International Journal of Physiotherapy and Research,
Int J Physiother Res 2022, Vol 10(2):4170-76. ISSN 2321-1822
DOI: https://dx.doi.org/10.16965/ijpr.2022.111

Original Research Article

Musculoskeletal Burden of Personal Protective Equipment (PPE) on Health Care Workers Working for Long Hours during COVID-19 Pandemic in India: A Survey

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ABSTRACT

Background: The COVID-19 pandemic has necessitated the use of enhanced personal protective equipment (PPE) by healthcare workers (HCWs) in patient-facing roles. Consistent use of PPE is reported to have so many direct or indirect negative effects on human body ranging from physiological impact which includes heat stress, dehydration, electrolyte imbalance, fatigue, confusion etc. to Dermatological complications like mask acne and rashes. Tightly fitted mask has been reported to produce neck pain. But there are no enough evidences for its musculoskeletal impact. The aim of the current study is to find out the effect of consistent use of PPE on musculoskeletal system.

Material and Method: A single-centre, retrospective cross-sectional study among a cohort of HCWs who performed COVID-19 duties and used enhanced PPE. The cohort consisted of different categories of doctors, nursing personnel, and other paramedical staff. A content validated questionnaire was disseminated through WhatsApp application and Email ID. Outcome measures include joint discomfort (measured through CMDQ), Fatigue (FAS score), Cramps, and muscle soreness.

Results: Retrospective analysis of the symptoms of 121 respondents is reported. FAS scoring showed 56.19% of the participants complained about fatigue. According to CMDQ tool, 68.59% participants reported discomfort in neck, 69.42% in the upper back, 57.85% in right leg, and 56.19% in left leg. Cramps are reported in 62.8% of the participants.

Conclusion: Our study demonstrates the undeniable negative impact of PPE on musculoskeletal system of the front-line HCWs using enhanced PPE and lays the ground for incorporating 'potential exercise regime' for the health care workers using PPE consistently for the foreseeable future.

KEY WORDS: SARS-COV-2**,** Personal Protective Equipment (PPE), Health care workers, Health, Neck pain, Headache, costume related pains.

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Access this Article online	Journal Information
Quick Response code	**International Journal of Physiotherapy and Research** ISSN (E) 2321-1822 | ISSN (P) 2321-8975 **https://www.ijmhr.org/ijpr.html** **DOI-Prefix:** https://dx.doi.org/10.16965/ijpr
DOI: 10.16965/ijpr.2022.111	**Article Information** Received: 21 Feb 2022 | Peer Review: 25 Feb 2022 | Accepted: 19 Mar 2022 | Published (O): 11 Apr 2022 | Published (P): 11 Apr 2022

INTRODUCTION

The COVID-19 pandemic in India is part of the worldwide pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Epidemics such as the severe acute respiratory syndrome, the Middle East respiratory syndrome coronavirus, and the Ebola virus, among others, represented a global wake-up call [1,2], substantially changing the way this type of public emergency was handled and highlighting the importance of community and preventive medicine in the management of these complex situations. The coronavirus disease 2019 (COVID-19) epidemic has seriously challenged the capacity of

national health systems to deal with it, confirming the importance of preventive and protection systems in controlling threats from biological risk [3].

In these circumstances, personal protective equipment (PPE) are the fundamental pillar of the health system and allows health care workers (HCWs) to perform their tasks correctly [4] while protecting themselves against the risk of contamination [5]. In this moment, when most HCWs are required to wear PPE, it is inevitable that, in many, their performance is affected, compared with normal situations when only trained staff use them. The use of PPE by health professionals guarantees performance with tolerable safety margins but, at the same time, generates physiological and psychological stress because of the constraints imposed by reduced breathability, increased heart rate, increased body temperature, and so forth [6,7,8].

Wearing Filtering face piece respirator (FFR) for a long period of time may also cause dizziness which can be caused by dehydration, hyperventilation (gasping for breath), elevated carbon dioxide levels in the blood, low blood sugar, anxiety and a number of other factors. It also causes dermatological problems (mask acne and rashes) due to synthetic material of PPE [7]. Apart from the physiological, dermatological and psychological stress, it is also putting burden on the musculoskeletal system, but there are limited evidences of it. Working for long hours in tight clothing (Hazmat suits with attached cap), tight masks and face shield restrict the movement of various joints specially neck and shoulder which can lead to joint stiffness and pain. Dehydration and lack of oxygen leads to muscular fatigue. Although the literature has started to address and highlight the musculoskeletal problems and issues related to PPE use [9], there is still a dearth of authentic literature pertaining to the issue. This cross-sectional study was aimed to see the musculoskeletal burden of PPE on HCWs and provide ground for appropriate usage of PPE and to incorporate potential exercise regime in the routines of HCWs to prevent various musculoskeletal discomforts and fatigue.

