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Face Mask and Heart rate Variability in Covid Center Workers – Cross Sectional Study

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Abstract

Introduction: Wearing mask has become norm in COVID 19 pandemic. There are conflicting reports of whether it causes stress and affect HRV. The wearing of N95 mask is mandatory at COVID center and it was imperative to find whether it affects HRV used as surrogate marker of stress thus reducing efficiency.

Method: It was interventional quantitative cross-sectional study on people who were working at Dahisar Jumbo COVID center for more than 1 year. Baseline demographic data, anthropometric parameters, vitals and heart rate variability were recorded. Then they were required wear N95 mask and immediately again heart rate variability recorded. As they have wear mask for 8 hours of duty, heart rate variability was recorded at the end of duty. N95 mask was supplied by center and were of standard quality.

Results: The paired t test is not significant in any of the HRV parameters immediately after wearing mask.

Conclusion: The wearing N95 mask doesn't deranged HRV to suggest any stress.

Keywords: Autonomic dysfunction, COVID -19, Stress, N95 mask.

Introduction

Wearing of face mask for day-to-day activities by most people was not routine practice till the outbreak of COVID 19 pandemic. Till before the spread of COVID 19 pandemic, mask was worn by doctors in patient care settings, laboratory workers in many laboratories and industrial workers (coal, silica, asbestos factories, and mines). The daily wearing of mask was not only important to prevent spread of infection but mandatory by most government and regulating bodies during COVID -19 pandemic. The mask used varied from cloth mask, surgical 3 ply mask, K94 mask, N95 mask, etc. [1] Most recommended in Indian healthcare settings was N 95 mask. KF94 masks (Korean standard) and N95 masks (US standard) are available. KF94 masks filter about 94% of particulate matter. It has the ability to filter particulates more than 0.4µm. Proper N95 is designed in such a way that it can filter out at least 95% of the dust and particulate in air. It can filter above 0.3µm particles size. They can block PM2.5 (<= 2.5µm) and virus-borne droplets (> 5µm) [2] This is a reason that it is used by a greater number of people. However, they are so tightly sealed that prolonged use or exercise can easily cause brain hypoxia, dizziness, restricted lung functions and other symptoms. For example, N95 masks are dust masks for industrial use. They are not suitable for long-term wear, especially for patients with cardiovascular disease, the elderly, and children. [3]

Oxygen concentration in air is 21%. The mask forms a closed space between the mask and the human face which contains the exhaled carbon dioxide (Dead Space Gas). Thus, when a person takes his next inhalation, the dead space gas first enters his lung followed by fresh gas. As a result, the oxygen concentration will reduce in the inhaled air. This reduced oxygen concentration may in the long-term cause significant hypoxia. The oxygen consumption of the brain is the highest. Hypoxia thus affects the brain first organ. The oxygen is redistributed through the regulation of autonomic nerves to vital organs. Hypoxia can have psychological effects too. Some studies have shown that hypoxia can cause stress, which can increase anxiety and depression.[4]

So, hypercarbia and hypoxia are the root causes of increased stress while wearing a mask.

So far handful of studies are conducted on effect of wearing mask and heart rate variability. Some were conducted pre-pandemic and some are conducted pandemically. Some are conducted with surgical mask and some are with N95 mask. Pre-pandemic studies are using training mask. A Japanese study in 1997, has inferred heart rate variability is affected by dead space increased by the face mask. [5] The elevation training mask study by Hyun Chul Jung et al.found that wearing an ETM during high-intensity cycling (70% of VO 2peak) induces modest hypoxaemia. Although this device did not affect HRV changes during cycling, it's not significant in most cases. It seems to delay the cardiac-autonomic recovery post exercise. [6] In 2019 another Japanese study by Yukio Fujita et al. found that the heated humidification mask decreased respiratory frequency and simultaneously increased surrogate maker for tidal volume compared with placebo mask. LF/HF and HF were not significantly different between two masks. [7]

