression of the forehead or scalp), headache location (maximal at the site of external compression) and relieving time (resolving within one hour after external compression is relieved) [9,10]. Except for relieving time, which was significantly within one hour of mask removal, we report aberration from some of these criteria in our work, especially in respect to the time interval between wearing of mask/PPE to the onset of headache which was 3-4 hours in majority of respondents. However, Elisheva R in New-York also reported that maximum (30.6%) of 343 of his respondents experienced headache after 3 hours of wearing masks [23]. We also report that most new onset mask induced headaches of our cohort were dull aching and compressing in nature which was not documented in previous studies. Possible explanations of these findings are difficult. However, mask headaches do not always arise from mechanical compression and other biochemical and psychological factors come to play role, as discussed earlier, requiring a considerable time for building up the headache. These factors may also contribute to different locations and natures of mask induced headaches. We believe that "mask induced headache" may be considered as a separate entity from "external compression headache" as the former has several features that are clearly distinct from the latter.

Other than headache, previous studies report of several other neurological complications after using mask/PPE, significant of which are sleep disturbance, loss of concentration and irritability [19]. In concordance to that, we report irritability, inability to concentrate, fatigue, dizziness, sleep disturbance and nasal stuffiness among mask/PPE users. All these conditions can be explainable by biochemical alterations discussed earlier, superadded by stress and anxiety related to mask use.

We acknowledge some limitations of the study. The sample size may be considered small. The actual sample size was less than calculated because we could not access physicians personally due to COVID 19 restrictions and doctors might have been busy, sick or stressed enough during pandemic to complete the exploratory Google form. A self-administered questionnaire in the form of goggle form was used which could have been affected by the recall bias. We assessed the personal stress level of the physicians by a grading which was arbitrary and subjective. We did not evaluate the hydration or relaxation status of the physician which could have an impact on development of headache. The study was cross-sectional and thus could not prove causality. We did not take into account the temporal evolution of the headache. We also did not evaluate any relationship between medication overuse and occurrence of mask associated headache.

The results of our study cannot be generalized as a whole for these data reflect a physician community working in hot & humid environments where majority had no access to air-conditioning and adequate resting opportunities. Although external validity can be considered for other tropical countries where workload and environments are identical, a multicenter and multinational study is required for generalization of the findings.

5 CONCLUSION

We presented the prevalence, characteristics and predisposing factors of mask/PPE associated headache among frontline physicians of Bangladesh and demonstrated significant impact of this headache on their daily life that can reduce his/her productivity and service quality. COVID 19 pandemic is likely to be having more waves with newer strains and thus effective strategies should be adopted while working with mask and PPE which might include effective control of pre-existing primary headaches, psychological

assessment & stress management in physicians who are vulnerable and shortening mask usage time. Up gradation of existing mask/PPEs into more user-friendly and comfortable designs can be tried. Mask/PPE headache needs more understandings and further prospective studies are required in this regard.

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