METHODS

Study design and method: A retrospective cross-sectional study was conducted in Holy Family Hospital (designated COVID-19 Hospital), Okhla New Delhi, India between July 2021 to August 2021. The Research Ethics Committee of the Holy Family Hospital approved the study protocol. A content validated questionnaire was prepared which included some general demographic details, questions for joint discomfort, questions to assess severity of fatigue and some questions related to symptoms which were self-experienced and discussed on group discussion (Appendix). Questions for joint discomfort were taken from a validated tool Cornell musculoskeletal discomfort questionnaire. Fatigue assessment was done using Fatigue assessment scale (FAS).

Participants were volunteers aged >21 and <60 years, Medical Doctors (Residents and interns), Nursing personnel, physiotherapist (Interns) and Radiographer from the emergency department, Intensive care unit and respiratory wards. Respondents who met the inclusion criteria: wearing level 3 type of PPE [FFR, chemical protective clothing (Hazmat suits), gloves, shoe cover, Goggles, face shield] for at least 6 hours /day, working at least 4 day a week and have been working for at least 1 month with COVID patients were selected. Those who were already diagnosed with musculoskeletal conditions like (Ankylosing spondylitis, listhesis and any type of arthritis), deep vein thrombosis, hypothyroidism, uncontrolled diabetes and hyper tension were excluded from the study.

CMDQ is a screening tool for musculoskeletal discomfort (MSD). In this tool frequency, severity and ability of musculoskeletal pain or discomfort to interfere with work in last seven days are reported by the study participants. It can also be used to report joint discomfort during previous month [10]. Discomfort was graded into three types: slightly, moderately and very uncomfortable and the score was 1,2,3 respectively. The interference with job was categorised into three groups: not at all, slightly, substantially inference and the score

was 1,2,3 respectively for the three groups. The weightage was given to the frequency score (Never=0, 1-2 times/week=1.5, 3-4 times/week=3.5, Once every day=5, Several times every day=10). The discomfort or severity of discomfort score was calculated by multiplying the above frequency score (0, 1.5, 3.5, 5, 10) by the discomfort score (1,2,3) by the interference score (1,2,3). The range of total attainable score can be (0-35.50).

The FAS is a 10-item scale evaluating symptoms of chronic fatigue. This scale evaluates both the aspect of fatigue, physical and mental fatigue [11]. Each item of the FAS is answered using a five-point, Likert-type scale ranging from 1 ("never") to 5 ("always"). Items 4 and 10 are reverse-scored. Total scores can range from 10, indicating the lowest level of fatigue, to 50, denoting the highest.

Method of data collection: For data collection, the WhatsApp number and Email ID of all the employees of different department are taken from their respective in charge/Head of the department. All the in charges/Heads of the department were explained about the purpose of the study and told to discuss with all staff of their department. Anonymity and confidentiality were assured to the participants. After taking informed written consent, the survey form was sent to them. Those accepted to be part of the survey were sent a link to the questionnaire, either through WhatsApp mobile application or Email ID. The participants were asked to fill the questionnaire according to the symptoms they felt during the peak time of Pandemic in India. Those participants who caught COVID-19 infection during the peak time are requested to fill the questionnaire according to the symptoms they felt after complete recovery from infection or before they caught infection. The submission of forms was kept open for a period of 30 days.

Study variables: Dependent Variables were

Musculoskeletal discomfort: MSD which is categorised as mild, moderate and severe discomfort (when discomfort was reported) and no discomfort (when no discomfort was reported) in CMDQ screening tool. Mild discomfort: The CMDQ score 1.5 was considered as mild discomfort. Moderate discomfort: The CMDQ score 1.6-10.5 was considered as moderate discomfort. Severe discomfort: The CMDQ score>10.5 was considered as severe discomfort. No discomfort or discomfort absent: The CMDQ score 0 was considered as no discomfort. Musculoskeletal discomfort is seen in various joints but major joints in which discomfort is reported and hence studied are Neck, upper back, right leg, left leg.