ValiollahDabidi Roshan et al. studied the effect of 2-weeks of moderate-intensity interval training (MIIT) based body weight combined with wearing face masks (surgery against N95) on the ANS response of healthy men following the submaximal treadmill running protocol (STRP) and 5 minutes of recovery during the SARS-CoV-2 pandemic. Although the intergroup changes in sympathetic and parasympathetic indices and mean RR after 2-weeks of MIIT show relative improvement, it was not statistically significant. [8]

José Francisco Tornero-Aguilera et al.studied the effect of surgical mask use in anaerobic running performance and inferred the higher levels of blood lactate and lower blood oxygen saturation require adaptation of the athlete's rest and recovery periods to the acute workload. [9]

Jose Francisco Tornero-Aguilera and Vicente Javier Clemente-Suarez studied the use of surgical mask during a 150 min university lesson produced an increased heart rate and a decrease in blood oxygen saturation, not significantly affecting the mental fatigue perception, reaction time and time, frequency and nonlinear hear rate variability domains of students. [10]

Zhixing Tian, Bong-Young Kim and Myung-Jin Bae research showed that wearing a mask can increase psychological stress. [11] The above studies were showing conflicting observation on effect of wearing mask.Wearing mask in COVID center was compulsory which would reduce the efficiency of healthcare workers if wearing mask itself causes stress. It was decided to study the immediate and intermediate effect of wearing mask on heart rate variability as a surrogate marker of stress.

Methods and Material

Study design

Interventional quantitative cross-sectional study

Setting

Dahisar Jumbo COVID facility, Mumbai. It was field hospital with 925 beds of oxygenated and non-oxygenated facility and 110 beds of ICU facility. There were many levels of staffing to cater to this patient care facility.

Sampling frame

Target population was staff working at Dahisar Jumbo COVID facility. Sample size was 52. Sample size calculation by Nunnally method.

Sampling technique used was non probability snow-ball method.

Subjects

Inclusion criteria

People working at Dahisar Jumbo COVID center for more than one year. Exclusion criteria: People having any known condition which may affect HRV diabetics, with heart disease etc.

Protocol of study

Subjects was recruited by above method. Informed Consent was taken. Baseline demographic data, anthropometric parameters, vitals and heart rate variability were recorded. Then they were required wear N95 mask and immediately again heart rate variability recorded. As they have wear mask for 8 hours of duty, heart rate variability was recorded at the end of duty. N95 mask was supplied by center and were of standard quality.

Anthropometric parameter noted was height and weight using digital weighing scale k4-003a and stadiometer of Ezlife. BMI was calculated thereof in Excel sheet using the formula BMI=weight in Kg/height in meter ^2. Vitals were recorded using multipara monitor Contec CMS 6000 and heart rate, respiratory rate, blood pressure and SPO2 were noted down to get an idea of baseline characteristics.

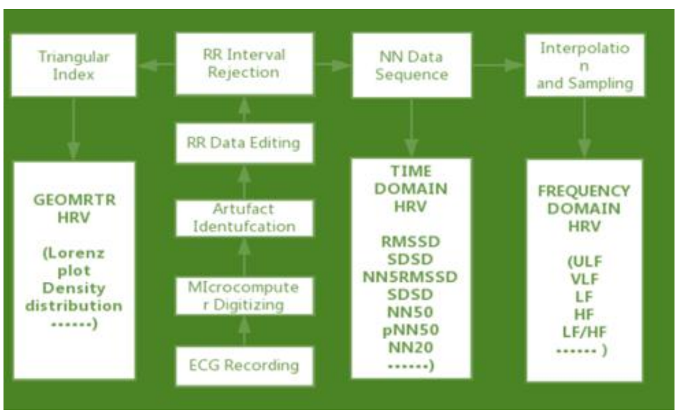
Recording of heart rate variability

Sinus arrhythmia occurs due to normal respiration. Heart rate increases during inspiration and decreases due to expiration. Conversely, RR interval decreases during inspiration and increases during expiration [12]. The sinus arrhythmias in ECG conveys normal cardiovascular health. This physiological phenomenon of variation in the time interval between heartbeats is defined as Heart rate variability (HRV), and in 1996, the "European Cardiology Society and the North American Society of