Fatigue: FAS score 0-21 is considered as No Fatigue, score of 22-34 is mild to moderate fatigue and 35-50 is considered as extreme fatigue.

Muscle cramps: Time, duration, location and impact on quality of life

Muscle soreness: Location of muscle soreness, effect on gait pattern

Statistical analysis: Outcome measures were recorded automatically on submission. During the first stage, scoring of all outcome measures was done according to their respective scoring scale. In the second stage, data was spread on the Microsoft excel sheet. Subsequently data analysis was done on IBM Statistical Package for the Social Sciences (SPSS) version 16 software. Descriptive and inferential statistics were analysed. p-value < 0.05 was taken as the statistical cut-off point.

RESULTS

We contacted 300 eligible staff. One hundred forty volunteers expressed the willingness to participate. Out of them 19 were excluded as they didn't match the inclusion criteria, resulting in a final cohort of 121 participants. Table 1 shows that the mean age of the study participants was 27.65- /+6.386 years ranging from 21-60 yrs. Out of all study participants,13.2% (N=16) were males and 86.8% (N=105) were females ; 76% of population were Nursing personnel(N=92),13.2% were Doctors (N=16),5.8% were Physiotherapists (N=7), and 5% (N=6) were Radiographers. Average working days in a month were 24days with the average of 8 working hours per day. Table 2 showed CMDQ score for different areas. It can be seen that 31.4% participants reported no discomfort

in neck, 4.13% reported mild discomfort, 33.05% moderate discomfort, and 31.1% reported severe discomfort in neck region. 30.5% of the participants reported no discomfort in upper back area, 2.4% of the participants reported mild, 27.27% moderate, and 39.66% reported severe discomfort in upper back region. Approximately 42% of the respondents reported no discomfort in legs, 3.3%reported mild, 20 %reported moderate, and 33% reported severe discomfort in legs. Table 3 shows the frequency distribution of participants as per FAS score. It can be seen that 43.8% of the participants reported no fatigue; 54.54% reported mild-moderate fatigue, and 1.6% of the participants reported severe fatigue.

Out of all participants 62.8% of the population reported cramps. Out of them 72.9% participants localised cramps to calf region, 19.6 percent in thigh region, and rest reported in biceps muscle. Out of all participants 17% of the participants reported cramps during day times, approximately half of the population (50.9%) experienced cramps during night, and 32.1% reported both day and night cramps. Out of all participants, 38.7% participants experienced cramps lasting for seconds, 53.2% reported cramps lasting for minutes, and 8.1% population reported cramps lasting for hours. Approximately half of the participants experienced that the quality of life has deteriorated to some extent and 10.7% reported it to be deteriorated to a very much extent. Approximately 28.1% participants complained about soreness in upper limb and lower limb muscles. Out of them 2.9% of the participants complained about sore biceps, 60% reported sore calf, 20% reported soreness in thigh, and 10% reported soreness in both calf and thigh. Approximately 33% of the participants reported their inability to lift heavy weights and do even light work because of sore muscles.

Characteristics	N (%)	Mean (SD); Range
Age(years)		Mean (SD): 27.65(6.386) Range: 21-51
Sex-N (%)	Females-105(86.8%) Males-16(13.2)	
Occupation profile- N (%)	Nurses-92(76%), Doctors-16(13.2%), Physiotherapist-7(5.8%), Radiographic technician-6(5)	
Marital status	Single: 87(71.9%), Married: 34(28.1%)	
Number of month PPE used		Mean (SD): 7.42(4.314) Range:1-16
Number of days in a month PPE used		Mean (SD): 24.21(1.224) Range:21-26
Number of hours per day PPE used		Mean (SD): 8.92(2.023) Range:6-12

Table 1: Distribution of the study participants according to their background characteristics (N=121).

Table 2: Distribution of the study participants according to attained Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) score (N=121).

Discomfort	CMDQ Score	Neck N (%)	Upper Back N (%)	Right leg (RL) N (%)	Left leg (LL) N (%)	Discomfort/Severity of Discomfort	Mean (SD)
Absent	0	38(31.4)	37(30.57)	51(42.14)	53(43.8)	No discomfort	Neck:12.3(17.6)
Present	1.5	5(4.13)	3(2.4)	4(3.3)	4(3.3)	Mild discomfort	Upper Back:14.4(17.7)
	1.6-10.5	40(33.05)	33(27.27)	26(21.48)	23(19)	Moderate discomfort	Right Leg:11.7(17.6)
	>10.5	38(31.4)	48(39.66)	40(33.05)	41(33.88)	Severe discomfort	Left leg:11.5(17.24)

Table3: Distribution of the study participants according to attained Fatigue Assessment Score FAS (N=121).

Fatigue	FAS score		N (%)	Severity of fatigue	Mean (SD)
Absent	0-21		53(43.8)	No Fatigue	FASt:22.61(5.298)
Substantial Fatigue	22-50	22-34	66(54.54)	Mild Fatigue	FASm:10.26(2.685)
		>/=35	2(1.6)	Extreme Fatigue	FASp:12.38(3.256)

Table 4: Distribution of study participants according to characteristics of cramps.

CRAMPS	N (%)
Location	Calf:72.9, Thigh:19.6, Biceps: Rest of the participants
Time	Day times:17
	Night times:50.9
	Both Day and night times:32.1
Duration	Seconds:38.7
	Minutes:53.2
	Hours:8.1
Quality of life deteriorated due to cramps	Not at all: 40.2
	Somewhat affected:49.1
	Very much affected:10.7
MUSCLE SORENESS	Biceps 2.9%
	Calf 60%
	Thigh20%
	Both calf and thigh 10%
	Change in walking pattern 8.9%
	Inability to lift weight 33%

DISCUSSION

There has been a flurry of research in recent literature on coronavirus and COVID-19, centering on its epidemiology, etiopathogenesis, pathology, prevention strategy, components of prevention, and treatment. Many studies have been done globally on PPE and its physiological and dermatological effects. However, none of these studies has addressed its impact on musculoskeletal system of HCWs while using PPEs.

Present study has reported joint discomfort [Neck discomfort (68.59%), upper back discomfort (69.42%), pain in legs (56.5%], Fatigue (56.19%), muscle cramps (62.8%), and muscle soreness 28.1%) as musculoskeletal problems associated with consistent use of PPEs. Fatigue in HCWs due to sustained use of PPE is due to heat stress, dehydration due to excessive sweating, loss of electrolyte, lack of oxygen and lactic acid deposition [6,8]. India is a tropical country with hot and, at times, both hot and humid conditions. Hence, this problem was even more daunting. Shutting down central air conditioning systems (with common air duct systems) in the hospitals to prevent the spread of droplets and droplet nuclei further aggravated this problem. In India HCWs were only getting FFR.

Prolong use of FFR led to lack of oxygen and CO2 retention in the space of FFR. Continuous inhaling air with loaded CO2 caused deoxygenated blood to reach working muscles and increase in CO2 concentration has led to lactic acid formation which caused early muscle fatigue and muscle soreness. In one of the preliminary, prospective, simulation study metabolic fatigue in healthcare worker is seen after 30 mins of simulation. In this work, capillary lactate level and Heart rate have been proposed as fatigue parameters. The lactate is a highly sensitive biomarker that provides accurate information about anaerobic metabolism [12,13]. In one of the studies done on Indian population,75% of the participants reported fatigue due to consistent usage of PPE [7]. In current study fatigue is determined by FAS score which measures physical as well as mental fatigue. FAS scoring has the advantage that it is self-administered and it also categorise the fatigue level into no fatigue, mild fatigue, and moderate level of fatigue. In present study most of the participants reported muscle cramps and muscle soreness most commonly in calf, thigh, adductor muscle of thigh and very few in biceps muscles.

Cramps in the muscles is due to dehydration and salt loss due to excessive sweating. Increase in lactic acid level due to start of anaerobic metabolism at the site of working muscles led to the muscle soreness. It has been seen in various studies that participants have reported cramps as a consequence of dehydration and loss of electrolyte [6,7].