Pacing and Electrophysiology Special Task Force" had compiled a method and guidelines for analysing heart rate variability (HRV) [13]. Many current studies have shown that HRV is related to many physiological and psychological phenomena of the human body. HRV is the result of autonomic nervous system activity and balance [14]. Normal physiological activities will maintain a certain HRV change value. When the human body encounters stress, anxiety and other external environmental influences, it will inhibit the variation of heart rhythm and reduce HRV. In current studies HRV was recorded using RMS digital polygraph with HRV analysis software. The frequency domain and time domain parameters were analysed further. The statistical software used was SPSS, IBM version 26. Descriptive statistics and paired T test were used as statistical tool.

The possible methods for HRV analysis.

Graph 1:



Results

Table 1: Demographic parameters and Vitals of Study Participants

Parameter	Mean	Standard Deviation
Age in years	31.15	10.75
Height in meter	1.64	.11
Weight in Kg	63.88	11.69
BMI kg/m2	23.88	4.84
HR per minute	74.50	10.05
RR per minute	21.78	7.45
SPo2 in percentage	114.69	123.62
SBP in mm of Hg	122.11	9.92
DBP in mm of Hg	76.75	9.21

Table 1 shows the demographic profile and basic vital parameters of study participants which have normal distribution.

Table 2: Baseline Heart Rate Variability Parameters (frequency domain and time domain)

Parameter	Mean	Standard Deviation
LF1	59.20	17.39
HF1	40.79	17.39
LFHF1	2.64	5.52
SDNN1	42.99	20.02
RNSSD1	35.48	19.67
NN1	46.51	50.48
PNN1	.180981	.1866692

Table 2 reveals heart rate variability parameters of the study sample. Frequency domain parameters analysed are LF1 (norm n.u. LF power in normalised units LF/(Total Power–VLF) #100), HF norm n.u. HF power in normalised units HF/(Total Power–VLF)#100 and LF/HF Ratio LF [ms2]/HF [ms2].

They are normal range. Time domain parameters used are SDNN ms Standard deviation of all NN intervals, RMSSD ms the square root of the mean of the sum of the squares of differences between adjacent NN intervals, NN50 count Number of pairs of adjacent NN intervals differing by more than 50 ms in the entire recording.

Three variants are possible counting all such NN intervals pairs or only pairs in which the first or the second interval is longer pNN50 % NN50 count divided by the total number of all NN intervals.

Table 3: Effect of Mask on HRV Parameters

Pairing	HRV parameters	T	Df	Sig.
Pair 1	LF1 - LF2	-1.000	51	.322
Pair 2	LF2 - LF3	1.000	51	.322
Pair 3	LF1 - LF3	.283	51	.778
Pair 1	HF1 - HF2	-1.455	51	.152
Pair 2	HF2 - HF3	.950	51	.346
Pair 3	HF1 - HF3	-.283	51	.779
Pair 1	LFHF1 - LFHF2	-1.658	51	.104
Pair 2	LFHF2 - LFHF3	-.739	51	.463
Pair 3	LFHF1 - LFHF3	-1.684	51	.098
Pair 1	SDNN1 - SDNN2	-.648	51	.520
Pair 2	SDNN2 - SDNN3	.747	51	.459
Pair 3	SDNN1 - SDNN3	.085	51	.933
Pair 1	RMSSD1 - RMSSD2	-1.788	51	.080
Pair 2	RMSSD2 - RMSSD3	3.275	51	.002
Pair 3	RMSSD1 - RMSSD3	1.606	51	.115
Pair 1	NN1 - NN2	-2.121	51	.039
Pair 2	NN2 - NN3	2.281	51	.027
Pair 3	NN1 - NN3	.675	51	.503
Pair 1	PNN1 - PNN2	-1.162	51	.251
Pair 2	PNN2 - PNN3	1.223	51	.227
Pair 3	PNN1 - PNN3	.918	51	.363