However, we were unable to found equivalent studies to the one presented here. In the present study we have described characteristics of cramps (day or night times, duration of cramps, and muscles in which cramps are mostly experienced) and quality of life deteriorated because of cramps. Present study also reported muscle soreness experienced by participants, change in walking pattern due to muscle soreness and their inability to lift even light weights. Muscle soreness is mainly reported in the lower limb muscles (Calf, Thigh, both Calf and Thigh muscles) as compare to upper limb muscles. In upper limb muscles soreness is reported only in biceps muscle. Current study also reported joint discomfort, its severity, and how this joint discomfort

interferes with job performance. Joint pain is reported in many joints of the body but discomfort is reported more in neck, upper back and both legs. It has been written in literature due to back strap of mask there is the tendency to tuck chin posteriorly. Sustained posteriorly tucked position causes posterior neck muscles to get stiff and causes neck pain. Also, tight strap of the mask causes compression around neck and jaw, which causes nerve compression and headache [9].

Another possible reason for the neck pain could be due to weight of face shield which causes COG to shift forward in order to balance it upper cervical spine goes into extension which causes tightness of suboccipital muscles. Due to fogging of protective goggles and face shield, there is a tendency for forward head posture in order to get clear view [6,7]. Over the period of time this causes forward head posture which leads to stiffness and pain around neck muscles. Size of the PPE can also cause discomfort. In a country like India which was the second most affected country in the world no attention was given on size of the PPEs. In one of the studies, as per Indian perspective 39% of the participants reported size related issues with PPE kit [7]. One of the studies reported problems faced by HCWs due to loosely fitted mask specially by women and taller health care group reported tight Hazmat suit [14].

In spite of the size of PPE, it has been experienced that tightly fitted attached head cap in Hazmat suit/jumper suit causes restriction in neck movement relative to lower body and restriction in shoulder movements which leads to altered mechanics around neck and shoulder area [15]. The altered mechanics leads to pain in neck and upper back over the period of time. Tight elastic band and tightly tied laces in the shoe cover might be the possible cause of decrease in blood supply to the working calf muscle and hence the possible cause of leg pain. Lactic acid deposition due to decrease in oxygen availability to the continuously working calf muscle is another possible reason for legs pain reported by health care group.

Limitation: Present study described only descriptive and inferential statistics of different variables. In future multivariate logistic regression can be done to evaluate the correlation between the joints discomfort, fatigue, age, number of working days in a month and number of working hours per day. Present study doesn't describe the correlation between these variables as number of working hours per day and number of working days in a month for every participant change with duty rotation (day shift and night shift). So, average number of working days and average number of working hours in a day is taken same for every participant.

The study was cross-sectional in nature so the causal association between MSD and occupational determinants could not be established.

The CMDQ was a self-reported questionnaire so there were the chances of over or under reporting of the MSD and the chance of recall bias could be high as the recall period was in couple of months. CMDQ is only a screening tool, not a diagnostic tool. The same is true for FAS score. One may over report and underreport his/her symptoms.

CONCLUSION

We believe that this first-of-its-kind, non-funded survey among HCWs, conducted in a country that has experienced some of the biggest burdens due to the COVID-19 pandemic, should serve as a guide to health administrators as well as other HCWs in adopting ways and means like incorporating special exercise regime to ameliorate the musculoskeletal problems encountered in the use of PPE kits.

ABBREVIATIONS

SARS-CoV-2 - severe acute respiratory syndrome coronavirus 2

PPEs- Personal Protective Equipment's

FFR- Filtering face piece respirator

HCW- Health Care Workers

CMDQ - Cornell Musculoskeletal discomfort questionnaire

FASt- Fatigue Assessment Score Total Fatigue

FASm- Fatigue Assessment for mental fatigue

FASp- Fatigue Assessment for physical fatigue

SPSS- Statistical package for the social sciences

Conflicts of interest: None

AUTHOR CONTRIBUTION: No co-author is there in the present study. All the research process from designing the research proposal to data collection and its analysis to writing the manuscript is done by the single author.

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ACKNOWLEDGEMENTS

I take this opportunity to thank Dr. Sumit Ray, Dr. Abha Sharma who helped me with the research. Lastly, I extend my warm gratitude to all the people who have participated in this project.

Link to Questionnaire:

https://docs.google.com/forms/d/e/1FAIpQLScU6d-rVWKniPeApvdgSaPTZtFp3LmCmCtW1jZlOi1gp7I13A/viewform?usp=pp_url

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How to cite this article: Sakshi Sachdeva Seth. Musculoskeletal Burden of Personal Protective Equipment (PPE) on Health Care Workers Working for Long Hours during COVID-19 Pandemic in India: A Survey. Int J Physiother Res 2022;10(2):4170-4176. **DOI:** 10.16965/ijpr.2022.111