Table 3 demonstrates the effect of wearing mask. The ECG was recorded at baseline, immediately wearing mask and 8 hours of wearing mask. It was analysed for various frequency domain and time domain parameters. LF1 is low frequency power in normalised units at baseline, LF2 is low frequency power in normalised units after wearing N95 mask and LF3 is low frequency power in normalised units after 8 hours of wearing N95 mask. Similarly, all other parameters are labelled. Paired t test was applied all three pairs as shown. The test is not significant in most cases.

Discussion

The study delineates whether wearing N95 mask can cause stress. For assessment of heart rate variability parameters were computed after recording the 5-minute ECG (after 15 minutes of resting). The parameters were recorded at baseline in morning, immediately wearing the mask and after 8 hours wearing the mask. Paired T test was used to find the difference between baseline and immediately after wearing mask, immediately after wearing mask and 8 hours after wearing mask and baseline with 8 hours of wearing mask. Though visually there was difference in various parameters but there was no statistical significance. LF value which signifies sympathetic tone and HF value indicate predominantly parasympathetic tone and LF/HF indicates sympatho-vagal balance. There is definite increase in the LF value but it is not statistically significant. HF value is reduced in most cases but again it is not statistically significant. The results therefore do not show increase in stress after wearing mask.

As far as time domain parameters of HRV analysis are concern, interpretation on short recording has to be guarded. SDNN index Mean of 5 min total power of frequency domain. SDNN is not a well-defined statistical quantity because of its dependence on the length of recording period. Thus, in practice, it is inappropriate to compare SDNN measures obtained from recordings of different durations. Similarly, RMSSD, NN50 count and pNN50 are equivalent of HF in frequency domain. RNSSD2 - RNSSD3 and NN2 - NN3 are showing significant statistical point toward change in parasympathetic tone which may be attributed to diurnal variation.

It was postulated that wearing mask increases stress and anxiety causing tilt of sympathovagal balance. Due to stress and anxiety, person hyperventilates. This reduces exhalation time and hence there is accumulation of carbon dioxide(rebreathing). [15]

Carbon dioxide accumulation may lead to headache, dizziness, hypotension, acidosis, muscle twitch, increase heart rate, chest pain, confusion and fatigue. Prolonged hypercapnia due to long term use of mask can have long standing effect on brain. There may be less oxygen which can cause nausea, rapid breathing and heart rate, clumsiness, emotional upset and fatigue. But our study shows there is hardly any change in sympathovagal balance. N95 doesn't impair sympathovagal balance. Our study is supported by Hyun Chul Jung et al, Yukio Fujita etal, and Valiollah Dabidi et al. Jose Francisco Tornero-Aguilera a study also concurred with our study. Zhixing Tian study differed with our study results which found that there is reduction in SDNN in people wearing mask. Our data was collected during third wave of pandemic and there is possibility of adaptations and therefore most of the HRV parameter are not grossly affected to indicate increase sympathetic and decrease parasympathetic tone used as a yardstick of stress.

Limitations of studies are it was only done on COVID center workers who had to wear mask. HRV was used as marker of stress. It would have been better to use some stress questionnaire which would give idea about the perception and subjective feelings. The scope of the study can be widened by recording 24-hour ECG using the wireless recording system and analysed so that time domain parameters are better commented on.

Conclusion

There is no short-term changes in HRV after wearing the mask. Therefore, wearing N95 mask does not increase sympathetic and decrease parasympathetic tone used as surrogate marker of stress.

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